CHAPTER 15
Preliminary Designs Of Road Projects

15. PRELIMINARY DESIGNS OF ROAD PROJECTS

Preliminary designs are prepared for five roads selected in Chapter 13. The functional classes, typical cross sections and other characteristics of these roads are examined in the same chapter. In accordance with the results of the examination, the preliminary designs are prepared with particular attention to local topography, drainage and other relevant conditions. A complete set of the preliminary designs is annexed to the report.

15.1. DESIGN CRITERIA

15.1.1. DESIGN STANDARDS

The preliminary designs of road projects are based on the Road Design Standards, NORMA for short, prepared by DNER (Departamento National de Estradas de Rodagem). Table 15.1-1 shows the classification of the road projects by design class and speed.

Table 15.1-1 Road Classification and Design Speed

Road	Applicable Design Class	Design Speed (km/h)
Avenida Primeiro de Dezembro	Class II	70 (50)
Avenida Mario Covas	Class II	60 (50)
Rua Yamada	Class IV	60
Rua da Marinha	Class IV	60 (50)

Note: Figures in parentheses indicate the minimum requirement.

15.1.2. GEOMETRIC DESIGN ELEMENTS

The design standards for the respective road classes are shown in Table 15.1-2. The element standards are defined by AUSTROADS (Lustrous National Office) in Brazil.

Table 15.1-2 Geometric Design Standards for Road Projects

Geometric Design Element	Unit	Av. Primeiro de Dezembro and Avenida Mario Covas	Rua Yamada and Rua da Marinha
Road Design Class		Class II	Class IV
Design Speed	km/h	70 (50)	60 (30)
Minimum Radius	m	170 (80)	125 (25)
Maximum grade	%	4.5 (5.5)	4.5 (5.5)
Width of Lane	m	3.5 (3.3)	3.0
Width of shoulder (out)	m	2.5 (0.5)	1.3 (0.5)
Vertical Clearance	m	5.5 (4.5)	5.5 (4.5)
Lateral Clearance			
Continuous	m	0.5	0.3
Spot	m	1.5	0.5

Note: Figures in parentheses indicate the minimum requirement.
Source: DNER

15.2. AV. PRIMEIRO DE DEZEMBRO

15.2.1. ALIGNMENT DESIGN

(1) Horizontal Alignment (Class II, Design Speed of 70km/h, L=8,466m)

Av. Primeiro de Dezembro functions as a secondary arterial that runs parallel to and on the south of Rodovia BR-316. By the proposed construction, the avenue is expected to fill the role of an important alternative route for Rodovia BR-316, by carrying part of the heavy traffic load on the latter. The avenue also serves as the shortest link from the growing residential areas in the southeastern suburbs to the Centro. The present roadside land use is mostly residential. The design conditions for horizontal alignment are as follows.

a) The road project starts from the intersection with Alameda Moca Bonita, the end of the on-going construction by the municipal government.

b) The horizontal alignment is designed to avoid, as much as possible, the residential areas expanding southward from the roadside of Rod. BR-316.

c) The control point for horizontal alignment is the planned environmental barriers to protect the catchment area of Lago Agua Preta.

d) Regarding the segment that crosses the upper stream of Lago Agua Preta, a bridge is constructed across the area protected by two environmental barriers.

e) The intersection with Avenida Mario Covas is provided with a T-form at-grade intersection with traffic signals.

f) The alignment in the vicinity of Alca Viaria is designed to avoid the catchment area.

g) The minimum radius requirement is 500m.

(2) Vertical Alignment

Design conditions for vertical alignment are as follows.

a) Because the road goes through the expanding residential areas, the design follows, as much as possible, the existing vertical alignment of the road.

b) The steepest longitudinal slope is 1.0%.

15.2.2. CROSS SECTION DESIGN

The cross section design adopts the road width of 40.0m, expecting the future widening to six lanes from the proposed four lanes. The four-lane road segment originating in the eastern edge of the Centro is now under construction by the Belem City government. Figure 15.2-1 compares the typical cross sections of the on-going and the proposed projects.

The required cross section elements each way are the sidewalk of 3.50m, the bikeway of 2.0m and the roadway of two 3.50m lanes.

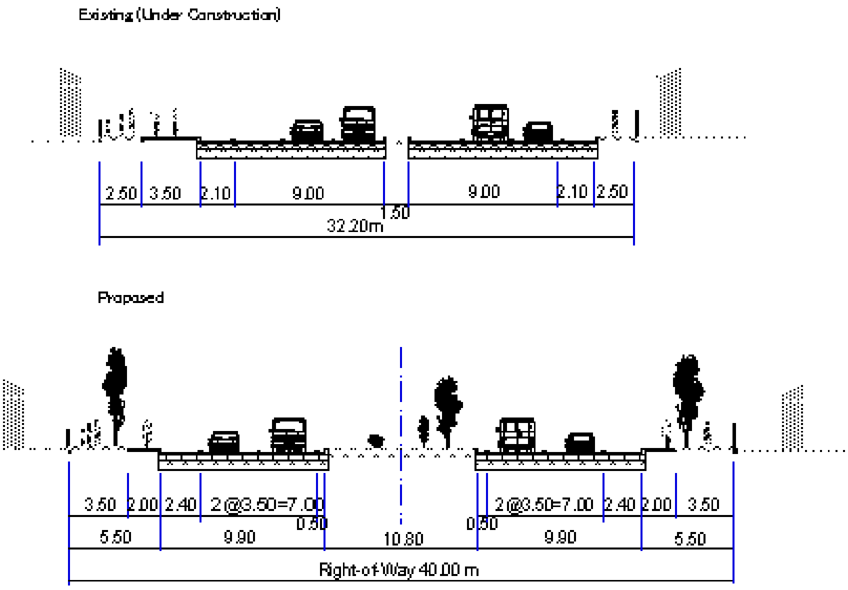


Figure 15.2-1 Proposed Cross Section for Av. Primeiro de Dezembro

15.2.3. DRAINAGE DESIGN

To protect the natural environment around the reservoir on the south, the proposed road fills the role of partly checking the household waste water from the northern residential areas from seeping into the reservoir.

Figure 15.2-2 shows the proposed drainage plan.

a) Near the origin of the proposed road, the water is drained off from the direction of BR-316 toward the reservoir.

b) Around the other end of the road, the water is drained off toward BR-316.

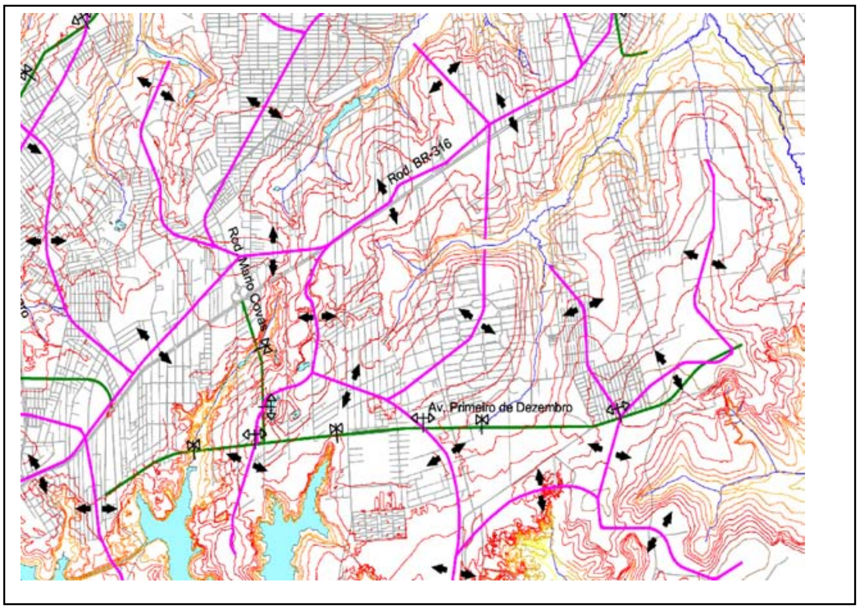


Figure 15.2-2 Proposed Drainage Plan for Av. Primeiro de Dezembro

15.2.4. STRUCTURE DESIGN

One bridge is proposed on the segment crossing Lago Agua Preta. The bridge is 510m long and crosses over the catchment area between two environmental barriers (protective walls) planned by Para State Government (Figure 15.2-3). Because of its long length, the bridge is 12.0m in width, made narrower than the road, with clear traffic segregation by the median. The cross section consists of the two-way roadway of 8.0m (two 3.5m-wide lanes flanked by the divider of 0.5m on both sides), and the sidewalk and the bikeway of 4.0m combined.

Because it passes over the natural conservation area between the environmental barriers, the bridge is designed to go well with the surrounding landscape. The details of the bridge construction are selected as follows.

a) The span length is 30m, the most economical length for normal bridges.

b) The girder height is kept as low as possible to avoid too imposing an appearance in the natural landscape.

c) It is judged possible to use the timbering during the construction, because the site is not always waterlogged.

d) The piers are shaped suitably to go well with the natural landscape.

e) Because the surface ground is soft, the foundation must be piled. Steel piles are used to avoid polluting the water of Lago Agua Preta.

The superstructure of the proposed bridge uses PC hollow slabs, with which it is possible to keep the girder height to relatively low 1.5m. In consideration of the surrounding landscape, the slabs with sloped webs are used and the same slope is repeated on the piers (Figure 15.2-4).

Figure 15.2-3 Location of Bridge Site

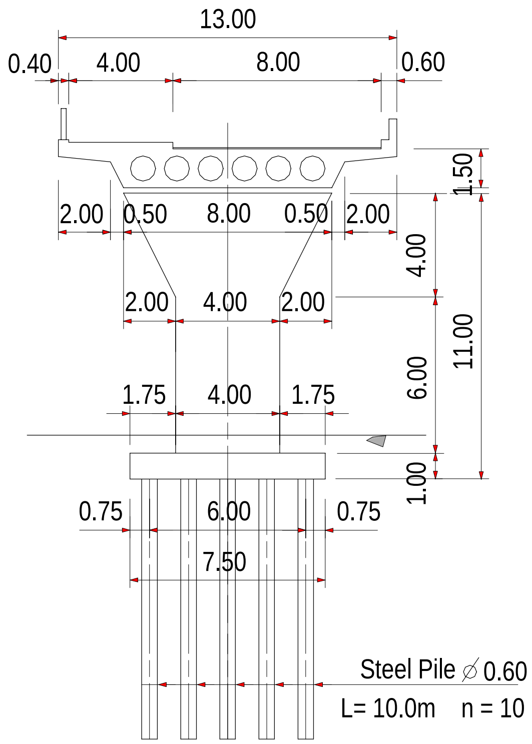


Figure 15.2-4 Cross Section of Proposed Bridge Structure

15.2.5. INTERSECTION DESIGN

The major intersections on Av. Primeiro de Dezembro are with Avenida Mario Covas and with Alca Viaria near the end of the proposed avenue. Because the traffic is expected to be relatively light on the two roads, a T-fom at-grade intersection is proposed at each location.

15.2.6. VOLUME OF WORKS

The cost of construction mainly consists of land acquisition, relocation of houses, a bridge and so forth, as shown in Table 15.2-1.

Table 15.2-1 Major Construction Works for Av. Primeiro de Dezembro

Work Element	Quantity	Remarks
Road Length (m)	8,466	
Relocation of Houses (unit)	1,380	
Length of Bridge (m)	510	One bridge across environmental barriers
Aggregated Length of Drainpipes (m)		
No. of At-grade Intersections	3	Two T-form intersections with traffic signals and one cross-form intersection

15.3. AVENIDA MARIO COVAS EXTENSION

The proposed extension links Rod. BR-316 with Av. Primeiro de Dezembro.

15.3.1. ALIGNMENT DESIGN

(1) Horizontal Alignment (Class II, Design Speed of 60km/h, L=2,931m)

The control point is the existing cloverleaf interchange on Rod. BR-316. The edge of the overpass bridge is the starting point of horizontal alignment design. The proposed road extension is aligned with the centerline of the existing road.

(2) Vertical Alignment

The starting point of vertical alignment design is the road surface height of the overpass bridge. The longitudinal slope from the overpass bridge down to the road level is 4%.

15.3.2. CROSS SECTION DESIGN

As with Av. Primeiro de Dezembro, the cross section design adopts the road width of 40.0m, expecting the future widening to six lanes from the proposed four lanes. The proposed cross section is shown in Figure 15.3-1. The cross section elements each way are the sidewalk of 3.50m, the bikeway of 2.0m and the roadway of two 3.50m lanes.

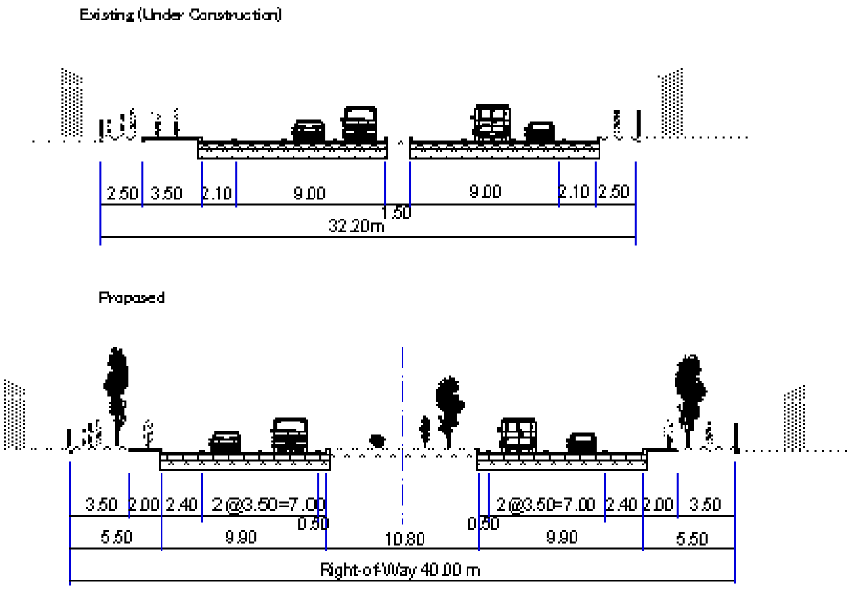


Figure 15.3-1 Proposed Cross Section for Avenida Mario Covas

15.3.3. DRAINAGE DESIGN

As shown in Figure 15.3-2, the water is drained off into the upper stream of the reservoir from the central segment of the proposed road extension.

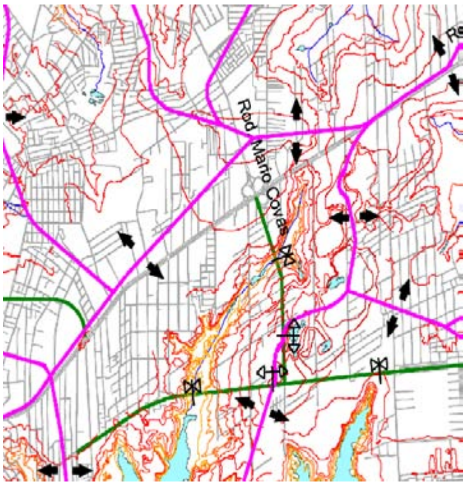


Figure 15.3-2 Proposed Drainage Plan for Avenida Mario Covas

15.3.4. STRUCTURE DESIGN

As in the case of Av. Primeiro de Dezembro, one bridge is proposed for Avenida Mario Covas extention on the segment crossing Lago Agua Preta. The bridge is 180m long and designed with appropriate environmental precautions described for Av. Primeiro de Dezembro.

The designs of superstructure, substructure and foundation are the same as the bridge on Av. Primeiro de Dezembro.

15.3.5. INTERSECTION DESIGN

The design covers the southeastern access to the existing cloverleaf interchange on Rod. BR-316.

The proposed extension of Avenida Mario Covas adds three directions of access at the interchange, as listed below.

a) From Avenida Mario Covas toward the suburbs along Rod. BR-316

b) From the Centro via BR-316 toward Av. Primeiro de Dezembro

c) From Av. Primeiro de Dezembro toward the suburbs along BR-316

15.3.6. VOLUME OF WORKS

The construction cost of the proposed extension consists of land acquisition, relocation of roadside houses, a bridge and so on. Major construction works are shown in Table 15.3-1.

Table 15.3-1 Major Construction Works for Avenida Mario Covas Extension

Work Element	Quantity	Remarks
Road Length (m)	2,931	
Relocation of Houses (unit)	66	
Length of Bridge (m)		
Aggregated Length of drainpipes (m)		
No. of Interchanges	1	A quarter of the cloverleaf
No. of At-grade Intersections	0	Included in the works for Av. Primeiro de Dezembro

15.4. RUA YAMADA

Rua Yamada is a collector connecting Icoaraci to Av. Independencia, and runs parallel to Rod. Augusto Montenegro. The road is expected to serve as an alternative route to Rod. Augusto Montenegro.

The present right of way is 14.60m wide with two lanes. The roadside land use is residential and semi-commercial.

15.4.1. ALIGNMENT DESIGN

(1) Horizontal Alignment (Class IV, Design Speed of 60km/h, L=10,000m)

The design is aligned with the centerline of the existing road. On the segment where the road has been already widened to four lanes, the design is aligned to the centerline of the right of way.

(2) Vertical Alignment

The design conforms to the vertical alignment of Rua Yamada. The steepest longitudinal slope is 0.45%.

15.4.2. CROSS SECTION DESIGN

Based on the traffic forecast through 2012, it is considered necessary to widen Rua Yamada into two-way four-lane road with the right of way width of 27.2m. Figure 15.4-1 compares the present and the proposed cross sections. The widened road consists each way of the sidewalk of 3.50m, the parking belt of 2.10m and the secondary-arterial-class roadway of two 3.0m lanes. The left-turn lane of 3.0m is provided next to the median.

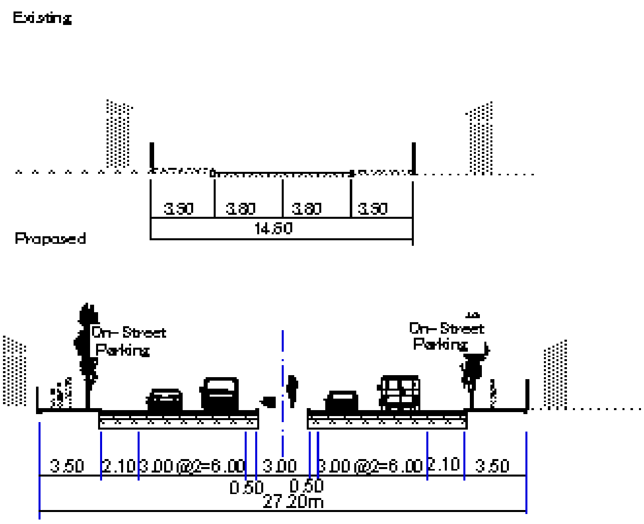


Figure 15.4-1 Proposed Cross Section for Rua Yamada

15.4.3. DRAINAGE DESIGN

To economize the cost, the design utilizes the available drainage structures, by extending three existing cross drainpipes.

15.4.4. STRUCTURE DESIGN

Four bridges are proposed for this road project, as explained below.

(1) Bridge across Val de Caes River

The road is raised 2 meters by banking near Val de Caes River. The river is normally 5-meter wide, but widens to about 20 meters when flooded. The proposed length for the bridge is 20m.

The superstructure uses PCI girders, because it is possible to lift the cast-at-site girders by the truck crane. As shown in Figure 15.4-2, the abutment is low and narrow. Therefore, the foundation uses steel-enforced concrete piles of square cross section that are easy to cast at the project site.

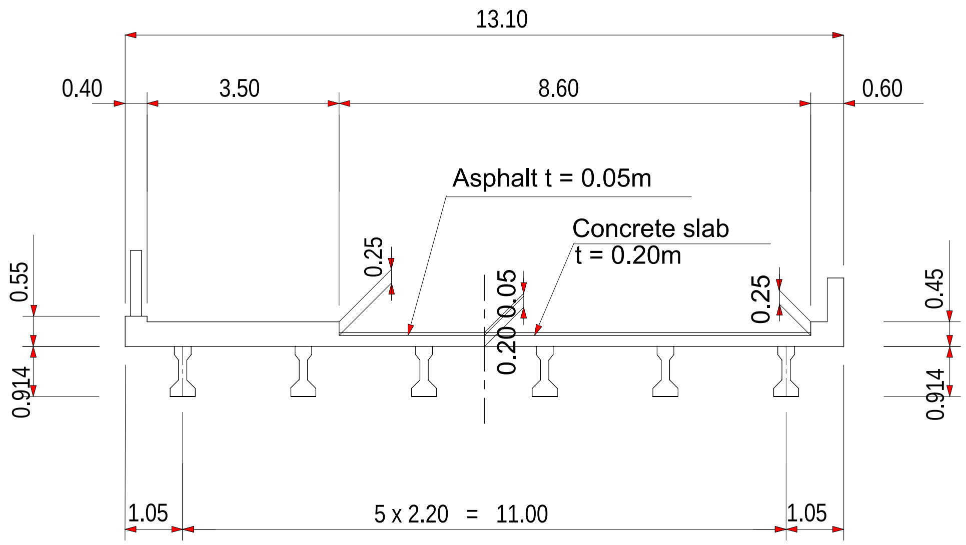


Figure 15.4-2 Cross Section of the Proposed Structure

(2) Bridge across the Flood Basin near Val de Caes River

The road is raised 6 meters by banking to improve the longitudinal alignment around the flood basin. According to the geological survey, the ground in the area is weak with the N value of 2 to 3 from the surface to the depth of about 20m. The banking of more than 3 meters on weak soils needs appropriate measures. The types of oncrete piles and geotextils that have been effective in the construction projects around Belem are used to cope with the problem of weak soils (Figure 15.4-3).

The proposed length of the bridge is 30m, because the site is in the flood basin. The superstructure uses PCI girders, because it is possible to lift the cast-at-site girders by the truck crane. The abutment is tall and wide. Therefore, the foundation uses steel piles.

(3) Bridge across Paracuri 1 River

The abutment must be tall, because the river bed is low at the Paracuri 1 site. The longitudinal height of the road must be kept as low as possible, because the roadside land use is residential. The proposed bridge is 30m long, with the superstructure of 2-span continuous PCI girders with span length of 15m, supported by one pier to keep the girder height low. The abutment and the foundation of the pier use steel piles.

(4) Bridge across Paracuri 2 River

The conditions at the Paracuri 2 site are the same as the Paracuri 1 site. The river bed is low and the river width is about the same and widens when flooded. Accordingly, the superstructure of the proposed bridge uses 2-span continuous PCI girders with span length of 15m. The foundation uses steel piles.

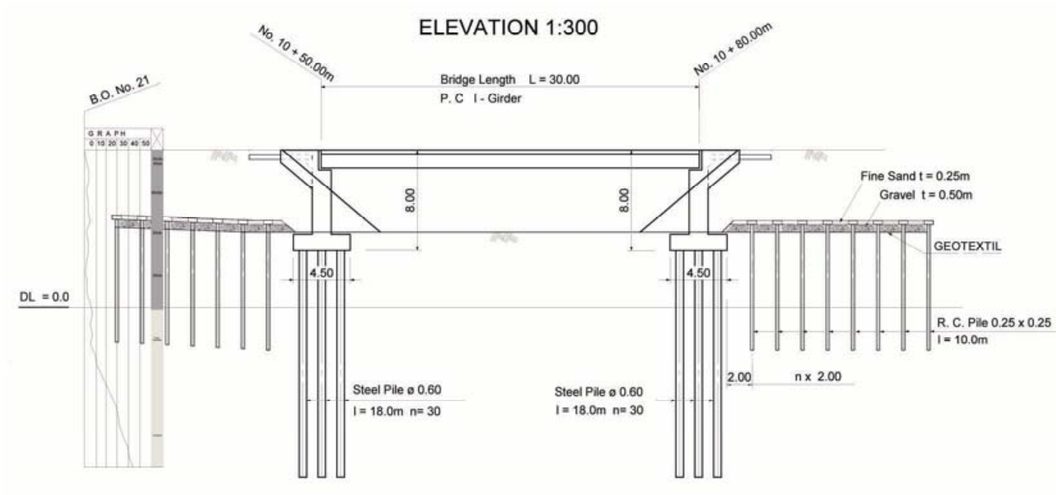


Figure 15.4-3 Cross Section of the Proposed Structure

15.4.5. INTERSECTION DESIGN

One major road that crosses Rua Yamada is Rod. Tadana, a collector road. The intersection is provided with an at-grade intersection with traffic signals.

15.4.6. VOLUME OF WORKS

The widening cost of Rua Yamada consists of land acquisition, relocation of roadside houses, extension of drainpipes and four bridges. Major construction works are shown in Table 15.4-1.

Table 15.4-1 Major Construction Works for Rua Yamada

Work Element	Quantity	Remarks
Road Length (m)	10,000	
Relocation of Houses (unit)	227	
Length of Bridge (m)	20+3x30	Four bridges
Aggregated Length of Drainpipes (m)		
No. of At-grade Intersections	1	A T-form intersection with traffic signals

15.5. RUA DA MARINHA

Rua da Marinha is a collector road connecting Av. Independencia to Av. Almirante Barroso. The proposed road project has the right of way width of 30.0m. The roadside land use is densely residential.

15.5.1. ALIGNMENT DESIGN

(1) Horizontal Alignment (Class IV Design Speed of 60km/h, L=10,000m)

The design is aligned with the centerline of the existing road, extending to the intersection with Alameda Mosa Bonita.

(2) Vertical Alignment

The design follows the vertical alignment of Rua da Marinha. The steepest longitudinal slope is 0.74%.

15.5.2. CROSS SECTION DESIGN

The control point is the border with residential areas on the south of the road. The necessary widening is extended into the abutting naval property on the north. Figure 15.5-1 compares the present and the proposed cross sections of the road. The new road consists each way of the sidewalk of 2.4m, the bikeway of 2.0m, the parking belt of 2.10m and the secondary-arterial-class roadway of two 3.0m lanes. The left-turn lane of 3.0m is provided next to the median.

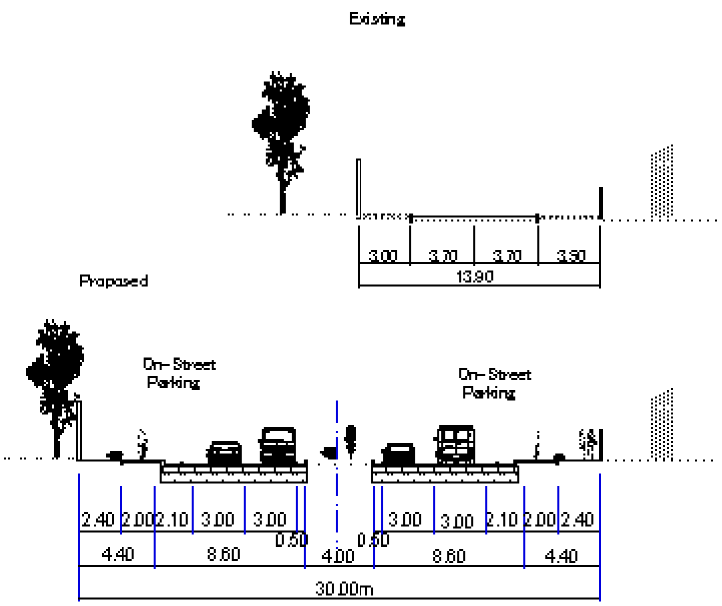


Figure 15.5-1 Proposed Cross Section for Rua da Marinha

15.5.3. DRAINAGE DESIGN

Utilizing the local natural slopes, the water is drained off to right and left from the central segment of the road, as shown in Figure 15.5-2.

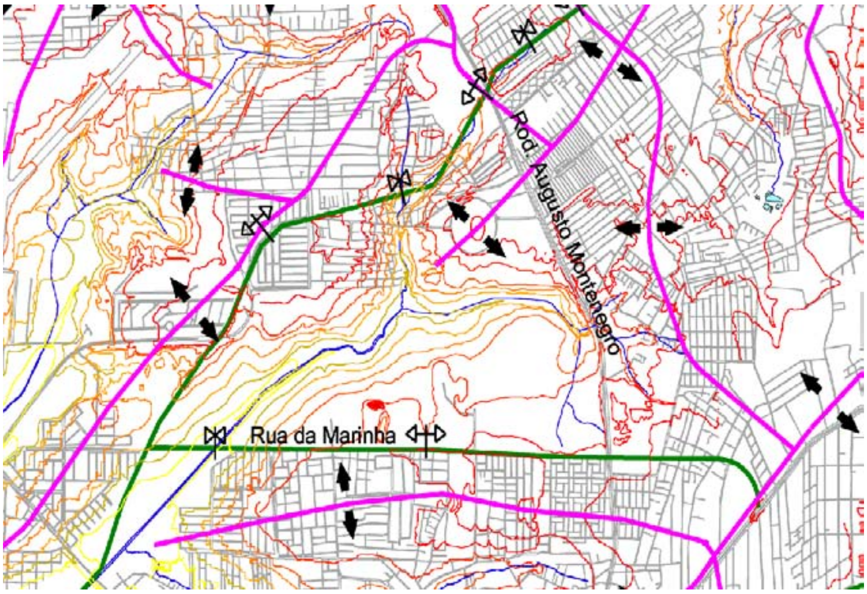


Figure 15.5-2 Proposed Drainage Plan for Rua da Marinha

Rua da Marinha skirts around the periphery of Parques Presidente Medici, the nature conservation area. Therefore, drainage structures and appurtenances are so designed to minimize the adverse effects on local fauna and flora. Due attention to the local natural habitat or ecosystem is needed from the planning stage through the operation and management. The road planning and design takes into account the following environmental precautions.

a) Attention to natural plant and animal life

The road development must be carefully designed to conserve the local natural habitat as a whole, including not merely rare and scarce species but common species.

b) Improvement on the natural environment

Various attempts are being made to create a man-made environment that coexists well with the natural environment. A network of man-made biotopes, for example, will contribute toward the improvement of nature conservation.

c) Long-term perspective

The development of eco-roads like the proposed road must be planned not only to satisfy the immediate needs but also to ensure the welfare of the future generations.

d) Mitigation measures during and after the road construction

During the construction stage, the discharge of polluted or muddy water and other temporary disturbances must be well controlled to protect the surrounding natural habitat. It is necessary to restore and re-vegetate those places that are temporarily disturbed and denuded for the purpose of road construction.

e) Attention to the local ecosystem

A road project has direct severance effects on the ecosystem. For example, roads that cut across natural paths of drainage will seriously disturb the entire balance of the local ecosystem (see Figure 15.5-1).

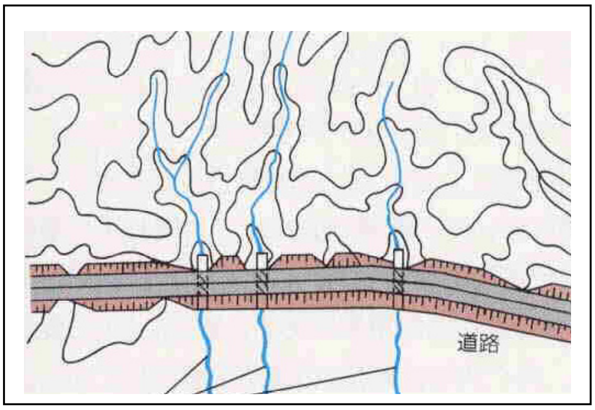


Figure 15.5-3 Natural Paths of Drainage

f) Cross drainpipes

Cross drainpipes used for the proposed road provide not only natural drainage but also paths for local small animals, as shown in Figure 15.5-4.

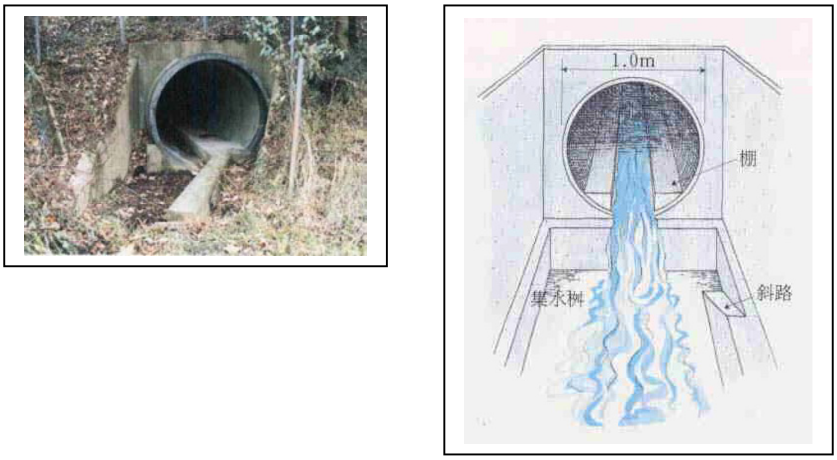


Figure 15.5-4 Cross Drainages for Local Small Animals

g) Gutters

Gutters of various designs are used for the proposed road to ensure safe mobility of small animals, as shown in Figure 15.5-5.

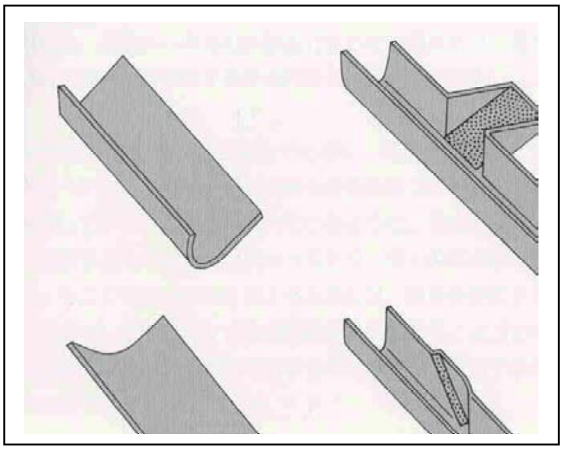
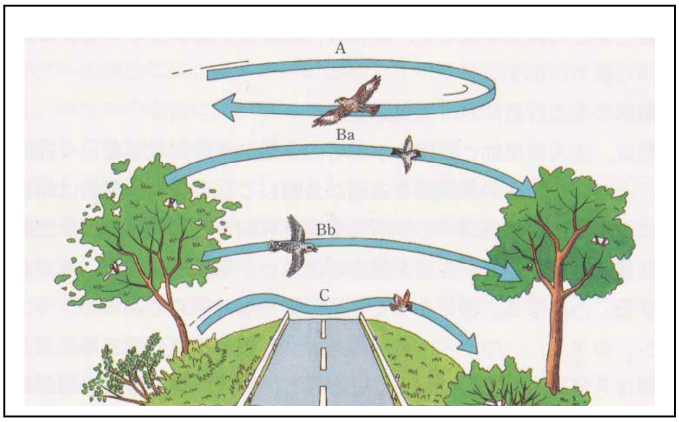


Figure 15.5-5 Gutters for Safe Mobility of Small Animals

h) Road appurtenances for animal crossing

Animals and birds might collide with passing motor vehicles when crossing the road. Appropriate conditions and appurtenances are provided at suitable locations along the proposed road, such as trees and shrubs planted close the shoulder that guide birds to fly over and protective fences or nets that discourage animals and birds from crossing (see Figure 15.5-6).



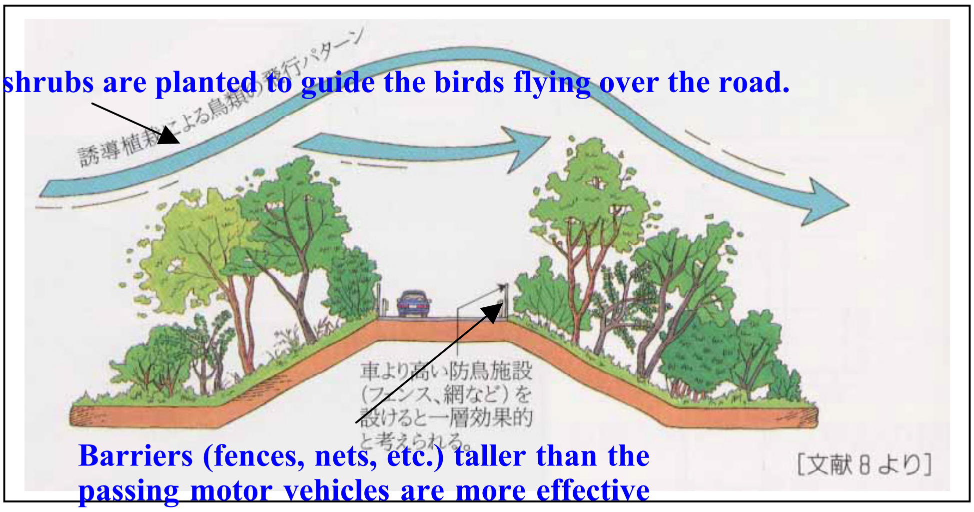


Figure 15.5-6 Examples for Road Appurtenances for Animal Crossing

15.5.4. STRUCTURE DESIGN

One bridge is proposed for Rua da Marinha at the site where the road crosses Sao Joaquim Channel in the nature conservation area. A space of more than 5m wide is provided for animal crossing in front of the abutment. The proposed bridge is 120m long, with the roadway clearly segregated by traffic direction. The superstructure uses PC hollow slabs with sloped web for the same landscaping reason described about the bridge on Av. Primeiro de Dezembro. The bridge has 4-span continuous girders with economical span length of 30m. Piers have a round cross section to resist the flow of the channel. The construction requires the timbering. It is necessary to do the construction works when the flow level of the channel is low.

15.5.5. INTERSECTION DESIGN

Rua da Marinha crosses three major roads: namely, Av. Independencia, Rod. Augusto Montenegro and Rod. BR-316. An at-grade intersection with traffic signals is provided at each location, because the incoming traffic to the intersection on each road is limited in volume.

15.5.6. VOLUME OF WORKS

The cost of widening Rua da Marinha consists of land acquisition, relocation of roadside houses and a bridge. Major construction works are shown in Table 15.5-1.

Table 15.5-1 Major Construction Works for Rua da Marinha

Work Element	Quantity	Remarks
Road Length (m)	4,555	
Relocation of Houses (unit)	109	
Length of Bridge (m)	120	A bridge across Sao Joaquim Channel
Aggregated Length of Drainpipes (m)		
No. of At-grade Intersections	3	Two T-form intersections and one cross-form intersection, each with traffic signals

CHAPTER 16
Construction Planning And Cost Estimate

16. CONSTRUCTION PLANNING AND COST ESTIMATE

16.1. GENERAL

This chapter describes the construction planning and working program as well as cost estimate for facilities of the trunk bus system and road projects. Both the construction planning and the cost estimate are based on the Preliminary Engineering Design described in Chapters 14 and 15.

The construction plan in Section 16.1 is developed on the basis of the circumstances at the construction sites, procurement of the materials and equipment for construction, environmental impact and sure and safe operation during the construction stage.

In Section 16.2, the most appropriate construction method, work items and working program for each project are defined. Next in Section 16.3, quantities for each project are described. In Section 16.4, detailed costs of each project, consisting of construction cost, land acquisition and compensation, engineering, administration and contingency costs are included. Finally, in Section 16.5, maintenance costs are estimated.

Projects are classified into the following.

(1) Trunk Bus System Projects

1) Trunk Busway
   a) Avenida Almirante Barroso
   b) Rodovia BR-316
   c) Rodovia Augusto Montenegro
2) Exclusive Trunk Bus Lane
   a) Av. Independencia on the Suburban Segment
   b) Av. Independencia on the Central Accessing Segment
3) Trunk Bus Priority Lane
   a) Central Area
   b) Icoaraci Area
   c) Avenida Pedro Cabral and Senador Lemos
   d) Avenida Mario Covas in Cidade Nova
4) Integrated Bus Terminals
5) Bus Facilities

(2) Road Projects

a) Avenida Primeiro de Dezembro/Avenida Mario Covas Extension
b) Rua Yamada
c) Rua da Marinha
d) Av. Independencia on Suburban Segment and Central Accessing Segment

16.2. CONSTRUCTION PLANNING AND PROGRAM

16.2.1. CONSTRUCTION PLANNING FOR BUSWAY PROJECT

Since the construction work is to be carried out on the existing roads under heavy traffic, it is most advisable to select construction methods to avoid interference with traffic and to minimize the construction period and cost.

(1) Trunk Busway

1) Avenida Almirante Barroso (proposed length = 6.00km)

The trunk busway on this existing road consists of two sections; one is the new trunk busway with one lane per direction and the other is the remaining section for vehicle lanes, bikeway and sidewalk renewed by overlaying pavement as extra work.

The major construction method for the trunk busway will include the following work:

- To remove the existing center median and bikeway
- To excavate, lay geotextile and backfill with selected material
- To lay and compact new sub-base and base course
- To provide drainage and median
- To pave the new trunk busway with concrete
- To build bus facilities such as bus stops
- To additionally overlay new pavement on the remaining section
- To demolish existing pedestrian bridges and build new pedestrian bridges
- To mark lanes
- To carry out other incidental work

During demolition of existing pedestrian bridges and constructing of new pedestrian bridges, the working area shall be protected from traffic by a movable safety barrier and/or fence. The construction procedure for pedestrian bridges is shown in Figure 16.2-1. The bridges shall be erected at night when traffic is light on the road.

2) Rodovia BR-316 (proposed length = 10.75km)

Double lanes for the trunk busway system are provided at the center median side of the road and the remaining section for other vehicles, bikeway and sidewalk will be improved by new pavement as extra work.

The construction method of this section is similar to that on Avenida Almirante Barroso.

3) Rodovia Augusto Montenegro (proposed length = 13.64km)

The trunk busway on this existing road consists of two sections: a new one-lane trunk busway per direction, and the remaining section for other vehicle lanes, bikeway and sidewalk by overlaying new pavement as extra work.

The construction method of this section is similar to that on Avenida Almirante Barroso. In addition, the following items are to be considered for the work on this segment:

- To remove existing electric poles on which a power line is installed.
- To relocate this power line facility.

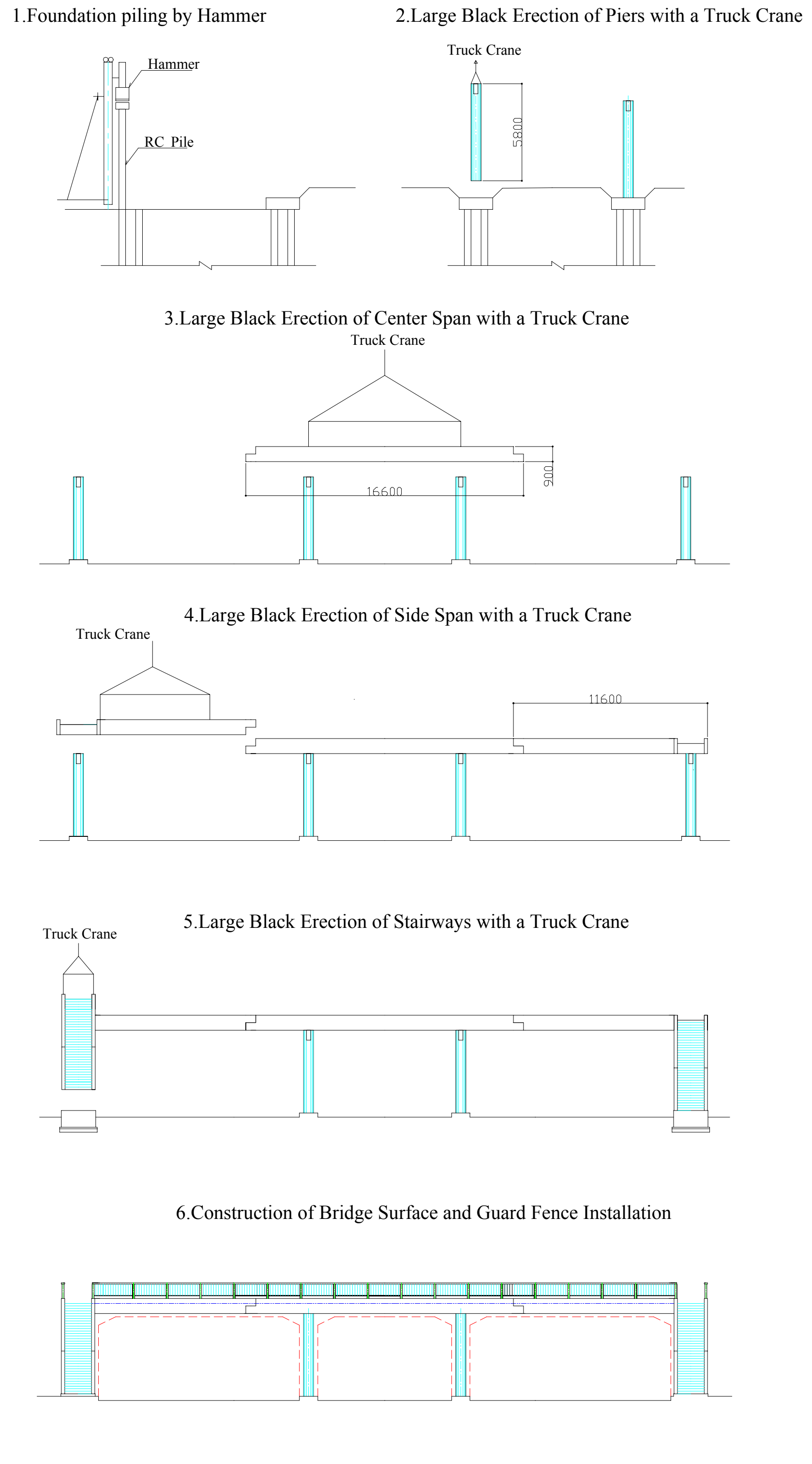


Figure 16.2-1 Construction Procedure of Pedestrian Bridge

(2) Exclusive Trunk Bus Lane (proposed length = 19.57km)

The exclusive trunk bus lane on Avenida Independencia consists of two segments; one is the central accessing segment and other is the suburban segment. The trunk bus lane will be provided on the median and roadsides of the new road section that is now being constructed and planned by Para State.

The major construction method for widening section will include the following work:

- To remove and cut existing asphalt pavement
- To excavate, lay geotextile and back fill with selected material
- To lay and compact new sub-base and base course
- To provide drainage and median
- To pave the new trunk busway with asphalt
- To build bus facilities such as bus stops
- To mark lanes
- To carry out other incidental work

While construction work is done under existing electric power poles, a construction method to avoid any interference or damage to the electric power facilities should be considered.

(3) Trunk Bus Priority Lane

1) Central Area (proposed length = 9.80km)

The single trunk bus priority lane of this area requires new colored pavement to segregate other vehicles. The major construction methods are included as the following work:

- To scarify the existing pavement
- To spray asphalt tack coat
- To pave the busway with colored asphalt
- To mark lanes
- To carry out other incidental work

Since the construction work is carried out on existing roads under heavy traffic, it is most advisable to select construction methods to avoid interference with traffic.

2) Icoaraci Area (proposed length = 3.27km)

The trunk bus priority lane of this area segregates other vehicles by colored asphalt pavement. The major construction methods are similar to those in the Central Area.

3) Avenida Mario Covas Area (proposed length = 3.55km)

The trunk bus priority lane of this area segregates other vehicles by colored asphalt pavement. The major construction methods are similar to those in the Central Area.

4) Av. Pedro Cabral and Senador Lemos (proposed length = 7.80km)

The single trunk bus priority lane of this area requires new colored pavement to segregate other vehicles. The major construction methods are included as the following work:

- To remove and cut existing asphalt pavement
- To excavate, lay geotextile and backfill with selected material

- To lay and compact new sub-base and base course
- To provide drainage and median
- To pave the busway with colored asphalt
- To build bus facilities as bus stops
- To draw a lane marking
- To carry out other incidental work

(4) Integrated Bus Terminals

Eight (8) new integrated bus terminals are to be constructed in this project. Each terminal is different in area and size; however, the structural types and facilities are similar.

The construction method for the bus terminals consists of the following work:

- To clean the sites and demolish existing buildings and structures
- To level the ground
- To excavate, lay geotextile and backfill
- To lay and compact sub-base and base course
- To construct terminal buildings and build bus bays
- To provide paving and colored pavement
- To draw a lane markings and to establish traffic signs
- To carry out other incidental work

(5) Bus Facilities

Bus stop facilities are provided on the right side of the busways in this project. Each bus stop has a platform 2.5m wide and 20m to 40m long; however, the structural types and facilities are similar.

The construction method for the bus facilities consists of the following work:

- To clean the sites
- To excavate, lay geotextile and backfill
- To lay and compact the sub-base and base course
- To pave the platform and construct curbing
- To construct structures such as shelter walls and roofs
- To draw lane markings and establish traffic signs
- To carry out other incidental work.

16.2.2. CONSTRUCTION PLANNING FOR ROAD PROJECT

(1) Av. Primeiro de Dezembro/Avenida Mario Covas Extension (proposed length = 10.08km)

The proposed road projects are an extension road and a new construction road with pre-stressed hollow slab bridges. The major construction methods in the projects consist of the following work:

1) Road segment:

- To grub and clean the sites
- To excavate, lay geotextile and backfill with selected material
- To lay and compact a new sub-base and base course
- To provide concrete curbing, drainage and median
- To pave the carriageway, bikeway and sidewalk with asphalt
- To mark lanes
- To carry out other incidental work

2) Bridge:

The substructure construction procedure will include the following:

- To drive steel piles or reinforcement piles
- To excavate the foundation after all the piles are driven
- To place blinding concrete, and to treat pile heads
- To assemble reinforcing bars and formwork for structures as abutments and piers
- To place concrete in the structures
- To carry out back-filling

As shown in Figure 16.2-2, the superstructure work is carried out by the erection girder method, which places hollow slab pre-stressed concrete without any interference with road traffic and river flow. The other major construction methods consist of the following work:

- To assemble form-work and reinforcing bars to place deck concrete
- To pave the deck with asphalt
- To carry out other incidental work, such as marking lanes and constructing guardrails

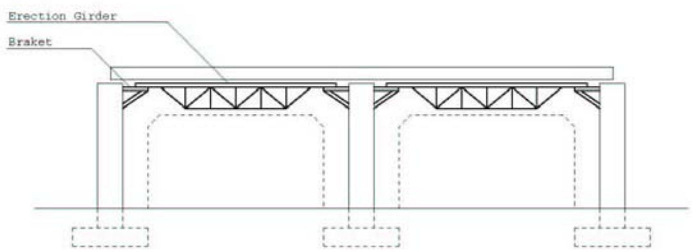


Figure 16.2-2 Erection Girder Method for PC hollow slabs

(2) Rua Yamada (proposed length = 10.00km)

This road project is to improve the existing road including installing pre-stressed hollow slab bridges and pre-stressed girder bridges. The major construction methods for road segments, bridge substructures and superstructures in this project are similar to those on Av. Primeiro de Dezembro. In addition, as shown in Figure 16.2-3, the ordinary passenger cars and buses shall be diverted to a temporary bridge until the completion of the new bridge. In Figure 16.2-4, for the construction of a pre-stressed girder, the erection girder method is carried out without any interference with river flow.

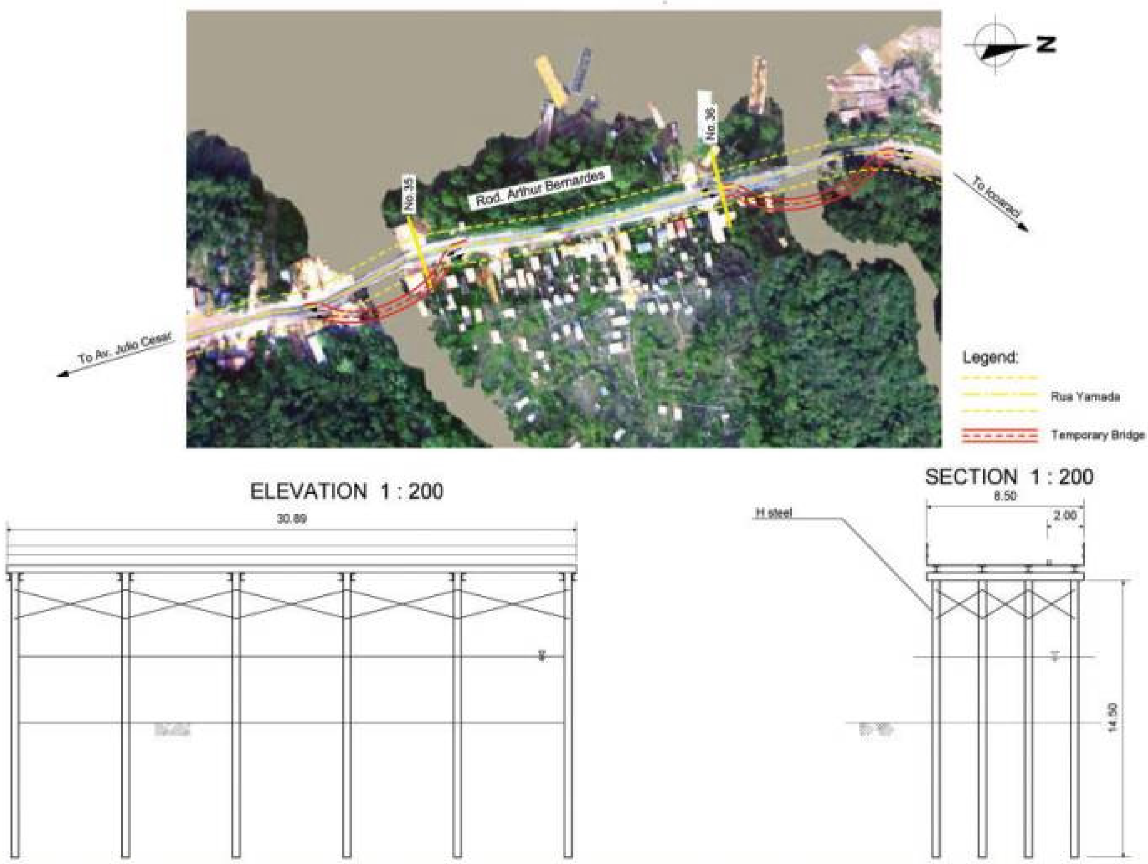


Figure 16.2-3 Traffic Diversion and Temporary Bridge

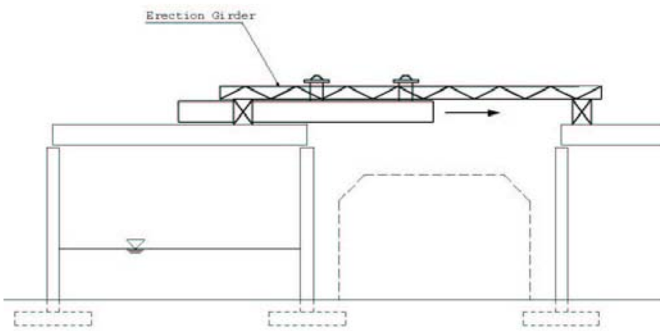


Figure 16.2-4 Erection Girder Method for PC Girders

(3) Rua da Marinha (proposed length = 4.56km)

This road project is to improve an existing road, including construction of a pre-stressed hollow slab bridge. The major construction methods for road segments, bridge substructures and superstructures are similar to those on Av. Primeiro de Dezembro.

(4) Av. Independencia on Suburban and Central Accessing Segment (proposed length = 19.57km)

This road project is a new construction road. (Para State is now constructing the suburban segment and is planning the central accessing segment.) The major construction methods for road segments, bridge substructures and superstructures are similar to those on Av. Primeiro de Dezembro.

In addition, as shown in Figure 16.2-5, private vehicles and buses shall be diverted to the temporary road (illustrated red line) until the completion of the new bridge at the Rodovia August Montenegro junction. While the construction work is carried out under existing electric power poles, a construction method to avoid any interference or damage to the power facilities should be considered.

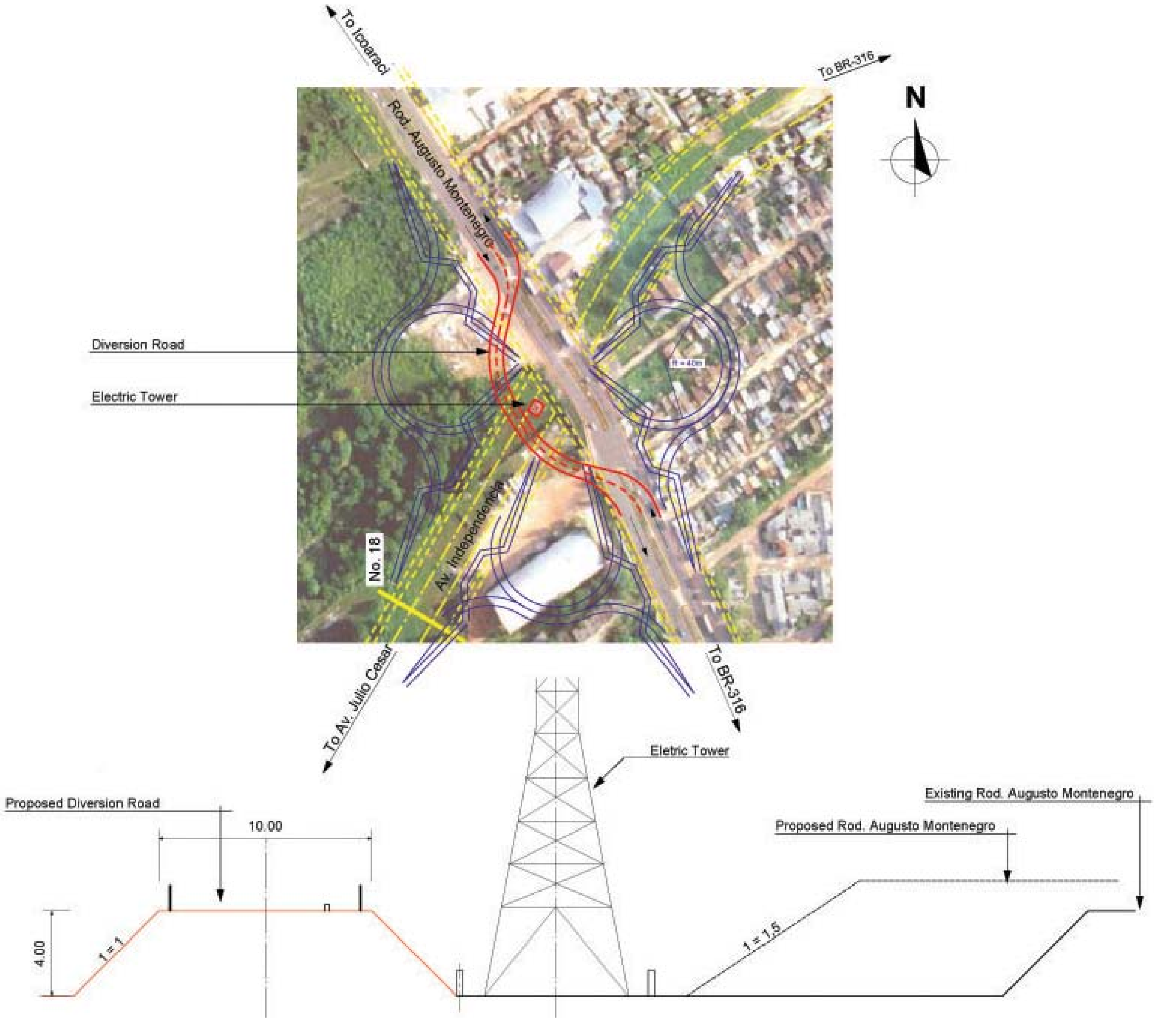


Figure 16.2-5 Traffic Diversion

16.2.3. Working Program for Trunk Busway Projects

Each working program of the trunk busway project is identified to examine project scale, characteristics and construction plan.

(1) Trunk Busway

The working programs for trunk busways are estimated as shown in Table 16.2-1 to Table 16.2-3.

Table 16.2-1 Working Program for Av. Almirante Barroso

Av. Almirante Barooso

Work Item	1st. Year												2nd. Year				Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1.Mobilization	━																
2.Road Works																	
Site Cleaning & Demolition		━	━														
Earth Works			━	━	━	━	━										
Pavement Works								━	━	━	━	━	━				
3.Pedestrian Bridge Construction																	
Existing Bridge Demolition				━	━												
Substructure						━	━	━									
Superstructure									━	━	━						
4.Bus Facilities												━	━				
5.Incidental Construction														━			
6.Demobilization															━		

Table 16.2-2 Working Program for BR-316

BR-316 Working Program

Work Item	1st. Year												2nd. Year				Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1.Mobilization	━																
2.Road Works																	
Site Cleaning & Demolition		━	━	━													
Earth Works			━	━	━	━	━	━									
Pavement Works							━	━	━	━	━	━	━				
3.Pedestrian Bridge Construction																	
Existing Bridge Demolition					━												
Substructure						━	━	━	━								
Superstructure									━	━	━	━					
4.Bus Facilities													━	━			
5.Incidental Construction															━		
6.Demobilization																━	

Table 16.2-3 Working Program for Rod. Augusto Montenegro

Rod. Augusto Montenegro

Work Item	1st. Year												2nd. Year				Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1.Mobilization	━																
2.Road Works																	
Site Cleaning & Demolition		━	━	━													
Earth Works			━	━	━	━	━	━	━								
Pavement Works							━	━	━	━	━	━	━	━			
3.Pedestrian Bridge Construction																	
Existing Bridge Demolition					━												
Substructure						━	━	━	━								
Superstructure									━	━	━	━					
4.Bus Facilities													━	━			
5.Incidental Construction														━	━		
6.Demobilization																━	

(2) Exclusive Trunk Bus Lane

The working programs for an exclusive trunk bus lane on Av. Independencia are shown in Table 16.2-4 and Table 16.2-5.

Table 16.2-4 Working Program of Av. Independencia on Central Accessing Segment

Av. Independencia on Central Accessing Segment

Work Item	1st. Year												2nd. Year				Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1.Mobilization,Preparation Works	—																
2.Road Works																	
Site Cleaning & Demolition		—															
Earth Works				—	—	—	—	—	—	—							
Pavement Works									—	—	—	—	—	—			
3.Bridge Construction																	
Foundation Cast In-situ Piling		—	—	—	—	—											
Substructure,Abutments, Piers						—	—	—									
Superstructure									—	—	—	—	—				
4.Bus Stop,Bus Shelter														—			
5.Incidental Works															—		
6.Demobilization																—	

Table 16.2-5 Working Program of Av. Independencia on Suburban Segment

Av. Independencia on Suburban Segment

Work Item	1st. Year												2nd. Year												3rd. Year												Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
1.Mobilization,Preparation Works	—	—																																			
2.Road Works																																					
Site Cleaning & Demolition			—	—																																	
Earth Works									—	—	—	—	—	—	—	—	—	—	—	—																	
Pavement Works																					—	—	—	—	—	—	—	—	—	—							
3.Bridge Construction																																					
Foundation Cast In-situ Piling					—	—	—	—	—	—	—	—																									
Substructure,Abutments, Piers													—	—	—	—	—	—	—																		
Superstructure																			—	—	—	—	—	—	—	—	—	—									
4.Bus Stop,Bus Shelter																															—						
5.Incidental Works																																—	—				
6.Demobilization																																		—			

(3) Trunk Bus Priority Lane

The working programs of trunk bus priority lanes are carried out as shown in Table 16.2-6 and Table 16.2-7.

Table 16.2-6 Working Program of Central, Icoaraci, Avenida Mario Covas

Central, Icoaraci, Rod.Mario Covas

Work Item	1st. Year												2nd. Year				Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1.Mobilization	—																
2.Excavation																	
Remove Existing Pavement		—	—	—	—	—	—										
3.Pavement Works																	
New Color Pavement							—	—	—	—	—	—	—				
4.Bus Facilities																	
Bus Stop, Bus Shelter													—	—			
5.Incidental Works														—	—		
6.Demobilization																—	

Table 16.2-7 Working Program of Av. Pedro Cabral and Senador Lemos

Av.Pedro Cabral and Senador Lemos

Work Item	1st. Year												2nd. Year				Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1.Mobilization	—																
2.Excavation																	
Remove Existing Pavement		—	—														
3.Pavement Works																	
Carriageway Pavement				—	—	—	—	—	—								
New Color Pavement									—	—	—	—					
4.Bus Facilities																	
Bus Stop, Bus Shelter													—	—			
5.Incidental Works														—	—		
6.Demobilization																—	

16.2.4. WORKING PROGRAM FOR ROAD PROJECTS

Each working program of a road project is also identified to examine project scale, characteristics and construction plan. The working programs are estimated as shown in Table 16.2-8 to Table 16.2-12.

(1) Avenida Primeiro de Dezembro

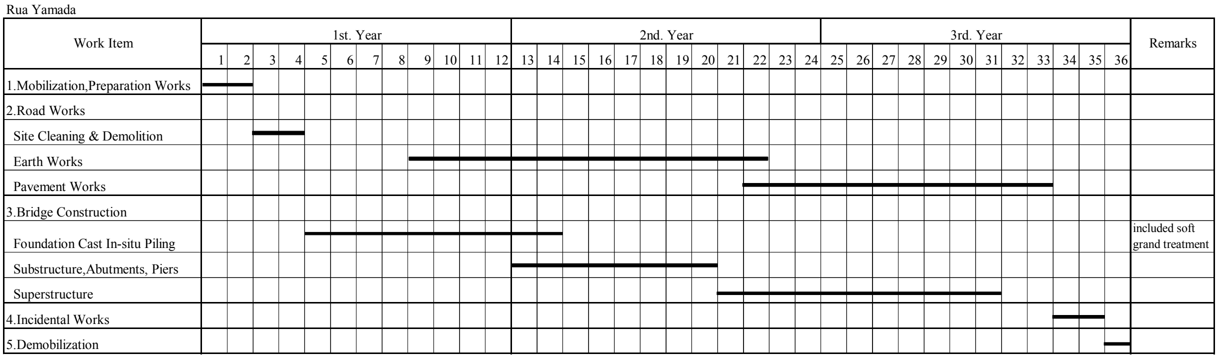
Table 16.2-8 Working Program of Av. Primeiro de Dezembro

Av. Primairo de Dezembro

Work Item	1st. Year												2nd. Year												3rd. Year												Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
1.Mobilization,Preparation Works	—	—																																			
2.Road Works																																					
Site Cleaning & Demolition			—	—																																	
Earth Works									—	—	—	—	—	—	—	—	—	—	—	—	—																
Pavement Works																					—	—	—	—	—	—	—	—	—	—	—						
3.Bridge Construction																																					
Foundation Cast In-situ Piling					—	—	—	—	—	—	—	—																									
Substructure,Abutments, Piers													—	—	—	—	—	—	—																		
Superstructure																				—	—	—	—	—	—	—	—	—	—								
4.Incidental Works																																—	—				
5.Demobilization																																		—			

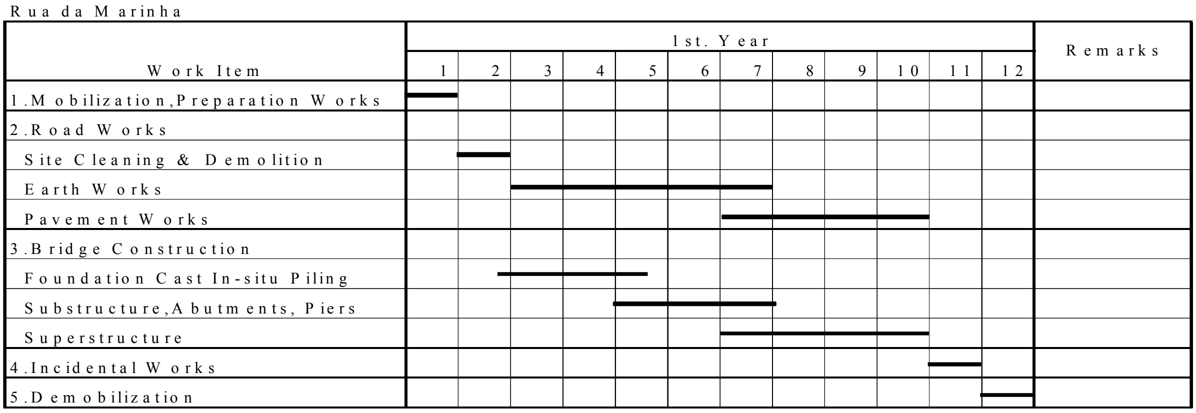
(2) Rua Yamada

Table 16.2-9 Working Program of Rua Yamada



(3) Rua da Marinha (proposed length = 4.56km)

Table 16.2-10 Working Program of Rua da Marinha



(4) Av. Independencia on Central Accessing Segment and Suburban Segment

Table 16.2-11 Working Program of Av. Independencia on Central Accessing Segment

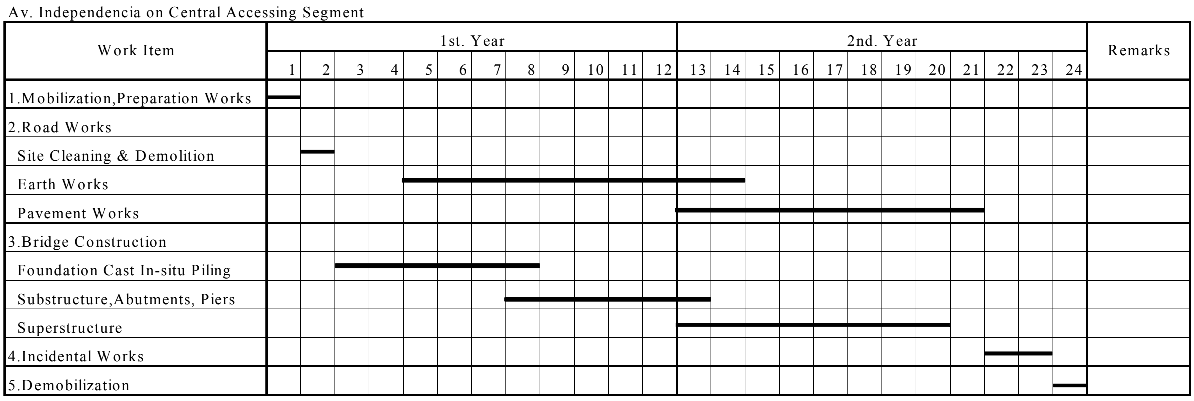


Table 16.2-12 Working Program of Av. Independencia on Suburban Segment

Av. Independencia on Suburban Segment

Work Item	1st. Year												2nd. Year												3rd. Year												Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
1.Mobilization,Preparation Works	—	—																																			
2.Road Works																																					
Site Cleaning & Demolition			—	—																																	
Earth Works								—	—	—	—	—	—	—	—	—	—	—	—	—	—	—															
Pavement Works																					—	—	—	—	—	—	—	—	—	—	—	—	—				
3.Bridge Construction																																					
Foundation Cast In-situ Piling					—	—	—	—	—	—	—	—	—																								
Substructure,Abutments, Piers													—	—	—	—	—	—	—	—																	
Superstructure																					—	—	—	—	—	—	—	—	—	—	—						
4.Incidental Works																																		—	—		
5.Demobilization																																				—	

16.3. VOLUME OF WORKS FOR PROJECT

The estimation of the projects volume is based on the facilities of the trunk busway and road projects in the Preliminary Engineering Design, as well as on construction method and operations for the project implementation.

16.3.1. VOLUME OF WORKS FOR BUSWAY PROJECTS

(1) Trunk Busway

The volume of major works for the trunk busway facilities of Av. Almirante Barroso, Rodovia BR-316 and Rodovia Augusto Montenegro is shown in Table 16.3-1. The description of major work items is as follows:

a) Demolishing and cleaning the existing median, including the bikeway

b) Removing and relocating plantings in the median

c) Cutting and removing existing asphalt pavement

d) Paving cement concrete for new busway

e) Overlay on mixed traffic lanes, bikeway and sidewalk

f) Providing drainage, lighting, lane marking, etc.

g) Improving at-grade signalized intersections

h) Demolishing existing pedestrian bridges and constructing new pedestrian bridges

Table 16.3-1 Volume of Trunk Busway

Work Items	Unit	Av. Almirante Barroso	Rod.BR-316	Rod.Augusto Montenegro
Site Clearing and Demolition				
Medium Plantation	m	1,860.0	10,110.0	12,275.0
Medium Plantation / Bikeway	m	3,500.0	0.0	0.0
Lighting	vol	143.0	141.0	0.0
Traffic Signal	vol	10.0	4.0	5.0
Electric Tower (medium)	vol	0.0	0.0	298.0
Electric Pole	vol	0.0	0.0	3,500.0
Existing Pedestrian Bridge	vol	4.0	4.0	3.0
Excavation				
Pavement				
Cutting Asphalt Pavement	m	10,720.0	20,220.0	19,550.0
Removal Asphalt Pavement	m^3	13,461.6	10,918.8	17,595.0
Soil (Waste)	m^3	10,436.0	18,198.0	53,762.5
Embankment				
Selected Material	m^3	1,072.0	29,116.8	21,505.0
Asphalt Concrete Pavement				
Carriageway				
Asphalt t = 7.5cm	m^2	0.0	60,660.0	17,595.0
Base course t = 20cm	m^2	0.0	60,660.0	17,595.0
Sub-base course t = 40cm	m^2	0.0	60,660.0	17,595.0
Overlay				
Asphalt t = 5	m^2	144,000.0	204,250.0	308,605.0
Sidewalk/Bikeway W=5.5m				
Asphalt t = 3cm	m^2	40,736.0	105,144.0	122,750.0
Base course t = 20cm	m^2	40,736.0	105,144.0	122,750.0
Cement Concrete Pavement				
Carriageway				
Portland Cement t = 22.0cm	m^2	42,880.0	80,880.0	78,200.0
Base course t = 20.0cm	m^2	43,952.0	82,902.0	80,155.0
Sub-base course t = 40.0cm	m^2	45,024.0	84,924.0	82,110.0
Color Pavement				
Asphalt Color Pavement	m^2	21,440.0	0.0	5,000.0
Drainage				
U shaped 0.3mx0.50m	m	0.0	20,220.0	24,550.0
Pipe culvert φ0.3m	m	2,649.6	5,055.0	5,646.5
Facilities				
Median Plantation W=2.5m	m	10,720.0	20,220.0	19,550.0
Sidewalk Plantation W=1.5m	m	0.0	20,220.0	19,550.0
Lighting	vol	357.0	674.0	818.3
Lane Marking	m	30,016.0	56,616.0	68,740.0
Signboard	vol	16.0	32.0	24.0
Traffic Signs	vol	20.0	18.0	24.0
Cat-eye (silver)	vol	1,072.0	0.0	0.0
Intersection				
At-grade signalized	vol	10.0	9.0	12.0
New Pedestrian Bridge	vol	4.0	5.0	3.0

(2) Exclusive Trunk Bus Lane

The volume of major works for the exclusive trunk bus lane on Av. Independencia that are classified into the two components of the Centro Accessing Segment and the Suburban Segments is presented in Table 16.3-2 and Table 16.3-3. The description of major work items is as follows:

a) Cleaning the sites

b) Removing and cutting asphalt pavement

c) Paving new asphalt for bus lane

d) Providing drainage, lighting, lane marking, etc.

e) Improving intersections at-grade signalized

f) Construction of new bridges and box culverts

Table 16.3-2 Volume of Exclusive Trunk Bus Lane

Work Items	Unit	Av.Independencia Central Accessing Segment	Av.Independencia Suburban Segment
Site Clearing and Demolition			
Field	m^2	61,600.0	85,504.0
Excavation			
Pavement			
Cutting Asphalt Pavement	m	4,160.0	0.0
Removal Asphalt Pavement	m^3	1,995.2	2,400.0
Soil (Waste)	m^3	65,920.0	18,720.0
Embankment			
Borrowed Fill	m^3	141,600.0	37,440.0
Embankment slope surface	m^2	10,110.0	7,020.0
Asphalt Concrete Pavement			
Carriageway			
Asphalt t = 7.5cm	m^2	49,018.7	58,016.8
Base course t = 20cm	m^2	50,526.7	61,720.0
Sub-base course t = 40cm	m^2	52,450.7	61,720.0
Sidewalk/Bikeway W=5.5m			
Asphalt t = 3cm	m^2	37,296.7	123,440.0
Base course t = 20cm	m^2	38,033.3	123,440.0
Color Pavement			
Asphalt Color Pavement	m^2	13,980.0	0.0
Drainage			
U shaped 0.3mx0.50m	m	4,660.0	0.0
Pipe culvert φ0.3m	m	1,071.8	0.0
Pipe culvert φ1.5m	m	494.7	80.0
Additional			
Storm Sewage	m	10,360.0	5,100.0
Facilities			
Sidewalk Plantation W=1.5m	m	4,160.0	0.0
Lighting	vol	451.9	822.0
Lane Marking	m	23,445.3	69,126.4
Signboard	vol	8.0	2.0
Traffic Signs	vol	16.0	4.0
Intersection			
At-grade signalized	vol	5.0	6.0
Grade Separated (Clover Type)	vol	0.0	1.0
Grade Separated (Trumpet Type)	vol	1.0	0.0

Table 16.3-3 Volume of Exclusive Trunk Bus Lane (continue)

Work Item		Unit	Central Accessing Segment	Av.Independencia Suburban Segment
Bridge				
Superstructure				
	Concrete 40Mpa	m^3	4,859.4	339.2
	Slab Concrete 30Mpa	m^3	241.1	612.7
	Steel Girder	ton	97.8	97.8
	Reinfoce Bar	ton	463.3	107.0
	Prestrest wire	ton	145.7	10.2
	Asphalt Pavement	m^2	5,235.0	1,595.0
	Guardrail	m	270.0	200.0
	Girder Erection	nos	6.7	21.3
	Formwork	m^2	8,167.5	4,357.4
	Void Form	m	2,250.0	0.0
	Support	m^3	20,535.0	0.0
	Expansion Joint	m	153.3	124.3
	Bearing	nos	68.0	60.7
Substructure				
	Concrete 25Mpa	m^3	1,763.4	915.6
	Reinfoce Bar	ton	123.0	49.6
	RC Pile 0.4×0.4m	m	424.0	682.7
	Steel Pile φ0.6m	m	3,074.0	0.0
	Formwork	m^2	1,947.8	1,240.9
	Support	m^3	150.5	68.8
	Scaffolding	m^2	2,555.3	1,346.7
	Excavation	m^3	4,535.0	1,545.3
	Backfill	m^3	5,167.3	1,097.3
	Coffer dam	m^2	1,885.8	0.0
	Temporary Jetty(Bridge)	m^2	930.0	0.0
Box Culvert				
	Concrete 25Mpa	m^3	1,612.3	0.0
	Reinfoce Bar	ton	112.9	0.0
	Asphalt Pavement	m^2	544.5	0.0
	Concrete Subgrade	m^2	207.0	0.0
	Formwork	m^2	1,320.7	0.0
	Support	m^3	2,277.0	0.0
	Scaffolding	m^2	446.4	0.0
	Excavation	m^3	6,253.3	0.0
	Backfill	m^3	1,892.7	0.0

(3) Trunk Bus Priority Lane

Table 16.3-4 shows the volume of major work items for the trunk bus priority lane in Central Area, Icoaraci Area, Avenida Mario Covas Area and Avenida Pedro Cabral and Senador Lemos.

The description of major work items under this project is as follows:

a) Removing and cutting existing asphalt pavement

b) Paving new colored asphalt and cement concrete for bus lane

c) Providing drainage, lighting, lane mark, etc.

Table 16.3-4 Volume of Trunk Bus Priority Lane

Work Items	Unit	Icoarach Area	Central Area	Rod. Mario Covas	Av.Pedro Cabral/Senador Lemos
Excavation					
Pavement					
Cutting Asphalt Pavement	m	0.0	840.0	0.0	600.0
Removal Asphalt Pavement	m^3	490.5	469.0	1,065.0	25,564.5
Soil (Waste)	m^3	0.0	0.0	0.0	25,272.0
Asphalt Concrete Pavement					
Carriageway					
Asphalt t = 7.5cm	m^2	0.0	0.0	0.0	67,275.0
Base course t = 20cm	m^2	0.0	0.0	0.0	68,445.0
Sub-base course t = 40cm	m^2	0.0	0.0	0.0	69,615.0
Sidewalk/Bikeway W=5.5m					
Asphalt t = 3cm	m^2	0.0	0.0	0.0	45,360.0
Base course t = 20cm	m^2	0.0	0.0	0.0	45,360.0
Cement Concrete Pavement					
Carriageway					
Portland Cement t = 22.0cm	m^2	0.0	1,470.0	0.0	1,050.0
Base course t = 20.0cm	m^2	0.0	1,554.0	0.0	1,110.0
Sub-base course t = 40.0cm	m^2	0.0	1,638.0	0.0	1,170.0
Color Pavement					
Asphalt Color Pavement	m^2	9,810.0	28,140.0	21,300.0	22,320.0
Drainage					
U shaped 0.3mx0.50m	m	0.0	0.0	0.0	11,340.0
Pipe culvert φ0.3m	m	0.0	0.0	0.0	2,268.0
Pipe culvert φ0.6m	m	0.0	0.0	0.0	1,360.8
Facilities					
Median Plantation W=2.5m	m	0.0	0.0	0.0	0.0
Sidewalk Plantation W=1.5m	m	0.0	0.0	0.0	5,670.0
Guard Rail	m	0.0	0.0	0.0	0.0
Lighting	vol	0.0	0.0	0.0	567.0
Lane Marking	m	0.0	0.0	0.0	7,938.0
Signboard	vol	0.0	0.0	0.0	11.7
Intersection					
At-grade signalized	vol	0.0	4.0	1.0	6.0

(4) Integrated Bus Terminals

The volume of integrated bus terminals is summarized in Table 16.3-5. Each terminal is different in area and size; however, the structural types and facilities are similar between one-story passenger building, platform, bus parking, taxi stand, office ticket, and shops.

Table 16.3-5 Volume of Integrated Bus Terminals

Terminal Name	Unit	Volume	Remarks
A: Icoaraci	Nos.	1	Area=11480m2
B: Tapana	Nos.	1	Area=15540m2
C: Mangueirao	Nos.	1	Area=15540m2
D: Coqueiro	Nos.	1	Area=18768m2
E: Aguas Lindas	Nos.	1	Area=9680m2
F: Marituba	Nos.	1	Area=16770m2
G: Independencia 1	Nos.	1	Area=10560m2
H: Independencia 2	Nos.	1	Area=10560m2

(5) Bus Facilities

Table 16.3-6 shows the volume of bus facilities included in the rehabilitation of Sao Braz Terminal. Each bus stop and shelter has a platform 2.5m wide and 20m to 42m long; however, the structural types and facilities—such as roofs, walls, benches, and stop signs—are similar.

Table 16.3-6 Volume of Bus Facilities

Bus Facilities	Unit	Volume	Remarks
Bus Shelter (Busway, Exclusive lane, short)	Nos.	32	
Bus Shelter (Busway, Exclusive lane, long)	Nos.	40	
Bus Shelter (Independencia, open type, long)	Nos.	6	
Bus Shelter (Central area, open type, short)	Nos.	4	
Bus Stop Sign	Nos.	45	
Sidewalk and Asphalt Coating	LS	1	
Sao Braz Terminal Rehabilitation	Nos.	1	

16.3.2. VOLUME OF WORKS FOR ROAD PROJECTS

The volumes of major works on Av. Primeiro de Dezembro/Avenida Mario Covas extension, Rua Yamada, Rua da Marinha and Av. Independencia are shown in Table 16.3-7 and Table 16.3-8. They include the following work items:

a) Demolishing and cleaning the sites

b) Cutting and removing existing asphalt pavement

c) Paving new asphalt on the carriageway, bikeway and sidewalk

d) Providing drainage, lighting, lane marking, etc.

e) Improving intersections to be at-grade signalized

f) Constructing new bridges and box culvert

Table 16.3-7 Volume of Road Projects

Work Item	Unit	Av. Primeiro de Dezembro	Rua Yamada	Rua Marinha	Av.Independencia
Site Clearing and Demolition					
Field	m^2	386,521.0	187,669.0	7,350.0	294,208.0
Electric Pole	vol	0.0	369.0	0.0	0.0
Excavation					
Pavement					
Cutting Asphalt Pavement	m	0.0	0.0	0.0	8,320.0
Removal Asphalt Pavement	m^3	0.0	7,600.0	2,960.0	8,790.4
Soil (Waste)	m^3	24,000.0	45,600.0	17,200.0	169,280.0
Embankment					
Borrowed Fill	m^3	64,000.0	0.0	64,800.0	358,080.0
Embankment slope surface	m^2	9,600.0	0.0	5,400.0	34,260.0
Asphalt Concrete Pavement					
Carriageway					
Asphalt t = 7.5cm	m^2	178,366.5	172,000.0	72,839.0	214,070.9
Base course t = 20cm	m^2	181,110.6	176,000.0	74,132.0	224,493.3
Sub-base course t = 40cm	m^2	186,873.0	180,000.0	75,856.0	228,341.3
Sidewalk/Bikeway W=5.5m					
Asphalt t = 3cm	m^2	91,470.0	70,000.0	33,618.0	321,473.3
Base course t = 20cm	m^2	91,470.0	70,000.0	33,618.0	322,946.7
Color Pavement					
Asphalt Color Pavement	m^2	0.0	0.0	0.0	27,960.0
Drainage					
U shaped 0.3mx0.50m	m	18,294.0	20,000.0	0.0	9,320.0
Pipe culvert φ0.3m	m	16,520.7	0.0	0.0	2,143.6
Pipe culvert φ0.6m	m	5,924.4	16,000.0	8,620.0	0.0
Pipe culvert φ1.5m	m	6,827.0	20.0	64.0	1,149.3
Box culvert 2.00 x 2.00 m	m	0.0	0.0	32.0	0.0
Additional					
Storm Sewage	m	3,600.0	0.0	0.0	30,920.0
Facilities					
Median Plantation W=2.5m	m	9,147.0	0.0	8,560.0	0.0
Sidewalk Plantation W=1.5m	m	10,518.0	19,800.0	8,560.0	8,320.0
Lighting	vol	621.0	666.0	0.0	1,274.0
Lane Marking	m	39,173.2	42,000.0	0.0	185,143.5
Signboard	vol	0.0	0.0	0.0	10.0
Traffic Signs	vol	0.0	0.0	6.0	20.0
Fence net for birds	vol	0.0	0.0	1.0	0.0
Drainage system for small animal	vol	0.0	0.0	5.0	0.0
Intersection					
At-grade signalized	vol	3.0	6.0	2.0	11.0
Grade Separated (Clover Type)	vol	0.0	1.0	0.0	1.0
Grade Separated (Trumpet Type)	vol	0.0	0.0	1.0	1.0

Table 16.3-8 Volume of Road Projects (continue)

Work Item		Unit	Av. Primeiro de Dezembro	Rua Yamada	Rua Marinha	Av.Independencia
Bridge						
Superstructure						
	Concrete 40Mpa	m^3	16,564.2	477.6	2,557.8	10,397.1
	Slab Concrete 30Mpa	m^3	0.0	1,037.3	0.0	1,182.0
	Steel Girder	ton	0.0	0.0	0.0	97.8
	Reinfoce Bar	ton	1,490.4	173.9	230.2	1,087.9
	Prestrest wire	ton	496.8	14.2	76.8	311.8
	Asphalt Pavement	m^2	11,040.0	2,236.0	1,680.0	11,635.0
	Guardrail	m	1,380.0	260.0	240.0	580.0
	Formwork	m^2	22,425.0	7,104.8	3,600.0	22,106.9
	Void Form	m	6,900.0	0.0	1,000.0	4,500.0
	Support	m^3	140,790.0	0.0	14,400.0	41,070.0
	Expansion Joint	m	216.0	242.0	44.0	420.2
	Bearing	nos	120.0	144.0	20.0	203.3
Substructure						
	Concrete 25Mpa	m^3	3,871.2	3,478.8	947.2	5,159.9
	Reinfoce Bar	ton	316.0	195.0	64.3	335.2
	RC Pile 0.4×0.4m	m	0.0	840.0	0.0	2,021.3
	Steel Pile φ0.6m	m	5,480.0	3,840.0	1,200.0	6,148.0
	Formwork	m^2	6,272.0	4,644.0	1,217.8	6,068.7
	Support	m^3	1,196.0	314.8	132.0	409.9
	Scaffolding	m^2	7,144.6	4,958.4	1,320.0	7,452.0
	Excavation	m^3	7,908.0	7,680.0	1,880.0	11,744.7
	Backfill	m^3	5,975.0	5,374.0	1,304.0	12,213.3
	Coffer dam	m^2	2,900.0	6,900.0	1,740.0	3,771.6
	Temporary Jetty(Bridge)	m^2	2,880.0	960.0	720.0	1,860.0
Box Culvert Direct Construction Cost						
	Concrete 25Mpa	m^3	0.0	0.0	0.0	3,224.6
	Reinfoce Bar	ton	0.0	0.0	0.0	225.7
	Asphalt Pavement	m^2	0.0	0.0	0.0	1,089.0
	Formwork	m^2	0.0	0.0	0.0	2,641.5
	Support	m^3	0.0	0.0	0.0	4,554.0
	Scaffolding	m^2	0.0	0.0	0.0	892.8
	Excavation	m^3	0.0	0.0	0.0	12,506.7
	Backfill	m^3	0.0	0.0	0.0	3,785.3
Soft Ground Treatment Direct Construction						
	Geotextil	m^2	0.0	8,500.0	0.0	0.0
	Fine Sand	m^2	0.0	2,125.0	0.0	0.0
	Gravel	m^2	0.0	4,250.0	0.0	0.0
	RC Pile0.25×0.25m	m	0.0	21,250.0	0.0	0.0

16.4. PROJECT COST

16.4.1. GENERAL

The project cost consists of direct construction, indirect construction, engineering service, contingency, land acquisition and administration costs. The contents and procedure of project cost are shown Figure 16.4-1.

Most of these costs are estimated based on the unit cost of work items obtained from a unit price analysis and in comparison with costs of similar projects in Belem Municipality. The estimation of the project cost is based on the results of preliminary engineering design, quantity take-off of each work item, and the construction method.

The fundamental concepts in estimating the project cost are as follows:

a) The unit cost of each component is determined based on the economic condition as of June, 2003 (1US$=2.9 R$, 1US$=120Jyen).

b) Engineering service cost is assumed to be 10% of the construction cost.

c) Contingency is approximated as 15% of the sum total of the construction cost and engineering service cost.

d) Land acquisition and compensation cost is evaluated by a counterpart of COHAB.

e) Administration cost is estimated to be 5% of the sum total of construction cost and engineering service cost.

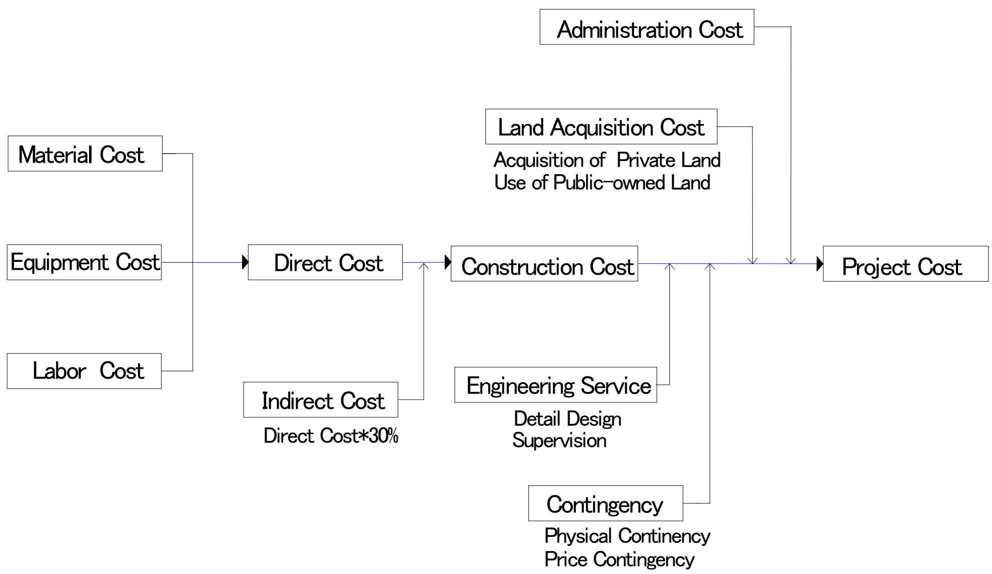


Figure 16.4-1 Procedure of Project Cost Estimate

16.4.2. CONSTRUCTION COST

The construction cost of work items consists of direct construction cost and indirect construction cost.

(1) Direct Construction Cost

The direct construction cost consists of construction materials cost, labor cost and construction equipment cost. Most of the items of unit cost data were collected from similar road projects within the BMA.

1) *Unit Labor Cost*

Table 16.4-1 shows the unit labor cost for local work required for implementing the project. The labor cost includes allowances such as social benefits, and insurance, and is based on hourly rates.

Table 16.4-1 Unit Labor Cost

Classfication	Unit	Basic Pay(R$)	Remarks
Unskilled	hour	2.31	
Skilled Labor	hour	3.92	
Driver	hour	4.29	
Operator	hour	4.81	
Foreman	hour	5.22	

2) *Unit Construction Material Cost*

The major construction material prices are shown in Table 16.4-2. The price of materials is based on the market price in the BMA.

Table 16.4-2 Unit Construction Material Cost

Material Item	Unit	Price(R$)	Remarks
Fine Aggregate	m3	12.00	
Coarse Aggregate	m3	35.00	
Crush Stone	m3	45.00	
Borrowed Soil	m3	9.00	
Ordinary Portland Cement	50kg,SC	15.00	
Reinforcing Bar	kg	1.70	
Reinforcing Bar (high tension)	kg	1.85	
Prestressing Cable(7nos. 12.7mm)	t	3,030.00	
Steel Plate(t=3/4")	t	1,960.00	
Section Steel(shaped)	t	2,200.00	
Lumber	m3	300.00	
Gasoline	l	1.85	
Diesel	l	1.28	
Bitumen(CAP-50/60)	t	1,035.88	
Emulsion(RR-1C)	t	743.50	
Concrete Pipe(φ0.4m)	m	27.44	
PVC Pipe(φ0.1m)	m	4.70	
Concrete Brick for Pedestrian (t=8cm)	m2	16.00	
Brick for house (8×12×25cm)	no.	0.15	
Nail	Kg	2.50	
Plywood	no.	15.00	
Grass	m2	4.62	

3) Unit Construction Equipment Cost

The construction equipment cost used for the estimation of the project is shown in Table 16.4-3 on an hourly rental basis.

Table 16.4-3 Unit Construction Equipment Cost

Equipment	Type/Model	Operation Cost(R$/Hr.)	Remarks
Bulltorzer	10t	60.72	
	20t	106.20	
Backhoe	95HP	45.42	
	124HP	74.45	
Truck shobel	1.8m3	62.29	
Truck	4t	28.53	
Truck with crane	8t	39.67	
DumpTruck	15t	56.44	
Water Truck	6000L	38.25	
Mobile Crane	16t	255.00	
	50t	443.50	
Motor Grader	3.5m	94.03	
Road Roller	10t	61.52	
Tire Roller	9t	62.02	
Vibratory Roller	12t	67.30	
Tamper/Rummer	7HP	12.51	
Asphalt Mixing Plant	40-60t/hr	257.06	
Asphalt Distributer	6000L	68.00	
Concrete Mixing Plant	40-60t/hr	154.24	
Concrete Transit Mixer	4m3	35.58	
Concrete Pump	60m3/h	81.00	
Compressor	40HP	20.90	
Generator	115KVA	23.01	

4) Unit Direct Construction Cost

The major unit direct construction cost of the work items by road section, structures and bus facilities is shown in Table 16.4-4 to Table 16.4-6. Appendix-C shows a unit direct cost.

Table 16.4-4 Unit Direct Construction Cost (Road)

Work Items	Unit	Unit Cost(R$)	Remarks
Site Clearing and Demolition			
Field	m^2	2.30	
Medium Plantation	m	37.50	relocate plant
Medium Plantation / Bikeway	m	143.40	relocate plant
Lighting	vol	103.80	
Traffic Signal	vol	1,719.90	
Electric Tower (medium)	vol	1,073.20	
Electric Pole	vol	103.80	
Pedestrian Bridge	vol	27,000.00	safety net
Excavation			
Remove Asphalt Pavement	m^3	98.20	base, sub-base
Soil (Waste)	m^3	4.00	transport 5km
Embankment			
Borrowed Fill	m^3	11.50	
Selected Material	m^3	13.90	
Embankment slope surface	m^2	6.70	planning
Asphalt Concrete Pavement			
Carriageway			
Asphalt t = 7.5cm	m^2	85.70	
Base course t = 20cm	m^2	29.00	
Sub-base course t = 40cm	m^2	24.30	
Overlay			
Asphalt t = 5cm	m^2	64.10	
Sidewalk/Bikeway W=5.5m			
Asphalt t = 3cm	m^2	44.80	
Base course t = 20cm	m^2	20.90	
.Cement Concrete Pavement			
Carriageway			
Portland Cement t = 22.0cm	m^2	139.00	
Base course t = 20.0cm	m^2	29.00	
Sub-base course t = 40.0cm	m^2	24.30	
Color Pavement			
Asphalt Color Pavement t=5cm	m^2	80.90	
Drainage			
U shaped 0.3mx0.50m	m	23.30	concrete
Pipe culvert φ0.6m	m	55.00	"
Pipe culvert φ1.5m	m	99.40	"
Facilities			
Median Plantation W=2.5m	m	58.20	
Lighting	vol	1,469.70	
Lane Marking	m	11.20	
Signboard	vol	868.90	steel column
Traffic Signs	vol	154.30	"
Cat-eye (silver)	vol	48.70	
Intersection			
At-grade signalized	vol	250,000.00	
Grade Separated (Clover Type)	vol	4,200,000.00	
Grade Separated (Trumpet Type)	vol	3,200,000.00	

Table 16.4-5 Unit Direct Construction Cost (structures)

Work Items		Unit	Unit Cost(R$)	Remarks
Bridge				
Superstructure				
	Concrete 40Mpa	m^3	339.80	
	Slab Concrete 30Mpa	m^3	278.20	
	Steel Girder	ton	4,547.60	welding,painting
	Reinfoce Bar	ton	2,790.00	
	Prestrest wire	ton	4,921.30	anchorage,grout
	Asphalt Pavement	m^2	85.70	
	Guardrail	m	193.80	steel
	Formwork	m^2	59.80	steel reuse
	Void Form	m	67.60	steel
	Support	m^3	103.60	steel reuse
	Scaffolding	m^2	55.80	"
	Expansion Joint	m	2,259.60	
	Bearing	nos	1,033.60	
Substructure				
	Concrete 25Mpa	m^3	278.20	
	Reinfoce Bar	ton	2,790.00	
	RC Pile 0.4×0.4m	m	364.80	
	Steel Pile φ0.6m	m	517.60	
	Formwork	m^2	59.80	steel reuse
	Scaffolding	m^2	55.80	"
	Excavation	m^3	4.00	transport 5km
	Backfill	m^3	11.50	
	Coffer dam	m^2	202.00	steel plate pile
	Temporary Jetty(Bridge)	m^2	751.10	H steel
Box Culvert				
	Concrete 25Mpa	m^3	278.20	
	Reinfoce Bar	ton	2,790.00	
	Asphalt Pavement	m^2	85.70	
	Formwork	m^2	59.80	steel reuse
	Support	m^3	103.60	"
	Scaffolding	m^2	55.80	"
	Excavation	m^3	4.00	transport 5km
	Backfill	m^3	11.50	
Soft Ground Treatment				
	Geotextil	m^2	50.90	
	RC Pile0.25×0.25m	m	263.90	
	Pile Cap Concrete 15Mpa	m^3	155.20	

Table 16.4-6 Unit Direct Construction Cost (Bus Facilities)

Work Items	Unit	Unit Cost(R$)	Remarks
Terminal A: Icoaraci	Nos.	2,331,160	Area=11480m2
Terminal B: Tapana	Nos.	3,410,724	Area=15540m2
Terminal C: Mangueirao	Nos.	3,411,124	Area=15540m2
Terminal D: Coqueiro	Nos.	3,803,892	Area=18768m2
TerminalE: Aguas Lindas	Nos.	1,988,790	Area=9680m2
Terminal F: Marituba	Nos.	3,630,592	Area=16770m2
Terminal G: Independencia 1	Nos.	1,818,448	Area=10560m2
Terminal H: Independencia 2	Nos.	1,818,048	Area=10560m2
Bus Shelter (Busway, Exclusive lane, short)	Nos.	36,018	
Bus Shelter (Busway, Exclusive lane, long)	Nos.	72,018	
Bus Shelter (Independencia, open type, long)	Nos.	32,896	
Bus Shelter (Central area, open type, short)	Nos.	16,448	
Bus Stop Sign	Nos.	7,200	
Sidewalk and Asphalt Coating	LS	10,000	
Sao Braz Terminal Rehabilitation	Nos.	498,740	

(2) Indirect Construction Cost

The indirect construction cost consists of common temporary facility cost and general administration cost. It is estimated to be 30% of the direct construction cost.

The common temporary work includes transportation of machines and plant, mobilization and demobilization of such temporary facilities as power supply, environmental protection, safety facilities and field office. The general administration cost involves the overhead of contractor’s head office.

16.4.3. ENGINEERING COST, CONTINGENCY AND ADMINISTRATION COST

(1) Engineering Service Cost

The engineering services cost consists of the consultancy cost for detailed designs and supervision of the project implementation. It is assumed to be 10 % of the construction cost.

(2) Contingency

The contingency cost consists of both physical contingency and price contingency. It is approximated at 15 % of the total of construction cost and engineering cost.

The physical contingency includes unexpected costs identified in the detailed design and construction stage such as unexpected rock excavation and work delay due to unusual weather. The price contingency includes price escalation or higher-than-anticipated price inflation.

(3) Administration Cost

The government of Para State provides staff members of administrative organization responsible for coordination and the management to implement the projects as the client, as well as the negotiation with land and house owners for expropriation and resettlement under implementation of this project. The administration cost will be 5% of the sum total of the construction cost, land acquisition and compensation cost.

16.4.4. LAND ACQUISITION AND COMPENSATION COST

Land acquisition and compensation cost are estimated based on the study by a counterpart of COHAB. The cost for the affected houses and private lands by widening of the road, construction of busway and bus terminals is estimated on the study. Land acquisition and compensation cost are shown in Table 16.4-7 and Table 16.4-8. According to the COHAB study, it is estimated that the land acquisition cost will be in the range of Real$2.3 to 8.0 /m^2 and the compensation cost for houses will be in the range of Real$ 7,600/house (area below 25m^2), Real$ 13,000/house (area 25 to 41m^2), Real$ 23,000/house (area more 41m2), and buildings are estimated about Real$ 130,000 to 370,000/building.

Table 16.4-7 Land Acquisition and Compensation Cost for Land and Houses

									INFRA / LAND R$			
LAND	IDENTIFICATION	ASSITED PROJECTS	SEGMENT	AVERAGE LENGTH. m	TOTAL AREA m²	MAX No LOTS	PROJ No LOT	R$ / m²	PROJ LOT	CHANGE/DE MOLITION	R$ / LAND	R$ TOTAL
4	Terreno da marinha	Independência *	P Alv. Cbral - A Mont	2,500	80,581	302	204	3.00	976,054.32	122,400.00	241,743.00	1,340,197.32
		Marinha	Independência - A Mont.	1,300			8		38,276.64	4,800.00		43,076.64
7	Granja do japonês Bengui	Yamada	Yamada	800	54,909	206	36	3.20	172,244.88	21,600.00	175,708.80	369,553.68
13	Campos de futebol Tapanã	Yamada	Tapanã	100	16,146	61	19	5.80	90,907.02	11,400.00	93,646.80	195,953.82
40	Sucata Icoaraci	Yamada	Arthur Bernardes	400	6,285	24	6	7.00	28,707.48	3,600.00	43,995.00	76,302.48
15	Canteiro Independência	Independência *	A Mont - Mário Covas	1,100	76,563	287	124	3.20	593,287.92	74,400.00	245,001.60	912,689.52
20	Fundos Granja Icuí	Independência *	Mário Covas - Curuçambá	1,000	87,044	326	258	3.50	1,234,421.64	154,800.00	304,654.00	1,693,875.64
34	Guajará PAAR	Independência *	Curuçambá - BR-316	2,100	54,861	206	63	3.40	301,428.54	37,800.00	186,527.40	525,755.94
25	Terreno galpão Guanabara	Primeiro de Dezembro	M Bonita - R Borges(30un)	700	15,059	56	30	8.20	143,537.40	18,000.00	123,483.80	285,021.20
		Marinha	A Mont - BR-316	1,000			17		81,337.86	10,200.00		91,537.86
31	Terreno próximo a R Borges	Primeiro de Dezembro	M Bonita - R Borges(30un) e até Alça	2,000	22,003	83	32	6.90	153,106.56	19,200.00	151,820.70	324,127.26
		Prolong M Covas	Prolong M Covas	1,500			9		43061.22	5,400.00		48,461.22
Sub total 1						**1,550**	**806**		**3,856,371.48**	**483,600.00**	**1,566,581.10**	**5,906,552.58**

Dispossession and contruction cost for new units / project

Marinha	2,468,701.30
P Dezembro	5,847,804.98
R Borges	6,099,747.17
Independência	26,878,132.88
Yamada	6,558,953.74
Sub Total 2	**47,853,340.07**
TOTAL	**53,759,892.65**

Note: * The costs for Avenida Independência correspond the total implantation of the project (Rodovia BR-316 / Avenida Pedro Alvares Cabral - Avenida Senador Lemos)

Table 16.4-8 Land Acquisition and Compensation Cost for Terminals

ITEM	TERMINAIS	ÁREAS (m²)	VALORES				Remarks
			MÍNIMO	ESTIMADO	MÁXIMO	BENFEITORIA	
			R$	R$	R$	R$	
1	**COQUEIRO** (Av. Mário Covas)	19,412.00	124,430.92	143,842.92	170,243.24	0.00	
2	**ICOARACI** (Trav. Soledade)	15,526.00	152,310.06	197,490.72	242,516.12	23,670.47	
3	**INDEPENDÊNCIA 2** (Av. Independên-cia c/ Estr. Icuí-Guajará)	10,760.00	109,214.00	0.00	131,487.20	0.00	own by governmet
4	**MANGUEIRÃO** (Rod. Augusto Monte-negro)	15,540.00	191,763.60	0.00	251,126.40	0.00	own by governmet
5	**INDEPENDÊNCIA 1** (Av. Mário Covas c/ Av. Independência)	10,890.00	110,206.80	121,423.50	132,640.20	4,641.98	
6	**ÁGUAS LINDAS** (Rod. BR-316)	8,006.77	82,549.80	91,517.38	100,565.03	90,058.69	
7	**MARITUBA** (Rod. BR-316)	16,770.00	105,483.30	126,613.50	147,911.40	5,427.24	
8	**TAPANÃ** (Rod. Augusto Montenegro em frente a Rod. Mário	16,065.00	194,868.45	220,251.15	253,345.05	3,806.64	
TOTAL		112,969.77	1,070,826.93	901,139.17	1,429,834.64	127,605.02	

16.4.5. PROJECT COST FOR BUSWAY PROJECTS

(1) Trunk Busway

The estimated project cost of each trunk busway project included in the extra works is shown in Table 16.4-9.

Table 16.4-9 Estimated Project Cost of Trunk Busways

Cost Items		Av. Almirante Barroso	Rod.BR-316	Rod.Augusto Montenegro	Remarks
Direct Construction Cost		30,340,837	55,029,338	58,782,212	
Busway		28,990,837	53,679,338	57,972,212	
Structures		1,350,000	1,350,000	810,000	pedestrian bridge
Bus Facilities		0	0	0	
Indirect Construction Cost		9,102,251	16,508,801	17,634,663	
Construction Cost		39,443,088	71,538,140	76,416,875	
Engineering Service Cost		3,944,309	7,153,814	7,641,687	
Contingency		6,508,110	11,803,793	12,608,784	
Compensation		0	0	0	
Administration		1,972,154	3,576,907	3,820,844	
Project Cost (1US$=2.9R$)	(R$)	51,867,661	94,072,654	100,488,191	
	(US$)	17,885,400	32,438,846	34,651,100	

(2) Exclusive Trunk Bus Lane

The estimated project cost of the exclusive trunk bus lane is shown in Table 16.4-10.

Table 16.4-10 Estimated Project Cost of Exclusive Trunk Bus Lane

Cost Items		Av. Independencia		Total	Remarks
		Suburban Segment	Central Accessing Segment		
Direct Construction Cost		31,317,001	30,717,998	62,034,999	
Busway		25,122,326	18,833,190	43,955,516	
Structures		6,194,675	11,884,808	18,079,483	bridge,box culvert
Bus Facilities		0	0	0	
Indirect Construction Cost		9,395,100	9,215,399	18,610,500	
Construction Cost		40,712,101	39,933,398	80,645,499	
Engineering Service Cost		4,071,210	3,993,340	8,064,550	
Contingency		6,717,497	6,589,011	13,306,507	
Compensation		15,965,107	9,508,658	25,473,765	
Administration		2,833,860	2,472,103	5,305,963	
Project Cost (1US$=2.9R$)	(R$)	70,299,775	62,496,509	132,796,284	
	(US$)	24,241,302	21,550,520	45,791,822	

(3) Trunk Bus Priority Lane

The estimated project cost of the trunk bus priority lane is shown in Table 16.4-11.

Table 16.4-11 Estimated Project Cost of Trunk Bus Priority Lane

Cost Items		Central Area	Icoaraci Area	Mario Covas	Av. Pedro Cabral Senador Lemos	Total	Remarks
Direct Construction Cost		3,634,125	841,796	2,077,753	20,111,538	26,665,212	
Busway		3,634,125	841,796	2,077,753	20,111,538	26,665,212	
Structures		0	0	0	0	0	
Bus Facilities		0	0	0	0	0	
Indirect Construction Cost		1,090,238	252,539	623,326	6,033,461	7,999,564	
Construction Cost		4,724,363	1,094,335	2,701,079	26,144,999	34,664,776	
Engineering Service Cost		472,436	109,433	270,108	2,614,500	3,466,478	
Contingency		779,520	180,565	445,678	4,313,925	5,719,688	
Compensation		0	0	0	0	0	
Administration		236,218	54,717	135,054	1,307,250	1,733,239	
Project Cost (1US$=2.9R$)	(R$)	6,212,537	1,439,050	3,551,919	34,380,674	45,584,180	
	(US$)	2,142,254	496,224	1,224,800	11,855,405	15,718,683	

(4) Integrated Bus Terminals

The estimated project cost of integrated bus terminals is shown in Table 16.4-12.

Table 16.4-12 Project Cost of Bus Terminals

Cost Items		Integrated Bus Terminals	Remarks
Direct Construction Cost		22,212,778	
Busway		0	
Structures		0	
Bus Facilities		22,212,778	total 8 terminals
Indirect Construction Cost		6,663,833	
Construction Cost		28,876,611	
Engineering Service Cost		2,887,661	
Contingency		4,764,641	
Compensation		1,028,744	
Administration		1,495,268	
Project Cost (1US$=2.9R$)	(R$)	39,052,925	
	(US$)	13,466,526	

(5) Bus Facilities

The estimated project cost of bus facilities is shown in Table 16.4-13.

Table 16.4-13 Estimated Project Cost of Bus Facilities

Cost Items		Bus Facilities	Remarks
Direct Construction Cost		5,129,204	
Busway		0	
Structures		0	
Bus Facilities		5,129,204	bus stop 45,bus shelter 82, Sao Braz terminal
Indirect Construction Cost		1,538,761	
Construction Cost		6,667,965	
Engineering Service Cost		666,797	
Contingency		1,100,214	
Compensation		0	
Administration		333,398	
Project Cost (1US$=2.9R$)	(R$)	8,768,374	
	(US$)	3,023,577	

16.4.6. PROJECT COST FOR ROAD PROJECTS

The estimated project cost for road projects is shown in Table 16.4-14. The cost of Rua da Marinha includes the appurtenance for animal crossing such as cross drainages and fly over fence.

Table 16.4-14 Estimated Project Cost of Road Project

Cost Items		Av. Independencia		Av. Primairo de Dezembro/Mario Covas	Rua Yamada	Rua da Marinha	Toatal	Remarks
		Suburban Segment	Accessing Segment					
Direct Construction Cost		54,439,275	56,312,370	80,124,297	50,973,430	22,238,590	264,087,962	
Busway		43,334,155	32,542,754	38,162,047	35,212,846	15,761,133	165,012,935	
Structures		11,105,120	23,769,616	41,962,250	15,760,584	6,477,456	99,075,026	
Bus Facilities		0	0	0	0	0	0	
Indirect Construction Cost		16,331,782	16,893,711	24,037,289	15,292,029	6,671,577	79,226,388	
Construction Cost		70,771,057	73,206,081	104,161,586	66,265,459	28,910,167	343,314,350	
Engineering Service Cost		7,077,106	7,320,608	10,416,159	6,626,546	2,891,017	34,331,435	
Contingency		11,677,224	12,079,003	17,186,662	10,933,801	4,770,177	56,646,868	
Compensation		20,078,216	11,272,436	12,605,162	7,200,764	2,603,316	53,759,893	
Administration		4,542,464	4,223,926	5,838,337	3,673,311	1,575,674	19,853,712	
Project Cost (1US$=2.9R$)	(R$)	114,146,067	108,102,054	150,207,905	94,699,880	40,750,351	507,906,258	
	(US$)	39,360,713	37,276,570	51,795,829	32,655,131	14,051,845	175,140,089	

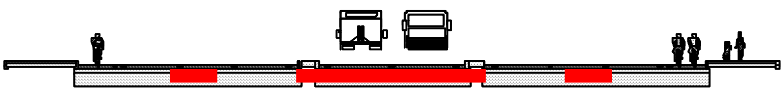
16.4.7. Total Project Cost

Table 16.4-15 shows the total project cost by the With and Without extra works. Figure 16.4-2 illustrates the extra works composed of overlay of carriage way and sidewalk, and drainage in which the parts of extra works are shown in green color. Table 16.4-16 shows the cost of extra works by project items in the trunk busway. The total project cost is approximately US$261.5 million including extra works, in which US$163 million are for the trunk bus project, and US$98.5 million are for the road projects. The extra works of trunk busway are estimated about US$27 million. It is equivalent to 27% of the total trunk busway cost.

Table 16.4-15 Total Project Cost by With and Without Extra Works

	Items	(1) Cost including Extra Works	(2) Cost excluding Extra Works	Difference	Ratio (2)/(1)
		Million US$			
(1)	Trunk Bus Project				
	Trunk Busway and Priority Lane	100.7	73.8	26.9	0.73
	Exclusive Trunk Bus Lane	45.8	45.8	0.0	
	Integrated Bus Terminals and Bus Facilities	16.5	16.5	0.0	
	Sub-total	163.0	136.1	26.9	0.83
(2)	Road Projects	98.5	98.5	0.0	
	(excluding Av. Independencia)				
Total Project Cost		261.5	234.6	26.9	0.90

Without Extra Works



With "Extra Works"; Green color shows the parts of extra works

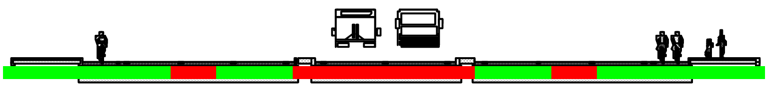


Figure 16.4-2 Part of Extra Works

Table 16.4-16 Extra Works by Items in Trunk Busway Project

Trunk Busway Project Cost

Cost Items	Av. Almirante Barroso			Rod.BR-316			Rod.Augusto Montenegro		
	For Busway	Extra Work	Total	For Busway	Extra Work	Total	For Busway	Extra Work	Total
Direct Construction Cost	17,635,895	12,704,941	30,340,837	41,936,913	13,092,425	55,029,338	39,000,631	19,781,581	58,782,212
Busway	16,285,895	12,704,941	28,990,837	40,586,913	13,092,425	53,679,338	38,190,631	19,781,581	57,972,212
Structures	1,350,000	0	1,350,000	1,350,000	0	1,350,000	810,000	0	810,000
Bus Facilities	0	0	0	0	0	0	0	0	0
Indirect Construction Cost	5,290,769	3,811,482	9,102,251	12,581,074	3,927,728	16,508,801	11,700,189	5,934,474	17,634,663
Construction Cost	22,926,664	16,516,424	39,443,088	54,517,987	17,020,153	71,538,140	50,700,820	25,716,055	76,416,875
Engineering Service Cost	2,292,666	1,651,642	3,944,309	5,451,799	1,702,015	7,153,814	5,070,082	2,571,605	7,641,687
Contingency	3,782,900	2,725,210	6,508,110	8,995,468	2,808,325	11,803,793	8,365,635	4,243,149	12,608,784
Compensation	0	0	0	0	0	0	0	0	0
Administration	1,146,333	825,821	1,972,154	2,725,899	851,008	3,576,907	2,535,041	1,285,803	3,820,844
Project Cost (1US$=2.9R$) (R$)	30,148,563	21,719,097	51,867,661	71,691,153	22,381,501	94,072,654	66,671,579	33,816,612	100,488,191
(US$)	10,396,056	7,489,344	17,885,400	24,721,087	7,717,759	32,438,846	22,990,200	11,660,901	34,651,100

Trunk Busway Project Cost	For Busway	Extra Work	Total
(R$)	168,511,295	77,917,210	246,428,505
(US$)	58,107,343	26,868,003	84,975,347

16.5. MAINTENANCE COST

The maintenance cost of the project is estimated by referring to maintenance work for similar roads and structural conditions in Belem Municipality and is estimated in the period of 20 years.

On the trunk busway, the exclusive trunk bus lane, the trunk bus priority lane, the road project and in the integrated terminal which are to be paved with asphalt pavement, it is estimated that 5% of the total trunk bus lane length and total trunk bus lane area will require overlay with a thickness of 5cm every year for the first 10 years. For the next 10 years, overlay with a thickness of 5cm will be required for the whole length and area once. The trunk busway is mainly concrete carriageway and it should be relatively maintenance-free. However, the maintenance cost per annum is approximately 0.2% of the total construction cost. The estimated maintenance cost in this project is shown in Table 16.5-1.

Table 16.5-1 Maintenance Cost

	Project Name	Type of Busway	Project Length (km)	No.of Bus Lane	Bus Lane Width(m)	Area of Bus Lane(m2)	Overlay Cost(R$/m2)	Open Year	Maintenance Cost(R$)		Maintenance Cost(US$)	
									1st to 10th year	11th to 20th year	1st to 10th year	11th to 20th year
1	Av. Almirante Barroso	Trunk Busway	6.000	2	3.5×2=7.0	–	–	2007	394,430	788,860	136,010	272,021
2	Rod.BR-316	Trunk Busway	10.750	2	3.5×2=7.0	–	–	2007	715,380	1,430,760	246,683	493,366
3	Rod.August Montenegro	Trunk Busway	13.635	2	3.5×2=7.0	–	–	2007	764,160	1,528,320	263,503	527,007
4	Av. Independencia on suburban segment	Exclusive Trunk Bus Lane	12.344	2	3.5×2=7.0	86,408	64.1	2011	2,769,376	5,538,753	954,957	1,909,915
5	Av. Independencia on central accessing segment	Exclusive Trunk Bus Lane	7.235	2	3.5×2=7.0	50,645	64.1	2007	1,623,172	3,246,345	559,715	1,119,429
6	Icoaraci Area	Trunk Bus Priority Lane	3.270	2	3.5×2=7.0	22,890	80.1(color pavement)	2007	916,745	1,833,489	316,119	632,238
7	Centro Area	Trunk Bus Priority Lane	9.800	2	3.5×2=7.0	68,600	80.1(color pavement)	2007	2,747,430	5,494,860	947,390	1,894,779
8	Mario Covas	Trunk Bus Priority Lane	3.550	2	3.5×2=7.0	24,850	80.1(color pavement)	2007	995,243	1,990,485	343,187	686,374
9	Av. Pedro Cabral and Senador Lemos	Trunk Bus Priority Lane	7.800	2	3.5×2=7.0	54,600	80.1(color pavement)	2007	2,186,730	4,373,460	754,045	1,508,090
	Subtotal		74.384						13,112,666	26,225,331	4,521,609	9,043,218

	Project Name	Type of Busway	Area of Bus Lane(m2)	Overlay Cost(R$/m2)	Open Year	Maintenance Cost(R$)		Maintenance Cost(US$)	
						1st to 10th year	11th to 20th year	1st to 10th year	11th to 20th year
1	Terminal A:	Bus Terminal	3,444	64.1	2007	220,760	441,521	76,124	152,249
2	Terminal B:	Bus Terminal	4,662	64.1	2007	298,834	597,668	103,046	206,093
3	Terminal C:	Bus Terminal	4,662	64.1	2007	298,834	597,668	103,046	206,093
4	Terminal D:	Bus Terminal	5,630	64.1	2007	360,909	721,817	124,451	248,903
5	Terminal E:	Bus Terminal	2,904	64.1	2007	186,146	372,293	64,188	128,377
6	Terminal F:	Bus Terminal	5,031	64.1	2007	322,487	644,974	111,202	222,405
7	Terminal G:	Bus Terminal	3,168	64.1	2007	203,069	406,138	70,024	140,047
8	Terminal H:	Bus Terminal	3,168	64.1	2007	203,069	406,138	70,024	140,047
	Subtotal					2,094,109	4,188,217	722,106	1,444,213

Project Name	Project Length (km)	No.of Lane	Lane Width(m)	Area of Lane(m2)	Overlay Cost(R$/m2)	Open Year	Maintenance Cost(R$)		Maintenance Cost(US$)	
							1st to 10th year	11th to 20th year	1st to 10th year	11th to 20th year
Av. Independencia on suburban segment	12.344	4	3.5	172,816	64.1	2010	5,538,753	11,077,506	1,909,915	3,819,830
Av. Independencia on central accessing segment	7.235	4	3.5	101,290	64.1	2007	3,246,345	6,492,689	1,119,429	2,238,858
Av. Primairo de Dezembro/Mario Covas	10.077	4	3.5	141,078	64.1	2010	4,521,550	9,043,100	1,559,155	3,118,310
Rua Yamada	10.000	4	3.5	140,000	64.1	2012	4,487,000	8,974,000	1,547,241	3,094,483
Rua da Marinha	4.555	4	3.5	63,770	64.1	2012	2,043,829	4,087,657	704,768	1,409,537
Total	44.211						19,837,476	39,674,951	6,840,509	13,681,018

PART E

PROJECT EVALUATION AND CONCLUSION

CHAPTER 17
Environmental Impact Assessment

PART-E PROJECT EVALUATION AND CONCLUSION

17. ENVIRONMENTAL IMPACT ASSESSMENT

17.1. WORKING FRAME OF EIA STUDY

17.1.1. INTRODUCTION

As discussed earlier, any large development project needs an official environmental license certified by SECTAM prior to construction or operations. By obtaining this environmental license, it is officially approved that potential environmental impacts to be caused by the proposed development project are well-studied and relevant environmental mitigation and monitoring programs described therein are well prepared. Basically, developers have to apply for three different types of environmental licenses: (1) LP, (ii) LI, and (iii) LO, successively (See Chapter 6 for more detailed information.) within their project cycle, and here, the EIA study for the LP application is of great concern.

In Brazilian EIA codes, official EIA/RIMA reports must be prepared for the environmental license evaluation process, and those reports must be made by the EIA consulting firms registered at the Ministry of Environment, the Government of Brazil.

Within this project, an ad-hoc EIA Study Team, consisting of the Counterpart Team, the JICA Study Team and a local EIA consulting firm, was assembled at an early stage of this project, and then, the preparation of the environmental license application was initiated.

17.1.2. WORKING SCHEDULE

The working schedule of entire EIA study of the proposed project is summarized in Table 17.1-1.

Table 17.1-1 Working Schedule of EIA Study

	2002								2003						
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7
1. Preparation of Project Brief	—														
2. ToR Discussions		—													
3. EIA STUDY			—	—	—	—	—	—							
4. PREPARATION OF EIA (D/F)							—	—	—						
5. PREPARATION OF RIMA (D/F)							—	—	—						
6. EIA/RIMA Evaluation by SECTAM										—	—	—	—	—	
7. Public Involvement											—	—	—		
8. Revising of EIA (D/F)														—	
9. CONSEMA examination															—
10. License Approval															—
F/S Schedule	I/C				P/R				Interi						D/F

Basically, the Study Team is in charge of technical supervision and support of the EIA study and takes all responsibility for the following subtask items:

1) Preparation of Project Brief
2) ToR Discussions
3) EIA Study

4) Preparation of EIA/RIMA (D/F) Reports

The following are major subtasks for which the Counterpart takes all responsibility:

1) Relevant Procedural Matters for the License Application Process

2) Public Involvement

Besides these, until the LP is officially approved by SECTAM, the Counterpart also takes all responsibility for other relevant subtasks and revising work of the EIA (D/F) after the assignment of the Study Team at Belem is over.

An environmental study relevant to the EIA of this proposed project was initiated after the completion of EIA ToR (final) in July 2002. After the EIA study was initiated, the working schedule of the entire EIA study was slightly modified, due to the difficulty of relevant environmental subtasks, and consequently, draft final reports of the EIA and RIMA were submitted to SECTAM by the end of February 2003. Then, the official announcement of the public review was made in the DIARIO OFICIAL, dated March 31, 2003. In that announcement, SECTAM declared that the draft final report of RIMA of the proposed project is available at the SECTAM Library, and any organizations, groups, parties or individuals interested in the proposed project can read it within the next 45 days. Also, they can submit any comments or questions about the submitted D/F report, and request further discussions at a public place (i.e., a public meeting) to SECTAM during this period.

At the same time, SECTAM assembled five evaluation study teams for submitted EIA reports and started their evaluations. After the public review period was terminated smoothly, it was found that SECTAM did not have any official requests for public meetings or forums from any organizations, groups, parties or individuals. As discussed earlier, it is not mandatory to have any public meetings when there is no official request during the public review period (See Chapter 6.). So, SECTAM decided not to have any public meetings or forums and to move forward to the next step, final evaluation by COEMA. Eventually, all EIA/RIMA evaluation work by SECTAM was officially completed in mid-July 2003, and the summary of their evaluations is to be sent to COEMA (SECTAM, personal communication, 2003).

17.2. IMPACT ASSESSMENT

17.2.1. INTRODUCTION

Throughout the previous initial engineering evaluation of each major road comprising entire project routes of new roads and bus system projects, described in Chapters 14 and 15, several modifications to the preliminary designs were carried out, due to feedback from the results of the IEE. As a result, several new design concepts, summarized in Table 17.2-1, were introduced into the final route and design selection for the entire project.

Table 17.2-1 Summary of Environmental Feedback from IEE

	Project Route Components	New Plan/Modification
1	Avenida Independencia	Partial route change to lessen the impact of cutting through the Environmental Reserve, Presidente Medici II. Mitigation measures such as fence, cage or animal path to lessen the conflict with fauna were introduced.
2	Rua Marinha	Mitigation measures such as fence, cage or animal path to lessen the conflict with fauna were introduced.

3	Rua Chermont	Cancelled due to the potential difficulties of large-scale expropriation.
4	Avenida Primeiro de Dezembro	Partial route change to avoid cutting through several watersheds near Alca Rodoviaria.
5	Avenida Primeiro de Dezembro	Bridge structure is selected to cross the watershed area of APA Belem, and PC Pile foundation, not CCPP (Concrete Cast-in Place Pile) type, is to be used to minimize the risk of accidental water quality deterioration during the construction period.
6	Avenida Mario Covas Extension	Same as above

Here, based on the selected best plan of route, road structure and nine associated bus terminal facilities, environmental impacts regarding several environmental factors are summarized separately in following section.

17.2.2. Descriptions of Impact Assessment

(1) Soils

1) Potential for Soil Erosion During and After the Construction.

Most of the new roads and bus system facilities along the selected route option will be constructed within the current plain road space, so no major impact on soil erosion will be expected.

Similarly, there is no steep hillside along any project route, so no major erosion will be expected, either.

However, some portion of the Primeiro de Dezembro route is to run through the APA Belem. So the area of ground clearance and/or earthwork shall be minimized as much as possible to avoid water quality degradation.

(2) Flooding/Inundation and Tributaries

1) Risk of Water Pollution to Major Tributaries During Construction.

During the construction period, there will be a risk of pollution to several tributaries running through APA Belem. This water pollution could be caused by an accidental spill of oil or any chemical solvent. So, it would be wise to prepare for the occurrence of an accidental spill of oil and other chemicals. It is essential that strict controls be established on operations in the storage of all potentially hazardous liquids such as oils. Emergency procedures should be developed in the event of an accidental spillage.

2) Excessive Water Blockage of Drainage System Due to the Construction Work and Related Local Flooding/or Inundation.

During the construction period, earthwork along the selected route will provide large-scale soil exposure to erosion that would generate extra sediments when the torrential rains hit the study area. This would cause excessive water blockage, and consequently jeopardize the regional drainage system. So, special care must be paid to avoid local flooding or inundation caused by accidental blockage of the drainage system.

3) Worsened Local Flood/or Inundation After the Construction.

Due to inappropriate integration of the current regional drainage system and the drainage design of the proposed project, a newly developed regional inundation problem might occur. It is reported that some areas of environmental reserve, Presidente Medici II, have this type of problem already. In Presidente Medici II, this problem was caused by the inappropriate drainage design of newly constructed riverbank, part of Macro-Drainage Project (Magalhaes, personal communication, 2002). After this river bank was constructed along the east side of this environmental reserve, some low-land areas within this environmental reserve became almost permanently inundated, and, eventually, the community surrounding this environmental reserve began to complain that they are annoyed by both the outbreak of mosquitoes and by the obnoxious compost smell of submerged and decaying vegetation, caused by the newly created inundation problem.

Also, due to the inappropriateness of the newly installed or re-organized regional drainage system that would combine both project drainage system and current existing ones, it might be likely to have local flood/or inundation problem at distant downstream site from discharge points of this new roads and bus system project. Capacity of any channel/tributaries/or pond to be used as receivers for this drainage system must be well-studied to lessen the chance of these local flood events.

4) Worsened Water Quality of Tributaries Due to the Partial Diversion of Run-off Water.

Within this study, some portion of run-off water in the upstream basin of the project route is to be intercepted by a newly created roadside drainage system, then conveyed to another basin for discharge. Some of that run-off water might contain certain amounts of household sewage that was originally discharged into APA Belem. As a result, the contaminant loading on another basin or tributary that will serve as the receiver will be increased by this diversion, and consequently, water quality degradation might occur. A water-quality study and pollutant mass-balance study shall be carried out to evaluate potential water quality change quantitatively.

(3) Flora/Fauna.

1) Destruction of Current Roadside Vegetation.

Three route components—BR-316, Av. Almirante Barroso and Av. Augusto Montenegro—will result in some loss of current roadside vegetation. Table 17.2-2 summarizes the number of trees to be affected by construction along each major route. In Belem, cutting, pruning or relocation of roadside vegetation requires official permission from FUNVERDE prior to the construction. In particular, some types of roadside vegetation such as mango trees are conserved as historical or cultural properties, so special attention must be paid to project-related handling of trees and shrubs in public places [DPHAC, personal communication, 2002].

Table 17.2-2 Roadside Vegetation

Location	Number of Trees		
	Small	Medium	Large
Almirante Barroso	296	21	186
BR 316	102	288	23
Augusto Montenegro	44	995	104
Total	442	1,304	313

Note: Small: D < 10.0 cm, Medium: 10.0 cm ≤ D ≤ 20.0 cm. Large: 20.0 cm ≤ D

(Source: This Study, 2002)

2) Destruction of Natural Vegetation

The project routes of Primeiro de Dezembro, Independencia and Marinha will result in some loss of the natural vegetation that might be registered as protected flora by law or regulation. The cutting, pruning or relocation of protected vegetation identified on both public and private lands requires official permission from IBAMA, SECTAM or FUNBERDE prior to construction. Special attention must be paid to project-related handling of natural vegetation.

3) Disturbance to Birds and Wildlife During the Construction Period.

During the construction period, noise and dust will result from the mechanical plant movement, or any earthwork activities. It is likely that any wildlife or birds roosting or feeding around two environmental reserves will move away to the surrounding quieter area temporarily. The return of these animals or birds will depend on the scale of the construction and increased noise resulting from the greater number of trucks as well as the tolerance of those creatures to the repeated disturbance.

4) Risk of Pollution to Aquatic Species During the Construction Period.

In case of a spill, as described earlier, there also will be the risk of pollution to aquatic species of both APA Belem and Presidente Medici II during the construction period. This could have a long-term, more severe impact on aquatic species populations. Those findings indicate that current water quality conditions within those environmental reserves are generally good, and therefore any large pollution incidents could have significant negative impacts on aquatic fauna. In particular, turbidity caused by sediment discharge or re-suspension of the bottom sediment; or increases in pH caused by untreated water discharge from the concrete-batching plant could adversely affect flora and fauna.

5) Disturbance to Animal Path After the Construction.

Some portions of project routes of Independencia and Marinha will cross Presidente Medici II and several riverside protected areas, and will cause habitat separation or loss of access to drinking places. Mitigation measures such as creation of animal paths shall be taken to lessen both the impacts of fauna community separation and animal-path cutting. Also, a roadside fence or cage that would protect animals from traffic accidents shall be prepared.

(4) Socio-Cultural Profile

1) Land Take Due to Road Alignments And Related Facilities Cconstruction.

Most of the bus system facilities will be constructed within the current road space. Also, its nine associated bus terminals located at remote places around Belem City will be constructed within state land, former factory buildings or current bus terminal spaces. So, no major land -takewill occur for the bus system project.

Table 17.2-3 summarizes expected expropriation required for bus terminal construction, as part of the bus system project.

Table 17.2-3 Expected Expropriation for Bus System Project.

	Location	Expropriation
1	Icoaraci	To be constructed within state-owned property. No expropriation.
2	Coqueiro	Same as above.
3	Marituba	To be constructed within ex-factory space. No expropriation.
4	Manguirao	To be constructed within state-owned property. No expropriation.

5	Tapana	Same as above.
6	Independencia (G)	Same as above.
7	Independencia (H)	Same as above.
8	BR316 (E)	To be constructed within currently used private company's bus-terminal space. Need to consider compensation for disrupting this bus company's business during the construction.
9	Sao Braz	Re-design of current bus terminal facility. No expropriation.

Some project routes of new roads such as AvenidaPrimeiro de Dezembro and Rua Yamada are planned through several densely inhabited areas, so they are likely to require large land takings or business disruptions around those areas. Within this study, it is estimated that approximately 1,818 houses must be expropriated for the entire project. More detailed discussion will be presented in Section 17.7.

2) *Disruption of Local Development Plan.*

There are several on-going infrastructure development projects across Belem City that might have some influences on this new road and bus system project (see Table 17.2-4). The direct interference, cumulative or secondary impacts of those with this proposed new road and bus system project must be considered. Among of them, special care must be paid to structural design integrity of the new road and bus system so that they do not interfere with each other.

Table 17.2-4 Major Development Projects Along the New Roads And Bus System Routes.

Project	Remarks
Primeiro de Dezembro Road Construction Project (L = 20 km)	Belem Municipality is constructing a new road between Marko and Utinga (L = 20 km). The proposed Primeiro de Dezembro route will connect this road at the western edge. Proper structural integrity must be established between the two projects.
Independencia Road Construction Project	Construction between August Montenegro and Alca Rodoviaria is underway. No design work for the remaining part around Una Basin (It will start after Macro-Drainage project will be terminated (COHAB, personal communication, 2002). Independencia is one of the project routes within this project and proper structural integrity must be established between current road project and the proposed project.
Alca Rodoviaria Road Construction Project	The proposed Primeiro de Dezembro route will connect this road at the eastern edge. Proper structural integrity must be established between the two projects.
Almirante Barroso Bike-Path Construction Project (Cicrovia)	Construction to shift the bike path to the center is underway (1.8 m x 2 lanes).
Entrocament Under-path Construction Project	Construction starts in spring of 2002, and is to be finished by 2004 (L = 150 m). Currently (as of fall, 2002), construction is suspended temporarily due to a budget problem (COHAB, personal communication, 2002).
Rua de Belem project	This road is to connect the canal and Trv da Piedade (L = 370 m, B = 14 m, Municipality road

	project). Now, the expropriation process is underway. Construction will start after this process is completed.
APA Belem Protection Project	Construction of protection wall surrounding APA Belem is underway, and some of the project routes might cross this wall location.
Macro-Drainage Project (Una Basin, A = 3,600 ha)	This project is still on-going. Some portions of Independencia are to be used as improved dike roads within this drainage project. Proper structural integrity must be established between the two projects.
Macro-Drainage Project (Tucunduba River Basin)	This project is also an on-going drainage project. Some portion of run-off water from another upstream basin of the project route might be conveyed and discharged to this basin.

3) Demolition of Roadside Houses.

As mentioned earlier, most of the bus system facilities will be constructed within the current road space or within state-owned properties, so no major roadside house demolition will occur for the bus system project. However, some routes of new road projects are planned to go through several densely inhabited areas, so it is likely to have several block-wide house demolitions within those areas. Within this study, it is estimated that 1,818 houses must be expropriated for entire project. A more detailed resettlement plan related to this issue will be discussed in Section 17.7.

(5) Historic and Cultural

1) Conflict with the Setting of Historical/or Monumental Facilities

Most of the bus system facilities will be constructed within the current road space, so no physical conflict with the setting of historical/or monumental facilities will occur for the bus system project. None of new road projects is to be constructed within the historically conserved area. So, no severe conflict with those facilities will occur for the road project, either.

2) Archaeological Discovery of Potential Archaeological Sites

Currently, an archaeological survey by different organizations is carried out near the Alca Rodoviaria project site, and we have been informed that there might be several undiscovered archaeological sites around the project route of Primeiro de Dezembro [Norat, personal communication, 2002]. If an important site is uncovered during road work, possible realignment of the road as well as a conservation program shall be considered.

(6) Material Transport

1) Increased Traffic Levels During the Construction for the Road Material Transport.

Due to the transport of a large amount of fresh concrete and other road materials required for the entire construction, a temporary traffic increase or traffic jams are expected to occur at several sites during the construction period. The following mitigation measures will be implemented to alleviate traffic jams to be caused by the construction:

1) All construction activities are planned during the nighttime when the city traffic condition is relatively less.

2) Two lanes are always kept open for the bus transportation during the construction period.

3) A temporal deck cover is planned to be used to cover the construction site during the daytime, and thus, the current road structure will be maintained as much as possible.

2) Preparation of Excavated Soil Dump-site.

Due to the poor soil quality for construction-use, no excavated soils or other construction wastes will be re-used and must be dumped at appropriate waste disposal sites. Industrial waste sites should be prepared and should be large enough for this excavated soil treatment. More detailed investigation of several candidate sites for construction-waste disposal will be required prior to any construction activities.

(7) Noise/Vibration

1) Noise and Vibration During the Construction Period

Since construction will result in almost continuous noise from a mobile mechanical plant and others sources, the noise and vibration levels will be significant during this period. As all construction activities are planned to start during the night, application of special mitigation measures such as noise barriers or silent construction machinery (e.g., HFV Hammer) might be considered to alleviate the noise and vibration impact around the school or residential areas.

2) Noise and Vibration Transmitted from the New Roads and Bus System.

Due to the increased traffic volume, the roadside-noise environment of several major routes such as Avenida Almirante Barroso would become worse after the proposed project starts. Currently, several hospitals, schools and parks that require a calm environment exist along those routes. Also, some project routes are to run through several residential areas where current traffic volume is very light. So, it might be wise to prepare noise and vibration mitigation measures such as installing a noise barrier to lessen the noise and vibration impacts on some residential areas.

Both noise and vibration prediction studies are to be carried out for the quantitative evaluation of both noise and vibration impact within this study. More detailed discussions about noise and vibration impact studies will be presented in Sections 17.5 and 17.6, respectively.

3) Noise and Vibration Transmitted from Bus Terminals

Table 17.2-5 and Table 17.2-6 summarize the total number of trunk and feeder buses, respectively, to be gathered at peak time.

Table 17.2-5 Total Number of Feeder Bus to be gathered at peak hour

	2007		2012	
	In	Out	In	Out
A	47	28	63	39
B	82	70	92	77
C	170	64	151	49
D	156	70	199	108
E	69	31	87	43
F	152	109	207	160
G	13	3	13	4
H	40	21	53	28

(Source: This Study, 2002)

Table 17.2-6 Total Number of Trunk Bus to be gathered at peak hour

	2007	2012
A	15	29
B	12	20
C	8	9
D	28	23
E	12	31
F	32	59
G	17	25
H	29	32
Sao Braz	153	128

(Source: This Study, 2002)

In this project, a more environmentally friendly type bus will be introduced for the trunk and feeder buses. Besides, a 2m-wide buffer zone is planned around the perimeter of each bus terminal facility. Thus, noise impacts on the surrounding community would be less significant.

(8) Air Pollution

1) Dust During the Construction Period

Similar to the temporary noise problem to occur during construction, it is likely there will be a dust problem during this period. The construction comprises large earthworks, but they are scheduled to be done within a relatively short period, so the magnitude of dust will not be major during this period. It might be recommended that stockpiles of sand and soil be well screened from residential areas. Frequent use of sprinklers would be inappropriate in Belem due to the fine soil characteristics (e.g., silt or clay). Multi-directional fall-out buckets should be used to monitor dust levels during the construction period.

2) Local Air Quality Degradation around New Road and Bus System

As described earlier, some project routes are to run through residential areas where current traffic volume is very light. It would be best to carry out a vehicular emission study to evaluate the impact on air quality of some residential areas.

Within this project, the current bus system is to be re-organized while a new environmentally friendly (much-reduced-emission-type engine) bus will be introduced, so it is expected that the total amount of vehicular emissions will be reduced, compared with the no-project scenario in the target year.

3) Vehicular Emissions

Besides this proposed project, there are several on-going relevant urban transport system improvement projects around the study area, and quantitative evaluation of the cumulative amount of all vehicular emissions (e.g., CO_2) to be generated from each project would be quite essential for further relevant environmental mitigation studies such as regional vehicular emission control or an anti-global warming program. More detailed discussions of CO_2 emissions will be presented in Section 17.4.

(9) Water Resources

1) Demolition of Shallow Wells

The existence of many shallow wells is recognized in several roadside communities along Primeiro de Dezembro, Independencia and other several routes, and some of them might be demolished due to the road alignment of this project. An alternative water supply system must be prepared as one of the compensation measures prior to the demolition work.

2) Risk of Pollution to the Aquifer During the Construction Period

During the construction period, it would be wise to prepare for an accidental spill of oil or hazardous solvent, and its resultant regional groundwater contamination. As described earlier, it is essential that all potentially hazardous liquids such as oils must be stored in secure containers in a restricted area. Emergency procedures should be developed in the event of an accidental spill.

(10)Visual Issues

1) Visual Conflict with Surrounding Community.

In historically, archaeologically or culturally conserved areas, no major construction activities other than the introduction of the colored pavement and bus stop construction or renewal are to be carried out. Also, most of the bus system facilities will be constructed within the current road space. So, no severe visual conflict with the surrounding communities will occur in the bus system project as long as proper aesthetic integrity is chosen.

Current regional aesthetic conditions around both project routes of Avenida Primeiro de Dezembro and Rua Yamada are poor. It might be possible to accentuate and improve the amenities of this townscape by integrating the planning of those new road projects into the local urban planning process.

There might be some visual conflicts with the surrounding townscape around the interchange, bridge, or viaduct part of Avenida Independencia, Rodovia Augusto Montenegro and Avenida Primeiro de Dezembro.

2) Loss of Visual Continuity of Townscape.

By the same token, no severe loss of visual continuity of the townscape will occur within the historically conserved area. On the contrary, the visual continuity of the townscape would be improved and accentuated by the linearity inherent to the new roads and the bus system facilities that will have a colored pavement structure.

As described earlier, several regional aesthetic conditions around new roads are poor. It might be possible to accentuate and improve and strengthen the visual continuity of those local townscapes by integrating the planning of those new road projects into the local urban planning process.

(11)Health

1) Risk of Malaria, Dengue and Waterborne Disease for the Construction Workforce, and Resultant Delays to the Construction.

As discussed earlier, lowland areas including the Una Basin have a bad reputation for dengue, malaria and other waterborne diseases. Due to the temporary change of the regional drainage system, there is some possibility to have newly flooded sites that would cause new outbreaks of malaria and dengue during the wet season. Daily precautions such as use of mosquito spray must be taken to lessen the risk to construction workers of infection by those diseases. It might be helpful to reduce permanently inundated areas by improving the local drainage system as well as by spraying pesticide periodically.

2) Risk of Malaria, Dengue and Waterborne Disease Outbreak after Construction.

By the same token, it would be essential to eliminate or lessen the chance of the creation of a pond or inundated area or eliminate frequently inundated areas along the project route by improving the regional drainage system. Again, structural integrity between the current local drainage and attached roadside drainage systems of the proposed project must be established to achieve a smooth regional drainage network system and lessen the chance of creation of new permanently-inundated areas.

17.3. IMPACTS MITIGATION

17.3.1. INTRODUCTION

The comprehensive, effective measures of the mitigation (i.e., avoidance, reduction, and elimination) of negative impacts for the pre-construction and construction phases of the project are described in this section. The objectives of the mitigation plan are to review impacts identified through the environmental impact assessment (EIA), and incorporate probable working practices into the mitigation plan at the pre-construction and construction phases of the project in order to anticipate those issues which are likely to require close environmental management.

The mitigation plan addresses to the negative impacts caused by the construction works and its operation. The impacts to be caused during the construction period are mostly of a temporary nature lasting only for the construction period, about five to seven years. Detailed descriptions of each mitigation measure are described in Table 17.3-1 and Table 17.3-2, and cost effective mitigation measures have been recommended. Principal purposes of this mitigation measure are as follows:

1) Maintenance of comfortable roadside environment throughout the project.
2) Alleviation of disturbance of regional hydrological balance, in particular, drainage system, and to lessen related secondary impacts.
3) Alleviation of disturbance of natural fauna/flora condition throughout the project.
4) Harmonization of new transport facilities with surrounding communities.
5) Smooth preparation for the expropriation program.

Mitigation measures must be incorporated into tender documents prepared under the engineering component of this project in order to ensure that the contractor is obliged to comply with measures in the environmental management plan (EMP).

17.3.2. IMPLEMENTATION

Table 17.3-1 and 17.1-2 summarize the measures to mitigate negative biophysical and socio-cultural impacts for all new roads and the bus system, respectively, identified in previous section. The organizations responsible for implementing and monitoring are identified.

Table 17.3-1 Summary of Mitigation Measures (Bio-Physical Environment)

Element/ Negative Impact	Mitigation Measure	Residual Impact	Responsibility	Monitoring Requirements	Implementation Schedule
Bio-Physical Environment					
Soils					
Potential for soil erosion during/and after the construction.	All earthworks should be undertaken as far as possible prior to the start of the rain season. All earthworks shall be minimized as small as possible. Disturbed soils must be re-vegetated.	Soil erosion minimized, but not eradicated.	Contractor	Engineer to monitor soil erosion.	On-going during construction
Floods/or inundation					
Risk of hazardous waste material exposure to major tributaries during construction.	Great care must be taken to ensure that potential contaminants do not enter any tributaries. All chemicals (oil, petrol etc.) must be kept in securely bounded areas with a capacity greater than the volume of chemical to be stored. Oily wastes must be stored at suitable disposal sites. The Contractor must submit written emergency procedures to be followed in the event of accidental spillage.	Risk of pollution reduced but not eliminated.	Contractor	Engineer	On-going during construction.
Local flood/or inundation caused by excessive water blockage of drainage system due to construction work.	Temporary and/or permanent drainage systems are designed to minimize the occurrence of local flood/or inundation and impact on the water quality of several tributaries. Surface run-off water must be collected in sediment ponds. The drainage system must be periodically cleared so as to ensure smooth water flow.	Local flood/or inundation minimized but not eliminated.	Design Engineer.	Contractor.	On-going during construction.
Worsened local flood/ inundation after the construction	Drainage systems that establish design integrity between local drainage system and those of new roads are designed to minimize the occurrence of local flood/or inundation. The drainage system must be periodically cleared so as to ensure smooth-running water flow.	Same as above.	Same as above.	Government of Para State	After Construction
Worsened water quality due to partial diversion of run-off water.	Manage non-point pollution through the application of the best management practices as determined by a state or municipality to be the most effective practicable means of achieving pollutant levels compatible with water quality goals. Use constructed wetlands to control non-point source pollution involving nutrients, pesticides and sediments.	Water quality degradation minimized.	Same as above.	Same as above	Same as above
Flora/Fauna					

Destruction of roadside vegetation.	Planting should be done wherever possible with native species that are likely to require little maintenance and may prove beneficial in maintaining ecosystem integrity with coordination of FUNVERDE. Topsoil must be removed, segregated, stored, and redistributed with minimum loss or contamination. Topsoil and subsoil may be removed separately and replaced in sequence. In cases where non-native species are deemed essential, careful monitoring should be planned.	Impact on roadside vegetation minimized, not eliminated.	Contractor	Contractor	Before construction.
Destruction of natural vegetation.	Planting should be done wherever possible with native species that are likely to require little maintenance and may prove beneficial in maintaining ecosystem integrity with coordination of IBAMA/SECTAM and/or FUNVERDE. In cases where non-native species are deemed essential, careful monitoring should be planned.	Destruction of natural vegetation minimized, not eliminated.	Contractor	Contractor	Before construction.
Disturbance to birds and wildlife during construction.	Although birds and wildlife (i.e., monkey) may be disturbed during the construction activities, the effect is likely to be very minor, and birds and wildlife will relocate to area further away from the construction site. After construction, birds and wildlife will return, depending on the scale of construction activities. IBAMA/SECTAM and/or FUNVERDE must be consulted. Timing, shaping and sizing of operations must be concluded to avoid breeding or nesting season and trees, protecting key food, cover, and water resources. Fencing will keep large mammals from direct contact with toxic chemicals in sedimentation ponds and from roadway to reduce the number of roadkills.	Animals and birds will move away. Habitat altered. Local ecosystem changed.	N.A.	N.A.	N.A.

Risk of pollution on aquatic species during construction.	Great care must be taken to ensure that potential contaminants do not enter APA Belem or any other water courses. All chemicals (oil, petrol etc.) must be kept in securely bounded areas with a capacity greater than the volume of chemical to be stored. The concrete batching plant must be located away from the riverbank, and effluent neutralized prior to disposal. Oil interceptors should be used, and oily wastes must be stored to suitable disposal sites. IBAMA/SECTAM and/or FUNVERDE must be consulted. Buffer strips must be left between construction sites and waterways. All streams restoration is to include alternating patterns or riffles, pools, and drops. The Contractor must submit written emergency procedures to be followed in the event of accidental spillage.	Risk of water pollution minimized, not eliminated.	Contractor	Contractor	During construction
Disturbance to animal path after construction	Local ecosystem such as access to drinking and feeding places shall be well-studied. Animal path, fence, and/or cage must be designed to lessen impact of fauna community separation. Create new feeding/drinking sites far distant from roadways.	Roadkills by traffic accident decreased, not eliminated. Habitat alternated. Local ecosystem changed.	Government of Para State	N.A.	N.A.

Table 17.3-2 Summary of Mitigation Measures (Socio-Cultural Environment)

Element/ Negative Impact	Mitigation Measure	Residual Impact	Responsibility	Monitoring Requirements	Implementation Schedule
Socio-Cultural					
Land Take					
Land take due to road alignment along new-road route.	Approximately 1,818 house will be expropriated along the route Alternative houses/or resettlement sites must be provided prior to the land take. Alternative houses shall be located as close to the previous locations as possible. Appropriate expropriation programs should be prepared. Resettlement issues will be discussed in Section 17.7	Housing rebuilt in alternate location. Appropriate compensation prepared.	Government of Para State.	Government of Para State	Before expropriation begins.
Conflict with on-going local development plans.	Direct interference among all projects must be avoided. Potential cumulative and/or secondary impacts shall be well examined.	All projects coordinated.	Government of Para State	N.A.	N.A.
Historical and Cultural					
Archaeological discovery of potential sites.	New or additional historic properties are discovered, damage to those newly discovered should be minimized. Typical mitigation measures include limiting the magnitude of the undertaking, modification of undertaking through the re-design, re-orientation of construction, repairing, rehabilitation, or restoration of affected areas, preservation and maintenance operation for involved historic properties, relocation of historic properties and so on. IPHAN/SECULT-DHPAC and FUMBELL must be consulted.	Disturbance to potential archaeological site minimized.	Contractor	N.A.	On-going during construction.
Material Transport					
Increased traffic level during construction for materials transport.	During construction period, trucks delivering materials to site should be thoroughly checked to ensure they are road worthy and that the brakes are in full working order. Where feasible, trucks should avoid driving through the residential areas. Trucks used for the transportation of material should be routed, where feasible, to avoid residential area. Re-use soil cut from earthwork for new roads construction as much as possible to lessen long-distance deliveries.	Risk of accidents reduced but not eliminated.	Contractor	Engineer	On-going during construction
Preparation of Excavated soil dump site.	Selection of soil dumping sites shall be well-discussed with relevant agency such as SECTAM. Soil dumping sites shall be well spread over entire project site to avoid local traffic congestion.	Illegal dumping of construction material/or soil avoided.	Contractor	Contractor	Before construction
Noise/vibration					

Noise and vibration during construction period	It is recommended that Environmental Standards for Construction Sites be adhered to. Purchased mobile equipment should be in compliance with Brazilian noise emission standards. Machinery and vehicles should be well maintained in order to keep their noise at a minimum.	Noise/vibration nuisance reduced and controlled.	Contractor	Engineer	On-going during construction
Noise/vibration transmitted from new roads and bus system.	Vehicular noise can be reduced at source through vehicle construction process, selection of tires and exhaustion system as well as vehicle maintenance. Also, the application of smooth, well-maintained surfaces is effective in reducing frictional noise and vibration. Noise barrier is the most common mitigative measures used. Low noise pavement is also useful mitigative measure. Note building façade insulation such as double window glazing is an option to dampen noise in building. More detailed discussion about noise impact prediction will be presented in later section	Same as above	Government of Para State	Government of Para State	After construction.
Air Pollution					
Dust during construction	Vehicles delivering materials should be covered to reduce spillage. Mixing equipment should be well sealed, and vibrating equipment should be equipped with dust-removal device. Wind erosion from open land can be controlled by use of following three basic techniques (watering, use of chemical stabilizers, and wind breaks) in addition to a vegetation cover. Operators should pay attention to their health.	Dust levels controlled.	Contractor	Engineer	On-going during construction
Local air quality degradation around new roads and bus system.	Introduce environmentally-friendly vehicle (e.g., hybrid type vehicle), more sophisticated I/M program, traffic regulation, clean fuel policy and others. It is recommended that air quality environmental standards be adhered to.	Air quality level controlled.	Government of Para State	Government of Para State.	After construction
Water Resources					
Pollution of existing wells.	Contractor must take adequate steps to prevent pollution, including bounding area at where any hazardous liquids such as oil or petrol are stored. Contractor must submit written details of the procedures to be implemented in the event of pollution incident.	Risk of groundwater pollution or depletion minimized but not eliminated.	Contractor	Contractor	Engineer On-going during construction
Demolition of shallow wells	New wells and/or alternative water supply system are to be provided.	Alternate water supply system prepared.	Government of Para State	N.A.	Before demolition begins.
Visual Resources					

Loss of visual continuity of townscape.	It is recommended that basic design and architectural elements (e.g., form, line, color, texture and architectural features) typically used in surrounding community should be used or repeated in order to ensure the compatibility in urban area.	Townscape visual continuity kept.	Design Engineer	N.A.	N.A.
Visual conflict with surrounding community.	Provision of greenbelts around project sites is recommended. Also, provision of appropriate visual screens or barriers in viewscape to preclude unsightly intrusion from the project is efficient. Incorporation of underground utilities (electricity, water, sewer and gas) in project planning. Provision of appropriate visual screens or barriers in the viewscape to preclude unsightly intrusions from the project. Planning and implementation of an appropriate landscaping program.	Visual conflict reduced to minimum.	Government of Para State	N.A.	N.A.
Health					
Risk of waterborne disease outbreak during construction	Basic health and safety education must be given to all construction workers prior to starting work, and adequate medical facilities should be provided, to help reduce the risk of spreading infectious diseases. Any effective prevention drug should be taken regularly before moving into areas, during stay, and for several weeks after departing.	Risk of waterborne disease infection minimized.	Contractor	Contractor	On-going during construction.
Risk of waterborne disease after construction.	Drainage systems that establish local drainage system and those of new roads are designed to minimize the occurrence of long-term inundation that would become possible origins of waterborne disease or outbreak of mosquitoes. The drainage system must be periodically cleared so as to ensure smooth water flow.	Risk of waterborne disease minimized. No newly created inundation happen.	Design Engineer	N.A.	N.A.

17.4. VEHICULAR EMISSION STUDY

17.4.1. INTRODUCTION

The purpose of this study is to evaluate the amount of vehicular emission to be generated by the future regional traffic and transport conditions around the Belem City Area, and to carry out a comparative study under the following two scenarios: **with-** and **without-**the proposed new road and bus system project in the years 2007, 2021 and 2020. Here, emissions of nitrogen oxides (NOX) and carbon dioxides (CO_2) are of concern. Besides, based on the construction schedule of the proposed project, summarized in Chapter 17, Life Cycle Assessment (LCA) Study of CO_2 emission is carried out to evaluate the emission loading to be generated from the construction activities.

17.4.2. COMPUTATION OF VEHICULAR EMISSIONS

The daily amount of the total emission loading of pollutants, $\mathbf{W_s}$, is computed by,

$$\mathbf{W_s = \Sigma E_s \cdot CK} \qquad (1)$$

where $\mathbf{E_s}$ is vehicle-type air pollution emission factor of targeted pollutants, and **CK** is the computational results (vehicle times kilometers) of future traffic and transport demand forecast (See Chapter 9 of main report). Based on NOX emission factors used at CETESB, Sao Paulo, the following three fuel-type, and traveling speed-dependent emission factors are used (see Table 17.4-1).

Table 17.4-1 Vehicle Emission Factors (NOX (g/km))

	Speed (km/hr)					
	10	20	30	40	50	60
Gasoline	0.839	0.732	0.700	0.690	0.691	0.701
Alcohol	1.319	1.212	1.180	1.170	1.171	1.181
Diesel	1.115	0.758	0.627	0.567	0.546	0.555

Note: Unit of emission factors for diesel is "(g/ton/km)". References: CETESB http://www.cetesb.sp.gov.br, 2002

Major numerical parameters to be used within this NOX emission study are summarized in Table 17.4-2. Within this NOX emission study, mainly the parameters of the vehicle weight of conventional bus and truck are perturbed.

Table 17.4-2 Numerical Parameters

Parameters	Remarks
Ratio of gasoline-fueled Car to alcohol-fueled one*1) Weight of Articulated Bus*2)	0.88 : 0.12 25 ton/vehicle
Weight of Conventional Bus *3) Weight of Truck*4)	13, 15 and 20 ton/vehicle (perturbed) 5 - 25 ton/vehicle (perturbed)

Source *1) This Study, *2) Anuario do Onibus 2002, Techni Bus, No. 10, 2002, *3) Normas para o Projeto das Estradas de Rodagem, Ministerio dos Transportes, 1973, and *4) Manual de Pre-Misturados a Frio, IBP.

No information or parameter of CO_2 emission factor exist in Brazil. So, vehicular emission factors summarized in current study reports are used for CO_2 emission study[5].

The estimation of the environmental benefit to be caused by the operation of the proposed transport project is carried out by evaluating the amounts of emitted NOX and CO_2 reduction that are due to the change of vehicle-kilometer of the entire transport situation.

17.4.3. RESULTS

Based on the evaluation procedures described previously, the calculation of the regional amount of NOX and CO_2 vehicular emission in the years 2007, 2012 and 2020 is carried out. As described earlier, sensitivity analysis while changing the two parameters of vehicle weight of conventional buses and trucks is conducted within the NOX vehicular emission study. Table 17.4-3 - Table 17.4-10 summarize computational results of vehicular emissions and the environmental benefit (reduction of emitted NOX). Similarly, Table 17.4-11 summarizes computational results of vehicular emissions and the environmental benefit (reduction of emitted CO_2).

[5] Environmental Bureau, Tokyo Metropolitan Municipality, Study on Vehicular Emission for Future Traffic Demands in Metropolitan Area, 2000

17.4.4. DISCUSSIONS

(1) NOX

Figure 17.4-1 - Figure 17.4-17 show the computational results of NOX vehicular emission while changing the two parameters of vehicle weight of the conventional buses and trucks. The amounts of the vehicular emission-reduction of NOX to be caused by the operation of the proposed transport project in the year 2020 vary between 6.82 tons/day (a 19.6%-reduction, see Table 17.4-7) and 3.62 tons/day (14.5%- reduction, see Table 17.4-10). This reduction can be explained by the following reasoning. After operation of proposed new roads and bus system starts, the entire public transport by bus will be improved greatly in comparison with the current non-organized bus operation. Then, some car commuters will switch to use the proposed bus system, provided that the bus fare of the proposed bus system is reasonably set for the public transport system users. Eventually, traffic volumes of several major roads around Belem City will be lessened due to this modal shift, and the severity of current traffic conditions (traffic jams, road safety and so on) will be alleviated to some extent. As a result, the entire traffic condition and roadside environment around the Belem City Area will be improved (A more detailed discussion of traffic transport benefits to be caused by the proposed transport project can be found in Chapter 9 of the main report). After the year 2012, the entire transport condition tends to be saturated and traffic flow becomes stagnant and then, city-wide traffic efficiency starts getting worse, while the entire vehicular emission loading of NOX increases. So, no further improvement in NOX reduction can be expected without other improvement projects.

(2) CO_2

Figure 17.4-18 shows the computational results of CO_2 vehicular emission. A similar CO_2 reduction tendency, discussed previously, can be found in this computational result. After the proposed project starts, the reduction amount of CO_2 vehicular emission increases, and this reduction rate reaches 26% in the year 2012. After 2012, this reduction rate tends to decrease slightly, due to the nearly saturated entire transport condition whereas the entire vehicular emission loading of CO_2 increases.

(3) Life Cycle Assessment of CO_2 Emission

Figure 17.4-19 shows the time variation of annual CO_2 emission loading during Year 2002 - 2020. Here, annual CO_2 emission loading for each scenario is computed based on LCA (Life Cycle Assessment) concept[1], and computed CO_2 emission loading to be generated by all construction activities such as construction machine operation and material delivery are added to the emission loading to be generated by entire transport system.

As shown in these figures, the CO_2 emission loading for With-Project scenario becomes higher than that of Without-Project scenario at the early stage of construction period. The deficit of CO_2 emission-loading (i.e., the difference of the CO_2 emission loading between both scenarios) is increased gradually during this period and reaches the highest in 2006 (the reduction rate is -6.1 %) since most of construction works of the proposed project are planned to be terminated by the end of this year.

After the operation of the proposed project starts partially in 2007, this deficit is disappeared dramatically and then, turned into the surplus (i.e., the emission loading for With-Project scenario is lower than that of Without-Project scenario) in 2007. After this,

[1] E.g., T. Morioka et. al., Life Cycle Assessment on Civil Engineering Activities (No. 1), Proc. of 3rd Conf. of Global Environment Symposium, pp61 - 66, 1995.

the CO_2 emission-loading surplus is increased asymptotically, and reach highest values around Year 2012 (the reduction rate is 25.8 %).

Table 17.4-3 Vehicular Emission (NOX, t/day)

	2007		2012		2020	
Truck W	With	Without	With	Without	With	Without
25	11.16	12.60	14.90	18.54	27.94	34.76
20	10.54	11.93	14.16	17.60	26.59	32.97
15	9.92	11.26	13.41	16.65	25.23	31.17
10	9.30	10.59	12.66	15.70	23.88	29.38
5	8.68	9.92	11.91	14.76	22.52	27.59

Note: Weights of A. Bus and C. bus are 25 and 20 t/vehicle, respectively, and weight of truck is perturbed.

Table 17.4-4 Vehicular Emission (NOX, t/day)

	2007		2012		2020	
Truck W	With	Without	With	Without	With	Without
15	9.93	10.92	13.53	16.31	25.75	31.10
13	9.68	10.52	13.28	15.79	25.42	30.35

Note: Weights of A. Bus and truck are 25 and 20 t/vehicle, respectively, and weight of C. Bus is perturbed.

Table 17.4-5 Vehicular Emission (NOX, t/day)

	2007		2012		2020	
Truck W	With	Without	With	Without	With	Without
25	10.55	11.59	14.28	17.25	27.11	32.89
20	9.93	10.92	13.53	16.31	25.75	31.10
15	9.31	10.25	12.78	15.36	24.40	29.31
10	8.69	9.59	12.04	14.42	23.04	27.52
5	8.06	8.92	11.29	13.47	21.69	25.72

Note: Weights of A. Bus and C. bus are 25 and 15 t/vehicle, respectively, and weight of truck is perturbed.

Table 17.4-6 Vehicular Emission (NOX, t/day)

	2007		2012		2020	
Truck W	With	Without	With	Without	With	Without
25	10.30	11.19	14.03	16.74	26.77	32.14
20	9.68	10.52	13.28	15.79	25.42	30.35
15	9.06	9.85	12.53	14.85	24.07	28.56
10	8.44	9.18	11.79	13.90	22.71	26.77
5	7.82	8.52	11.04	12.95	21.36	24.98

Note: Weights of A. Bus and C. bus are 25 and 13 t/vehicle, respectively, and weight of truck is perturbed.

Table 17.4-7 Vehicular Emission, NOX Reduction

	2007		2012		2020	
Truck W	(t/day)	(%)	(t/day)	(%)	(t/day)	(%)
25	1.44	11.41	3.64	19.63	6.82	19.61
20	1.39	11.65	3.44	19.55	6.38	19.35
15	1.34	11.92	3.24	19.47	5.94	19.06
10	1.29	12.22	3.04	19.38	5.50	18.73
5	1.25	12.56	2.85	19.28	5.07	18.37

Note: Weights of A. Bus and C. bus are 25 and 20 t/vehicle, respectively, and weight of truck is perturbed. Reduction (%) = 100 x (Emission without - Emission with)/(Emission without)

Table 17.4-8 Vehicular Emission, NOX Reduction

	2007		2012		2020	
Truck W	(t/day)	(%)	(t/day)	(%)	(t/day)	(%)
15	1.00	9.12	2.78	17.03	5.35	17.19
13	0.84	7.97	2.51	15.90	4.93	16.25

Note: Weights of A. Bus and truck are 25 and 20 t/vehicle, respectively, and weight of C. Bus is perturbed.
Reduction (%) = 100 x (Emission without - Emission with)/(Emission without)

Table 17.4-9 Vehicular Emission, NOX Reduction

	2007		2012		2020	
Truck W	(t/day)	(%)	(t/day)	(%)	(t/day)	(%)
25	1.04	9.01	2.98	17.25	5.78	17.58
20	1.00	9.12	2.78	17.03	5.35	17.19
15	0.95	9.25	2.58	16.79	4.91	16.75
10	0.90	9.40	2.38	16.51	4.47	16.25
5	0.85	9.56	2.18	16.20	4.03	15.68

Note: Weights of A. Bus and C. bus are 25 and 15 t/vehicle, respectively, and weight of truck is perturbed.
Reduction (%) = 100 x (Emission without - Emission with)/(Emission without)

Table 17.4-10 Vehicular Emission, NOX Reduction

	2007		2012		2020	
Truck W	(t/day)	(%)	(t/day)	(%)	(t/day)	(%)
25	0.89	7.92	2.71	16.19	5.37	16.71
20	0.84	7.97	2.51	15.90	4.93	16.25
15	0.79	8.03	2.31	15.58	4.50	15.74
10	0.74	8.09	2.11	15.22	4.06	15.16
5	0.70	8.17	1.92	14.80	3.62	14.50

Note: Weights of A. Bus and C. bus are 25 and 13 t/vehicle, respectively, and weight of truck is perturbed.
Reduction (%) = 100 x (Emission $_{without}$ - Emission $_{with}$)/(Emission $_{without}$)

Table 17.4-11 Vehicular Emission, CO2 Reduction

	With	Without	Reduction (t/day)	Reduction (%)
2007	1383.88	1588.25	204.37	12.87
2012	2106.72	2846.73	740.00	25.99
2020	5468.00	7207.55	1739.56	24.14

Note: Reduction (%) = 100 x (Emission $_{without}$ - Emission $_{with}$)/(Emission $_{without}$)

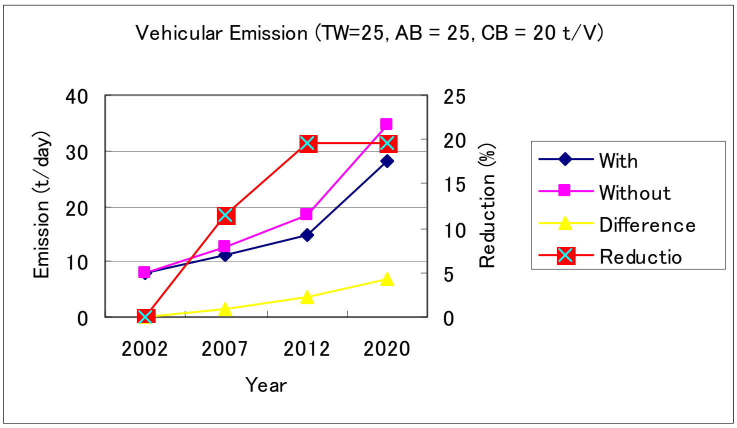


Figure 17.4-1 Vehicular Emission (NOX, Truck = 25 t, C. Bus = 20 t, A. Bus = 25 t)

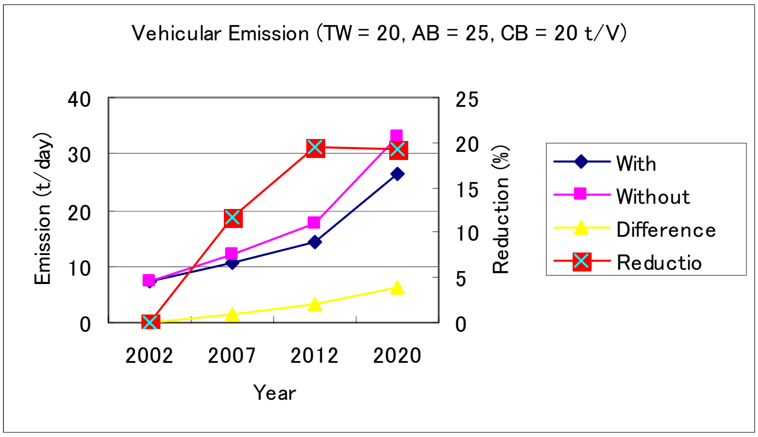


Figure 17.4-2 Vehicular Emission (NOX, Truck = 20 t, C. Bus = 20 t, A. Bus = 25 t)

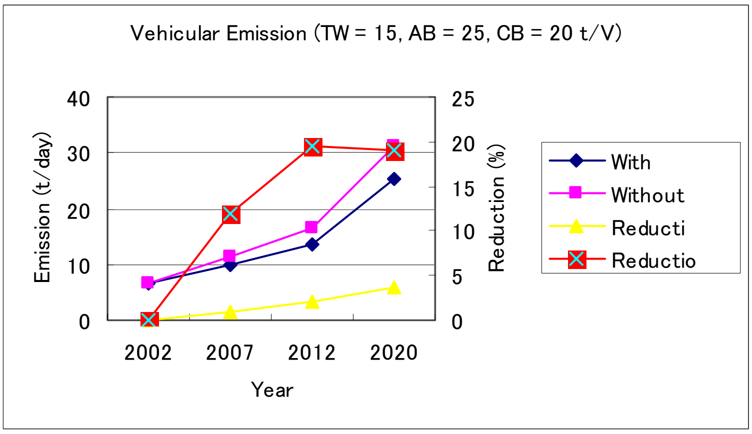


Figure 17.4-3 Vehicular Emission (NOX, Truck = 15 t, C. Bus = 20 t, A. Bus = 25 t)

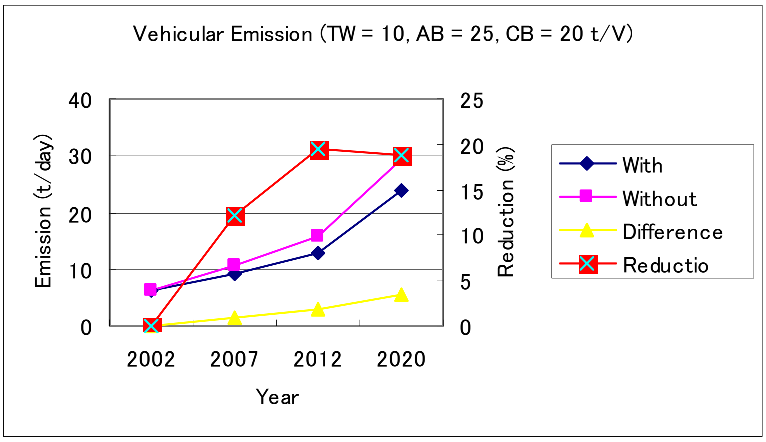


Figure 17.4-4 Vehicular Emission (NOX, Truck = 10 t, C. Bus = 20 t, A. Bus = 25 t)

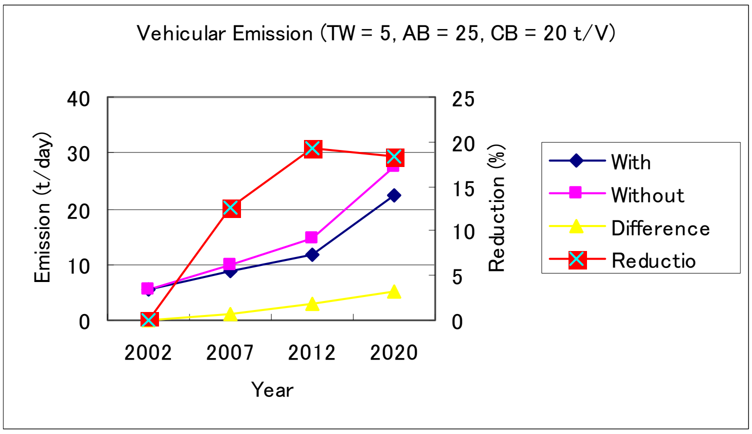


Figure 17.4-5 Vehicular Emission (NOX, Truck = 5 t, C. Bus = 20 t, A. Bus = 25 t)

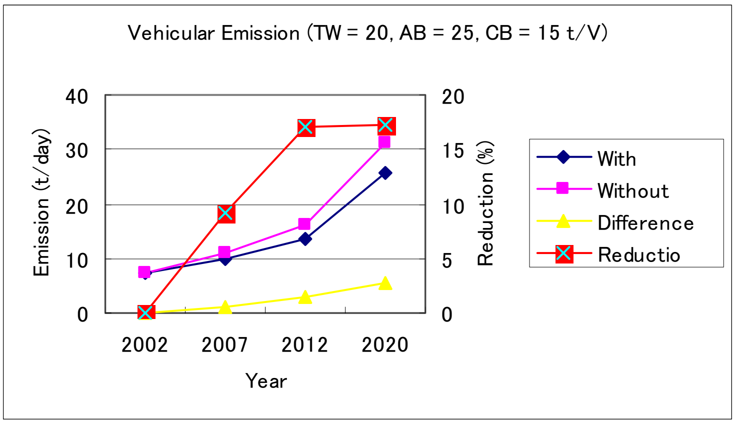


Figure 17.4-6 Vehicular Emission (NOX, Truck = 20 t, C. Bus = 15 t, A. Bus = 25 t)

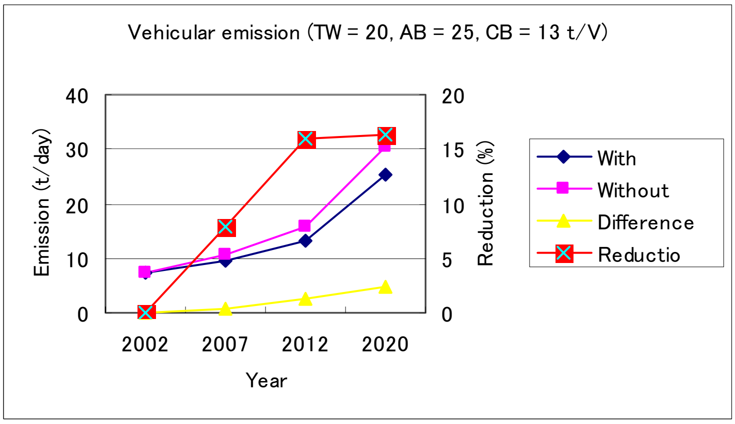


Figure 17.4-7 Vehicular Emission (NOX, Truck = 20 t, C. Bus = 13 t, A. Bus = 25 t)

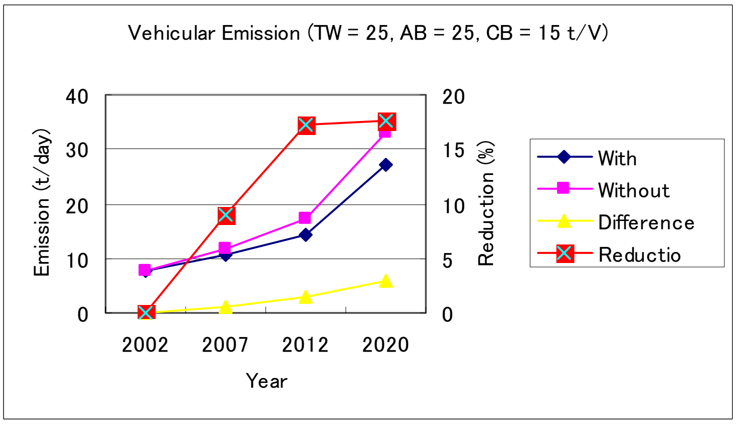


Figure 17.4-8 Vehicular Emission (NOX, Truck = 25 t, C. Bus = 15 t, A. Bus = 25 t)

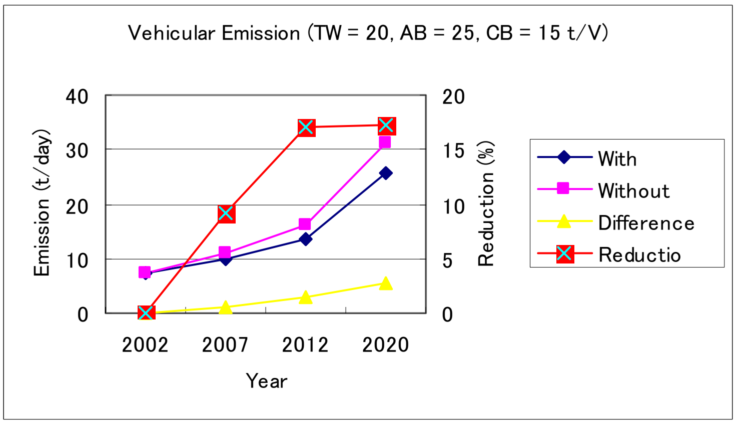


Figure 17.4-9 Vehicular Emission (NOX, Truck = 20 t, C. Bus = 15 t, A. Bus = 25 t)

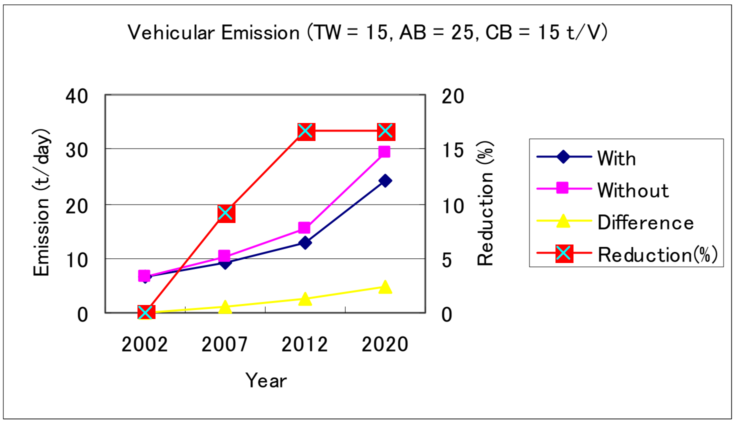


Figure 17.4-10 Vehicular Emission (NOX, Truck = 15 t, C. Bus = 15 t, A. Bus = 25 t)

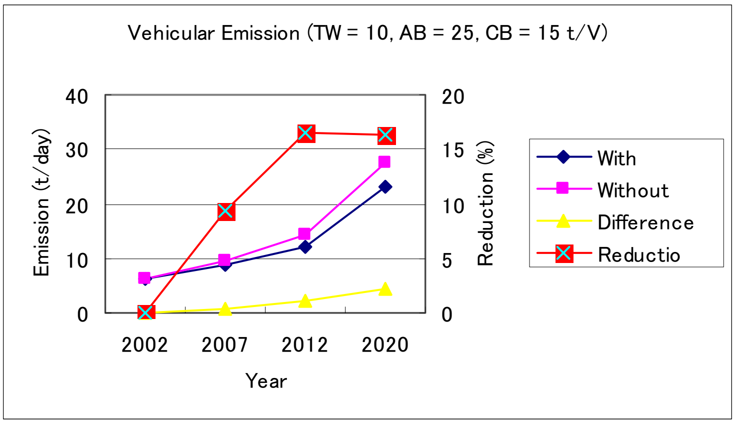


Figure 17.4-11 Vehicular Emission (NOX, Truck = 10 t, C. Bus = 15 t, A. Bus = 25 t)

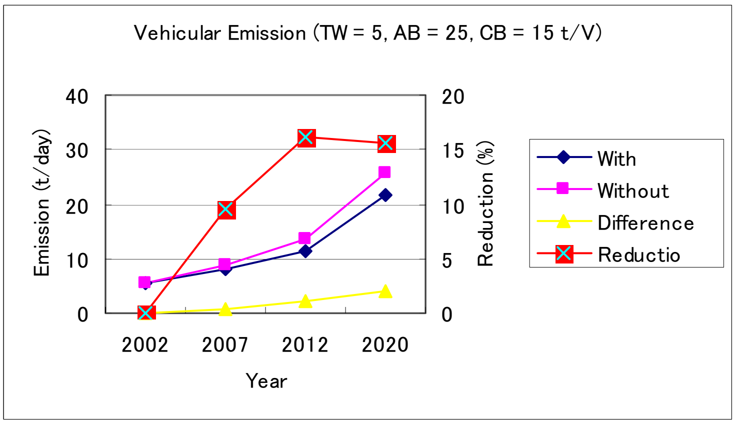


Figure 17.4-12 Vehicular Emission (NOX, Truck = 5 t, C. Bus = 15 t, A. Bus = 25 t)

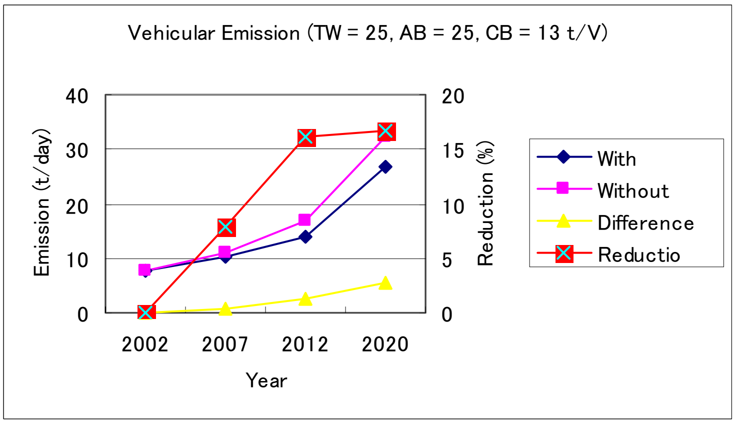


Figure 17.4-13 Vehicular Emission (NOX, Truck = 25 t, C. Bus = 13 t, A. Bus = 25 t)

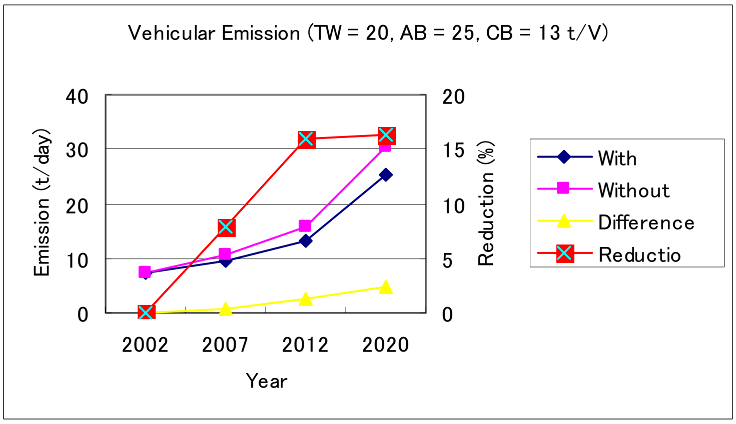


Figure 17.4-14 Vehicular Emission (NOX, Truck = 20 t, C. Bus = 13 t, A. Bus = 25 t)

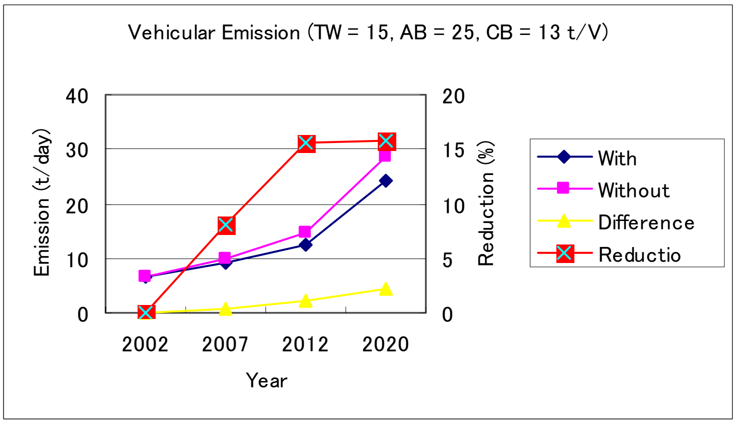


Figure 17.4-15 Vehicular Emission (NOX, Truck = 15 t, C. Bus = 13 t, A. Bus = 25 t)

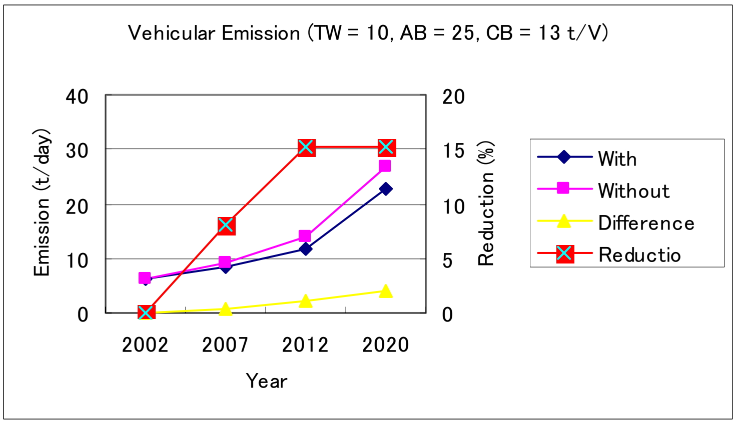


Figure 17.4-16 Vehicular Emission (NOX, Truck = 10 t, C. Bus = 13 t, A. Bus = 25 t)

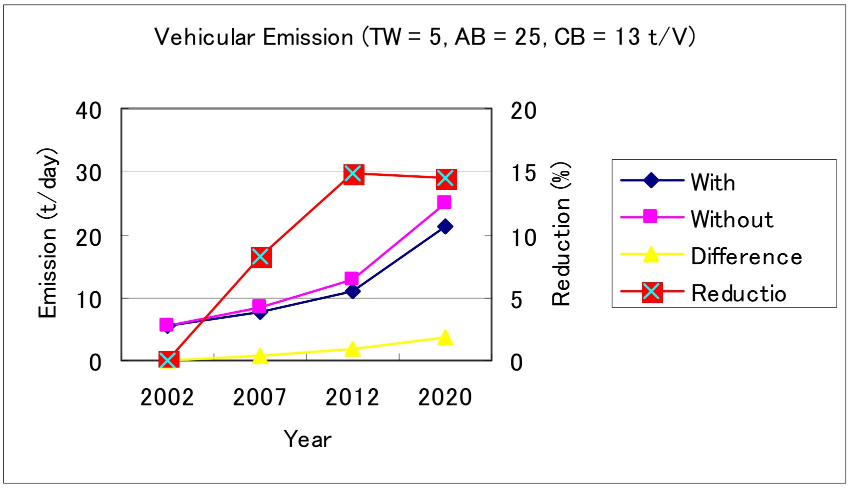


Figure 17.4-17 Vehicular Emission (NOX, Truck = 5 t, C. Bus = 13 t, A. Bus = 25 t)

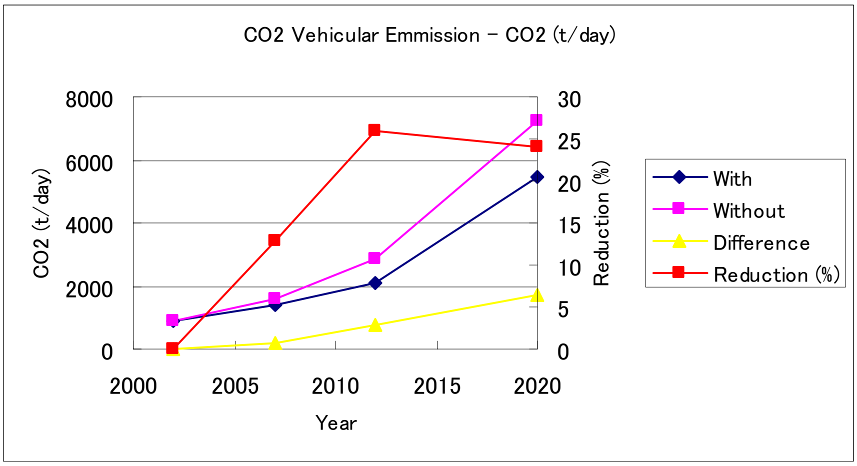


Figure 17.4-18 Vehicular Emission (CO_2)

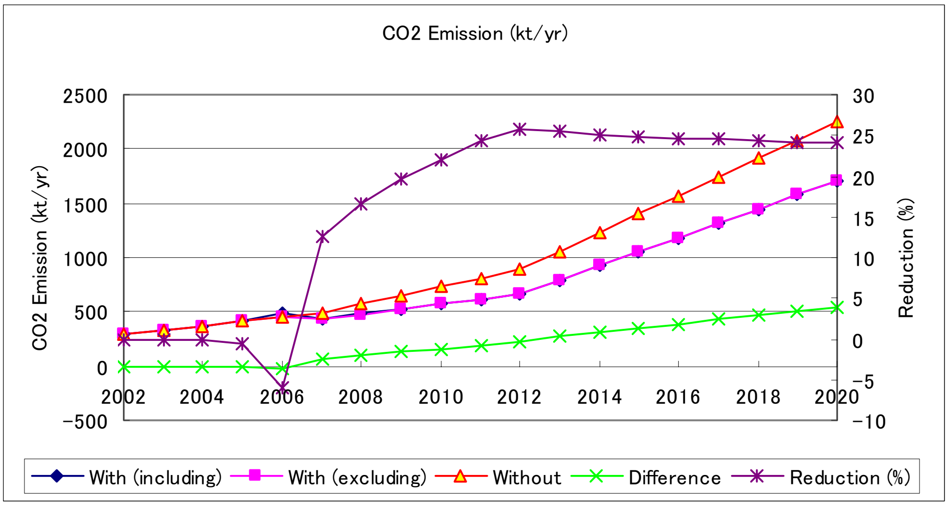


Figure 17.4-19 LCA-based CO_2 Emission (k ton/yr), Year 2002 - 2020

17.5. NOISE IMPACT PREDICTION

17.5.1. OBJECTIVES

The purpose of this analysis is to evaluate the sound pressure level to be generated by the future traffic and transport conditions along main routes such as Avenida Almirante Barroso, and find suitable impact mitigation measures within this project.

17.5.2. NUMERICAL PARAMETERS

Basically, the noise impact prediction study is carried out for daytime and nighttime transport conditions. Table 17.5-1 summarizes the outline of this noise impact prediction. In the following, two noise mitigation measures, (i) low noise pavement, and (ii) noise barrier, are of concern. The transport conditions between daytime peak (7:00 a.m.) and nighttime peak (6:00 a.m.) are almost the same, so the noise barrier study is carried out only for the daytime case. Due to the lack of traveling speeds of passenger cars for the nighttime case, two assumed traveling speed parameters of passenger cars (40 and 50 km/hr) are used, based on results of current study reports [EVPDTU, 2001]. Using these values, both traveling speeds of conventional bus and the truck are computed.

Table 17.5-1 Numerical Conditions

	Descriptions
Prediction Method	B-method specified by Acoustics Society of Japan
Target Year	Years 2002, 2007, 2012 and 2020
Simulation Case	Carry out simulation for the daytime peak (7:00 a.m.) and the nighttime peak (6:00 a.m.), respectively. Simulation is carried out for following four cases, 1. Verification (Year 2002) 2. Without-Project scenario at Year 2007, 2012 and 2020. 3. With-Project scenario at Year 2007, 2012 and 2020 without any mitigation measures. 4. With-Project scenario at Year 2007, 2012 and 2020 with some mitigation measures.
Power Level*1)	Heavy Truck & Bus : $L_w = 90.0 + 10.0 \log_{10} V$ Passenger Car : $L_w = 82.0 + 10.0 \log_{10} V$ where V is vehicle moving speed [km/hr]
Prediction Point	Boundary between public and private property (hp = 1.2 and 6.0 m, respectively) located at two noise survey points of Avenida Almirante Barroso.
Noise Mitigation Measures	The following two mitigation measures are considered, 1. Low Noise Pavement 2. Noise Barrier Note: Noise barrier study is carried out for the daytime peak case for the simplification.

*1) ASJ Roadside Noise Study Group [ASJ, 1998]

17.5.3. RESULTS AND DISCUSSIONS

(1) Day time

Table 17.5-2 and Table 17.5-3 summarize the predicted sound pressure level at Bosque and Sao-Braz, respectively. Both tables list predicted results for (i) Without-Project scenario, (ii) With-Project-scenario without any mitigation measures, and (iii) With-Project-scenario with low noise pavement installation.

L_{eq} values at Bosque and Sao-Braz in Year 2002 Without-Project scenario are computed as 83.84 and 83.63 dBA, respectively, and the order of the magnitude of those values are very close to those of actual L_{DN} values at both points, obtained from the survey results (See Section 6.5 of Chapter 6.). So, it can be said this noise prediction method is valid within this study.

In all Without-Project cases, it is found that both predicted noise levels at Bosque and Sao-Braz exceed the current daytime noise standard of Brazil. When the proposed project is implemented without any noise mitigation measures, predicted sound pressure levels at both receptor positions tend to be decreased by 2 dBA. This is mainly caused by the re-design of vehicle lanes, increasing the physical distance between the centerline of the outermost vehicle lane and the receptor position slightly. When low-noise pavement is implemented within the With-Project scenario, the predicted sound pressure levels at both receptor sites are decreased further by 1.5 dBA. So, it can be said that low noise pavement would achieve a moderate noise impact reduction. It is noted that periodic maintenance will be required for this type of pavement to maintain high-performance of the pavement structure.

Table 17.5-4 and Table 17.5-5 summarize the predicted sound pressures level at Bosque for the With-Project scenario with noise barrier installation. The difference between the two tables is the height of the sound emission source, Hnes (Hnes values used within Table 17.5-3 and Table 17.5-4 are 1.0 m and 0. 3 m, respectively). Similarly, Table 17.5-6 and Table 17.5-7 summarize the predicted sound pressures level at Sao-Braz for the With-Project scenario with noise barrier installation. When a noise barrier is installed, predicted sound pressure levels at hp = 1.2 m are reduced considerably, whereas sound pressure levels at hp = 6.0 m are increased and exceed the current Brazilian noise standard (55 and 60 dBA for the residential, and commercial and mixed area, respectively). These changes are mainly caused by the effect of the diffraction of the noise transmission. The physical distance between the noise emission source and receptor with hp = 1.2 m is increased by the noise barrier installation. However, reflected sound energy is shifted toward another direction by noise barrier installation, and consequently the sound pressure levels at some higher places such as the point at hp = 6.0 m are increased considerably. So, it can be said that noise barrier installation would provide significant roadside noise reduction for ground-level pedestrians but not for the high-rise buildings. Additional mitigation measures such as building facade insulation would be necessary. Figure 17.5-1 - Figure 17.5-6 visualize major prediction results summarized in Table 17.5-2 -Table 17.5-7.

(2) Night time

Table 17.5-8 and Table 17.5-9 summarize the predicted sound pressure levels at Bosque and Sao-Braz, respectively. In all Without-Project cases, it is found that both predicted noise levels at Bosque and Sao-Braz exceed the current nighttime noise standard of Brazil (50 and 55 dBA for the residential, and commercial and mixed area, respectively). When the proposed bus lane system is built without any noise mitigation measures, both predicted noise levels at Bosque and Sao-Braz tend to be decreased by 2 dBA. When low-noise pavement is implemented within the With-Project scenario, the predicted sound pressure levels at both receptor sites are decreased further by 1.5 dBA. Figure 17.5-7 - Figure 17.5-10 visualizes major prediction results summarized in Table 17.5-8 and Table 17.5-9.

Table 17.5-2 Simulation Results (Day Time, Bosque (1))

	2002	2007	2012	2020
Without-Project	83.84	82.82	82.46	82.94
With-Project without any noise mitigation	**	81.21	80.81	80.45
With-Project with Low Noise Pavement	**	79.34	79.19	79.63

Table 17.5-3 Simulation Results (Day Time, Sao-Braz (1))

	2002	2007	2012	2020
Without-Project	83.63	82.53	82.03	82.06
With-Project without any noise mitigation	**	80.96	80.51	80.26
With-Project with Low Noise Pavement	**	79.08	78.87	79.46

Table 17.5-4 Simulation Results (Day Time, Bosque, With Noise Barrier (2))

With-Project: Noise Barrier (Hnes = 1.0 m)				
Noise Barrier Height	Prediction Point Height, hp	2007	2012	2020
2.0 m	1.2 m	69.4	69	69.02
	6.0 m	87.87	87.56	87.46
2.5 m	1.2 m	66.86	66.45	66.53
	6.0 m	85.75	85.47	85.47
3.0 m	1.2 m	64.77	64.35	64.44
	6.0 m	83.38	83.13	83.25

Note: Hnes is the height of noise emission source.

Table 17.5-5 Simulation Results (Day Time, Bosque, With Noise Barrier (3))

With-Project: Noise Barrier (Hnes = 0.3 m)				
Noise Barrier Height	Prediction Point Height, hp	2007	2012	2020
2.0 m	1.2 m	67.98	67.59	67.7
	6.0 m	86.53	86.26	86.31
2.5 m	1.2 m	65.71	65.3	65.43
	6.0 m	84.39	84.14	84.29
3.0 m	1.2 m	63.81	63.38	63.5
	6.0 m	81.98	81.75	82

Note: Hnes is the height of noise emission source.

Table 17.5-6 Simulation Results (Day Time, Sao-Braz, With Noise Barrier (2))

With-Project: Noise Barrier (Hnes = 1.0 m)				
Noise Barrier Height	Prediction Point Height, hp	2007	2012	2020
2.0 m	1.2 m	69.05	68.61	68.79
	6.0 m	87.64	87.29	87.36
2.5 m	1.2 m	66.48	66.03	66.29
	6.0 m	85.51	85.18	85.38
3.0 m	1.2 m	64.38	63.91	64.19
	6.0 m	83.13	82.83	83.16

Note: Hnes is the height of noise emission source.

Table 17.5-7 Simulation Results (Day Time, Sao-Braz, With Noise Barrier (3))

With-Project: Noise Barrier (Hnes = 0.3 m)				
Noise Barrier Height	Prediction Point Height, hp	2007	2012	2020
2.0 m	1.2 m	67.61	67.18	67.49
	6.0 m	86.29	85.97	86.22
2.5 m	1.2 m	65.33	64.88	65.2
	6.0 m	84.14	83.84	84.21
3.0 m	1.2 m	63.41	62.95	63.27
	6.0 m	81.71	81.45	81.93

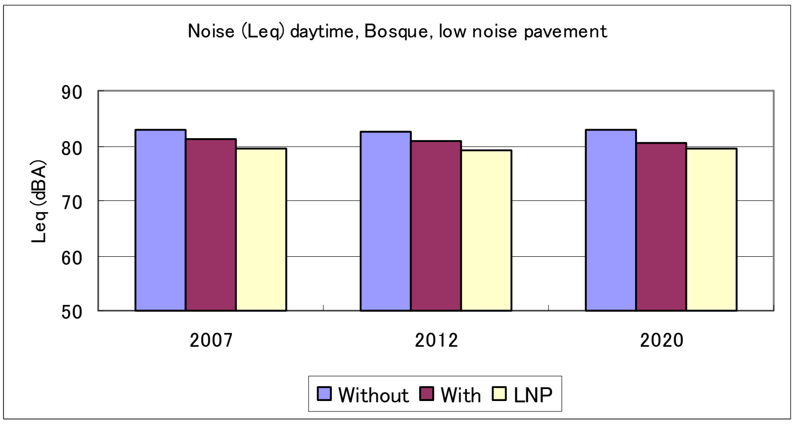
Note: Hnes is the height of noise emission source.

Table 17.5-8 Simulation Results (Night Time, Bosque)

	2002		2007		2012		2020	
Speed(km/hr)	40	50	40	50	40	50	40	50
Without-Project	84.06	84.99	82.69	83.58	81.8	82.62	81.09	81.72
With-Project without any noise mitigation	**	**	80.83	81.64	80.28	81.05	79.22	79.74
With-Project with low noise pavement	**	**	78.74	79.24	78.40	78.87	78.14	78.37

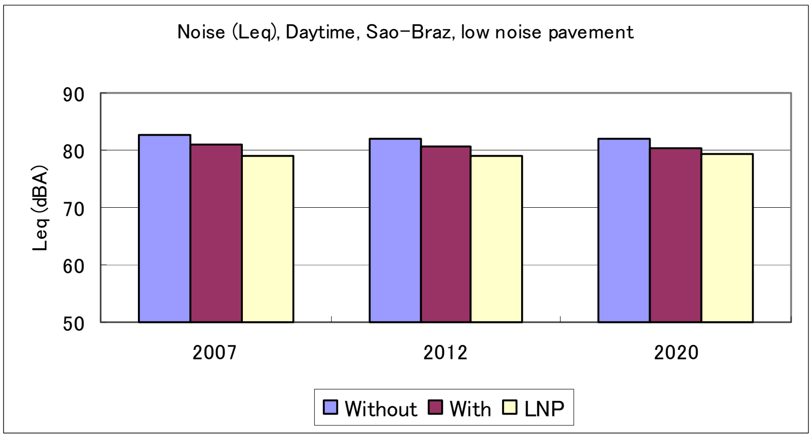
Table 17.5-9 Simulation Results (Night Time, Sao-Braz)

	2002		2007		2012		2020	
Speed(km/hr)	40	50	40	50	40	50	40	50
Without-Project	84	84.94	82.62	83.53	81.67	82.52	80.64	81.34
With-Project without any noise mitigation	**	**	80.73	81.54	80.15	80.94	78.87	79.42
With-Project with low noise pavement	**	**	78.64	79.15	78.28	78.76	77.78	78.05



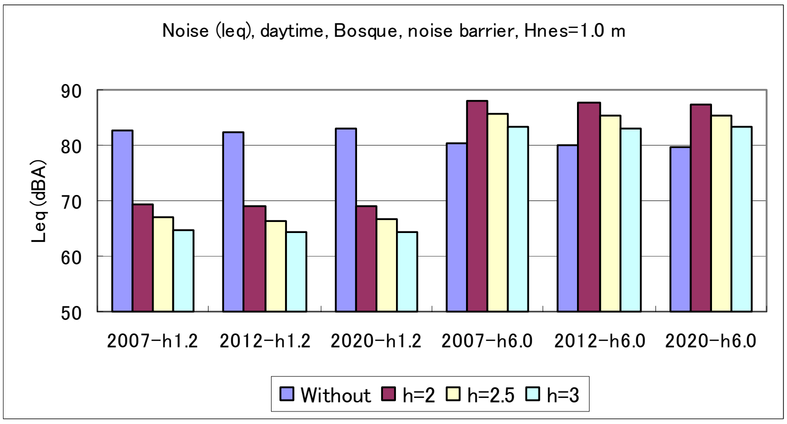
Note: "LNP" indicates the With-Project with Low Noise Pavement case.

Figure 17.5-1Predicted Leq Value (Bosque, Daytime, Low Noise Pavement)



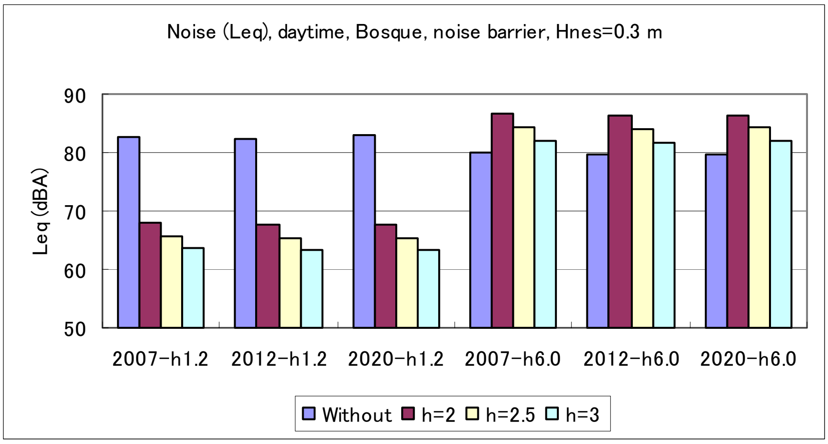
Note: "LNP" indicates the With-Project with Low Noise Pavement case.

Figure 17.5-2 Predicted Leq Value (Sao-Braz, Daytime, Low Noise Pavement)



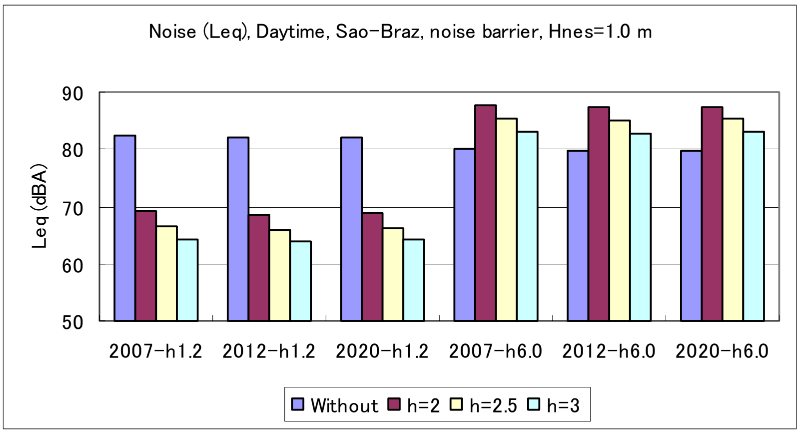
Note: "2007-h1.2" indicates that Leq value at the h= 1.2 m receptor height in 2007.

Figure 17.5-3 Predicted Leq Value (Bosque, Daytime, Noise Barrier, Hnes = 1.0 m)



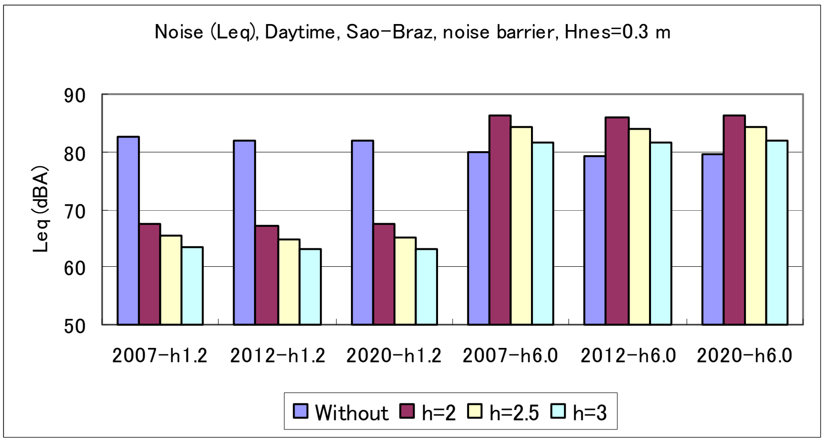
Note: "2007-h1.2" indicates that Leq value at the h= 1.2 m receptor height in 2007.

Figure 17.5-4 Predicted Leq Value (Bosque, Daytime, Noise Barrier, Hnes = 0.3 m)



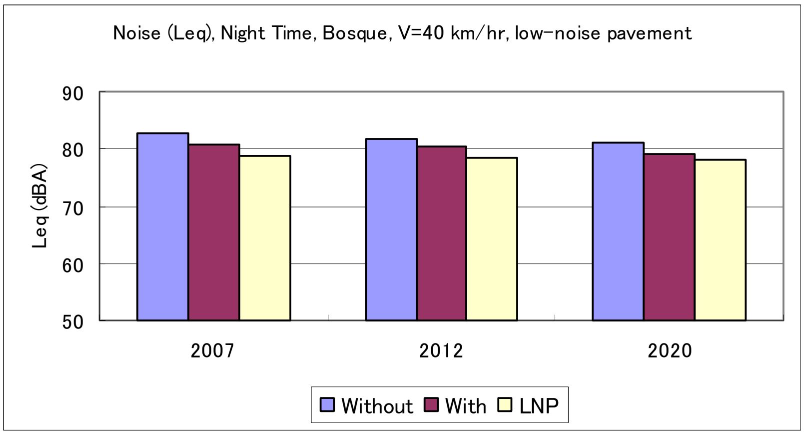
Note: "2007-h1.2" indicates that Leq value at the h= 1.2 m receptor height in 2007.

Figure 17.5-5 Predicted Leq Value (Sao-Braz, Daytime, Noise Barrier, Hnes = 1.0 m)



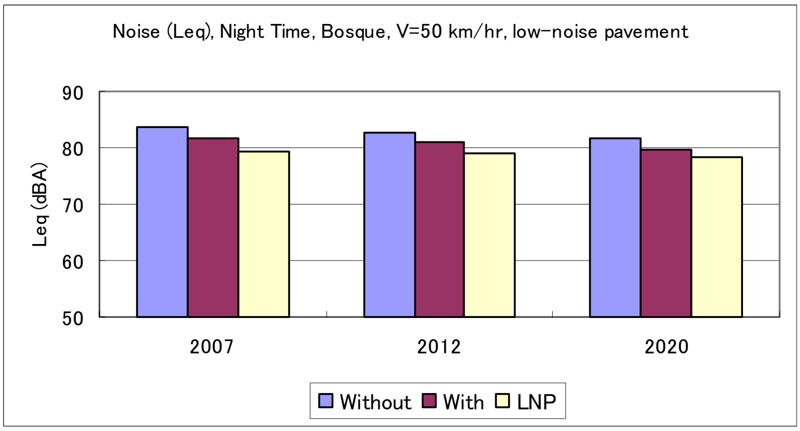
Note: "2007-h1.2" indicates that Leq value at the h= 1.2 m receptor height in 2007

Figure 17.5-6 Predicted Leq Value (Sao-Braz, Daytime, Noise Barrier, Hnes = 0.3 m)



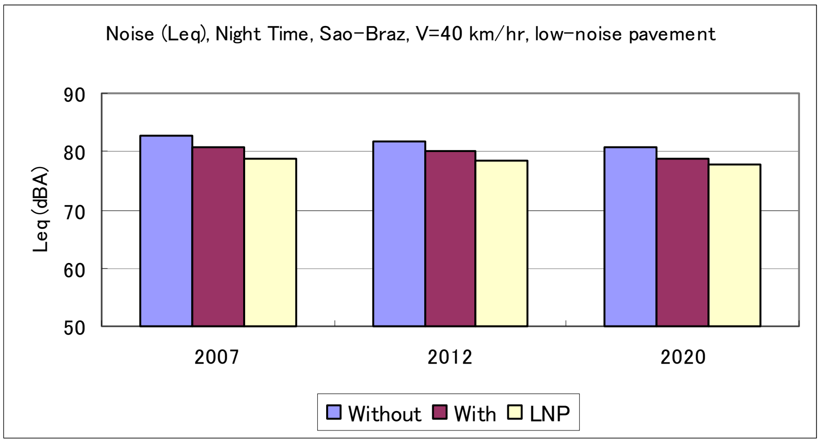
Note: "LNP" indicates the With-Project with Low Noise Pavement case.

Figure 17.5-7 Predicted Leq Value (Bosque, Nighttime, V = 40 km/hr, Low Noise Pavement)



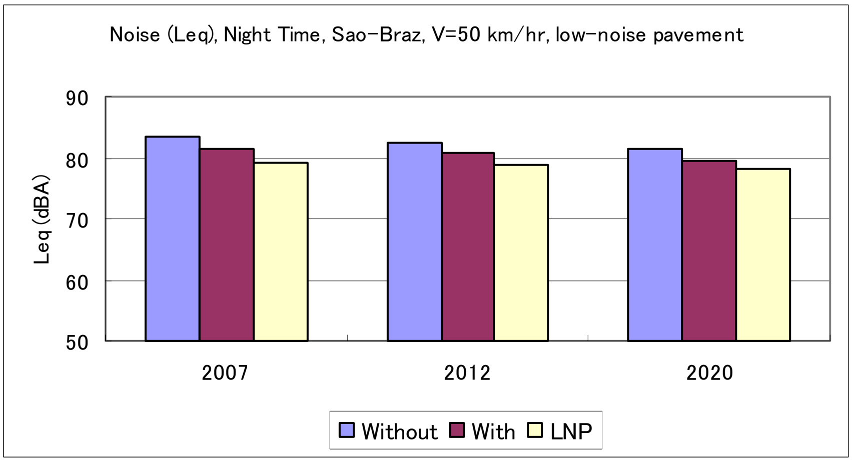
Note: "LNP" indicates the With-Project with Low Noise Pavement case.

Figure 17.5-8 Predicted Leq Value (Bosque, Nighttime, V = 50 km/hr, Low Noise Pavement)



Note: "LNP" indicates the With-Project with Low Noise Pavement case.

Figure 17.5-9 Predicted Leq Value (Sao-Braz, Nighttime, V = 40 km/hr, Low Noise Pavement)



Note: "LNP" indicates the With-Project with Low Noise Pavement case.

Figure 17.5-10 Predicted Leq Value (Sao-Braz, Nighttime, V = 50 km/hr, Low Noise Pavement)

17.6. VIBRATION IMPACT PREDICTION

17.6.1. OBJECTIVES

The purpose of this analysis is to evaluate the vibration level to be generated by the future traffic and transport conditions along main routes such as Avenida Almirante Barroso, and find suitable impact mitigation measures within this project.

17.6.2. NUMERICAL PARAMETERS

Basically, the vibration impact prediction study is carried out for daytime and nighttime transport conditions. Table 17.6-1 summarizes the outline of this vibration impact prediction. In the following, two noise mitigation measures, (i) flatness improvement of the road surface, and (ii) base course improvement, are of concern. Here, the road surface flatness and the condition of the base course are expressed in terms of the standard deviation of the road surface roughness, σ (unit: mm), and the dominant vibration frequency, f (unit: Hz). Within this study, the values of the road surface flatness and the dominant vibration frequency of current road conditions are assumed to be 8 mm and 20 Hz, respectively.

Due to the lack of traveling speeds of passenger cars for the nighttime case, two assumed traveling speed parameters of passenger cars (40 and 50 km/hr) are used, based on results of current study reports [EVPDTU, 2001]. Using these values, traveling speeds of both conventional buses and trucks are computed.

Table 17.6-1 Numerical Conditions

	Descriptions
Prediction Method	Standardized Prediction Method specified by the Ministry of the Ministry of Construction, the Government of Japan
Target Year	Years 2002, 2007, 2012 and 2020
Simulation Case	Carry out simulation for the daytime peak (7:00 a.m.) and the nighttime peak (6:00 a.m.), respectively. Simulation is carried out for following four cases, 1. Verification (Year 2002) 2. Without-Project scenario at Year 2007, 2012 and 2020. 3. With-Project scenario at Year 2007, 2012 and 2020 without any mitigation measures. 4. With-Project scenario at Year 2007, 2012 and 2020 with some mitigation measures.
Prediction Point	Boundary between public and private property at two vibration survey points of Avenida Almirante Barroso.
Vibration Mitigation Measures	The following two mitigation measures are considered, 1. Improved flatness of road surface 2. Base course Improvement

17.6.3. Results and Discussions

(1) Daytime

Table 17.6-2 and Table 17.6-3 summarize the predicted L_{10} values at Bosque and Sao-Braz, respectively. L_{10} values at Bosque and Sao-Braz in the Year2002 Without-Project scenario are computed as 55.35 and 54.66 dB, respectively, and the order of magnitude of those values is very close to those of actual L10 values at both points, guessed from the survey results (See Section 6.6 of Chapter 6.). So it can be said that this vibration prediction method is valid within this study.

In all Without-Project cases, it is found that both predicted L_{10} values at Bosque and Sao-Braz vary around 50 dB, below the current daytime vibration standard of Japan (65 dB). When the proposed project is implemented, predicted L_{10} values at both prediction points tend to be decreased by 3 - 4 dB. This is mainly caused by the following two factors: (1) the re-design of vehicle lanes, increasing the physical distance between the centerline of the outermost vehicle lane and the prediction point slightly, and (2) the improved pavement condition of the road surface. When the base course of the road structure is improved within the With-Project scenario, the predicted vibration levels at both prediction points are decreased further by 2 dB. So, it can be said that a significant amount of vibration reduction can be expected by implementing the proposed project as long as proper structural maintenance is carried out. Figure 17.6-1 - Figure 17.6-4 visualize major prediction results summarized in Table 17.6-2 and Table 17.6-3.

(2) Nighttime

Table 17.6-4 and Table 17.6-5 summarize the predicted L_{10} values at Bosque and Sao-Braz, respectively. In all Without-Project cases, it is found that both predicted L_{10} values at Bosque and Sao-Braz vary between 52 and 54 dB, below the current nighttime vibration standard of Japan (60 dB). When the proposed bus lane system is built, predicted L_{10} at both Bosque and Sao-Braz tends to be decreased by 3 - 4 dB. When the base course of the road structure is improved within the With-Project scenario, the predicted L_{10} at both sites is decreased by 2 dB further. Figure 17.6-5 - Figure 17.6-12 visualize major prediction results summarized in Table 17.6-4 and Table 17.6-5.

Table 17.6-2 Simulation results (Day Time (Bosque(1))

	2002	2007	2012	2020
Without-Project	55.35	53.62	52.24	51.11
With-Project (σ=5, f=20)	**	50.91	49.7	47.35
With-Project (σ=4, f=20)	**	50.19	48.98	46.63
With-Project (σ=3, f=20)	**	49.26	48.05	45.69
With-Project (σ=5, f=25)	**	49.38	48.18	45.82
With-Project (σ=5, f=30)	**	48.14	46.93	44.57

Table 17.6-3 Simulation results (Day Time (Sao-Braz(1))

	2002	2007	2012	2020
Without-Project	54.66	53.05	51.64	50.16
With-Project (σ=5, f=20)	**	50.54	49.26	47.21
With-Project (σ=4, f=20)	**	49.81	48.54	46.49
With-Project (σ=3, f=20)	**	48.88	47.6	45.55
With-Project (σ=5, f=25)	**	49.01	47.73	45.68
With-Project (σ=5, f=30)	**	47.76	46.48	44.43

Table 17.6-4 Simulation results (Night Time (Bosque (2))

	2002		2007		2012		2020	
Speed (km/hr)	40	50	40	50	40	50	40	50
Without-Project	53.49	54.62	51.75	52.87	50.41	51.54	49.42	50.55
With-Project (σ=5, f=20)	**	**	48.97	49.94	47.72	48.69	45.46	46.4
With-Project (σ=4, f=20)	**	**	48.25	49.22	46.99	47.96	45.46	45.67
With-Project (σ=3, f=20)	**	**	47.31	48.28	46.06	47.03	43.8	44.74
With-Project (σ=5, f=25)	**	**	47.44	48.41	46.19	47.16	43.93	44.87
With-Project (σ=5, f=30)	**	**	46.2	47.16	44.94	45.91	42.68	43.62

Table 17.6-5 Simulation results (Night Time (Sao-Braz(2))

	2002		2007		2012		2020	
speed (km/hr)	40	50	40	50	40	50	40	50
Without-Project	52.71	53.83	51.1	52.22	49.73	50.85	48.35	49.48
With-Project (σ=5, f=20)	**	**	48.53	49.49	47.2	48.16	45.3	46.23
With-Project (σ=4, f=20)	**	**	47.8	48.76	46.47	47.43	44.57	45.5
With-Project (σ=3, f=20)	**	**	46.87	47.83	45.54	46.5	43.64	44.57
With-Project (σ=5, f=25)	**	**	47	47.96	45.67	46.63	43.77	44.7
With-Project (σ=5, f=30)	**	**	45.75	46.71	44.42	45.38	42.52	43.45

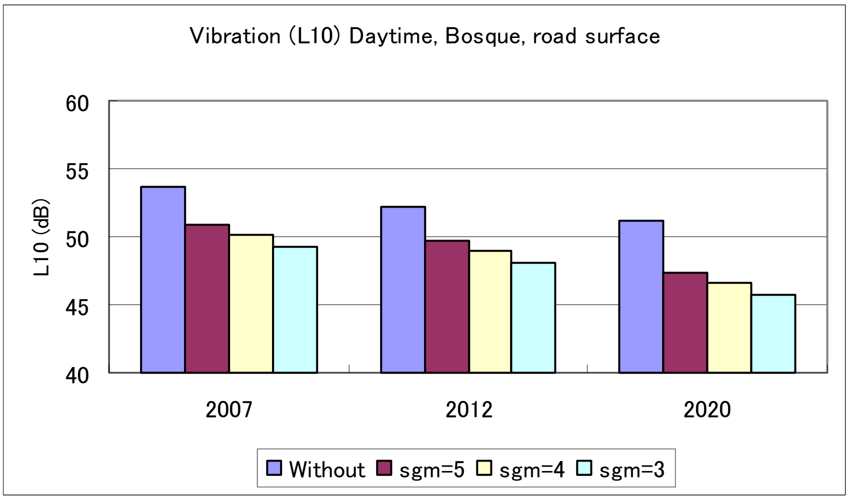


Figure 17.6-1 Predicted L10 Value (Bosque Daytime, road surface flatness σ=3, 4, and 5 mm)

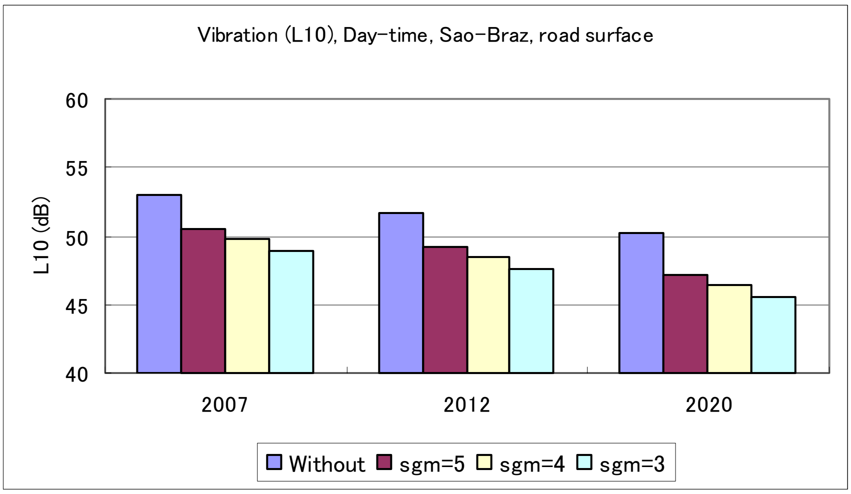


Figure 17.6-2 Predicted L10 Value (Sao-Braz, Daytime, road surface flatness σ=3, 4, and 5 mm)

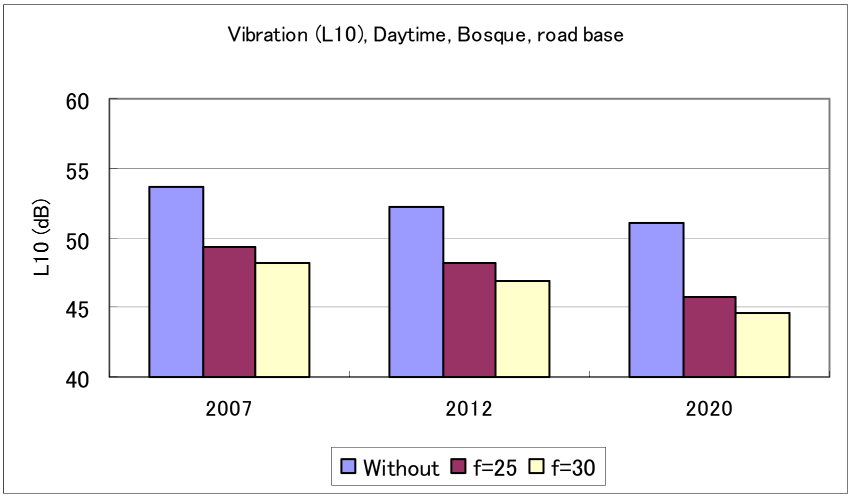


Figure 17.6-3 Predicted L10 Value (Bosque, Daytime, vibration frequency f = 25 and 30 hz)

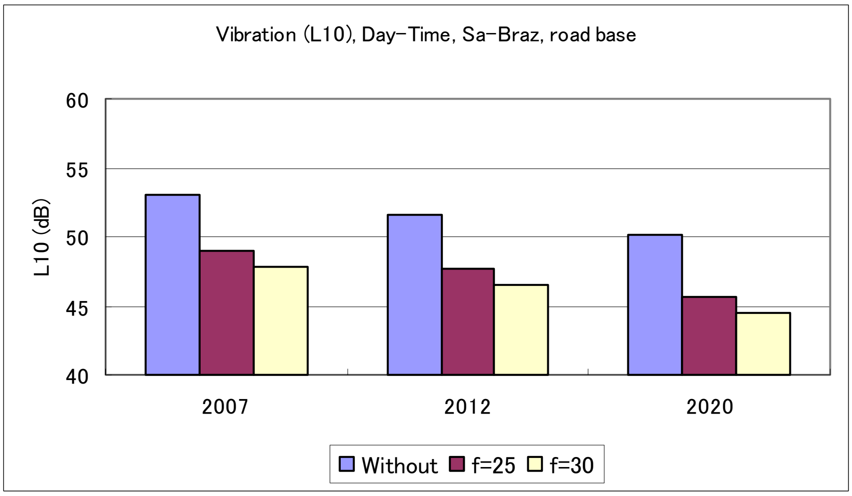


Figure 17.6-4 Predicted L10 Value (Sao-Braz, Daytime, vibration frequency f = 25 and 30 hz)

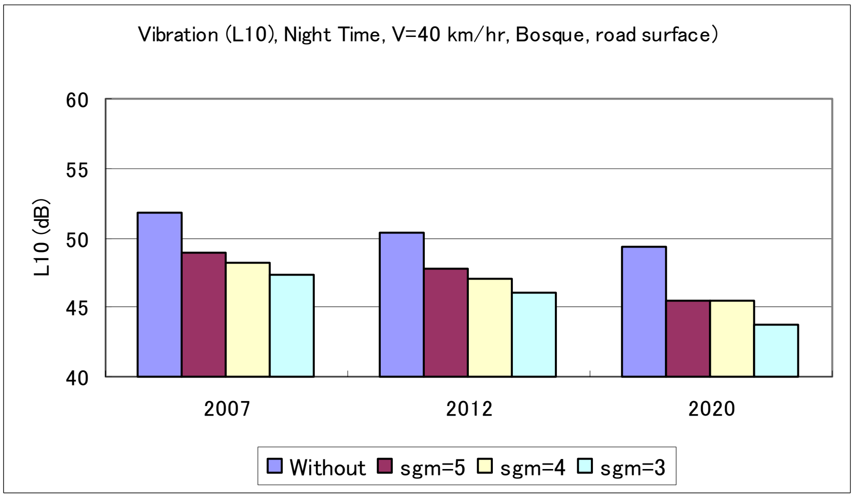


Figure 17.6-5 Predicted L10 Value (Bosque Nighttime, V=40 km/hr, road surface flatness σ=3, 4, and 5 mm)

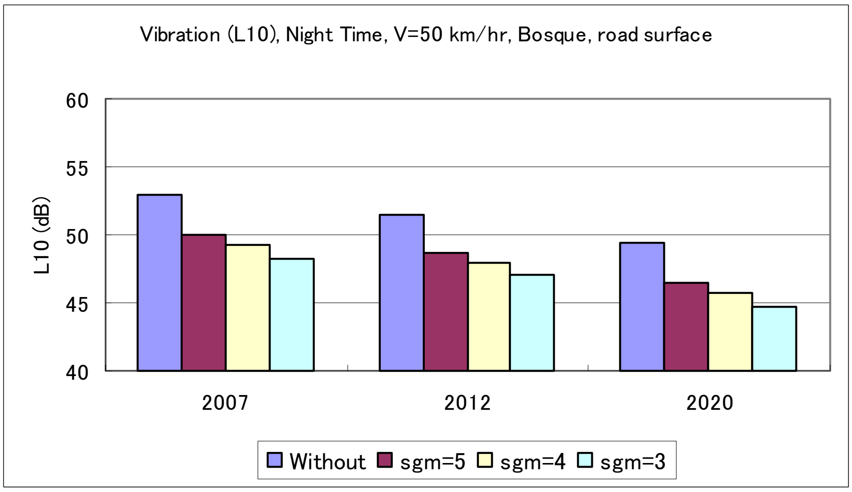


Figure 17.6-6 Predicted L10 Value (Bosque Nighttime, V= 50 km/hr, road surface flatness σ=3, 4, and 5 mm)

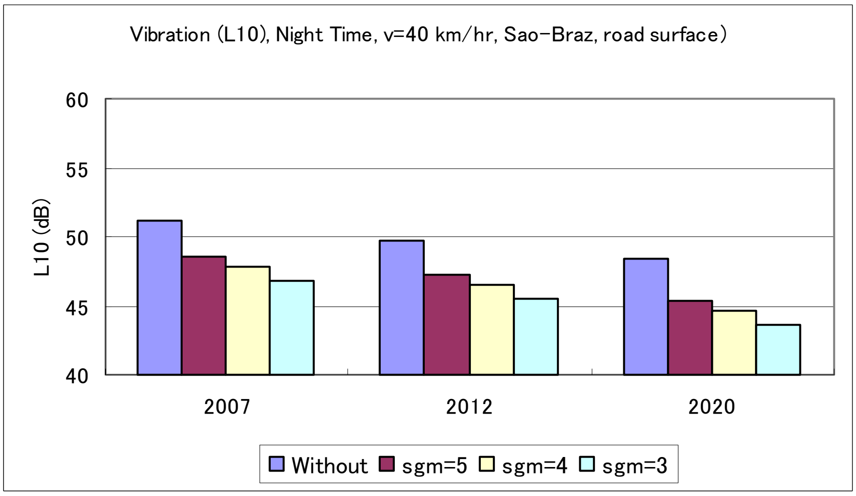


Figure 17.6-7 Predicted L10 Value (Sao-Braz, Nighttime, V=40 km/hr, road surface flatness σ=3, 4, and 5 mm)

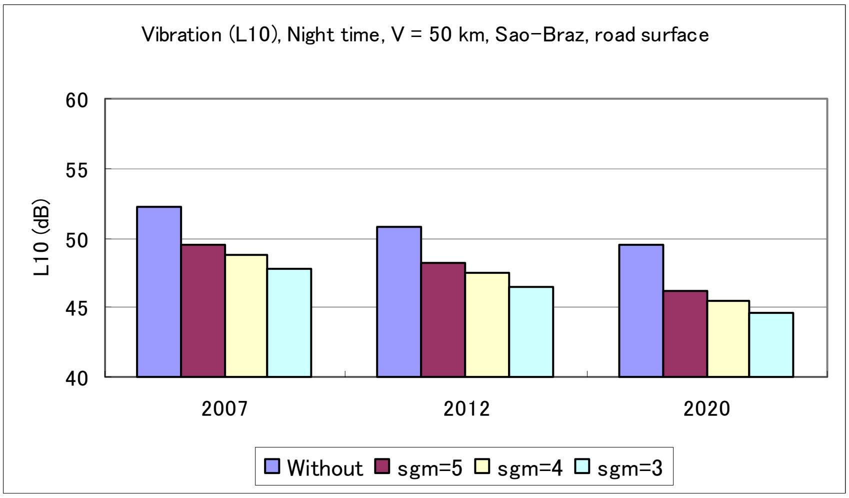


Figure 17.6-8 Predicted L10 Value (Sao-Braz, Nighttime, V= 50 km/hr, road surface flatness σ=3, 4, and 5 mm)

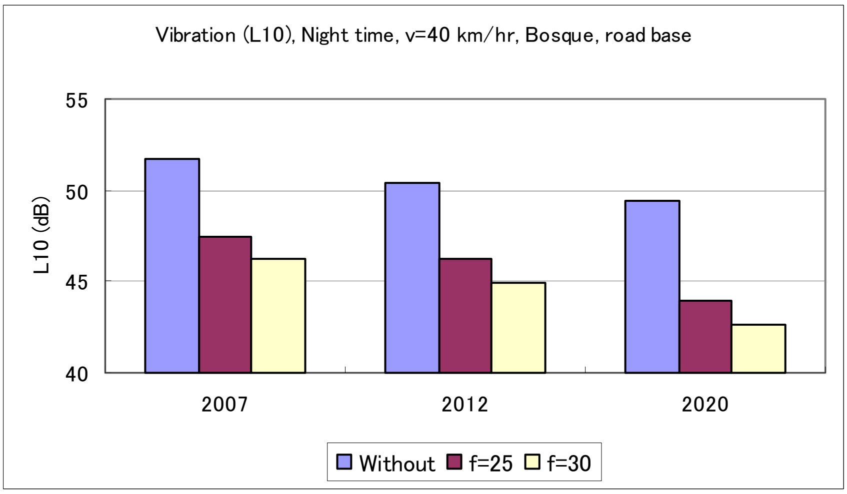


Figure 17.6-9 Predicted L10 Value (Bosque, Nighttime, V= 40 km/hr, vibration frequency f = 25 and 30 hz)

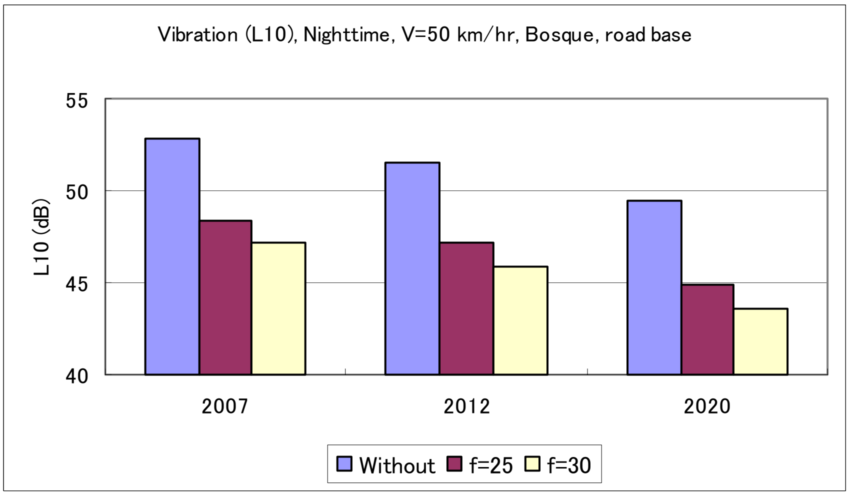


Figure 17.6-10 Predicted L10 Value (Bosque, Nighttime, V= 50 km/hr, vibration frequency f = 25 and 30 hz)

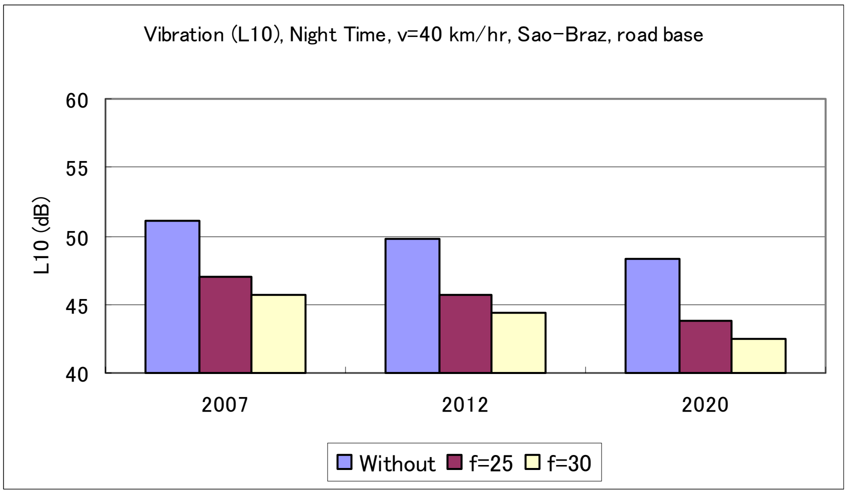


Figure 17.6-11 Predicted L10 Value (Sao-Braz, Nighttime, V= 40 km/hr, vibration frequency f = 25 and 30 hz)

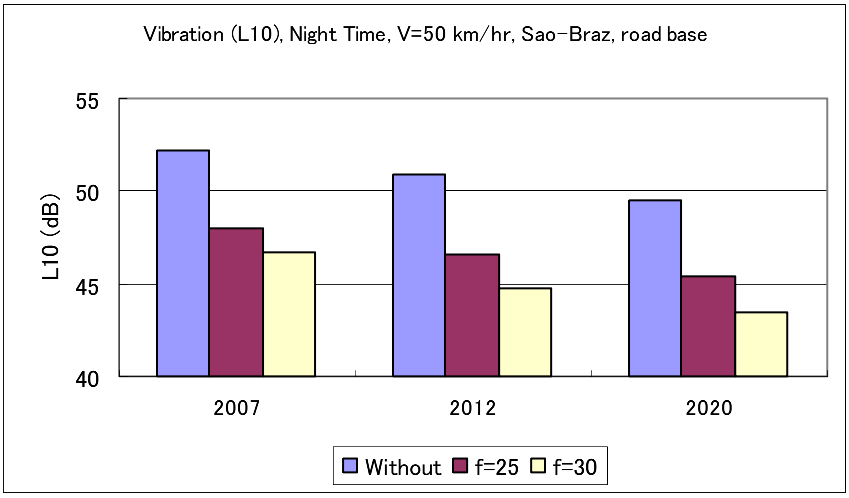


Figure 17.6-12 Predicted L10 Value (Sao-Braz, Nighttime, V= 50 km/hr, vibration frequency f = 25 and 30 hz)

17.7. RESETTLEMENT

Expropriation of land and buildings is one of the most critical issues in implementation of public utility and facility development such as road development. Therefore, the study team conducted studies on the following:

1) Laws and regulations on expropriation for public works in Brazil,
2) Procedure of expropriation and resettlement,
3) Cases of expropriation and resettlement caused by public works in Belem,
4) Compensation for expropriation and resettlement, and
5) The estimated number of existing houses/buildings affected by the projects proposed by the study team.

17.7.1. LAWS AND REGULATIONS ON EXPROPRIATION FOR PUBLIC WORKS IN BRAZIL

(1) Decree-Law on Expropriation for Public Works

Decree-Law No. 3,365, which was decreed on June 21, 1941 by the President of the Republic and consists of 42 articles, is only one law to apply to expropriations caused by public works in Brazil.

Expropriation of any and all assets is implemented based on this law not forcibly but legally and democratically after declaration of the public work. Only the implementing body of public works (the Federal Government, the states, municipalities, the Federal District and territories) can expropriate private assets.

Sixteen cases are provided as public works in Article 5 of the law. These are as follows:

1) National security
2) State defense
3) Public safety in case of calamity
4) Public health
5) Creation and enhancement of population centers, constant supply of means of subsistence
6) Industrial use of mines and mineral deposits, water and hydraulic energy
7) Public assistance, works for hygiene and decoration, health units, clinics, weather stations and sources of medication
8) Performance or protection of public services
9) Opening, protection and enhancement of public streets or highways; implementation of urbanization plans; division of lands with or without buildings for their enhanced economic, hygienic or esthetic use, and construction or expansion of industrial districts
10) Functioning of means of mass transportation
11) Preservation and conservation of historical and artistic monuments, whether isolated or part of urban or rural complexes, as well as the means necessary to maintain and enhance the most valuable aspects or characteristics and, moreover, the protection of landscapes and sites specially endowed by nature

12) Adequate preservation and conservation of files, documents and other moveable assets of historical or artistic value

13) Construction of public buildings, commemorative monuments and cemeteries

14) Construction of stadiums, and aerodromes or landing fields for aircraft

15) Reconstruction or display of a work or invention of scientific, artistic or literary nature

16) Other cases provided for in special laws

Any and all persons molested by the excess or abuse of authority are granted compensation for damages and losses, with no harm to the right to lodge a penal action. Furthermore, any and all burdens of rights against the asset expropriated are subrogated in the price (compensation) paid. (Refer to the appendices.)

(2) Calculation method for land value

There are several calculation methods for land value authorized in Brazil. Basically, value of land expropriated is estimated based on physical and social characteristics of the land. COHAB, which is one of the state companies and an expert of expropriation, uses "Software para Avaliacoes de Bens por Inferencia Estatistica – Avalien 2.4" for calculation of land price. The calculation process is as follows:

1) The land to be expropriated is identified.

2) A physical and social survey of the land to be expropriated (size, location, land use and development condition of surrounding area) is conducted.

3) Samples are collected of the cost of land with the same characteristics as the land to be expropriated. The cost of land that is advertised in newspapers and magazines for sale is collected as samples.

4) Unit prices (R$/m2) of seven (7) samples, which are selected from among samples collected, are used for estimation of the value of the land to be expropriated. Physical and social condition of the land are also considered.

5) A standard unit price of the land is estimated.

6) A maximum and a minimum unit price (R$/m2) are also calculated based on a standard one.

7) A maximum and a minimum price of the land expropriated are calculated.

17.7.2. PROCEDURE OF EXPROPRIATION AND RESETTLEMENT

Procedure of expropriation and resettlement caused by the public work is as follows:

1) An implementing body declares implementation of the public work.

2) The implementing body investigates the physical condition of properties (house—(size, material, construction year, etc.); land—(size);, land use), and social and economic condition of owners or families that must remove to other places because of a public work.

3) After investigation, the implementing body evaluates value of a house, land and business for resettlement compensation.

4) The implementing body shows the estimated value to an owner and starts negotiation.

5) If the owner agrees to the conditions an implementing body proposes, the owner goes out to the place an implementing body provides or another place the owner finds.

6) If an owner does not agree to the conditions proposed, then the implementing body asks the court of law for mediation.

7) The court judges and shows the interested parties (the implementing body and the owner) a new proposal for mediation.

8) If both sides agree to a new proposal, the owner goes out to the place an implementing body provides or another place the owner finds.

9) If they do not agree, then the court again judges and decide the final price.

10) Construction work is started after removal of habitants.

Figure 17.7-1 shows the flow of procedure of expropriation and resettlement. Based on the current project reports, four major expropriation programs prepared by the Government of Para State are reviewed as the case study. Descriptions of each expropriation case are attached in Appendix-D.

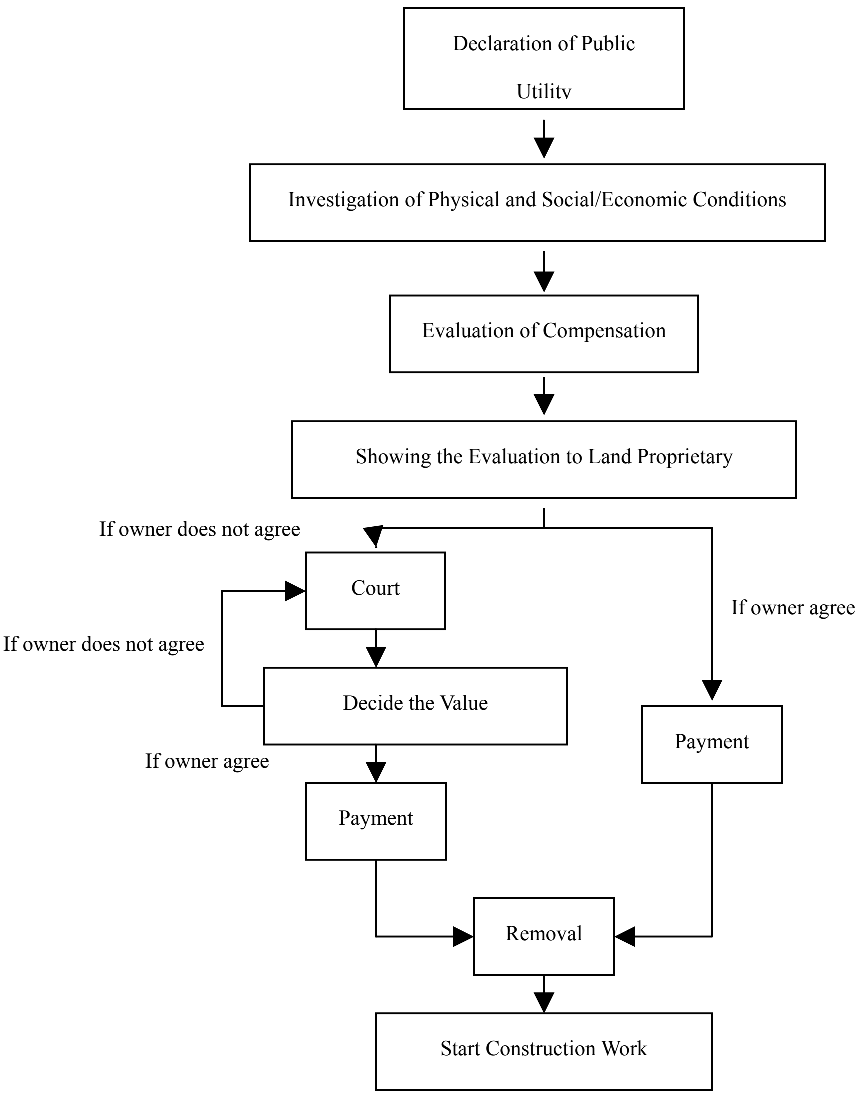


Figure 17.7-1 Flow of Procedures of Expropriation and Resettlement

17.7.3. EXPROPRIATION ESTIMATION

When resettlement or relocation issues arise within a large infrastructure project, full compensation must be prepared prior to any construction activities. Based on the basic design of the proposed road and bus system project, the number of house to be expropriated was estimated. Followings are major directions and/or assumptions, used for this estimation.

1) Houses to be expropriated are to be classified into following four categories: (i) Total land area, A, is less than 25 m^2, (ii) $25 < A < 41m^2$, (iii) $41\ m^2 \leq A$ and (iv) Special building (e.g., school, hospital, factory and other large-sized building).
2) It is assumed that the owners of houses classified into categories (i) and (ii), above, (i.e., $A < 41m^2$) will choose a resettlement plan. Otherwise, monetary compensation will be chosen.
3) The Para State will prepare resettlement sites around the project areas.
4) The owner who chose the resettlement plan will move into the nearest resettlement sites.
5) Expropriation caused by the on-going Para State - Independencia project (four-lane) is excluded from the proposed project.

In general, it is better to have a resettlement-related social survey in order to grasp exactly how many families are willing to move into each new resettlement places. However, since the compensation issue would be a very sensitive and controversial issue to communities around those areas, it is quite difficult to have this kind of social survey at this stage. So, based on the past expropriation experience of COHAB and other governmental agencies, assumption number 2, mentioned above, was introduced for convenience.

Based on those assumptions, expropriation estimation was carried out, and it was found that approximately 1,818 houses must be expropriated within this project (See Table 17.7-1). Among of them, 601 families will move into resettlement sites.

Table 17.7-1 Summary of House to be Expropriated

	$A \leq 25m^2$	$25<A<41m^2$	$41m^2 \leq A$	Special Building	sub total
1. Independencia	154	290	705	15	1,164
2. Marinha	10	15	87	2	110
3. Yamada	26	35	154	12	227
4. P-D Dezembro	17	45	166	7	235
5. P-M. Covas	2	7	61	12	82
Total	209	392	1,173	48	1,818

(Source: This Study, 2003)

17.7.4. RESETTLEMENT PLAN.

It is essential to prepare the resettlement program in order to proceed with the entire project smoothly, even though it is hard to implement any resettlement action programs related to the infrastructure project under current situation of Belem. Within this study, the Para State will prepare nine resettlement sites around the project area (see Figure 17.7-2).

Table 17.7-2 summarizes the outline of those nine resettlement sites.

Table 17.7-2 Resettlement Sites prepared by Para State

	COHAB ID#	Name	A (m2)	Capacity (house)
1	4	Terreno da Marinha	80,581	302
2	7	Granja do Japones Bengui	54,909	206
3	13	Campos de Futebol Tapana	16,146	61
4	40	Sucata Icoaraci	6,285	24
5	15	Canteiro Independencia	76,563	287
6	20	Fundos Granja Icui	87,044	326
7	34	Guajara PAAR	54,861	206
8	25	Terreno Galpao Guanabara	15,059	56
9	31	Terreno Proximo a R Borges	22,003	83
Total			413,451	1,551

Note: COHAB ID # is the site identification number of the public land owned by COHAB.

The construction cost of all of the resettlement sites is summarized in Chapter 16. Again, it is strongly recommended to have more intensive resettlement surveys prior to the full construction activities of this project.

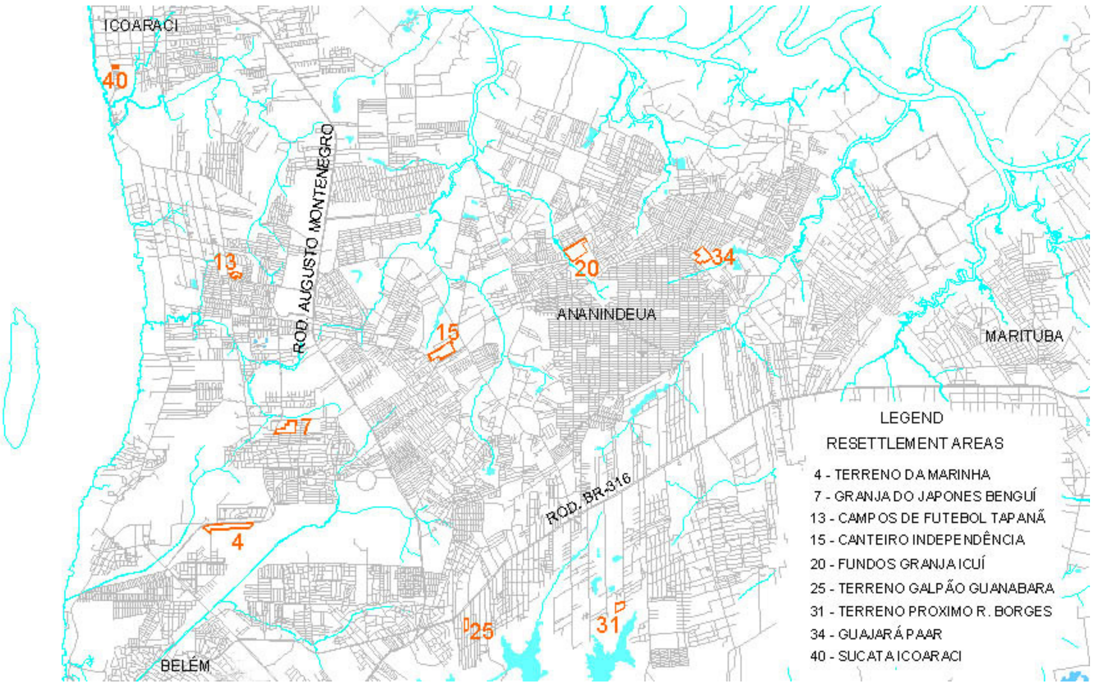


Figure 17.7-2 Resettlement Sites

17.8. ENVIRONMENTAL MONITORING

17.8.1. INTRODUCTION

The main objectives of environmental monitoring are to provide continuous feedback on project implementation to identify actual or potential successes or problems at an early stage, and to implement timely adjustments to management of the whole project. Monitoring is a continuous assessment of project implementation and must be an integrated part of good management during the construction.

17.8.2. OBJECTIVES

The objective of the monitoring system is to assist in management of the project through:

1) Defining requirements and procedures for environmental monitoring (type of equipment to be used, monitoring schedule, parameters to be monitored and so on).
2) Identifying targets and objectives for the project implementation.
3) Keeping environmental records for the project evaluation.
4) Identifying problems arising from the project, and figuring out procedures for the environmental remediation in the event of pollution or similar incidents.
5) Providing readily available results of related environmental analysis for decision -making process.

17.8.3. SCOPE OF THE MONITORING PLAN

The scope of the monitoring plan is:

1) To identify the monitoring tasks to be undertaken by EM during the construction phase.
2) To identify the nature and schedule of the monitoring.
3) To identify samples to be taken for analysis and parameters to be measured.

17.8.4. METHODOLOGY

The basic approach to prepare this monitoring plan has comprised:

1) Reviews of the mitigation plan discussed in the previous chapter, and in particular, of the monitoring requirements identified for the construction phase of the project.
2) Discussions with engineering staff engaged in the project design and planning.
3) Consideration of the environmental monitoring experience.

Agency coordination is addressed, and coordination with on-going monitoring programs such as the monthly water quality survey at APA Belem by COSANPA are vital in the development of a post-EIA monitoring system. The monitoring objectives should be related to the anticipated impacts of the action. Comprehensive and targeted monitoring can be planned. Several iterations might be necessary to achieve a workable monitoring system. Figure 17.8-1 identifies several work elements associated with the development of a monitoring system.

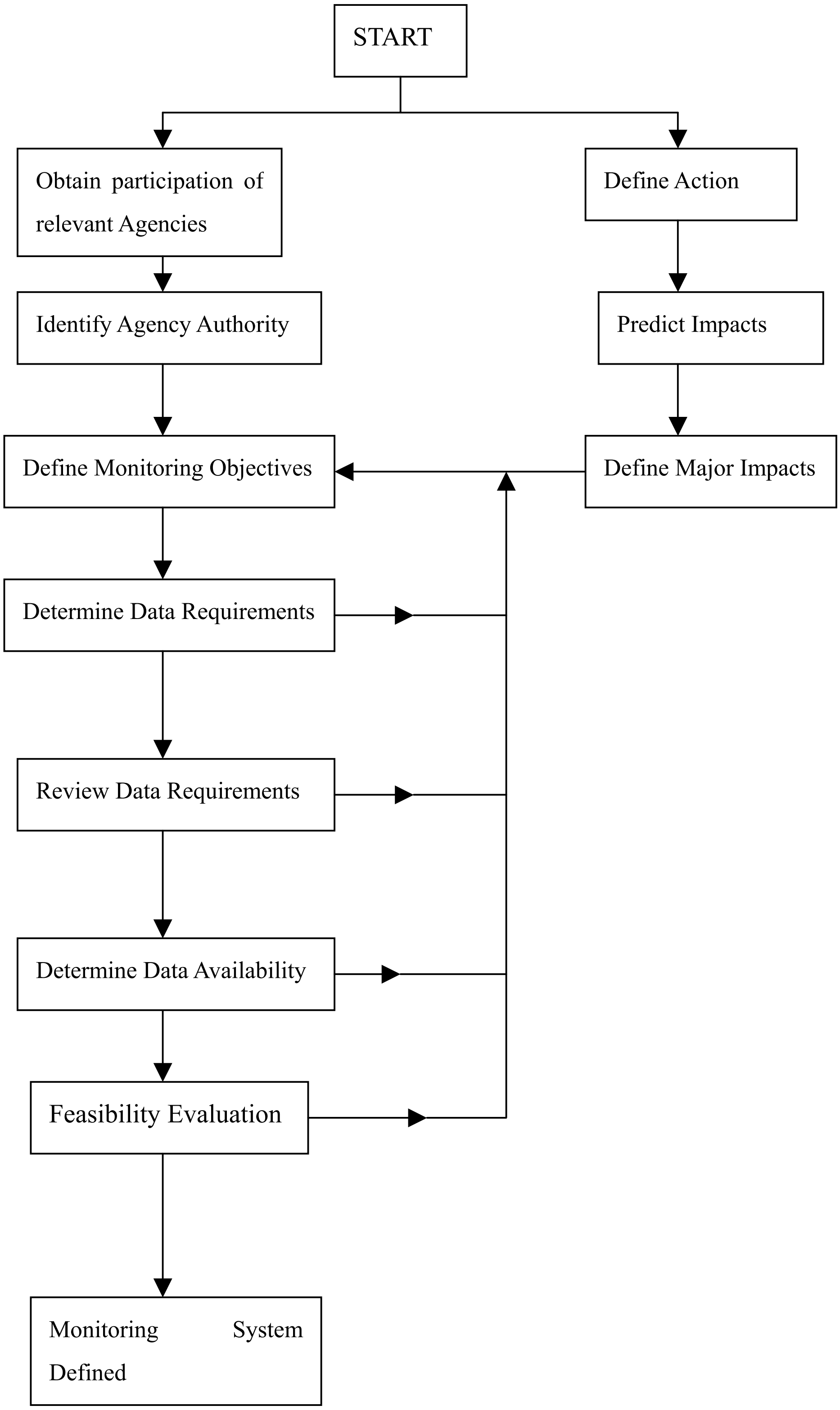


Figure 17.8-1 Figure 1 Monitoring Methodology Flowchart, Phase I - Development of a Monitoring System (from Canter, 1996)

17.8.5. ENVIRONMENTAL MONITORING

The aim of the monitoring plan is to develop a cost-effective approach to monitor the contractors' environmental performance. Certain parameters (e.g., roadside air quality, noise and vibration, surface/subsurface water quality around the project area and so on) can be monitored through measurements, and others can only be monitored through observation (e.g., tree cutting, roadkills, unusual death of species). Careful observations made through this monitoring work, established by advance planning, are a key for successful environmental management to prevent problems (or at least to limit their effects).

Baseline data to be summarized in this project will help to define the requirements for the site restoration and provide a basis for the comparison of effects during the construction. A post-project audit should be carried out to examine the success of the site restoration and evaluate the effectiveness of the mitigation measures adopted.

17.8.6. MONITORING REQUIREMENTS

The monitoring requirements of the Monitoring Programme were identified in the Mitigation Plan. The Engineer should be responsible for the monitoring the activities of the contractor, and the EM and the Assistant EM should assist the Engineer in the monitoring which requires measurements, based on responsibilities listed in previous chapter.

The monitoring activities can be divided into the following two groups; (i) those that can be carried out through the measurement, and (ii) those that will be carried out through observation. Figure 17.8-2 shows the suggested relationship between the Client, Engineer and Contractor's teams.

Table 17.8-1 provides more detailed descriptions of the activities to be undertaken for each of the monitoring requirements. It is strongly recommended that corresponding clauses should be developed for the inclusion in the bid documents. The monitoring requirements for the air quality, noise and vibration, groundwater level, and surface and subsurface water quality to be followed will be the responsibility of the EM.

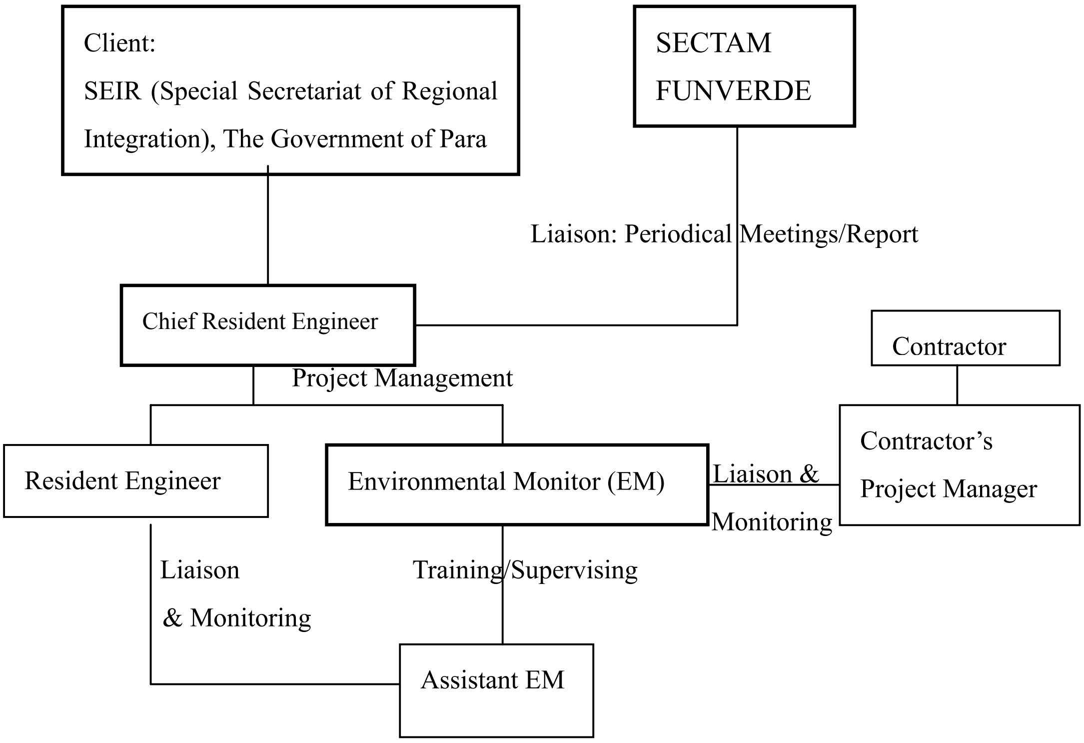


Figure 17.8-2 Relationship among Client, Engineer and Contractor's team

Table 17.8-1 Monitoring Activities and Indicators

Monitoring Issue	Monitoring Method	Positive Indicator
Soils	Engineer should make a daily inspection of earthworks, and ensure that slopes are suitably graded. Once earthworks are complete, Engineer should monitor restoration measures implemented by Contractor, such as revegetation or use of geotextiles.	Absence of rills, gullies or other erosion features.
Vegetation	Engineer should ensure that excessive clearance of vegetation is avoided. Contractor must seek approval of Engineer prior to clearance. Re-planting or relocation of trees should be done with the coordination of FUNVERDE/ SECTAM and/or IBAMA.	The area of vegetation to be cleared is minimized. Relocation/or replanting is coordinated with FUNVERDE/ SECTAM and/or IBAMA.
Birds/wildlife/aquatic species	Engineer should examine the timing, shape and size of operations to avoid breeding or nesting season and trees, protecting key food, cover, and water resources. The number of roadkill and unusual death of aquatic species shall be counted.	No trace of roadkills, or unusual death of any species.
River Sedimentation	Engineer should monitor sedimentation of major tributaries and sandbar generation downstream of new routes for safe flood control.	No trace of significant sedimentation or new sandbar generation. Secure safe river space and local water is made to flow smoothly.
Regional Drainage System	Engineer should monitor the occurrence of newly developed inundation or flooding events around the project site.	No trace of permanent inundation or flooding. No complaints about the compost smell generated from submerged and decaying plants.
Groundwater Level	Engineer should periodically monitor regional groundwater level distribution and enhanced consolidation to be caused by groundwater level drawdown.	No big groundwater level fluctuation. No regional vegetation change or enhanced aquifer consolidation.
Land Take	Engineer should ensure that the contractor gives advance warning of any land-take or demolition. The Special Secretariat of Regional Integration (SEIR) is to arrange compensation for land loss where necessary. New houses are to be built prior to demolition.	Land-take and house demolition minimized. Relocation and compensation program well prepared.

Road Safety	Engineer should monitor the condition of trucks arriving at the site and keep a record of night driving.	No road accidents related with project. Night driving kept to minimum.
Waste Material	Engineer to ensure waste dumping site for construction waste material, soil, and so on.	No illegal disposal of waste material.
Noise and Vibration	Noise measurement should be carried out at the boundary and the inside of the work site and at the nearest sensitive receiver. Vibration measurement should be carried out within the historical areas and residential areas.	Noise levels at the nearest sensitive receiver should not exceed the Brazilian environmental standards.
Air Pollution	Observations should be made on the level of dust generated during construction activities. Damping down should be carried out if levels are unacceptable. Further details on the method to be used are provided in following sections.	Deposition of dust on surfaces should decrease with increased dampening.
Water Resources	Engineer should monitor the occurrence of dried-up wells to be caused by groundwater level drawdown during the construction period.	No significant water quality degradation and/or dried-up wells recognized throughout construction period.
APA Belem	Engineer should monitor the water quality of Lakes Bolonha and Agua Preta, and tributaries running into APA Belem during the construction activity. The number of roadkills and unusual deaths of aquatic species shall be counted.	No significant water quality degradation recognized throughout construction period.
Landscape	Engineer should visually inspect earthworks to prevent excessive excavation. Temporary screening may be appropriate in some cases.	Landscape alteration reduced to the minimum. Townscape amenities improved.
Complaints	Engineer should inspect the record of complaints made by local residents, to be kept by Contractor, and should check that action is taken quickly and that the number of complaints does not rise significantly.	Number of complaints decreases.

(1) Noise and Vibration

The purpose of the noise and vibration monitoring is to limit nuisance to local residents, historical properties and to the workforce, and the noise should be measured frequently during the construction. Potential sources of noise include a heavy construction plant and vehicles. An ad-hoc approach should be taken, depending on the type of activities in progress and their location on site in relation to sensitive receivers. Background noise and vibration level must be measured before project commencement. Parameters to be monitored for noise and vibration are Leq (dBA) and L10 (dB), respectively. Remedial measures will be taken when the Leq value exceeds the Brazilian environmental standard. In Brazil, no environmental standards for vibration are established, yet (See Chapter 6.), but property damage caused by traffic-origin vibration was reported in current study reports [e.g., Hayashida, 2002]. So, it is wise to use other ISO-based vibration standards such as the one implemented in Japan for vibration monitoring (See Chapter 6.).

(2) Dust

The objective of the dust monitoring is to control the nuisance to both local residents and the workforce on site. Monitoring sites should be located in areas where there are sensitive receivers. Generally, dust generation is the most severe along unpaved access roads and at areas where loose materials are handled (e.g., industrial waste site, stockpiles and so on). Based on those facts, the monitoring station sites should be determined. The parameter to be monitored is PM-10 and/or the weight of the dust accumulated within a specific time period (e.g., 1 week, 1 month). The background dust level must be measured before project commencement, and remedial measures are to be taken where a greater than 50% increase of the background dust level occurs or when PM-10 value exceeds the Brazilian environmental standard.

(3) Groundwater Level

The objective of the groundwater monitoring is to observe changes in the regional water balance during the construction. Several monitoring wells should be installed in order to establish a proper monitoring network, and the monitoring will determine whether there is a severe drawdown/or uprising, that will be lead to regional aquifer consolidation/or vegetation change.

(4) Groundwater Quality

Monitoring can be done by the monitoring system, described in previously. Parameters to be monitored include: organoleptic conditions such as color and odor; physico-chemical characteristic such as turbidity, conductivity, sulfate and aluminum content; undesirable substances such as nitrates and hydrocarbons; and toxic substances such as chromium, lead and pesticide. Polluted discharge from road surfaces can be assessed either by heavy metal content, oil or suspended matter. Also, spillage of untreated household effluents can be detected by BOD, COD, Coli-form, grease and other common parameters.

(5) Surface Water Quality

It is essential to have periodical water quality tests during the construction phase of the project in order to check the water quality pumped from excavations and discharges from construction sites, and to monitor the effects of any localized pollution due to human activities and spills. In particular, an intense water quality monitoring program should be implemented around the APA Belem watershed area. Monitoring of the ambient water quality will determine whether there are likely to be problems for downstream uses, whereas monitoring of the effluents will help to identify the source of the problem and the remedial action. Parameters to be monitored should reflect the type of contaminants likely to be detected. For example, contamination caused by the fresh concrete may be detected through increased pH levels.

17.8.7. IMPLEMENTATION AND OPERATION OF MONITORING PROGRAM

In general, implementing the monitoring system requires considerable efforts in obtaining specific inter-agency agreement and necessary funding. This step mainly involves data collection, analysis, and evaluation. Impact evaluation will involve the pre-determination of criteria to be used for the interpretation. These criteria should be based on legal, institutional limits, professional judgments and public inputs. Development of appropriate response plans to impact trends can be time-consuming and technically difficult, and may require considerable coordinating efforts. It is important that such plans be developed prior to implementation of the monitoring system. It is also very important that periodical summary reports be prepared in order to document the finding and resultant response to the post-EIA (or EIS) monitoring program. Figure 17.8-3 delineates the implementation and operation of monitoring system.

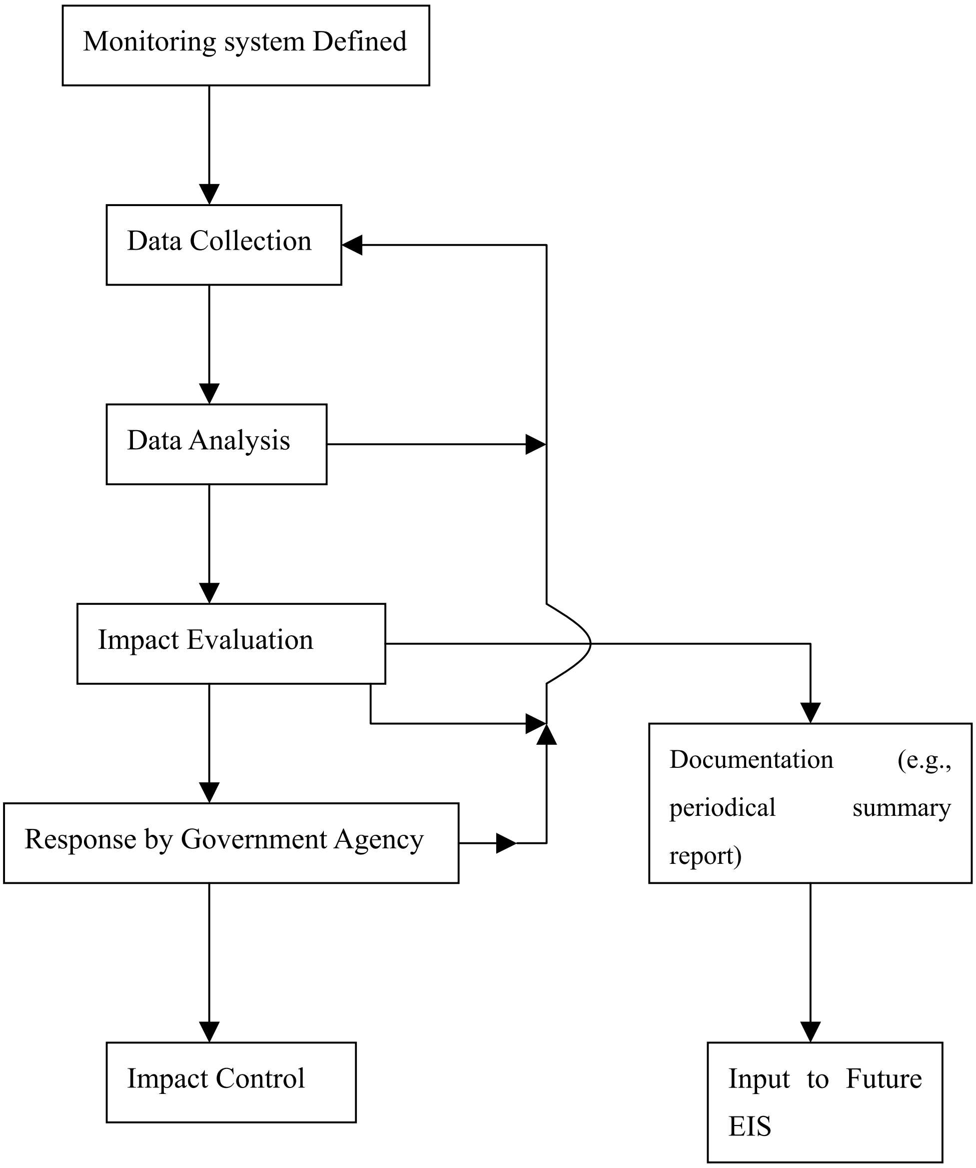


Figure 17.8-3 Implementation and Operation of Monitoring System (after Canter, 1996)

17.8.8. MANPOWER AND BUDGETING

It is envisaged that the Engineer will carry out the environmental monitoring programme as a part of the contract throughout entire construction work. The EM will be employed on a full-time basis. Also, the Assistant EM will be full-time, and will report to the Engineer, and the EM. The cost of implementing the monitoring plan will include the full-time salary of the EM and Assistant EM. It may be necessary to employ an international environmental expert for the initial training of EMs and subsequently to attend at audit time.

17.8.9. ENVIRONMENTAL MANAGEMENT COSTS

Environmental protection costs are of two types: (i) sub-components of roads and bus system structures (e.g., drains, vegetation, animal path, fence and net), and (ii) technical support and management. Generally, the cost of direct environmental protection measures such as animal path construction works is included within the estimate of the direct construction cost. The cost for the later item is summarized as environmental management costs, and is usually included within the administration cost, described in Chapter 16.

The environmental technical support for the project consists of the following five components: (1) hiring environmental personnel, (2) local consultation, (3) training and co-ordination meeting, (4) facilitation, and (5) survey equipment.

The local consultation consists of developing and implementing a briefing for contractor personnel, and preparation/or implementation of workshops for local officials. The training and meeting coordination involve workshops, and quarterly gatherings for exchanging information and compatible decision-making by officials and expert in different departments. Additional cost will be required for facilitating miscellaneous activities, and diverging project activities, including environmental monitoring.

From the economic point of view, it is strongly recommended to carry out periodic on-site monitoring such as roadside air quality, noise/vibration and water quality surveys not by another contracted survey company but by EMs themselves. Besides, those instruments manufactured recently are very portable and accurate, so that the feedback of those survey results to the environmental monitoring program will be quick. The total cost of that equipment is 160,000 Brazilian Real$ (It would cost more than 1,000,000 Brazilian Real$[2)] if that periodical monitoring work is contracted to another survey company).

[2)] This rough cost estimate is based on the actual cost required for the roadside environmental survey, conducted within this study.

CHAPTER 18
Implementation Plan

18. IMPLEMENTATION PLAN

18.1. INTRODUCTION

In Chapter 14: Preliminary Design for Facilities of Trunk Busways, and Chapter 15: Preliminary Design for Road Projects, the preliminary design and its volume of works for the trunk busways, eight (8) integrated bus terminals, and road projects are made and estimated. In Chapter 16, those project costs are estimated by each project.

In this chapter, the project implementation schedule until the year 2012 was made based on the following steps.

Step 1: Examination of project priority by cost-benefit analysis

Step 2: Preparation of implementation schedule and investment

In Step 2, the following conditions are considered when the project implementation schedule is prepared.

a) The adjustment of construction year of bus and road projects based on the travel demand on both road and bus facilities

b) The balance of annual investment cost

In Paragraph a), when only the busway will be a prior investment, not taking into account traffic conditions for private vehicles, traffic congestion will occur on the private vehicle lanes, while trunk bus operation service will keep good conditions. Therefore, it is indispensable to adjust both construction years based on the traffic conditions on both road and bus facilities.

As for Paragraph b), when preparing the implementation schedule for the study projects, the balance of investment is indispensable to efficiently manage the procured project fund.

18.2. PROPOSED TRUNK BUS SYSTEM PROJECTS

The proposed trunk bus facilities are classified into three components: road structures, integrated bus terminals and bus stop facilities. The road structures are composed of trunk busways, exclusive trunk bus lanes and trunk bus priority lanes.

<u>*Trunk busways*</u> are introduced to three arterial roads of Avenida Almirante Barroso, Rodovia BR-316 and Rodovia Augusto Montenegro and the exclusive trunk bus lane to Avenida Independencia. A trunk bus priority lane is provided on selected arterial roads within the Centro and the built-up area of Icoaraci.

<u>*Eight (8) integrated bus terminals*</u> are planned along three arterial roads: three terminals (A, B and C) are along Rodovia Augusto Montenegro, two (E and F) along Rodovia BR-316, one (D) on Avenida Mario Covas and two (G and H) along Avenida Independencia, now under construction.

<u>*Bus stops*</u> are constructed on the right side of the busway (buses normally have their doors on the right side of their body). Each stop has a platform 2.5m wide and 40m to 50m long (to accommodate two articulated buses simultaneously).

Table 18.2-1 shows list of trunk bus system projects, in which the project volume/length and project cost for each project item are summarized. The total project cost of the trunk bus system is estimated at US$163 million, at 2002 prices, of which US$146 million is for the busway, US$13.5 million is for the integrated bus terminals, and the balance is for bus stop facilities. The equivalent unit cost per the busway length, including the integrated bus terminals and bus stops, is US$2,190,000/km.

Table 18.2-1 List of Trunk Bus System Projects

No.	Project Name	Type of Busway	Project Length (km)	No. of Bus Lane (/direction)	Project Cost (1000US$)
1. Busway Projects					
1)	Av. Almirante Barroso	Trunk Busway	6.000	2	17,886
2)	Rodovia BR-316	Trunk Busway	10.750	2	32,439
3)	Rodovia August Montenegro	Trunk Busway	13.635	2	34,651
4)	Av. Independencia on the Suburban Segment	Exclusive Trunk Bus Lane	12.344	2	24,241
5)	Av. Independencia on the central accessing Segment	Exclusive Trunk Bus Lane	7.235	2	21,551
6)	Bus Priority Road from Icoaraci Bus Terminal to Rodovia Augusto Montenegro	Trunk Bus Priority Lane	3.270	2	496
7)	Bus Priority Road from Sao Braz Bus Terminal into Centro	Trunk Bus Priority Lane	9.800	2	2,142
8)	Bus Priority Road on Avenida Pedro Cabral and Senador Lemos	Trunk Bus Priority Lane	7.800	2	11,855
9)	Rodovia Mario Covas in Cidade Nova	Trunk Bus Priority Lane	3.550	2	1,225
	Sub-Total		74.384		146,486
2. Integrated Bus Terminals			Area m2		
1)	Terminal A: Icoaraci	Bus Terminal	11,480		1,454
2)	Terminal B: Tapana	Bus Terminal	15,540		2,092
3)	Terminal C: Mangueirao	Bus Terminal	15,540		2,011
4)	Terminal D: Coqueiro	Bus Terminal	18,768		2,294
5)	Terminal E: Aguas Lindas	Bus Terminal	9,680		1,238
6)	Terminal F: Marituba	Bus Terminal	16,770		2,188
7)	Terminal G: Independencia 1	Bus Terminal	10,560		1,118
8)	Terminal H: Independencia 2	Bus Terminal	10,560		1,072
	Sub-Total				13,467
			Number		
3. Bus Facilities (Bus Stops)		Bus Stop	45		3,023
		Bus Shelter	82		
		Sao Braz Terminal Rehabilitaion	1		
4. Total Cost of Trunk Bus System Project					162,976

18.3. PROPOSED ROAD PROJECTS

Four (4) road projects are planned in the study, which are: new construction of Av. Independencia (Para State is now constructing the suburban segment and is planning the Centro accessing segment in this study), extension and new construction of Primeiro de Dezembro, and improvement of Rua Yamada and Rua da Marinha.

Table 18.3-1 shows a list of road projects, in which the project volume/length and project cost by each project item are summarized. The total road project cost in exclusive of the Av. Independencia project is estimated at US$99 million, at 2002 prices, of which US$51.8 million is for Av. Primeiro de Dezembro, US$32,700 is for Rua Yamada and the balance is for Rua da Marinha. The equivalent unit cost per the road length is US$4.00 million/km.

Table 18.3-1 List of Road Projects

No.	Project Name	Project Length (km)	No. of Lane (/direction)	Project Cost (1000US$)	Remarks
1)	Av. Independencia on the Suburban Segment	12.344	4	39,360	Constructing by Para State
2)	Av. Independencia on the central accessing Segment	7.235	4	37,276	Planning by Para State
3)	Av. Primeiro de Dezembro/Rodovia Mario Covas Extension	10.077	4	51,796	New construction road
4)	Rua Yamada	10.000	4	32,655	Road Improvement
5)	Rua da Marinha	4.555	4	14,052	Road Improvement
Sub-Total excluding Av. Independencia		24.632		98,503	Only Study Projects
Total		44.211		175,139	

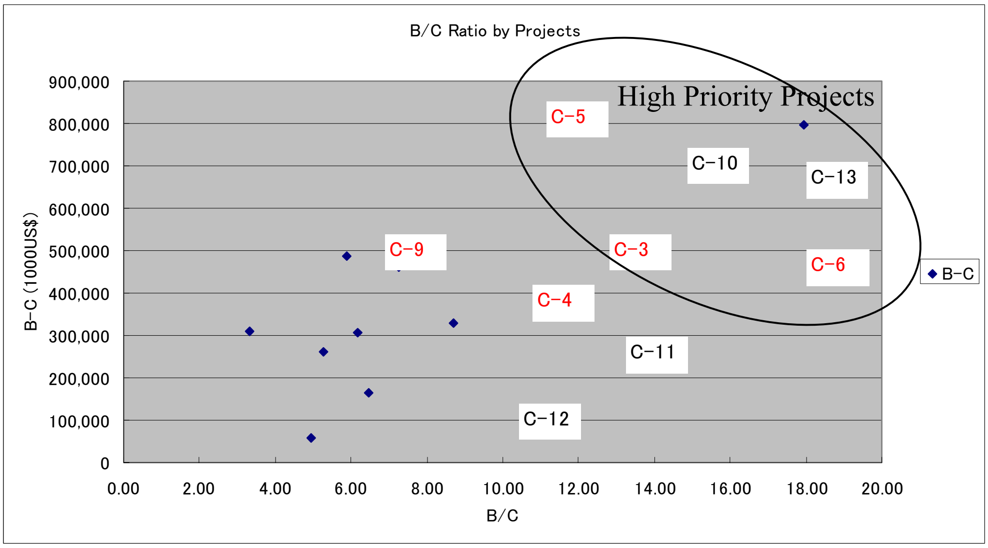
18.4. IDENTIFICATION OF THE PROJECT PRIORITY

For identification of the project priority of the trunk bus and road projects, the projects are examined from the following three (3) viewpoints:

1) From the viewpoint of the economic effect of the project
2) From the viewpoint of the bus operation on Av. Almirante Barroso
3) From the viewpoint of the characteristics of project

(1) From the Viewpoint of the Economic Effect of the Project

Cost-benefit analyses (B/C) of the bus and road projects are done for the identification of the priority of the project. The cost-benefit analyses (with and without project cases) are conducted based on the do-nothing (existing) transport network in 2002. In Figure 18.4-1, the horizontal axis of the figure shows the B/C ratio and the vertical axis of figure shows the B-C value. In this figure, basically, projects with a high value of B/C ratio and B-C value are selected for the high priority, and projects with a low value of B/C and B-C are selected as a Middle Term Project to be implemented near the year 2012.



Note：
Case-3： Trunk bus system on Av. Almirante Barroso-BR-316
Case-4： Trunk bus system on Av. Almirante Barroso-Rod. Augusto Montenegro
Case-5： Trunk bus system on Av. Almirante Barroso-BR-316 and Rod. Augusto Montenegro (“Y-type”)
Case-6： Trunk bus system on Av. Independencia
Case-9： Trunk bus system on “Y-type”＋Av. Independencia
Case-10： Construction of Av. Independencia
Case-11： Construction of Rua Yamada
Case-12： Construction of Rua da Marinha
Case-13： Construction of Av. Primeiro de Dezembro

Figure 18.4-1 Economic Analysis of Each Project

From the economic analysis, the priority of each trunk bus and road project is identified. Alternative Case-3, Case-5 and Case-6 are placed on high priority. Especially, Case-5: “Y-type” trunk bus system, in which the trunk bus system on Av. Almirante Barroso-BR-316 and Rod. Augusto Montenegro is operated, is a high priority project.

From the viewpoints of cost-benefit evaluation, the following classification in the study projects is defined:

1) For High Priority Projects
   - Trunk bus system on Av. Almirante Barroso-BR-316 and Rod. Augusto Montenegro (“Y-type”)
   - Road project on Av. Independencia
   - Road project on Av. Primeiro de Dezembro
2) For Middle Term Projects
   - Road project on Rua Yamada
   - Road project on Rua da Marinha

(2) From the Viewpoint of the Bus Operation on Av. Almirante Barroso

In Chapter 10, the demand analysis on the trunk busways was conducted. The conventional bus volumes on Av. Almirante Barroso in 2007 and 2012 are heavy when no trunk bus project is implemented. The bus volumes will reach 640 vehicles in the “without” trunk bus system in 2007. This would make it very difficult to operate a bus service. Therefore, construction of the “Y-type” trunk bus system will be needed in 2007. In 2012, it is indispensable that the trunk bus system should operate on the Centro accessing segment on Av. Independencia from the traffic demand analysis.

From the viewpoints of the bus operation, the conclusion of the trunk bus system in the traffic demand analysis is as follows:

1) The construction of a trunk bus system on Av. Almirante Barroso- BR-316 and Rod. Augusto Montenegro by 2007 is indispensable for efficient bus operation.
2) The implementation of the Centro accessing segment of Avenida Independencia by 2012 is indispensable.

(3) From the Viewpoint of the Characteristics of Projects

The Para State Government has been implementing Av. Independencia that connects the north side of Centro to Cidade Nova. Av. Independencia in the suburban segment between Rodovia Augusto Montenegro and Alca Viaria is now under construction and the Centro accessing segment of this road has been planned for in this study.

This road has four lanes over the entire length from Centro to Alca Viaria. The study proposes the road widening and the intersection improvement to include the road into the proposed trunk busway system.

Av. Independencia is expected to share the function of BR-316 and Rodovia Augusto Montenegro. This road is indispensable not only to improve the public transport system in BMA, but also to alleviate traffic congestion caused by private vehicles. The economic analysis of this road indicates high priority.

18.5. IMPLEMENTATION PROGRAM

(1) Trunk Bus Projects

Table 18.5-1 shows the implementation program and investment by year according to working item. The implementation program for trunk busway facilities including integrated bus terminals and bus stops is planned for the period of three years from the beginning of 2004 to the end of 2006. In the beginning of 2007, the trunk bus system will be operated on Av. Almirante Barroso-BR-316 and Rodovia Augusto Montenegro, as well as on the suburban segment of Av. Independencia.

In order to operate the trunk bus system on the Centro accessing segment of Av. Independencia by the beginning of 2011, the widening of this segment should be planned for the period of three years from the beginning of 2008 to the end of 2010.

Since this study completes in the middle of 2003, the next stage shall be continuously conducted according to the implementation schedule listed from Working Items 2 to 6. Detailed design and environmental assessment in the detailed design stage are to be started from the beginning of 2004 and it takes one year.

Another important thing is procurement of project cost. In the economic and financial evaluation in the study, financial feasibility analysis was conducted on the assumption of interest rates of several financial resources. The project fund procurement to implement these projects must be started as soon as possible, since it is only one and half years until construction of trunk busways begins.

Table 18.5-1 Implementation Program for Trunk Bus Projects

Working Items	Classification	2002	2003	2,004	2,005	2,006	2,007	2,008	2,009	2,010	2,011	2,012
1. Completion of Feasibility Study												
2. Detailed Design (including Field Survey)												
3. Environmental Analysis												
4. Approval of Environment												
5. Preparation of Tender Document												
6. Procurement of Project Costs												
7. Tender for Construction												
8. Tender Evaluation												
9. Contract of Contractor												
10. Construction of Trunk Busway (Including related integrated bus termina	Av. Aliminante (US$1000)			3,556	3,556	10,774						
	Rod. August Monteneguro (US$1000)			6,889	6,889	20,873						
	Rod. BR-316 (US$1000)			6,449	6,449	19,541						
	Av. Independencia (US$1000)			6,280	6,280	16,021		5,612	7,743	3,856		
	Priority Lane (US$1000)			941	941	13,836						
	Bus Facilities (US$1000)			1,058	1,058	14,374						
Sum.Trunk Bus+Priority Lanes+Integrated Bus Terminals	162,976			25,173	25,173	76,335	19,084	5,612	7,743	3,856		

(2) Road Projects

Table 18.5-2 shows the implementation program and investment by year according to working item. The Para State government is now constructing Av. Independencia in the suburban segment between Rodovia Augusto Montenegro and Alca Viaria. The completion of the road by the year 2006 is advisable together with widening of two lanes prepared for the trunk bus system.

In order to ensure operation of the trunk bus system on the Centro accessing segment of Av. Independencia in 2011 as mentioned above, this segment of the road with four lanes for private vehicles and two lanes for trunk buses has to be constructed by 2011. This segment is of great importance for public transport and private traffic in the BAM.

The economic analysis indicates higher priority on Av. Primeiro de Dezembro. The implementation program for this road is planned for the period of three years from the beginning of 2008 to the end of 2010.

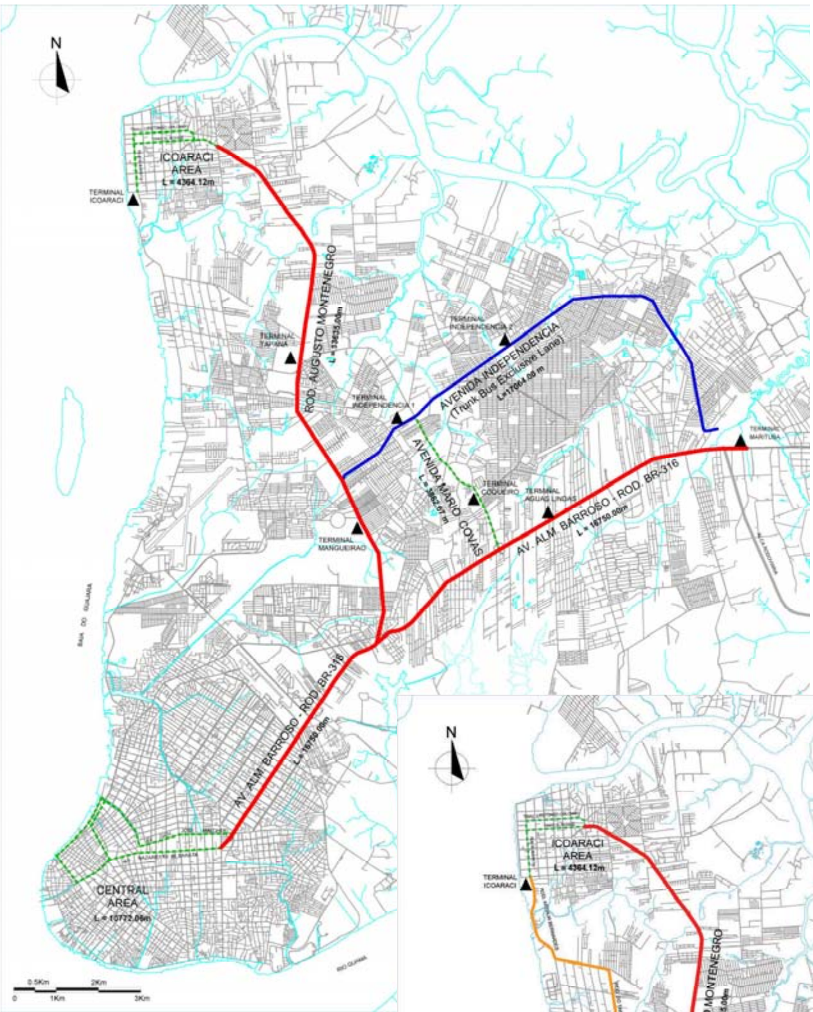
The implementation program for Rua Yamada and Rua da Marinha is planned for the period of three years from the beginning of 2010 to the middle of 2012, and for the period of one year from the middle of 2011 to the middle of 2012, respectively. Those are because the project priority is somewhat low.

Though the implementation of road projects is not a tighter schedule in time than that of the trunk bus projects, it takes time to negotiate with residents for land acquisition and resettlement of houses. Therefore, the project fund procurement to implement the road projects, as well as that of the trunk bus projects, must be started as soon as possible,. This is because different financial resources from those of the trunk bus projects will be supposed.

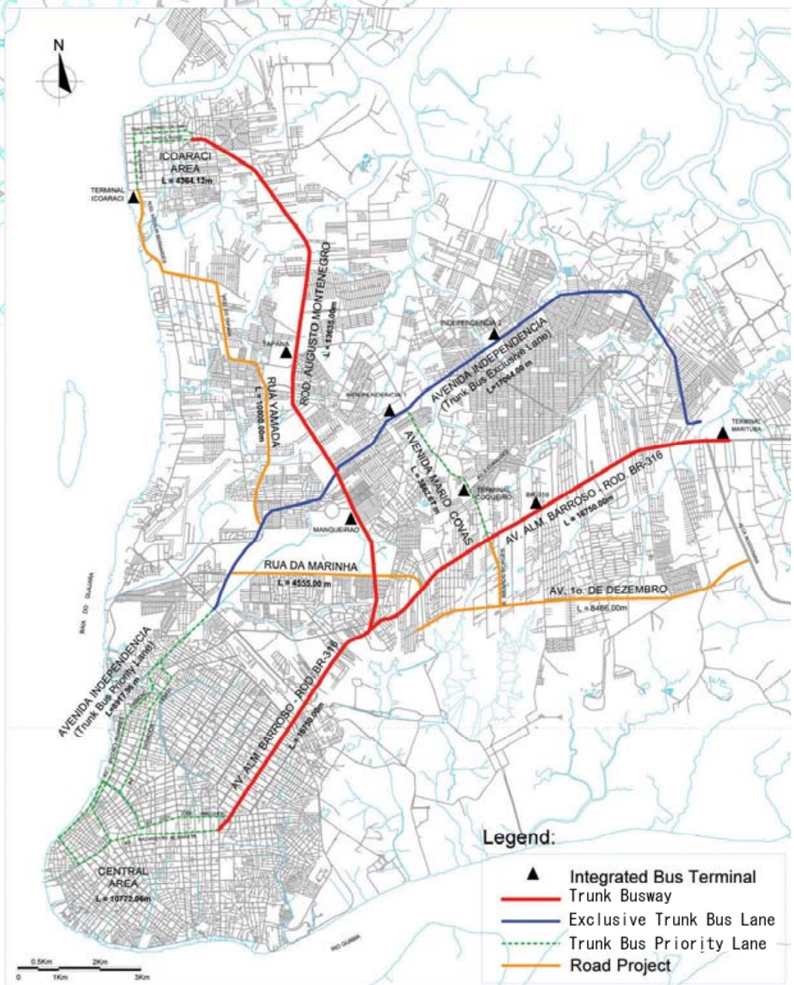
Table 18.5-2 Implementation Program for Road Projects

Working Items	Classification	2002	2003	2,004	2,005	2,006	2,007	2,008	2,009	2,010	2,011	2,012
1. Completion of Feasibility Study												
2. Detailed Design (including Field Survey)												
3. Environmental Analysis												
4. Approval of Environment												
5. Land Acquisition & Compensation												
6. Preparation of Tender Document												
7. Procurement of Project Costs												
8. Tender for Construction												
9. Tender Evaluation												
10. Contract of Contractor												
11. Construction of Roads	Av. Independencia	2,924	7,993	10,906	15,028	10,562		14,935	7,801	6,487		
	Rua Yamada				2,009	2,009	2,009			10,224	10,575	5,829
	Rua da Marinha					1,270	1,270					11,512
	Av. Primeiro de Dezembro			3,308	3,308	3,308		16,076	16,628	9,168		
Road Project excluding Av. Independencia (US$1000)	98,503			3,308	5,317	6,587	3,279	16,076	16,628	19,392	10,575	17,341
Toatl (including Av. Independencia)	338,116	2,924	7,993	39,387	45,518	93,484	22,363	36,623	32,172	29,735	10,575	17,341

According to the implementation program, proposed road and busway networks in 2007 and 2012 are shown in Figure 18.5-1.



Transport Network in 2007



Transport Network in 2012

Figure 18.5-1 Proposed Road and Busway Network in 2007 and 2012

18.6. REQUIRED INVESTMENT

Figure 18.6-1 shows investment cost required in each year to implement the projects. As can be seen, the investment cost of Av. Independencia is excluded in the road projects because Av. Independencia has been implemented by the Para State government. The total investment of the trunk bus and road projects is estimated at US$261 million, of which US$163.0 million, equivalent to 62% of the total, is estimated for the trunk bus projects and US$98.5 million is for the road projects.

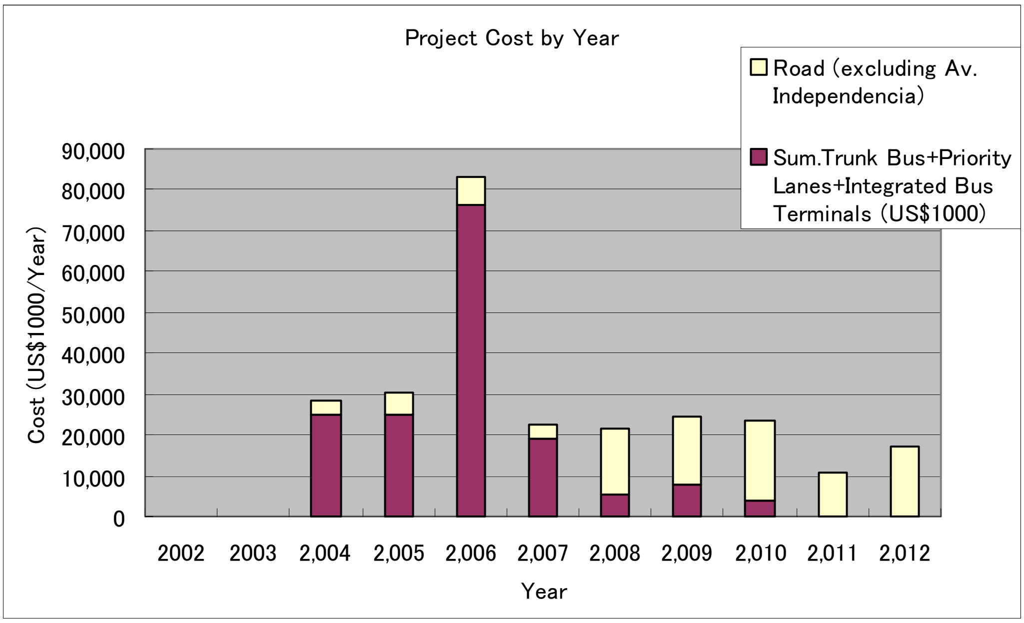
The investment of the trunk bus projects will peak in 2006 when the busways are constructed. After that, investment of a busway on the Centro accessing segment of Av. Independencia will start from 2008.

The investment of the road projects will concentrate on Av. Primeiro de Dezembro after 2008 and then, on Rua Yamada and Rua da Marinha after 2010.

Table 18.6-1 Required Investment Cost by Year

Classification	2002	2003	2,004	2,005	2,006	2,007	2,008	2,009	2,010	2,011	2,012	Total
Sum.Trunk Bus+Priority Lanes+Integrated Bus Terminals (US$1000)	0	0	25,173	25,173	76,335	19,084	5,612	7,743	3,856	0	0	162,976
Road (excluding Av. Independencia)	0	0	3,308	5,317	6,587	3,279	16,076	16,628	19,392	10,575	17,341	98,503
Trunk Bus & Road Projects	0	0	28,481	30,490	82,922	22,363	21,688	24,371	23,248	10,575	17,341	261,479

Figure 18.6-1 Required Investment Cost by Year



CHAPTER 19
Organization Of Trunk Bus System

19. ORGANIZATION OF TRUNK BUS SYSTEM

19.1. CURRENT SITUATION OF THE BUS SYSTEM

As mentioned in Chapter 7, item 7.10, three organizations manage public transport lines in the BMA. CTBel controls 88% of the lines, including municipal lines of the capital, and metropolitan lines connecting Belem with the other municipalities in the region.

Despite its dominant position, CTBel, created in December 1989, does not yet satisfactorily manage this system, especially concerning the constitution of legal instruments for delegation of services, the quality of its material resources and the qualifications of its personnel (item 7.10).

The metropolitan public transport system is operated by 29 companies with fleets that vary between 12 and 325 vehicles. The number of operating companies and the great variation of size among them, in addition to the absence of legal instruments for delegation, extraordinarily hinder the management of the system.

The spatial distribution of the operating companies in the BMA shows a concentration in the Primeira Legua Patrimonial (First Delimitation of Municipal Land), where practically no areas of exclusive operation exist, and smaller companies predominate. The largest companies are found in the Expansion Area, mainly along the main traffic corridors.

This great heterogeneity among the operating companies directly influences operating costs and expenses and, consequently, service standards, mainly for maintenance and mean age of the fleet.

Another aspect deserving emphasis is the economics of the system, because the absence of a clear fare policy that stipulates regular readjustment periods is making the systematic renovation of the fleet difficult for the operating companies. Added to this are the many non-paying riders, falling into 18 categories representing close to 22% of the passengers carried, and the lack of control of the half-fare concession system for students.

(1) Main Operational Problems of the System

The operational concept of the public transport system is obsolete, with a predominance of radial lines connecting the different neighborhoods with the downtown, causing intense overlapping of lines in the main corridors and inadequate service in the peripheral neighborhoods. This is due to significant demand in all these neighborhoods for service to downtown Belem.

The imbalance between supply and demand causes an extremely adverse situation for the current system, and it is confirmed that in Marechal Hermes Avenue, there pass close to 470 buses/hour, with mean occupation of 25% of the capacity of the vehicle, causing an excess of available seats higher than 35,000. These same lines, however, leave their terminals in the neighborhood with full capacity, and fail to meet part of the demand along the corridors.

The imbalance of the operational model is aggravated by the lack of infrastructure suitable to public transport — such as exclusive or priority roads or lanes, and neighborhood terminals — further hindering operation of the system.

This situation negatively affects economic and operational conditions. The intense overlapping of lines in the most central lines leads to frequent “failures to stop” on the part of operators, a situation in which the bus does not stop at the bus stop, due to the accumulation of lines there, and it also becomes difficult to control the cycle time and frequency of the lines.

Concerning procedures followed by the operating personnel, the number of user claims has been high, leading to a belief that the absence of continued personnel training programs, together with the uncertain working conditions of workers in this category, have been decisive in generating these conflicts.

19.2. PROPOSAL OF ORGANIZATION FOR THE BUS SYSTEM OF THE BMA

In this chapter, a new organization will be proposed for the bus system of the Belem Metropolitan Area (BMA), focusing on the following aspects:

- The metropolitan integrated management model;
- The model for operation of the trunk bus system.

19.2.1. THE METROPOLITAN INTEGRATED MANAGEMENT MODEL

(1) Background

The integrated management of the metropolitan public passenger transport systems began to be formed in Brazil starting from the end of the '70's, with the creation of Metrobel in the Belo Horizonte Metropolitan Area, EMTU/Recife in the Recife Metropolitan Area, and EMTU/SP in the São Paulo Metropolitan Area. There followed, already in the '80's, other metropolitan management entities, among which EMTU/Belem is emphasized, whose purpose was to manage public passenger transport of the BMA in an integrated way.

In spite of the unquestionable benefits that were allowed by those examples of integrated management, political reasons, among them the question of municipal autonomy, in particular of the capitals, have made those attempts at integrated management be progressively disassembled. In that way, by the end of the '80's, only the Recife Metropolitan Area kept its metropolitan management organization, EMTU/Recife. Added to this was the urban agglomeration of Goiânia, management of which had been delegated by the municipality to the state.

In this period, few other metropolitan regions attempted integrated management, because in regions like Salvador, Curitiba, and Fortaleza, the state capitals had such dominance in the metropolitan area that they dispensed with major concerns about intermunicipal travel. However, Porto Alegre Metropolitan Area, where the capital is relatively small within the urban agglomeration does not conform to this rule; even so, it deals in an isolated way with its public transport system, fully separating it from the typically metropolitan intermunicipal services.

In recent years, new integrated management models have started to be formed, led by the capital municipalities, that started to manage the whole public passenger transport system of each of their metropolitan regions. These are the cases of Curitiba, Goiânia, and, to a certain extent, Belem; the first two shall be specified in detail in the following item.

(2) The Existing Integrated Models

1) Recife Metropolitan Area - RMA

The oldest and most lasting experience (remaining to date) in Brazil of metropolitan public passenger transport management is that of the Recife Metropolitan Area (RMA), through the Metropolitan Company of Urban Transports - EMTU/Recife.

EMTU/Recife is a public state company created in March 1980, to manage the intermunicipal public passenger transport of the RMA and the intramunicipal public passenger transport of Recife, the latter delegated through agreement between the municipality and the state. Upon its creation, EMTU/Recife was linked to the Transport

Secretariat of the State of Pernambuco that, throughout the time has had other designations, such as Infrastructure Secretariat. More recently, starting from April 2001, EMTU/Recife has become subordinated to the Urban Development and Special Project Secretariat, also a state organ, created on the same date.

At the time of its creation it was anticipated that EMTU/Recife might assume all the management of the public passenger transport of the RMA, covering not only the intermunicipal lines, that were under the authority of the state, but also, the internal systems of each municipality, provided that the management was delegated by each of them. In fact, only the capital (Recife) has delegated this authority, through agreement that has already been reformulated no less than twice in the '90's, increasing the control mechanisms of Recife over its transport system, without revoking, however, the management authority of EMTU/Recife, over the municipal lines. It is important to emphasize that with the exception of Olinda, the other municipalities of the RMA do not have significant internal bus line networks that might conflict with the metropolitan system.

At present, the Recife Municipality participates with approximately 50% of the metropolitan system managed by EMTU/Recife, although this is hard to measure, given the integration level practiced since 1980.

In addition to the agreement with the municipality of Recife, EMTU/Recife has also signed an agreement with the municipality of Jaboatao dos Guararapes, limited in this case to a few lines that have been made compatible with the intermunicipal lines in the area, and has started to integrate with Metro, which makes up part of the metropolitan transport system managed by EMTU/Recife, designated as the Integrated Structural System (SEI). In this case, these specific intramunicipal lines have started to be controlled by the metropolitan manager, even taking part in the Compensation Chamber system.

EMTU/Recife receives from the operating companies a management fee of 4% for passengers carried on all the lines under its responsibility; this is included in the fare calculation.

Starting from 1999, EMTU/Recife also began to manage transit in the RMA, even in Recife, an activity that was conducted until then by Detran-PE.

Metropolitan management of the RMA has always been subordinated to a deliberative council, originally designated as the Governing Board of EMTU/Recife, and made up of eight members, one of whom was the Mayor of Recife and another, a mayor of the RMA, in turns. Later, in 1985, this board was expanded to 19 members, and started, then, to incorporate, in addition to the previous participants, four assemblymen, four state congressmen, and two representatives of the communities, among others.

A great institutional change of this board occurred in 1989, when the Metropolitan Urban Transport Council (CMTU) was organized, separating the activities related to the public transport system of the RMA from the internal administrative matters of EMTU/Recife. The function of the CMTU is to define the policies, the guidelines, and the main transport actions of the RMA, including fare readjustments, and it behooves EMTU/Recife to operate as an executive secretariat of the same. It is currently composed of 30 members, namely:

- Three representatives of the government of the state: the Secretary of Urban Development and Special Projects (Chairman of the Council), the Secretary of Planning, and the Chairman of EMTU/Recife;
- Fourteen mayors of the RMA, including that of Recife;
- One state congressman;

- Four assemblymen, including two of Recife with terms of office of two years, and two of the other city halls of the RMA, in semiannual turns;
- One representative of the employers' union (of the bus companies);
- One representative of the workers' union (drivers and collectors);
- One representative of the CBTU, operator of the Metro of Recife (Metrorec);
- One representative of the CTTU - Urban Traffic and Transport Company of Recife;
- Three representatives of community entities (representatives of the users of the system);
- One representative of the students.

It is pertinent to note that Recife Municipality and the State of Pernambuco each have four members in this council. For the Recife Municipality: the mayor, the chairman of the CTTU, and two assemblymen; and, for the state: two secretaries, the chairman of EMTU/Recife, and one congressman.

Figure 19.2-1 shows the management structure of the Recife Metropolitan Area.

2) Curitiba Metropolitan Area - CMA

The experience of integrated management of public transport in the Curitiba Metropolitan Area is relatively recent. In fact, the capital has organized its public transport system since the middle of the '70's and, since then, it has managed it through the URBS - Urbanizacão de Curitiba S/A. Throughout this time, some conflicts have occurred with the bus lines coming from the neighboring municipalities, that resulted in some lawsuits, on the account of the use of the road infrastructure of Curitiba by the intermunicipal lines.

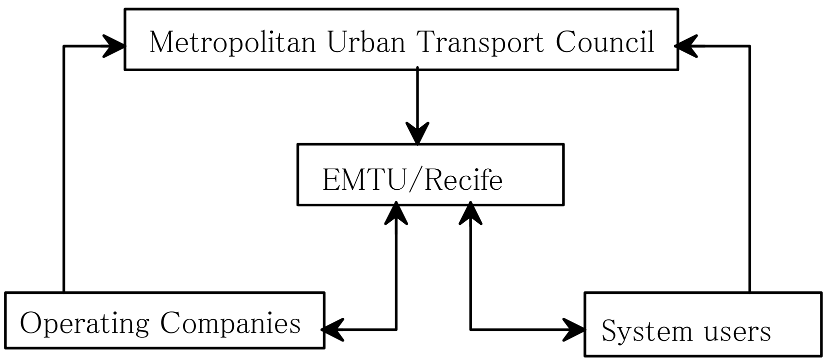


Figure 19.2-1 Management Structure of Recife Metropolitan Area

Until 1996, there were some attempts to make the operation of the lines of other municipalities compatible with the municipal system of Curitiba, with no great success. Since then, an agreement has been concluded between the governments of the state and the Municipality of Curitiba, whereby the URBS started to manage the metropolitan intermunicipal lines of 13 (besides Curitiba) of the 25 municipalities that make up the CMA. Additionally, the URBS manages the intramunicipal lines of the municipalities of Fazenda Rio Grande, Almirante Tamandare, Pinhais, and Colombo (in the latter, close to 90% of the system).

There does not exist any municipal legislation, either in Curitiba or in the other municipalities, that authorizes the actuation of the URBS in the neighboring municipalities. All metropolitan management is based on the agreement mentioned above. The URBS receives as a management fee 4% of the fares collected on the lines under its responsibility and manages the metropolitan system with the same technical structure, even of personnel, that operates in the capital.

At present, of the system managed by the URBS, close to 60% of the lines and of the fleet, and 75% of the passengers carried, are of Curitiba Municipality. The URBS also has under its responsibility the management of the school transport and of chartering, provided that the same are metropolitan. In the backup infrastructure for metropolitan transport, such as terminals and exclusive road sections, the state provides the resources for the work and the municipality gives support for land and accesses. For the bus stops, the URBS proposes the places where they should be located, and the responsible city hall is in charge of procuring the infrastructure and installing them.

The metropolitan management system of the CMA also has a forum, designated as ASSOMEC - Association of the Curitiba Metropolitan Area Municipalities, in which there participate all the mayors of the municipalities of the CMA, the chairman of which is the current mayor of Curitiba. A monthly meeting is held, which the mayor of the capital uses to transmit information about metropolitan transport and the management by the URBS. ASSOMEC is only an association and does not have a deliberative nature.

The fares collected on all the bus lines of the system managed by the URBS are determined by the Municipality of Curitiba. At the time of fare readjustments, the URBS makes the calculations and submits the necessary percentages, to the governor of the state, who approves the readjustments for the intermunicipal lines.

Figure 19.2-2 shows the management structure of the Curitiba Metropolitan Area.

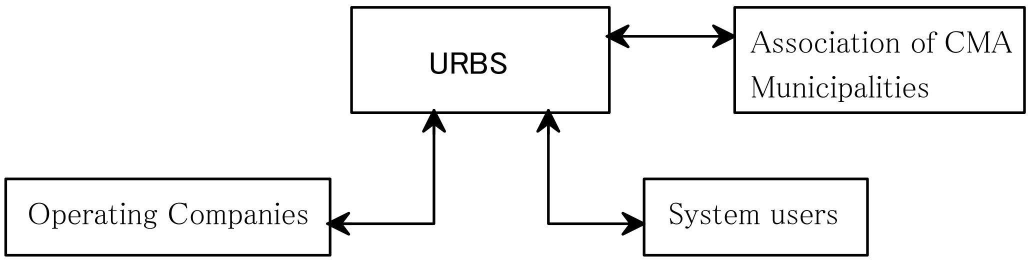


Figure 19.2-2 Management Structure of Curitiba Metropolitan Area

3) Goiania Metropolitan Area –GMA

The newly created Goiania Metropolitan Area (GMA) has a long tradition of integrated management of public transport, starting in 1976, when it was only a built-up urban area, and the municipal government of Goiania has delegated to the State of Goias, for 30 years, the management of its municipal transport system. At this time, the government of the state created TRANSURB, which has assumed responsibility for supervision and control of this system.

Though Goiania delegated management of the public transport to the state before the municipal government of Recife followed the same practice, the management in the GMA has suffered several reorganizations over time, so that the experience of EMTU/Recife is longer and more lasting, because it remains with the same entity to date.

Starting in 1990, in addition to managing, TRANSURB started to directly operate some of the bus lines. Then, in 1997, it was substituted as operator by METROBUS, and concentrated solely on management.

In 1999, with the creation of the Goiania Metropolitan Area (GMA), the Goiania Public Services Regulatory Agency (AGR) was also created within the state administration, and started to manage public transport in the GMA, leaving TRANSURB with only the function of a depository of the concession contract for the lines of the municipality of Goiania that will be in force until the year 2006.

A physical and operational study of rationalization of the public transport system, with metropolitan coverage, was conducted between 2000 and 2001, and recommended, among other things, a reformulation of the management model then in force, with the creation of a specific organ for public transport. In fact, the state AGR was already finding problems in satisfactorily performing its management functions, aimed at providing this service.

The Executive Management Group for the Metropolitan Public Transport Network (GETRANS) was then provisionally created, and has assumed the official role of a managing organ, linked to the Deliberative Chamber of Public Transport (GMA), that started to have the following composition:

- Four members of the municipal government of Goiania: the Mayor, the Chairman of GETRANS, the Chairman of the Municipal Transit Superintendence, and the Secretary of Planning;
- Two members of the State Government: Infrastructure Secretariat and Regulatory Agency (AGR);
- Two mayors of other municipalities of the Metroppolitan Area - Aparecida de Goiania and another (in turns);
- One member of the State Legislative Chamber.

Simultaneously, measures have been taken to create the Metropolitan Public Transport Company (CMTC), which should assume the management of the public transport in the GMA, in place of GETRANS. This entity, linked to the municipal administration, will be a public company, with participation of 50% by the Municipality of Goiania, 25% by the state, and 25% by the other municipalities of the GMA. It will be a closed-ended joint-stock company, in the form of a public company governed by the joint-stock company law. It will be invested with police power, and will be organized, installed, provided, and managed by the municipality of Goiania. With this, the capital regains the management of its public transport, sharing control with the state and the other municipalities of the GMA.

A fee corresponding to 3% of the value of the fares is to be collected for management of the public transport of the GMA. The intramunicipal system of Goiania should cover from 70 to 75% of the whole metropolitan area.

Figure 19.2-3 shows the management structure of Goiania Metropolitan Area.

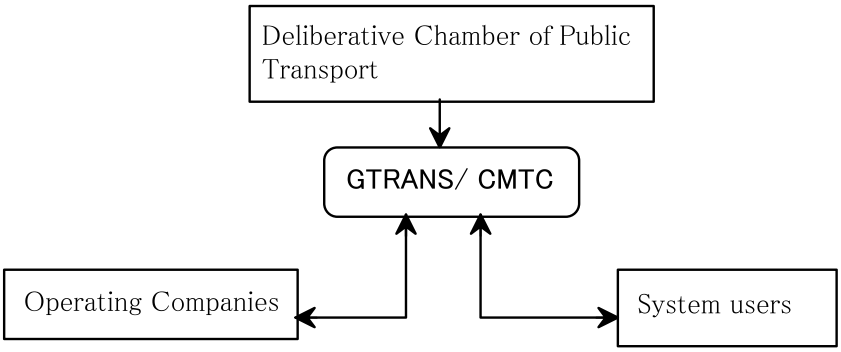


Figure 19.2-3 Management Structure of GMA

(3) Premises and Determining Factors for the Model of the BMA

The objective of the organization model of the public transport to be implemented in the BMA should be integrated management of all the bus transport in the region, because the physico-operational model proposed totally expands the municipality of Belem.

The possible formats of the models should take into account two aspects:

- Government level to which the management entity is linked;
- Deciding model.

The government level basically characterizes who guides or leads the process or, more specifically, to whom the managing entity is formally linked: to the state or to the municipality.

The deciding model defines the decision-taking process, that might be collegiate, through deliberative councils, or centralized in the executive levels, i.e., in the highest leader of the managing entity or in its hierarchical superiors, that may be a secretary of government or, as a last resort, the Mayor or the Governor.

Table 19.2-1 summarizes the four possibilities of formats, identifying the existing practices that are better exemplified by the same.

Table 19.2-1 Summary of Four Possibilities of Formats

Government Model → Deciding Model↓	State	Municipality
Collegiate	Recife	Goiania
Centralize	-	Curitiba

Naturally, between the extremes, there are possible intermediate solutions. The managing entity of Goiania is a municipal company (therefore linked to the Municipality of Goiania), but 50% of its capital belongs to the state and other municipalities of the metropolitan region. On the other hand, the management model of Curitiba is centralized in URBS, or the Mayor of Curitiba. However, there is also a consultative (not deliberative) council in which the actions and the results attained are presented and discussed.

Another strong determining factor to be considered in the model selected for the BMA is the preponderant dimension (number of trips) of the capital in the metropolitan context and the existence of a municipal managing entity already in operation, CTBel, the actuation of which expands the limits of Belem.

It is also important to emphasize that it is necessary to look for a metropolitan management model that can last by adapting itself to the different political situations that happen to occur. For this, it is essential that the construction of the model have extensive participation of all the parties involved and that it is implemented with proper flexibility, enabling it to migrate from the current situation to a future one.

(4) The Management Model Proposed

It is recommended to implement a transition model, in which implementation activities of the Study projects are separated from the management activities of the existing public transport system. Therefore, it will be necessary to create an Executive Transport Group (GET) for the implementation of the Study projects, while existing executive organization continues with its management functions. To articulate the activities of both organs, it will be necessary to organize a Metropolitan Urban Transport Council (CMTU), in accordance with the scheme shown in Figure 19.2-4.

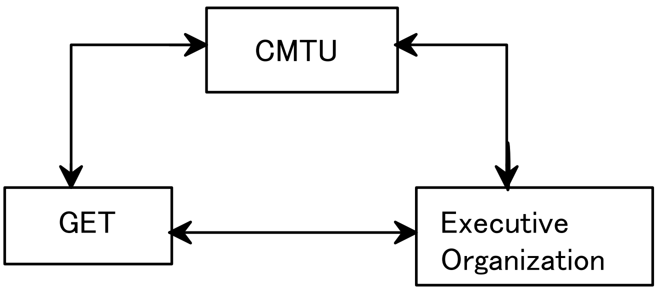


Figure 19.2-4 Scheme of Articulation of GET with Existing Executive Organization

The CMTU will have an important role of articulation of GET with CTBel to avoid the confrontation with them in the implementation stage of the project when the GET and CTBel propose different proceedings.

This council should have the participation of the government of the state, of the municipal government of Belem, of the other city halls of the municipalities that make up part of the BMA, of class entities representative of the different social segments, and of the bus operating companies.

The Executive Transport Group (GET) will be a temporary organization to implement projects and the Regional and Urban Development Executive Office (SEDURB) in the Para State will play a key role. The GET shall be administratively linked to the state and should have its actions subordinated to the Metropolitan Urban Transport Council (CMTU), operating as an executive secretariat of the same. Figure 19.2-5 shows the general scheme for the implementation of the Study projects, and the management of the public transport system of the Belem Metropolitan Area.

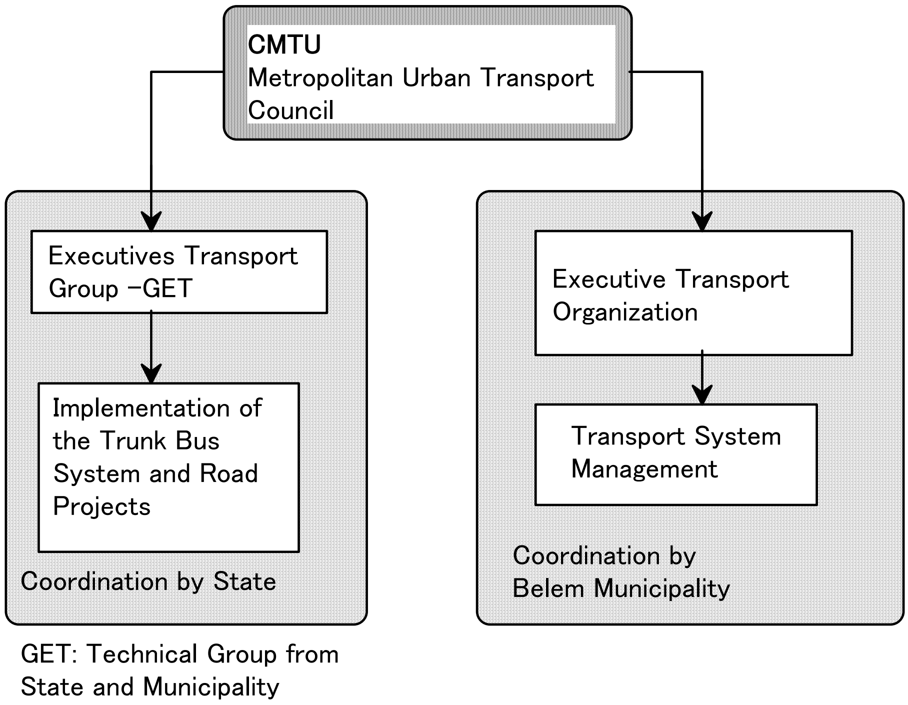


Figure 19.2-5 General Scheme for the Implementation of the Study Projects

For the composition of the technical body of the Executive Transport Group (GET), it shall be necessary to contract officials of the government of the state and of the municipal government of Belem. It shall be a transitional organ. The GET will be responsible for the implementation stage. After the end of this stage, the GET will become the Metropolitan Managing organization or its technical team will be absorbed by the future metropolitan managing entity.

Figure 19.2-6 is proposed for the Executive Transport Group (GET), made up of a chairmanship, three advisory boards, and four managements:

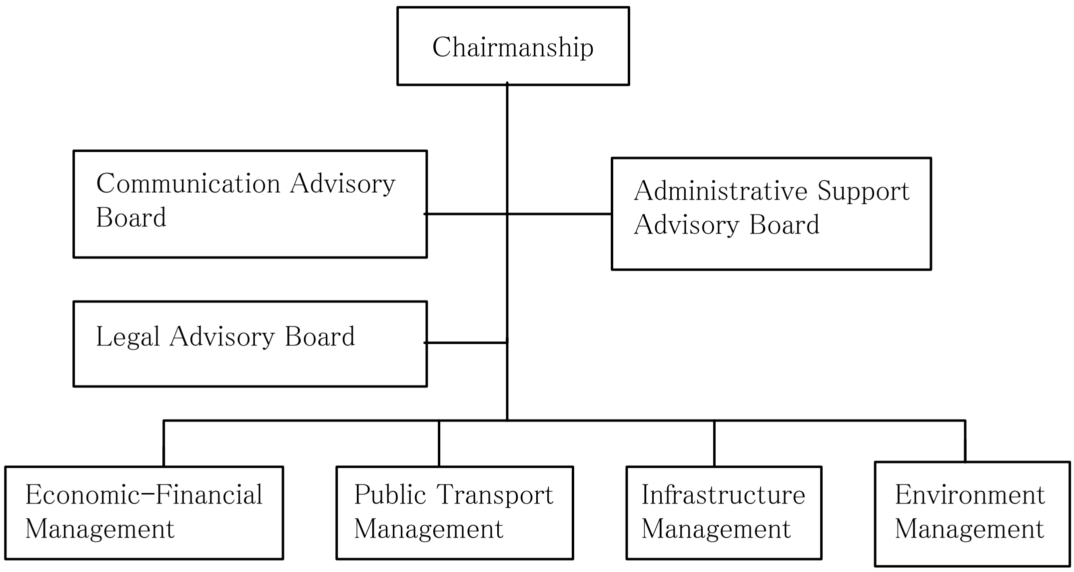


Figure 19.2-6 Organization Chart Proposed for the Executive Transport Group (GET)

The authority of each unit of the GET will be outlined below:

- Chairmanship:

  Coordinates all the work and actions of the group and represents the GET in the CMTU.

- Administrative Support Advisory Board:

  Gives administrative support to the activities of the group.

- Legal Advisory Board:

  Supports the chairmanship and the managements in legal and institutional matters involving the different agents that participate in the implementation of the Study projects, including the bus operating companies.

Communication Advisory Board:

  Disseminates the necessary information to the population and acts as the interface between the group and the communications media.

- Economical - Financial Management

  Handles the economic and financial aspects of the project, including identification of financing sources, preparation of programs for the gathering of funds, follow-up of the disbursements and of the financial schedule for the implementation of the STUDY projects.

- Public Transport Management

  Specifies in detail the integrated network and proposes alternatives for the distribution of the new bus lines among the different operators. Follows up the management of the existing lines to prevent eventual modifications or creation of new services from making the trunk bus system difficult or even unfeasible.

- Infrastructure Management

  Specifies in detail and adjusts the projects, contracts the work, and follows up the road interventions, including even the construction of terminals.

- Environmental Management

  Specify in detail and adjust the environmental impact studies, follow up the work and the implementation of the mitigating measures, and take care of the expropriations and resettlements.

(5) The Management of the Integration Terminals

Among the activities of the future managing entity it is necessary to pay special attention to the management of the terminals, including their daily operation, cleaning, safety and maintenance.

In most of the cities that operate integrated bus systems, the management of the terminals is the responsibility of the public authority, usually through their managing organs. These are the cases of the following cities as shown in Table 19.2-2.

Table 19.2-2 Number of Terminals by Cities

City	Number of Terminals
Fortaleza	7
RM of Recife	10
Goiania	10
RM of Curitiba	28 + about 350 tube stations

In some situations commercial activities are explored within the terminals, such as snack bars, kiosks or advertisements. However, these activities do not always succeed commercially and, normally, do not generate significant income, because in the urban integration terminals the time of stay of the users is minimal, and those places are not considered as shopping and service centers.

On the other hand, in closed terminals with free integrations among the different bus lines, the intensive utilization of internal commercial activities is not advisable, because it generate foot-traffic flows of people that are not users of the transport system, such as employees of the kiosks, suppliers of merchandise, and residents of adjacent areas. These traffic flows of people foreign to the transport system make the control and operation of the terminal difficult and eventually cause loss of income. The success of these activities in areas outside the terminals depends on a set of complementary actions of land use regulations that should be implemented by the municipalities.

Another model of management of urban terminals is the one practiced by EMTU/SP, in the corridor of the ABD (São Mateus - Jabaquara), in which the operation of the trunk bus lines has been bid out, together with the management of the nine integration terminals, some of them operating with free integrations and others with physical integrations only. In this case, the operation and maintenance of the terminals is responsibility of the Metra, a concessionaire company of the corridor, though there also exist agreements with the municipal governments and SPTrans for some maintenance expenses that extend the contract of the concessionaire. It is important to emphasize that even in this case, the commercial activities inside the terminals did not succeed, and are now practically defunct.

For the case of the BMA, it shall be possible for the terminals to be directly managed by the managing entity that happens to control the public transport system. In case a bidding process is held for the rearrangement of the lines and of the operating companies, it is considered that it is appropriate to include the management of the integration terminals in the concession contracts of the system, in the pattern in which it is being practiced in São Paulo, in the São Mateus - Jabaquara corridor.

(6) The Study as an Instrument of Integrated Development in the BMA

The Para State Government intends to implement the trunk bus system and road projects proposed in this feasibility Study in coordination with other sectorial plans of the state, promoting an integrated development and social program in the BMA

The road and public transport projects in this Study have a structuring nature of land and urban transport in the metropolitan area, either through their eight integration terminals that reinforce or create new metropolitan sub-centers, or through new roads that improve accessibility of peripheral areas of this area.

To promote coordination between the Study projects and others to be executed by different state sections, the Para State plans Long-Term Plan/PPA 2004 – 2007, the creation of the Metropolitan Integration Program. In the Program, the Study is intended as the guiding project of the other action programs in the BMA which include other supplementary projects and actions to implement management instruments, integrated development of the

BMA and also of land use planning in the municipalities of Ananindeua, Marituba, Benevides, and Santa Barbara do Para, as below:

1) Metropolitan Strategic Plan - Prepared by the state, together with the civil society, industry, and municipalities of the RMB. The aim of this plan is to define economic and social development strategies, considering the guidelines already stipulated in the Study, for the metropolitan municipalities, and the economic potentialities of the region;

2) Metropolitan Management System - Starting from the proposal of integrated metropolitan management for the transportation system, mentioned in this chapter, item 19.2.1. This action is intended to expand the metropolitan management to other "common services of metropolitan interest" with the creation of the Deliberative Council of the BMA, its Sectorial Chambers, and Executive Secretariat;

3) Urban Master Plans of Ananindeua, Marituba, Benevides, and Santa Barbara do Para. In this action, the state government intends to support these municipalities in preparing and implementing their master plans, in accordance with what is stipulated in Article 182 of the Brazilian Constitution and in the Statute of the City. In these plans, guidelines shall be drawn land use planning, and municipal development compatible with the proposals in the Study;

4) Implementation of Avenida Independencia – An important metropolitan corridor, it shall be executed by the Government of Para State with two lanes per direction, and later expanded with one more bus exclusive lane per direction proposed in the Study;

5) Intermunicipal-Interstate Bus Terminal - To be implemented beside the Marituba Terminal, on Rodovia BR-316 with Alca Viaria, making the physical integration into the urban system possible. This new terminal shall replace the current one of Sao Braz that shall be utilized by the trunk bus system proposed in the Study.

In addition to the projects and actions mentioned above, the PPA 2004 - 2007 anticipates the implementation of other projects affecting the BMA, which might be grouped into six large areas, as follows:

1) Tourism and Environment - In this area there are three highlighted projects:
   a) Amazonia Park, in the area of Pirelli, in Marituba
   b) Utinga Park, in Utinga
   c) Mangal das Garças Park, in Cidade Velha
2) Culture Sports and Leisure - In this area there are two highlighted projects:
   a) Sports and Leisure Square, in the area close to the Olympic Stadium of Para
   b) Music City, in Avenida Almirante Barroso
3) Education – In this area there are two highlighted projects:
   a) Health Technical School, in Marambaia
   b) Lauro Sodre Science and Technology Institute, at Av. Almirante Barroso
4) Work and Social Inclusion - In this area there are two highlighted projects:
   a) Worker's House, at Av. Magalhaes Barata
   b) Labor and Production School in Icoaraci
5) Health - In this area there are two highlighted projects:
   a) Metropolitan Hospital, at Rodovia BR-316, in Ananindeua

b) Sarah Kubitschek Hospital, at Rodovia Arthur Bernardes

6) Housing - Within the Our House Program there are nine anticipated actions aimed at making private home ownership available to the population with a family income up to 20 times the minimum wage.

The PPA 2004 - 2007 shall be sent to the Legislative Assembly of the State by August 30, 2003 for approval in this fiscal year, and shall become effective as State Law starting from 2004.

The Metropolitan Integration Program shall also promote the coordination of the Study with other projects anticipated in the PPA, allowing better equipment access for those projects, reinforcing their functions, and promoting the integrated development of the BMA.

19.2.2. MODEL FOR THE OPERATION OF THE TRUNK BUS SYSTEM

The physical and operational arrangement proposed for the Public Passenger Transportation System of the BMA anticipates the trunking of part of the bus lines that operate at present as conventional services, characterizing two different corridors, that of Rodovia Augusto Montenegro, and that of the BR-316, that join in the corridor of Av. Almirante Barroso. Within this arrangement, it is possible to identify five groupings of bus lines, with their respective operating companies, namely:

- Trunk Bus Corridor A (Augusto Montenegro);
- Trunk Bus Corridor B (BR-316);
- Central Area;
- UFPA, and
- Mosqueiro

The purpose of this item is to propose an organization model for the companies, that facilitates the implementation and operation of the trunk bus system, by harmonizing it with the conventional line system, which remains.

(1) Some Organization Models of Trunk Bus Systems in Brazil

At present, several trunk bus or simply integrated bus line systems operate in Brazil, with different organizational solutions. The models adopted in five different cities are presented below, starting from that with the lowest participation of public authority in the management, to that with the highest involvement.

1) Goiania

In Goiania, the trunk bus system is articulated by feeder bus lines to 10 terminals, involving different operating companies. The trunk bus line is operated by Metrobus, a state public company, and the feeders by private companies. As the integrations are processed in confined environments (closed terminals), each operating company gets the payment from the user in the first vehicle he boards. Thus, in a neighborhood/downtown displacement using a feeder bus line and a trunk bus line, the user pays the feeder bus line and, in the inverse direction, the payment is made on the trunk bus line.

Users may also practices double integration, i.e., feeder-trunk-feeder travel. In this case, the operating companies of the feeders would get the payments and the operating company of the trunk bus line would carry the user with no remuneration. According to information collected, this kind of displacement is not significant in Goiania, however, there are signs of under-remuneration of the public company, Metrobus, responsible for the trunk bus line.

2) Fortaleza

In Fortaleza no trunk bus system exists, but, integrations between the different bus lines are extensively practiced, articulated in seven terminals, in which the integrations are free, in confined environments. In the system of Fortaleza, there is a Fare Compensation Chamber (CCT), in which the managing entity, ETTUSA, calculates the costs and the income of each company and notifies the operators' union of the debits and credits of each of them, to the effect that the compensations are made. In this way, the companies are remunerated for the effectively rendered service. If eventually a company carries many integrated passengers that originate from other operators, it will have income lower than its costs and it will be compensated by the compensation system.

It is important to warn that in recent years the Compensation Chamber system of Fortaleza is showing some problems. Thus, the companies that had to reimburse the excess funds collected from the users have failed to do so consistently, preventing compensation to the companies with deficits that would be creditors of the system. In practice, the system of Fortaleza is operating the same as that of Goiania, in which each operator is effectively remunerated with the resources of the users when they board the buses, outside the integration terminals.

3) Sao Paulo - ABD Corridor (Sao Mateus - Jabaquara)

In the San Mateus - Jabaquara corridor, the trunk bus lines are operated by Metra, made up by a consortium of companies that hold the concession of the operation of the corridor, obtained through a bidding process. In this system there are nine terminals to which the feeder bus lines converge, part of them making fare integrations (free integrations in confined environments) and part making physical integrations only (the users pays a new fare in order to transfer from one line to another).

In this system, no income compensation mechanism is practiced. In this way, each operator gets the funds collected from its paying users. In the case of the trunk bus lines, when double free integrations occur, there is under-remuneration that was not significant until a short time ago. In recent years, that kind of user has increased and there is already concern about how to implement mechanisms that might compensate the trunk bus line operating company.

4) Recife

In the Recife Metropolitan Area there is the Integrated Structural System (SEI), made up of six radial corridors and four perimetric ones, articulated by 10 integration terminals, where transfers occur between trunk bus lines, Metro included, and also between trunk bus lines and feeder bus lines, always in confined environments, with free integrations.

The compensation of income among all the companies of the system, even those involved in the integrations, is made through the Fare Compensation Chamber (CCT), managed by the local managing entity, EMTU/Recife, in the pattern described for the case of Fortaleza. EMTU/Recife controls part of the financial resources of the system and effectively ensures the transfers between the different operators. Therefore, the eventual under-remuneration of some of them as a result of non-paying users that originate from the integrations is compensated by the CCT.

The Metro of Recife does not use the income compensation system. It is pertinent that a portion of its demand is made up of users with double integrations that do not pay when they get on the Metro, and there are signs that there is under-remuneration of that mode.

5) Curitiba

The public transportation of Curitiba Metropolitan Area is the most extensive in terms of integrations, and operates almost 500 trunk and feeder bus lines, articulated in 28 integration terminals and more than 200 tube stations, where the transfers of the users occur in the free way.

All the income of the system is centralized and controlled by the local managing entity, the URBS, which pays each operating company according to the effectively rendered service, service this entity planned and previously programmed also by the URBS. In this way, the remuneration of the operators is totally separate from the funds that each of them receives from the users carried, and it is not relevant either to the place or the company to which the user makes the payment of his displacement.

(2) Proposal of Organization for Operation of the Trunk Bus System of the BMA

The basic idea for the arrangement of the companies that operate in the Public Transportation System of the BMA is to group them in associations of operators, as a function of the trunk bus corridors, in the pattern of the consortia practiced in Porto Alegre, the premises of which are:

- The companies that make up the consortium operate in isolated geographic areas (basins), in which there is well-characterized demand, or a market of passengers of each associated set. Overlapping of the lines of different consortia occur only in the areas close to downtown. Thus, disputes for the market of passengers are practically non-existent among them;
- The management of the operation of each consortium is centralized, and seeks harmony among the different operating companies and maximum rationalization in the rendering of the service. The technical teams operating the system (traffic heads, travel and passenger controls, among others), are subordinated to the operational coordination of the consortium;
- In each consortium the companies operate as if they were a single entity, acting as individual, isolated companies in their internal activities, i.e., in the maintenance, in the purchases, and in the administrative routines;
- There are financial compensations among the consortia, through a Fare Compensation Chamber (CCT) system. The areas (set of lines/companies) with the best financial results transfer funds to those with more modest results. The calculations of the debits and credits of each consortium are made by the local managing entity, EPTC, and the transfers of funds are promoted by the operating companies' union, which centralizes the income that originates from the advance sales of tickets (Transportation Voucher). Within each consortium the pro-rating of the funds is made as a function of the unit costs of each company and of the services effectively rendered by each of them.

For the case of the Belem Metropolitan Area, there are two suggested alternatives:

1) Consortium of Companies;
2) Consortium of Lines

1) Consortium of Companies

In the consortium of companies there would be involved all the operators that have integrated or conventional lines in the area of influence of the two trunk bus corridors, in addition to the companies that happen to operate the trunk bus lines. In that way, two consortia would be created, A and B, that correspond respectively to the trunk bus corridors of the Rodovia Augusto Montenegro and of BR-316.

Table 19.2-3 shows the distribution of all the companies among the five different groupings of lines, with consortia A and B included.

As can be seen, the organization of consortia by companies shows a significant problem, because the many operators, and the scattering of their lines makes several of them operate in more than one area, which, in practice, prevents the principles that guide the formation of the consortium from being conformed to.

Table 19.2-3 Distribution of Companies per Area of Actuation

Seq.	Company Code	Consortium-A		Consortium-B		Central Area	UFPA	Mosqueiro
		Convent.	Integrated	Convent.	Integrated			
1	AA					x		
2	AB					x		
3	AC	x	x				x	
4	AD					x	x	
5	AE	x					x	
6	AF	x		x	x	x	x	
7	AG			x		x		
8	AH			x		x		
9	AI	x		x			x	
10	AJ							x
11	AK	x	x	x		x		
12	AL			x		x		
13	AM					x		
14	AN					x		
15	AP						x	
16	AQ					x		
17	AR	x	x	x		x		
18	AS					x		
19	AT	x	x				x	
20	AU1			x			x	
21	AU2			x	x			
22	AU3			x	x			
23	AU4			x	x			
24	AV			x	x			
25	AZ	x	x	x			x	
26	BB			x	x			
27	BC			x	x			
28	BD	x				x		
29	BF			x				

Note:

- Bus Companies with integrated and conventional routes in the same consortium (6)
- Bus companies with integrated and conventional routes in several areas or consortium (6)
- Bus companies with routes for UFPA, that might make integrations with the trunk lines (5)
- Bus companies with conventional lines (12)

In this method, consortium A would be made up of nine companies that operate in the following operating areas:

- Three that operate in consortium A and in UFPA (AC, AE, and AT);
- Two that operate in Consortium A, in Consortium B, and in the Central Area (AK and AR);

- Two that operate in Consortium A, in Consortium B, and in UFPA (AI and AZ);
- One that operates in Consortium A, in Consortium B, in the Central Area, and in UFPA (AF);
- One that operates in Consortium A, and in the Central Area (BD);

Regarding Consortium B, it would be made up of 16 companies, with the following distribution among the actuation areas:

- Six that operate exclusively in Consortium B (AU2, AU3, AU4, AV, BB, and BC);
- Two that operate in Consortium B, in Consortium A, and in the Central Area (AK and AR);
- Two that operate in Consortium B, in Consortium A, and in UFPA (AI and AZ);
- One that operates in Consortium B, in Consortium A, in the Central Area, and in UFPA (AF);
- Three that operate in Consortium B, and in the Central Area (AG, AH, and Al);
- One that operates in Consortium B, and in UFPA (AU1);
- One that operates exclusively in Consortium B, with conventional lines (BF).

Even if associations are formed with only the companies that participate in the trunk bus (integrated) system, Consortium B would be made up of seven companies that would also have conventional lines in the area of the consortium and one of them, AF, would also operate in Consortium A.

In the case of Consortium A, the situation is more complex, because the five companies that would operate in the integrated system also operate conventional lines in the area of the consortium and also have services in other areas, such as the Downtown or the UFPA.

In consideration of the above, it is possible to conclude that the alternative of organization by consortia of companies is difficult to implement, because it is practically impossible to operationally isolate sets of lines and, consequently, of entrepreneurial interests. That alternative would be feasible only with an extensive restructuring of the whole system of bus lines and operating companies of the Belem Metropolitan Area, which might be made feasible only through a bidding process.

2) Consortium of Bus Lines

In the consortium of lines there would be involved only the lines that happen to be integrated in order to make up the trunk bus system, including the trunk bus lines themselves.

Table 19.2-4, below, shows a summary of the situation of Consortium A, before and after the implementation of the trunk bus system, considering as a basis the offered service and the demand in 2002. In accordance with what can be noted, in the consortium by lines there would be only five companies involved, that in the future situation would be operating 15 integrated lines and six trunk bus lines, with a total fleet of 353 vehicles, i.e., a reduction of 5.4% (20 fewer buses), compared with the current situation.

Table 19.2-4 Summary of the Situation Before and After Consortium A - Basis 2002

Bus Companies	Current Situation		Proposed Situation			
	Fleet	Routes	Fleet		Routes	
			Convent.	Integrated	Convent.	Integrated
AC	85	7	43	12	3	4
AK	12	1	12		1	
AR	88	15	53	18	10	5
AT	111	12	71	23	8	4
BD	13	2	13		2	
AE, AI, AZ	12	1	12		1	
AI, AT	8	1	8		1	
AR, AF	6	1	6		1	
AR, AT	11	1	11		1	
BD, AF	11	1	11		1	
AR, AK	2	1		2		1
AT, AZ	14	1		2		1
TRUNK				56		6
TOTAL	373	44	240	113	29	21

The summary of Consortium B, also considering as a basis the offers of service and the demand in 2002, is shown in Table 19.2-5, in which is confirmed the involvement of seven companies, that would start to operate 41 integrated lines and six trunk bus lines, with a fleet of 605 vehicles, i.e., 88 fewer buses than the current situation (reduction of 12.7%).

Table 19.2-5 Summary of the Situation Before and After Consortium B - Basis 2002

Bus Companies	Current Situation		Proposed Situation			
	Fleet	Routes	Fleet		Routes	
			Convent.	Integrated	Convent.	Integrated
AF	291	26	81	90	7	19
AG	39	3	39		3	
AL	27	1	27		1	
AU1	8	1	8		1	
AU2	74	10	16	48	2	8
AU3	55	4	8	19	1	3
AU4	71	7	8	41	1	6
AV	6	1	6		1	
BB	29	3	23	6	2	1
BC	12	3	4	8	1	2
BF	13	1	13		1	
AH,AU2,AZ,AR	32	2	32		2	
AI, AU1	12	1	12		1	
AK, AU2	12	1	12		1	
AU2, AU3	2	1		2		1
AV,BC	10	1		10		1
TRUNK				92		6
TOTAL	693	66	289	316	25	47

The pro-rating of the services in the situation proposed, i.e., in the trunk bus system, should consider as basis the current fleets of each company, allocated in the integrated lines and, in the future situation, there would be a proportional reduction for each of them. The trunk bus lines should also be prorated among the companies involved and will be useful to promote the balance of services among them, by considering a final reduction of the fleet of 5.4% for the lines that make up part of Consortium A and of 12.7% for Consortium B.

The remuneration of the operators in the future trunk bus system should be as a function of the paying passengers of each one, and Compensation Chamber-type income compensation systems would be prevented, in principle. Therefore, in feeder bus line-trunk bus line travel, the company responsible for the feeder bus line would get the collection and, in the inverse direction, the operator of the trunk bus line would get it.

It is necessary to consider that the unit costs per line should be different among the different services. In this way, the feeder bus lines will have shorter travels than the trunk bus lines, and consequently this affects their Annual Mean Travel (PMA's). On the other hand, in the trunk bus lines there more expensive vehicles (e.g.: articulated) would operate, naturally increasing their costs. These characteristics of the different lines of the system will demand that Tables for allocation of the operational costs for each case be kept and that the prorating of the new lines among the different operators takes into account the income and the specific costs of each of them.

In the eventuality that the companies involved in the system show differentiated profitability (income/cost), it will be necessary to seek a balance of results by promoting a rehandling of the services between them. In case the imbalances persist, it is possible then to evolve to a Compensation Chamber system exclusively for the trunk bus system, in which the managing entity would make the calculations of the surpluses and of the deficits of each company, and would be responsible for the necessary compensations.

In an extreme situation, it is possible to consider even compensations between both consortia, in case one of them happens to be much more profitable than the other.

19.2.3. ALTERNATIVES FOR ORGANIZATION OF THE TRUNK SYSTEM

In this Study, analysis has been undertaken of three alternatives for organization of the trunk bus system operating companies as shown in Figure 19.2-8 to Figure 19.2-10.

For each of these alternatives, it is necessary to consider a metropolitan transport management organization as shown in Figure 19.2-7, to be created or reformulated at the start of the operation of the trunk bus system. This organization shall have jurisdiction for planning, supervising, and controlling the operation as well as setting the fare policy of the overall system.

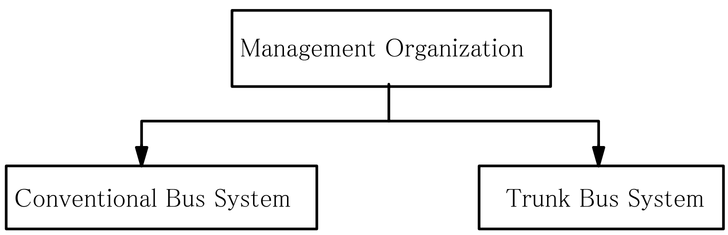


Figure 19.2-7 Metropolitan Transport Management Organization

In alternative 1 as can be seen in Figure 19.2-8, it is suggested public bidding be realized within the legal framework, stipulated today, in which the operating companies (A, B, ……… X, Y, and Z) would present themselves as candidates for rendering the new public transport service in the trunk bus system.

Alternative-1

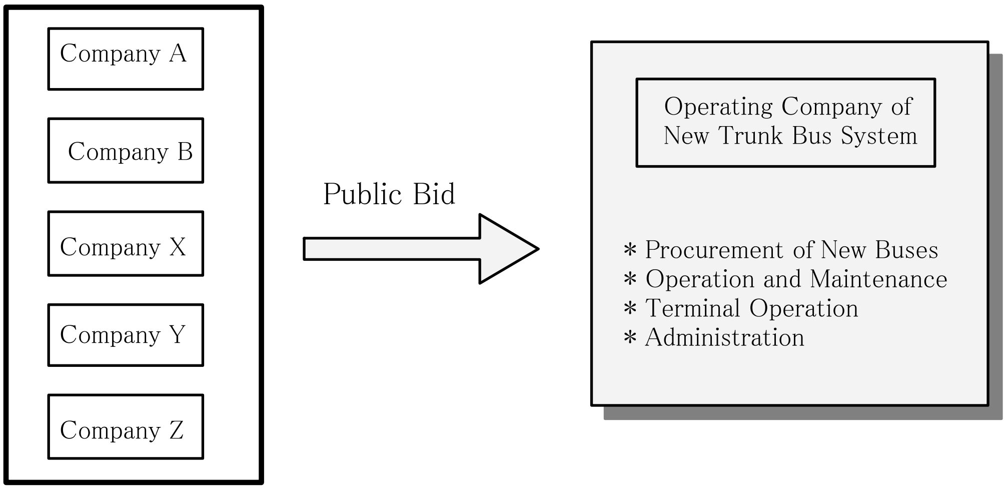


Figure 19.2-8 Company organization - Alternative 1

In this case, it would be possible to reduce the current number of operating companies of the system. However, this might lead to the exclusion of some local companies that have knowledge of the reality of the local bus system.

Alternative 2 retains the same companies that operate, today, in the public transport system. Those involved in the trunk bus process would form a consortium of operators with participation proportional to the number of the bus fleets.

This consortium would be responsible for the collection, control and distribution of the income among the participating companies, and for the administration of the integration terminals.

In this case, it becomes necessary to adopt electronic ticketing as a way of optimizing control of the supply and demand and of expediting the distribution of the income to the companies participating in the consortium.

Alternative 2

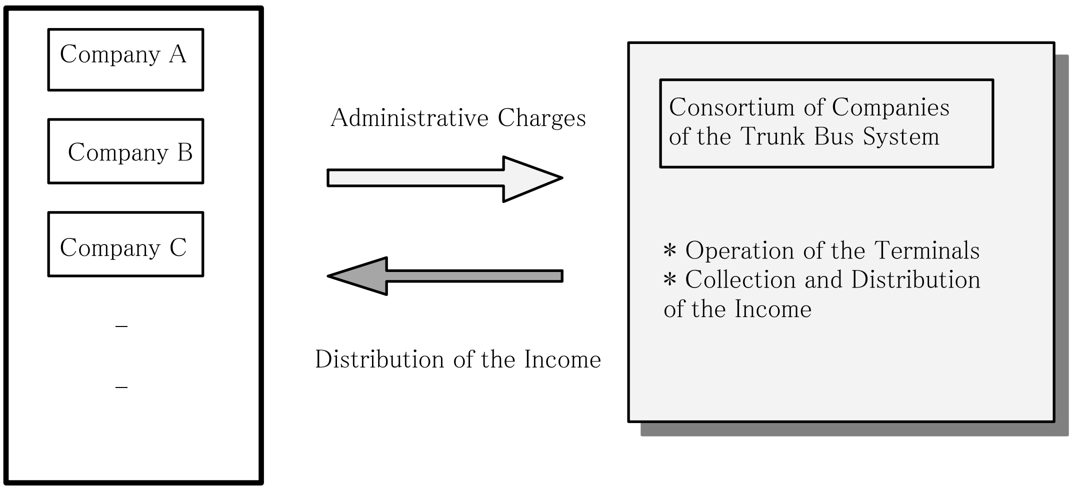


Figure 19.2-9 Company organization - Alternative 2

Alternative 3 shows the same conditions as the participation of the current public bus companies in the formation of the consortium. However, in this alternative, the management organization participates in the administration of the integrated bus terminals and in the composition of the consortium.

The participation of the management organization in the consortium of companies reduces the costs of the operation, the implementation and maintenance of the system, and makes possible better control of the operation for the public administrations.

Alternative 3

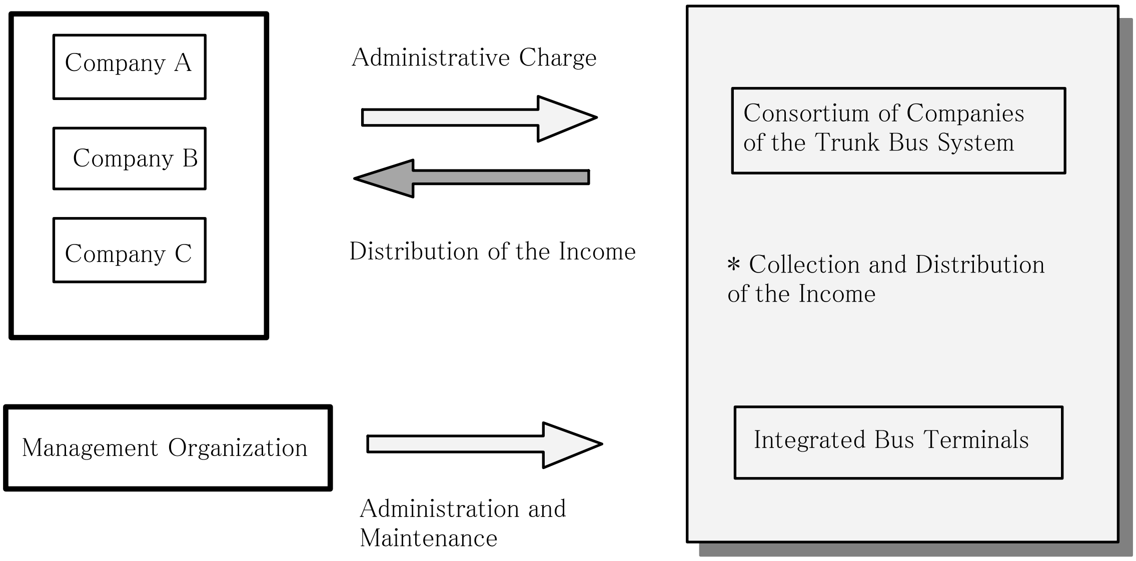


Figure 19.2-10 Company organization - Alternative 3

The alternatives mentioned above already have been utilized in several Brazilian cities, such as Goiania, Belo Horizonte and Porto Alegre. Supplement studies shall be required for each alternative matter to understand conditions between the bus passengers, bus company owners, and drivers related in the system, considering the legal, operational, and economic aspects in the implementation stage of the project.