5.5. PRESENT TRAFFIC SAFETY SITUATION

5.5.1. TRAFFIC ACCIDENTS

Traffic accident data from the SISP (Integrated System of Public Security, composed of civilian police, military police, fire fighting agency, military and DETRAN) is analyzed by looking into the following items:

(1) Trend of annual traffic accidents

Figure 5.5-1 and Table 5.5-1 show the trend of traffic accidents in the Belem Metropolitan Area (hereinafter BMA) for the last seven years from 1995 to 2001. In the years 2001 and 1995, there were a total of 5,392 and 6,314 accidents, respectively. The annual increase rate from 1995 to 2001 is -2.60%. On the other hand, the annual increase rate from 1998 to 2001 is 3.47%. Due to the strengthening of traffic control by the municipality under the new Brazilian traffic law, the number of accidents was drastically decreased in 1998. However, the trend of annual accident occurrences shows the tendency of increase after 1998.

(2) Number of victims (injuries and fatalities)

Table 5.5-1 also shows the number of victims during the last seven years. The annual increase rate of victims is higher than the increase rate of the total number of accidents, which is 0.04%.

The number of injuries in 2001 was 1,546 and annual increase rates are -0.21% and 3.58% for the last seven years and four years, respectively. On the other hand, the number of fatalities is decreasing. The numbers of fatalities in 1998 and in 2001 were 254 and 228, respectively, and annual increase rate is –3.54% for the last four years.

The tendency of number of victims/accident increases for the last seven years, but the number of fatalities/accidents decreases for the same period. This is due to the seat belt requirement from the year 1998.

In 2001, for every accident there was an average of 0.042 fatalities. This means that there is one person killed for every 24 accidents.

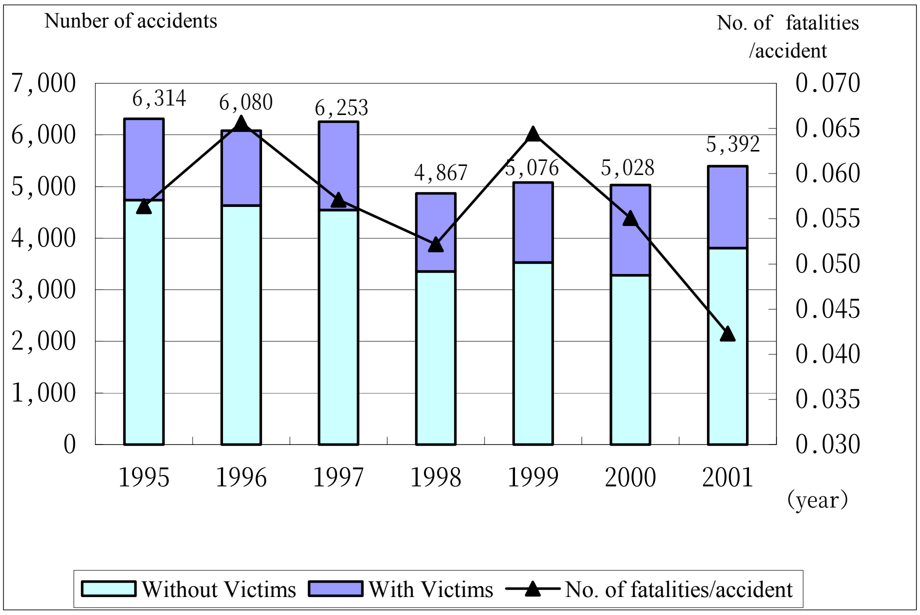


Figure 5.5-1 Number of Accidents in the Belem Metropolitan Area (1995-2001)

Table 5.5-1 Number of Accidents in the Belem Metropolitan Area (1995-2001)

Items		Year							Annual increase	
		1995	1996	1997	1998	1999	2000	2001	2001/1995	2001/1998
Accidents	Total	6,314	6,080	6,253	4,867	5,076	5,028	5,392	-2.60%	3.47%
	With Victims	1,578	1,446	1,711	1,510	1,548	1,749	1,582	0.04%	1.56%
	Without Victims	4,736	4,634	4,542	3,357	3,528	3,279	3,810	-3.56%	4.31%
Vivtims	Total	1,922	1,757	2,131	1,645	1,779	2,096	1,774	-1.33%	2.55%
	Injuries	1,566	1,358	1,774	1,391	1,452	1,819	1,545	-0.22%	3.56%
	Fatalities	356	399	357	254	327	277	229	-7.09%	-3.39%
No. of victims/accident		0.304	0.289	0.341	0.338	0.350	0.417	0.329		
No. of fatalities/accident		0.056	0.066	0.057	0.052	0.064	0.055	0.042		

Source: S.I.S.P.

(3) Number of accidents by municipality

Number of accidents and victims and registered number of vehicles by the municipality in 2001 are shown in Figure 5.5-2 and Table 5.5-2.

The total number of accidents in the study area, Belem and Ananindeua are 5,392, 4,768 (88.4% of the total) and 506 (9.4%), respectively. The accident index per 10,000 vehicles in the study area, Belem and Ananindeua are 323, 333 and 238, respectively. Ananindeua shows the lowest accident index among the municipalities.

On the other hand, the fatality index per 10,000 vehicles in the study area, Belem and Ananindeua are 14, 10 and 22, respectively. The fatality index in Belem is the lowest while the fatality index in Ananindeua is almost double that in Belem.

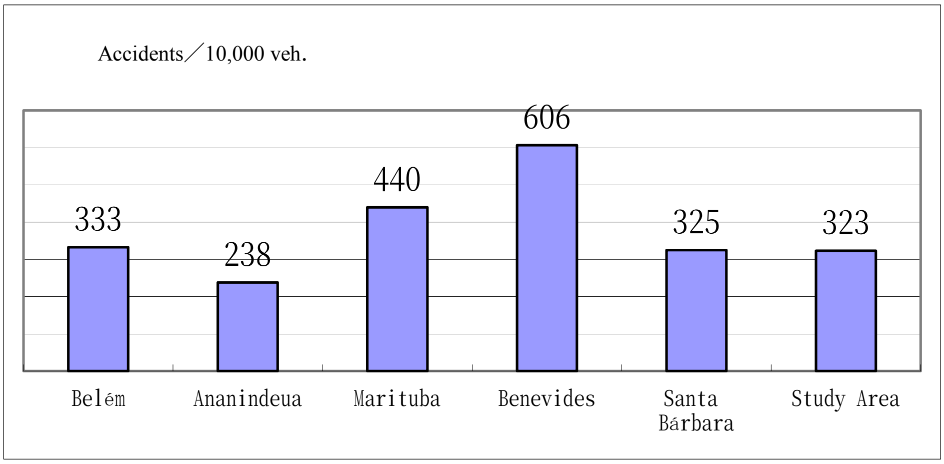


Figure 5.5-2 Accident Index per 10,000 Registered Vehicles

Table 5.5-2 Number of Accidents by Municipality in the BMA in 2001

Municipality	Total no. of accidents	%	No. of accidents with victims	%	Accidents without victims	%	No. of registered vehicles	Accidents/ 10,000veh.
Belém	4,768	88.4%	1,156	73.1%	3,612	94.8%	143,313	333
Ananindeua	506	9.4%	325	20.5%	181	4.8%	21,237	238
Marituba	69	1.3%	63	4.0%	6	0.2%	1,568	440
Benevides	45	0.8%	35	2.2%	10	0.3%	742	606
Santa Bárbara	4	0.1%	3	0.2%	1	0.0%	123	325
Total	5,392	100.0%	1,582	100.0%	3,810	100.0%	166,983	323

Source: SISP

Number of Victims during Accidents by Municipality in RMB in 2001

Municipality	Total no. of victims	%	No. of fatalities	%	No. of injuries	%	No. of registered vehicles	Victims/ 10,000veh.	Fatalities/ 10,000veh.
Belém	1,282	72.3%	150	65.5%	1,132	73.3%	143,313	89	10
Ananindeua	374	21.1%	46	20.1%	328	21.2%	21,237	176	22
Marituba	72	4.1%	15	6.6%	57	3.7%	1,568	459	96
Benevides	43	2.4%	15	6.6%	28	1.8%	742	580	202
Santa Bárbara	3	0.2%	3	1.3%	0	0.0%	123	244	244
Total	1,774	100.0%	229	100.0%	1,545	100.0%	166,983	106	14

Source: SISP

(4) Number of accidents by type of vehicles

Figure 5.5-3, Table 5.5-3, Figure 6.5-4 and Table 6.5-4 show the number of accidents by type of vehicles in the BMA and Belem in 2001, respectively. The following are the major findings based on the above tables:

- Accidents between cars are the major type of accidents, which are 74% of the total accidents in the BMA.
- Accidents between cars & pedestrians and cars & bicycles are 12% and 10% of the total accidents, respectively.
- There are some cases of accidents at boarding/alighting of bus, which are low as 1.5% of the total accidents.
- The tendency of the accidents by type of vehicles in Belem is almost the same as in the BMA. However, the percentage of accidents between cars is slightly higher in Belem (79%) than that in the BMA (74%).

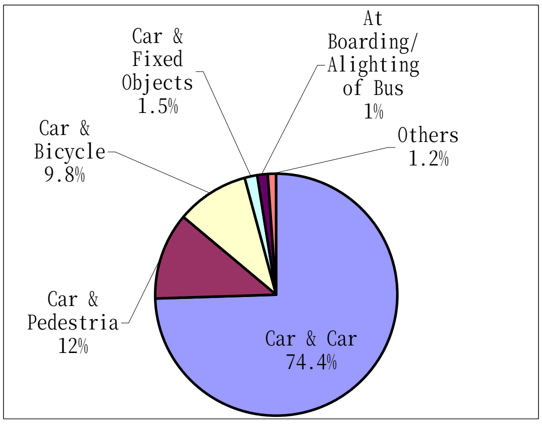


Figure 5.5-3 Accidents by Type of Vehicle in the BMA (March – December 2001)

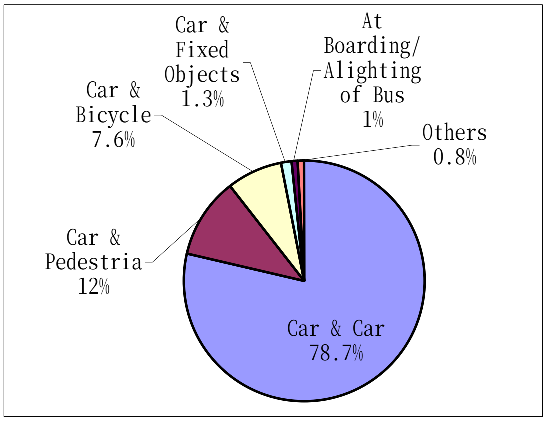


Figure 5.5-4 Accidents by Type of Vehicle in the Municipality of Belem (March – December 2001)

Table 5.5-3 Accidents by Type of Vehicle in the BMA (March – December 2001)

Collision by type of vehicles	No. of Accidents	Percentage
Car & Car	4,012	74.41%
Car & Pedestrian	635	11.78%
Car & Bicycle	526	9.76%
Car & Fixed Objects	81	1.50%
At Boarding/Alighting of Bus	72	1.34%
Others	66	1.22%
Total	5,392	100.00%

Source: SISP

Table 5.5-4 Accidents by Type of Vehicle in the Municipality of Belem (March – December 2001)

Collision by type of vehicles	No. of Accidents	Percentage
Car & Car	3,753	78.71%
Car & Pedestrian	511	10.72%
Car & Bicycle	361	7.57%
Car & Fixed Objects	61	1.28%
At Boarding/Alighting of Bus	42	0.88%
Others	40	0.84%
Total	4,768	100.00%

Source: SISP

(5) Causes of traffic accidents

Figure 5.5-5 and Table 5.5-5 show the number of accidents by cause in Belem in 2001. The following are the major findings based on the data from SISP:

- Out of a total of 962 accidents with information, 381, or about 40%, were due to various violations of safe driving.
- Accidents caused by violation of traffic rules, such as violation of priority road, traffic signals and one-way regulations are 260 cases, or 27% of the total.
- Sudden change of lane accounted for 129 cases, comprising 13.4% of the total, which can be included in the case of the violation of safe driving, is also one of the most serious types of accident.
- Accidents caused by drunken driving are 81 cases, comprising 8.4% of the total accidents.
- Accidents involving pedestrians account for 48 cases, or 5% of the total. The main cause of this type of accident is not paying attention.

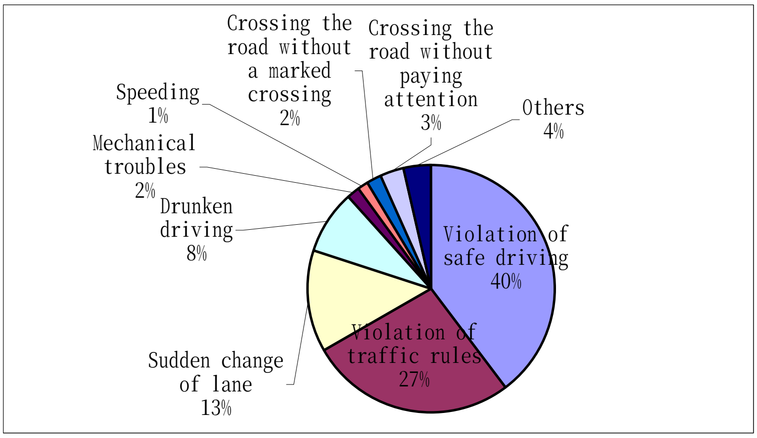


Figure 5.5-5 Number of Accidents by Cause in the Municipality of Belem in 2001

Table 5.5-5 Number of Accidents by Cause in the Municipality of Belem in 2001

Car/ Pedestrian	Causes		No. of accidents	Percentage
Car	Violation of safe driving		381	39.6%
		Without pay attention	205	
		Without keep distance	176	
	Violation of traffic rules		260	27.0%
		Violation of priority of road	132	
		Violation of traffic signal	102	
		Violation of one-way road	26	
	Sudden change of lane		129	13.4%
	Drunken driving		81	8.4%
	Mechanical troubles		15	1.6%
	Over speeding		14	1.5%
Pedestrian	Cross the road without crossing		19	2.0%
	Cross the road without paying attention (including bus bording/alighting)		29	3.0%
Others	Others		34	3.5%
	No information		3,806	-
Grand total (excluding no information)			962	100.0%

Source: S.I.S.P.

(6) Traffic accidents by road

Table 5.5-6 and Figure 5.5-6 show the number of accidents by road and the location of hazardous roads in the Municipality of Belem in 2001, respectively. Table 6.5-6 also shows the ranking from 1 to 20 out of a total 311 roads where more than one accident has occurred. Major findings from these data are as follows:

- The most hazardous road is Av. Almirante Barroso, with 386 accidents, comprising approximately 10% of total accidents. This is the busiest transport corridor in Belem. Following Av. Almirante Barroso, Rodovia. Augusto Montenegro, Av. Pedro Alvares Cabral, Av. Senador Lemos and Av. G. J. Malcher rank of second to fifth in number of accidents. All in all, these five roads account for 1,181, or approximately 25% of the total accidents.
- Accident index per length of road (km) is also shown in Table 5.5-6. The most serious accident index of 63 is along Av. Almirante Barroso, followed by Av. Visconde de Souza Franco, Av. Governador Jose Malcher, Av. Nazare and Av. Magalhaes Barata. These are one-way roads with public transport corridors except for Av. Almirante Barroso.

Table 5.5-6 Number of Accidents by Length of Road in the Municipality of Belem in 2001

Ranking	Name of road	No. of accidents	Percentage	Road length (km)	No. of lanes	Two-way/ one-way	Accidents/km
1	Av. Almte. Barroso	386	8.10%	6.10	8	2-way+Med	63
2	Rod. Aug. Montenegro	289	6.07%	14.30	4/8	2-way+Med	20
3	Av. P. Alv. Cabral	258	5.41%	8.54	4/6	2-way+Med	30
4	Av. S. Lemos	128	2.69%	4.80	4	1-way/2-way/ 2-way+Med	27
5	Av. G. J. Malcher	120	2.52%	2.20	3/2	1-way	55
6	Av. V. S. Franco	89	1.87%	1.50	3/7/8	1-way/1-way+Med	59
7	Av. M. de Herval	89	1.87%	2.68	4	2-way+Med	33
8	Av. P. Miranda	76	1.59%	2.90	6	2-way+Med	26
9	Rod. Arthur Bernardes	71	1.49%	13.90	2	2-way	5
10	Av. Nazaré	71	1.49%	1.36	3	1-way	52
11	Av. D. de Caxias	71	1.49%	2.40	4	1-way/2-way+Med	30
12	Av. C. Furtado	67	1.41%	4.48	2/3	1-way	15
13	Av. Alc. Cacela	66	1.39%	4.45	3/4	1-way/2-way	15
14	Av. J. Bonifácio	66	1.39%	3.57	3/4	1-way/2-way	18
15	Av. Magalhaes Barata	61	1.28%	1.34	4	1-way	46
16	Av. J. César	61	1.28%	4.86	6/4	2-way+Med	13
17	Tv. Pe. Eutíquio	60	1.26%	4.24	3	1-way	14
18	Av. Primeiro de Dezembr	60	1.26%	2.17	6	2-way+Med	28
19	R. Mundurucus	52	1.09%	4.90	3	1-way/2-way	11
20	Av. G. Bittencourt	52	1.09%	4.23	3	1-way	12
21-311	Others	2,572	53.98%				
Grand Total		**4,765**	**100.00%**				

Source: SISP/Detran/Pa

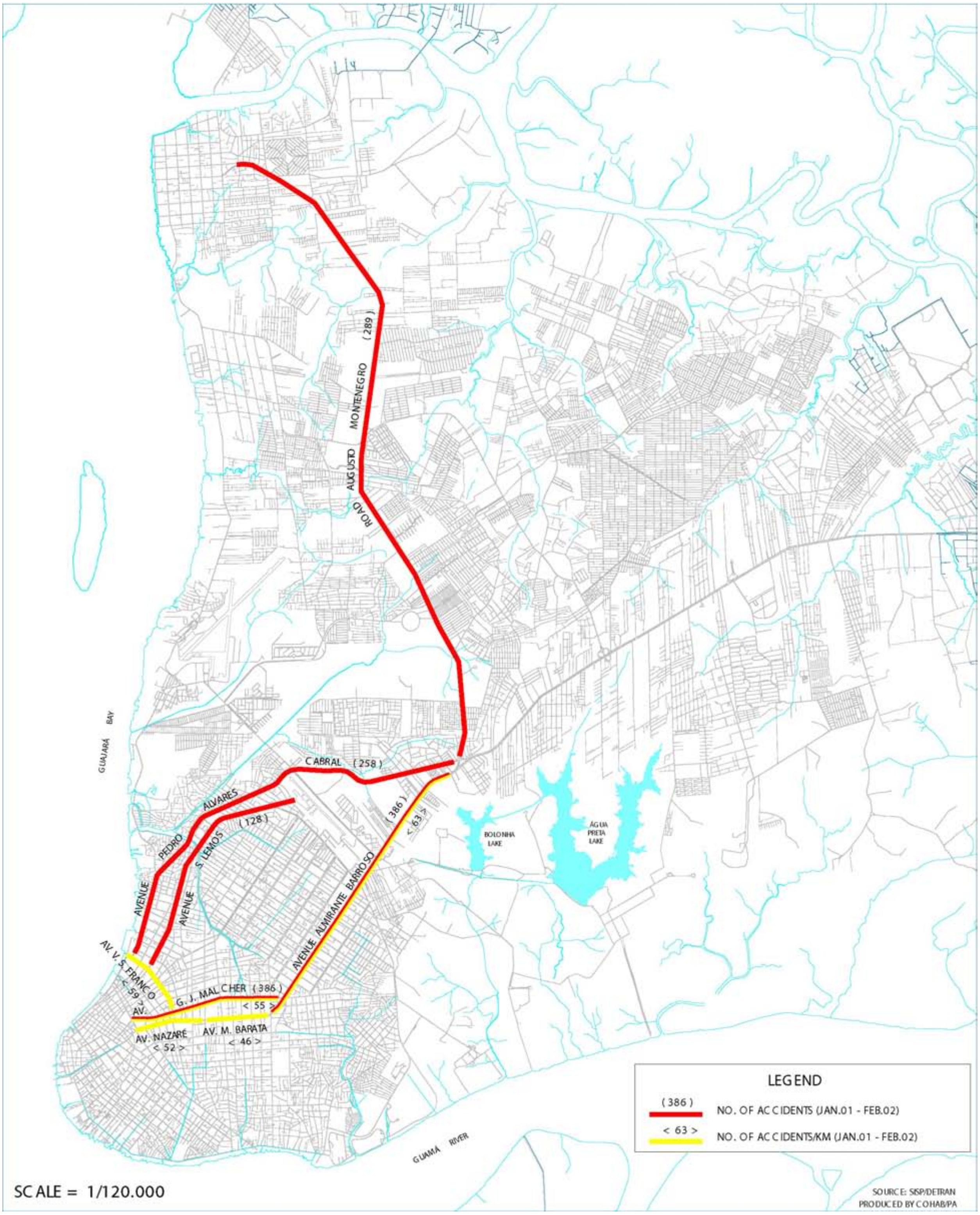


Figure 5.5-6 Location of the Most Hazardous Roads in the Municipality of Belem in 2001

5.5.2. TRAFFIC SAFETY

With the increase of cars, the incidence of serious traffic accidents has been accelerated. Various measures have been implemented to minimize traffic accidents in the study area, especially by the transfer of responsibility of traffic enforcement from the state government to the municipalities by the revision of the Brazilian traffic laws and regulations in 1998. Another vital measure is traffic safety education. The responsibilities of each agency are summarized below.

DETRAN: DETRAN has responsibility to supervise and give advice on traffic safety education for the municipalities. Since DETRAN is responsible for issuing traffic licenses, DETRAN has to prepare a traffic safety education curriculum for driving schools. DETRAN and other related agencies also conduct a countrywide traffic safety campaign.

CTBel: The Section of Education for Traffic, which has responsibility for traffic safety education under CTBel in Belem, is conducting various traffic education and information campaigns to make people understand the importance of traffic safety, aiming not only at adults but children as well, as presented in Photo 6.5-1. CTBel also established a traffic park for school children in Belem in 2000 named “Cidade Crianca” (Child City), to allow the children to experience actual traffic conditions, considering that they are the future drivers, located along Av. Bernardo Sayao, as shown in Photo 6.5-2.

DEMUTRAN: Division of Traffic Education, which has responsibility for traffic safety education under DEMUTRAN in Ananindeua, is conducting various traffic education and information campaigns for adults and children. It is similar to what is being done by CTBel in Belem. Pamphlets on traffic safety for school children, as shown in Photo 6.5-3, are going to be distributed to schools soon. DEMUTRAN is also to start the construction of the ‘Cidade Transporte (Transport City)’, which is a traffic park for children, within this year.

GETRAT (Special Study Group for Decreasing Traffic Accidents): This study group is a product of the ‘Stop Accidents Campaign’ by the Ministry of Transport and endorsed by the Governor of Para State. Various campaigns of traffic information in the study area are to be conducted to decrease traffic accidents.

Photo 5.5-1 Various Pamphlets for Traffic Safety Campaign in CTBel

Photo 5.5-2 Cidade Crianca (Traffic Park in Belem)

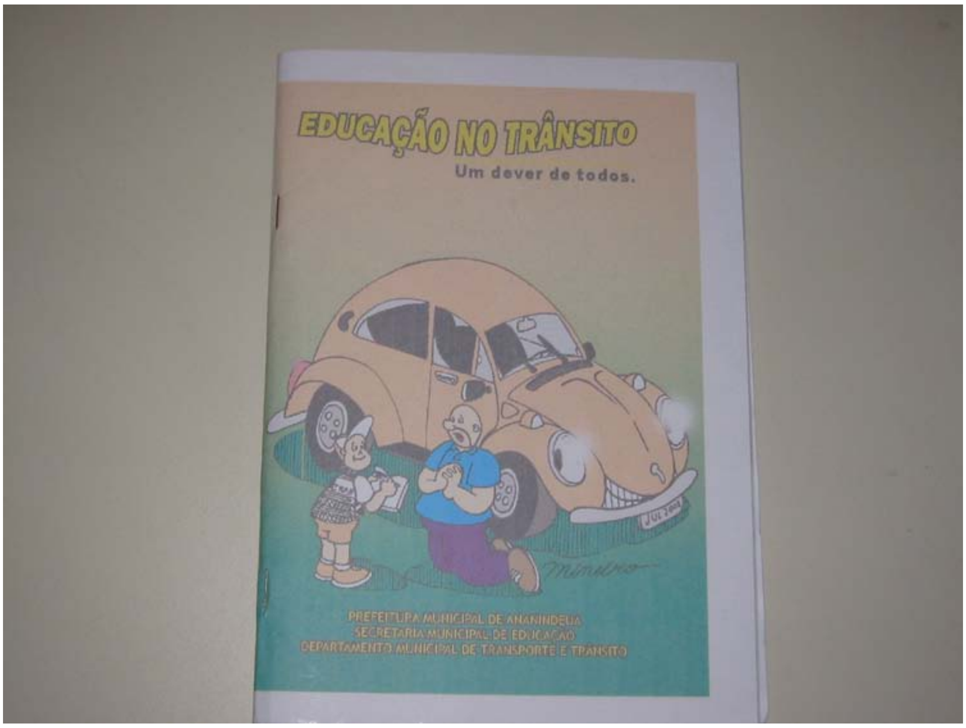


Photo 5.5-3 Traffic Safety Education Pamphlet for School Children in Ananindeua

5.6. EXISTING PROBLEMS AND ISSUES

Based on the above discussions, the existing problems and issues are summarized below and presented in Figure 5.6-1:

- The Belem CBD Area has a dense road network with narrow streets. This is the result of the development in Belem that preserves the historical buildings and facilities. The road space is relatively efficiently used, adopting the one-way system along trunk roads and allowing on-street parking using the stop lane along the side of streets. However, the capacity of part of the roads deteriorates because of the illegal on-street parking along trunk roads and the rough driving of bus drivers. Considering the future increase of traffic demand and limited road space in the Belem CBD, it is necessary to study comprehensive traffic management measures, including efficient road-space usage and traffic control.
- The implementation of efficient bus system is essential for the Study area, because the bus is the main public transport system in this area. However, the current bus system in the study area is not always convenient due to the poor bus-stop facilities and bus-route information. In addition, the concentration of bus routes, which exceeds the demand, causes traffic congestion, especially in the Belem CBD. Therefore, it is necessary to prepare a plan for the convenient and efficient restructuring of the bus system including rerouting of bus routes.
- Bicycles are an important mode of transport in the study area, despite a lower utilization than buses and private cars. However, the traffic mix of bicycles and 4-wheel vehicles in the Icoaraci area presents many problems. Bike lanes located in the median along several municipal roads are completed and others are underway. On the other hand, bicycles use the road space without bike lane markings, not only the median side, but also the sidewalk side; this is very dangerous, especially along the BR-316 corridor. Therefore, it is necessary to coordinate the bike-lane network system in the examination of a comprehensive transport system.
- Basically, pedestrian space such as sidewalks is well maintained, with a line of old mango trees alongside streets in the Belem CBD. However, street vendors occupy some sidewalk space. There have been times when bus passengers wait for the bus on the carriageway, exposing themselves to danger. In addition, many pedestrians cross the road without using pedestrian crossings, especially in the suburban area such as along BR-316 and Rodovia Augusto Montenegro corridors because of the poor pedestrian facilities. It is necessary to prepare safe and convenient pedestrian facilities.
- Traffic accidents are one of the most serious problems in the study area. It is said that the number of fatalities has decreased because of the seat belt requirement and traffic safety campaign after 1998; however, in reality, the number of accidents has increased. There are various reasons for the increase of traffic accidents, notably the lack of attention while driving and the violation of traffic rules. There is also the tendency for many traffic accidents to occur along public-transport corridors. Therefore, it is necessary not only to introduce traffic-safety measures along public-transport corridors, but also to strengthen traffic-safety education, especially for adults.

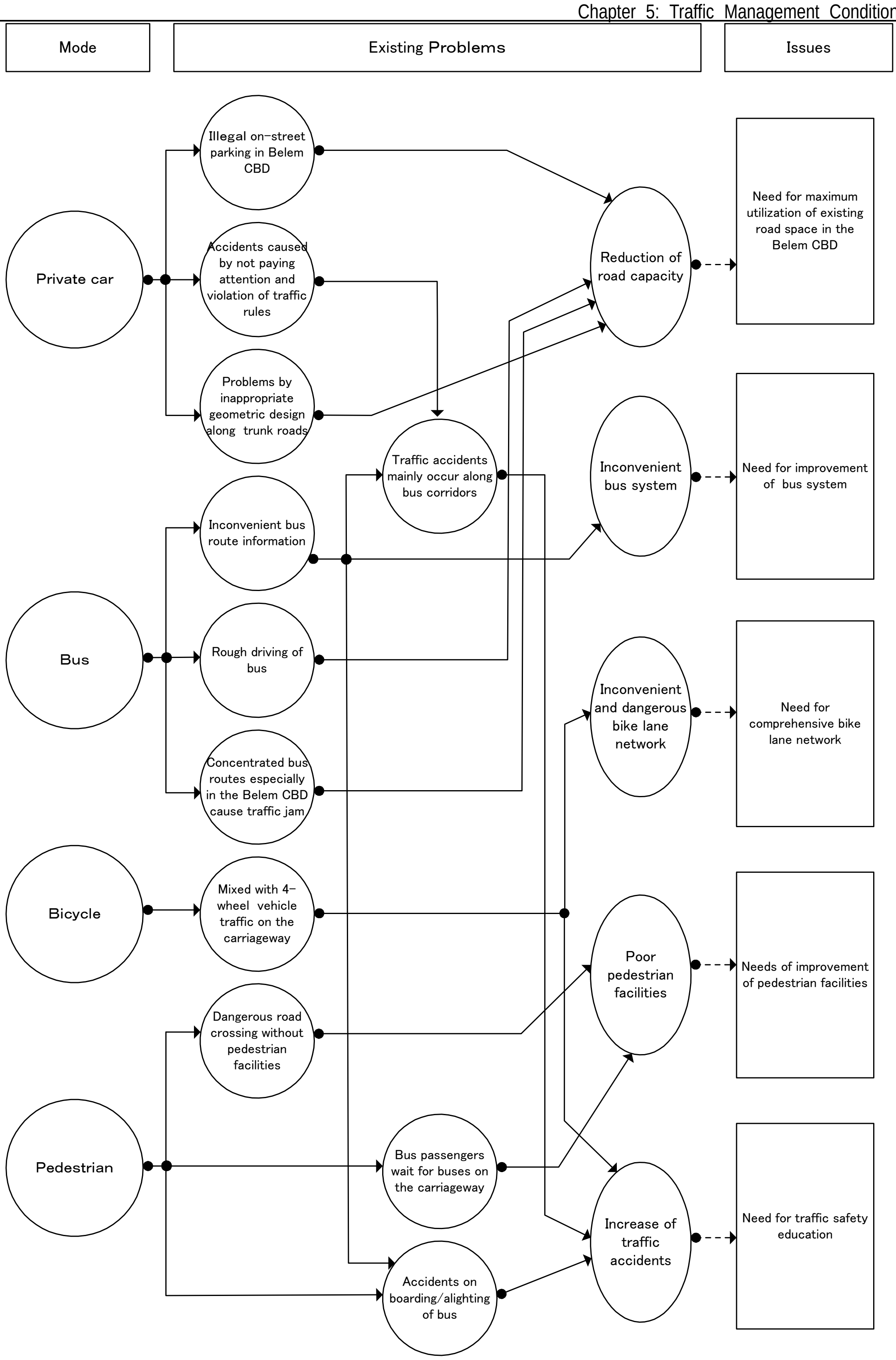


Figure 5.6-1 Existing Problems and Issues

5.7. SAFETY MEASURES FOR PASSENGERS OF BUSWAY SYSTEM IN CURITIBA

This is the result of interviews with Ms. Anive Alcantara Soares, Mr. Jose Alvaro Twardowski and Engr. Paulo Roberto Malucelli held at URBS (Transport Company of Curitiba), and of the site survey in Curitiba in June 13, 2002.

Curitiba is the state capital of Parana in southern Brazil. Its development has been planned to cater to its population now reaching approximately 1,500,000. Especially, Curitiba is world-renowned for its public transport system featuring the busway system, which carries approximately 2,300,000 passengers/day, or 70% of daily total trips in Curitiba. The citizens of Curitiba find this public transport based on an integrated busway system to be safe, convenient and comfortable. Moreover, this busway system is based on a trunk busway and distributes the feeder bus route network to/from busway terminals with a dense bus route network. The system charges a flat fare of 1.35 real (about US$0.5) and theoretically, one can transfer about 700 times in one ride in this bus network.

On the other hand, one of the serious traffic problems in Curitiba is traffic accidents due to the rapid increase of private cars, a condition experienced by other cities of Brazil, though the rate of accident fatalities/10,000 registered vehicles in Curitiba of 1.3 is lower than the average of Parana State's (6.1) and tends to decrease due to the large-scale traffic safety campaign being conducted.

URBS, with a staff of 1,700, is responsible for coming up with comprehensive transport measures and policies, including traffic safety measures in some Municipalities of the Metropolitan Region of Curitiba. Originally, URBS was established in 1972 to construct and improve municipal roads. Now, they are putting a great deal of effort into the traffic safety education and information campaign. For instance, they repeatedly appealed to drivers to slow down on approaching pedestrian crossings and to stop and allow pedestrian to cross, in the hope that this will become a spontaneous behavior in the future. However, some of the drivers are not even aware of the road markings for pedestrian crossing. The strategy of URBS for traffic safety is to concentrate first on the need of drivers to completely understand the traffic rules, then examine and develop traffic safety measures such as traffic signs and road marking, etc.

Based on the above background and observation in Curitiba, the following are major findings from the viewpoint of safety measures for passengers of the busway system and others:

a. In Curitiba, the trunk busway is constructed on the median side and through-traffic lanes serving low-speed traffic are prepared on both sides of the busway. The roads for high-speed traffic are constructed at a place be 100m (1 block) away from the low-speed traffic lane. Since heavy and high-speed vehicles use those roads, the roads parallel with the trunk busway (low-speed lanes) are used for light and low-speed traffic. Therefore, it is possible to narrow through-traffic lanes for bus stops on the trunk busway (See Figure 5.7-1.).

b. As for the types of structure at intersections, at-grade intersections are predominant. The pedestrian overpasses and underpasses are few because sometimes there are robberies and rapes at these facilities in Brazil.

c. At bus stops where there is relatively low traffic volume, the lane width of the carriageway is narrow for safe crossing of bus passengers. However, there is no marking of pedestrian crossings at the bus stops (See Figure 5.7-2.).

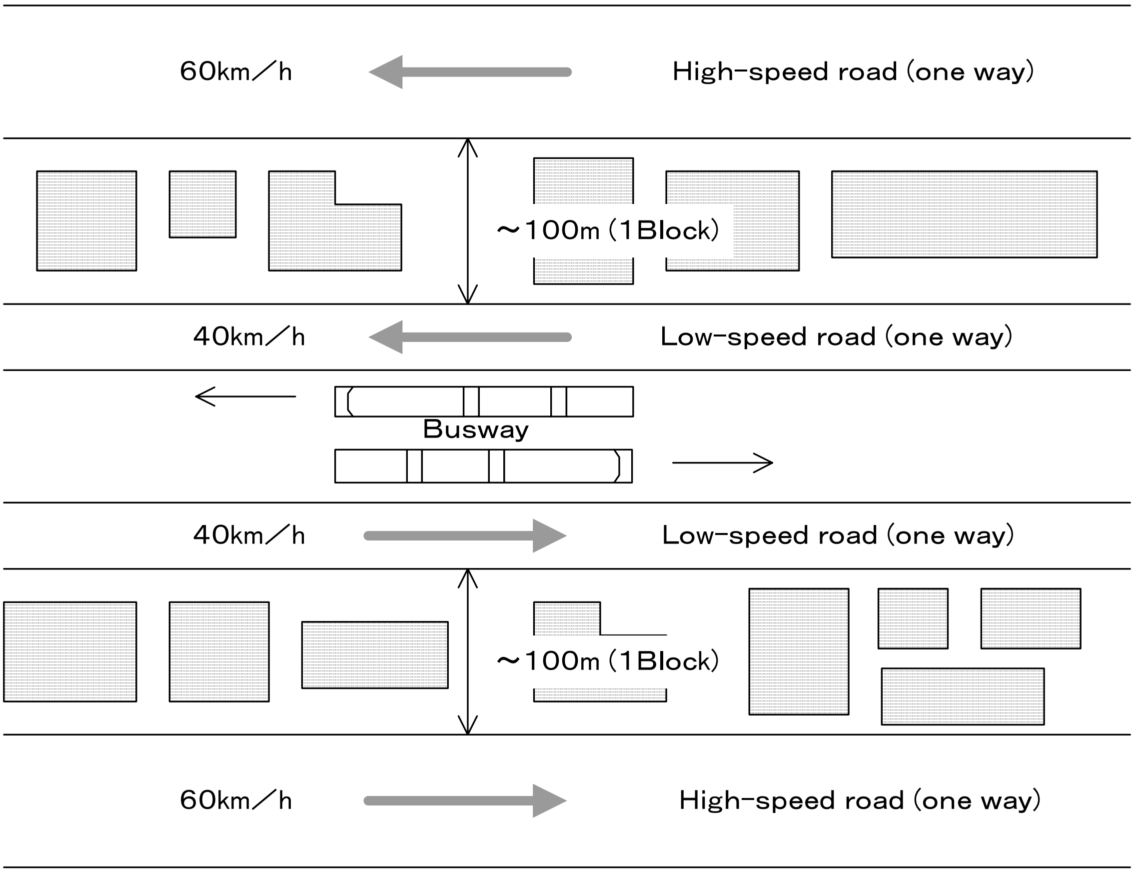


Figure 5.7-1 Concept of Busway Corridor

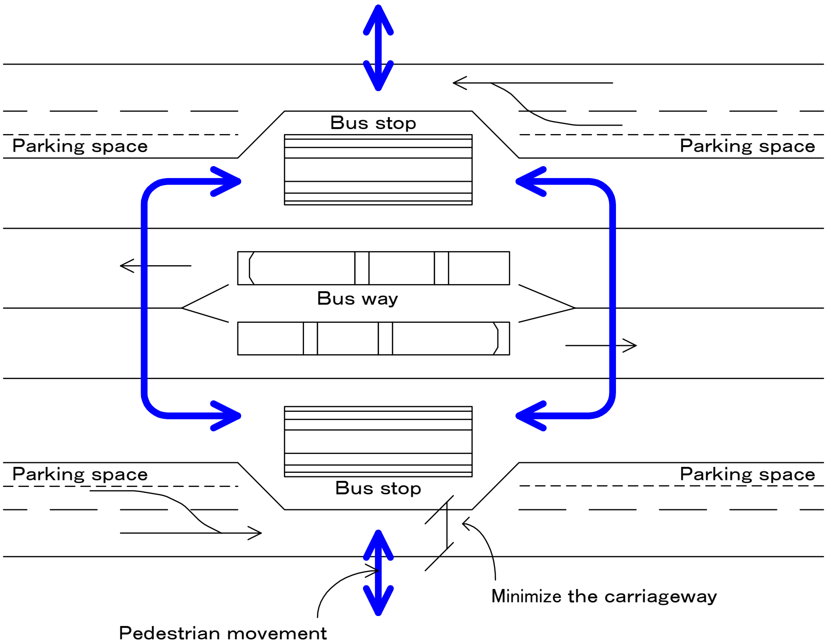


Figure 5.7-2 Pedestrian Facilities at Bus Stop with Low Traffic Volume

d. At busway stops where there is a relatively heavy traffic volume, zebra markings and a safety guard fence for pedestrian crossing are prepared, but there is no traffic signal at this point. The traffic safety education for drivers is conducted at the bus stops where drivers slow down at the pedestrian crossings and stop when they see pedestrians, spontaneously (See Figure 5.7-3.).

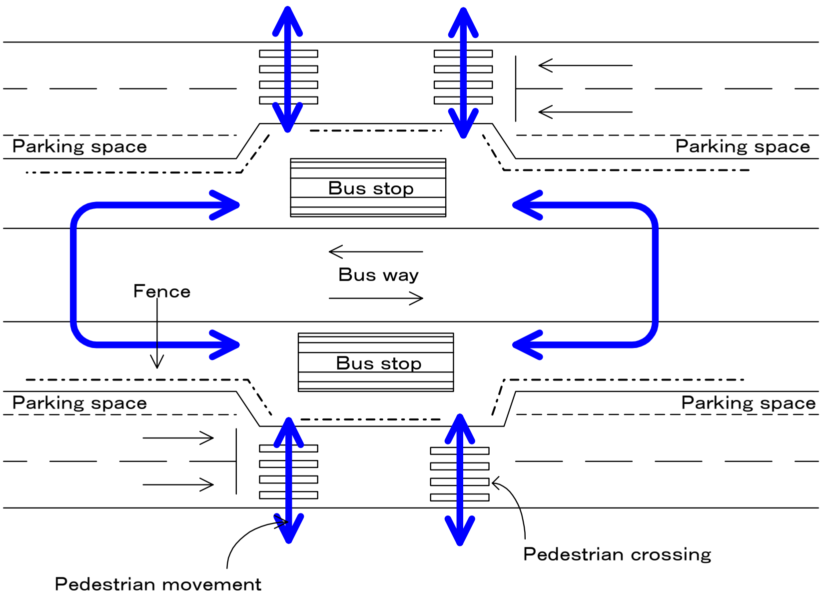


Figure 5.7-3 Pedestrian Facilities at Bus Stop with Relatively Heavy Traffic Volume

e. At busway stops where there is a relatively heavy traffic volume and many bus passengers boarding/alighting, traffic signals for pedestrians are installed.

f. A unique tube-shaped bus stop facility is safe and easy for boarding/alighting. When the bus stops at a bus stop, and the doors of the bus stop automatically open after the bus step connects to the bus stop floor with a coupler from the bus (See Photo in Figure 5.7-4.).

g. Illegal use of busway space by bicycles is noted. However, the traffic accidents on the busway between buses and bicycles are not many. Therefore, URBS has a plan to penalize illegal bicycles. However, an ambulance can use the busway space to provide service more efficiently (See Photo in Figure 5.7-4.).

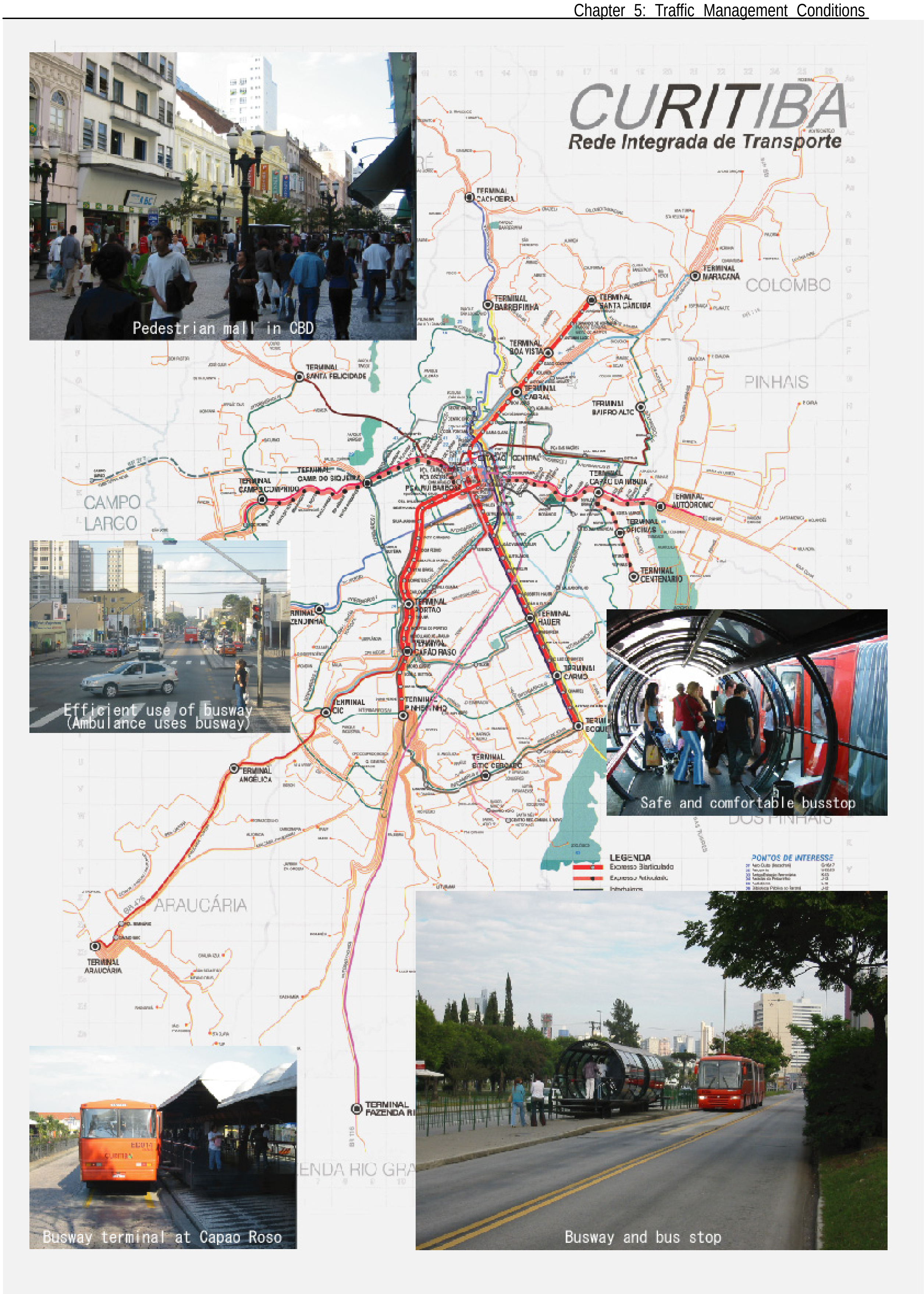


Figure 5.7-4 Traffic Scenes at Curitiba

CHAPTER 6
Initial Environmental Examination (IEE)

6. INITIAL ENVIRONMENTAL EXAMINATION

6.1. INTRODUCTION

6.1.1. OBJECTIVES

The objectives of this Initial Environmental Examination (IEE) Study are to collect fundamental environmental information related to the Belem Metropolitan Transport Project, and estimate potential environmental impacts, so that appropriate measures are incorporated into the scheme selection, planning and design to ensure that it is environmentally sound. It allows the designers to address environmental issues in a cost-effective fashion after all possible scheme and design alternatives are considered.

6.1.2. OUTLINE

This report summarizes the results of the Initial Environmental Examination (IEE) which assesses the potential impacts associated with the metropolitan transport project presented for the detailed design study to be followed at the next stage. Sections 2 and 3 describe the environmental baseline, and legal and administrative framework of Brazil. In Section 4, results of the screening and the scoping of the proposed project are summarized.

6.2. DESCRIPTION OF ENVIRONMENT

6.2.1. BIO-PHYSICAL ENVIRONMENT

(1) Geography and Climate

Belem City is located in the northern part of Para State, and the elevation of most of the study area is less than 50 meters above sea level. The most important geographic features are the Guama River, several tributaries running into the Guajara Bay (Amazon River), and Lakes Bolonha and Agua Preta, forming regional natural drainage system. Table 6.2-1 summarizes typical features of Lakes Bolonha and Agua Preta.

There is a strong influence of tidal movements on the water level fluctuation of the Guama River. The water level of the Guama River is monitored four-times a day by Para State Port Authority. Following are water level parameters of the Guama River, which were used within the design work of the Macro-Drainage Project [COSANPA, personal communication, 2002],

W.L. max = 3.4 m, and W.L min = 0.2 m

There is no gauge station that measures the water level or the flow rate of any creeks and/or tributaries. Most of the lowland area is highly flood-prone due to the heavy torrential rainfall during the rainy season. Also, regional drainage of those run-off waters becomes stocked due to the significant diurnal tidal movement of the Guama River during the Equinox (e.g., the water level around the Guama River becomes higher than the water level of tributaries running into the Guama River).

Belem is one of the rainiest cities in Brazil, and the annual rainfall around the study area ranges between 2,500 and 3,000 millimeters, characterized by the short-rainfall-duration storm. Basically, there is no specific dry-season: the least rain is in October whereas it rains much in March and April. The average temperature and relative humidity are 25 °C (the highest of 34 °C and the lowest of 18°C), and 85 %, respectively. Table 6.2-2 summarizes the meteorological data measured at one of the meteorological stations operated by the Ministry of Agriculture.

Table 6.2-1 Water Reservoirs (Lake Bolonha and Lake Agua Preta)

	Lake Bolonha	Lake Agua Preta
A (m^2)	1.79×10^6	7.20×10^6
V (m^3)	2.10×10^6	10.55×10^6

Table 6.2-2 Meteorological Data (Ministry of Agriculture, 1961 - 1990)

	1	2	3	4	5	6	7	8	9	10	11	12
Rain [mm]	367	418	436	360	304	140	152	131	140	116	112	216
T [°C]	25.6	25.5	25.5	25.7	25.9	25.9	25.8	26.0	26.1	26.4	26.4	26.1
Evaporation [mm]	42	36	42	42	56	68	73	73	90	74	76	60
Relative Humidity(%)	86	91	91	91	88	86	85	84	84	83	83	86

Note: values of all parameters except evaporation listed in this table are 30 year-averaged ones (1961 - 1990) while the evaporation parameters are 10-year averages (1976 - 1985).

According to a meteorological study based on the data collected between 1931 and 1960, the prevailing wind directions are northeast, north, and east, and the mean wind speed varies between 2.6 and 2.9 meters/sec throughout the year. Note that the percentage of quiescent days throughout the year is 45% [Cabral, 1993]. Another recent meteorological study based on the data collected between 1963 and 1981 shows that prevailing wind directions are east, northeast and southeast, and the percentage of quiescent days throughout the year is 40.4 % [Cabral, 1993]

(2) Geology and Seismology

The most typical geological component of the Amazon Basin is known as the Barreiras Group that lies on cretaceous sandstone of the Alter Do Chao formation. Along the coastline of Para State, this Barreiras Group lies on the Miocene limestone of the Pirabas Formation. Soils are alluvial with some strata of sand, silt and clay.

There are five major fault lines around Belem City, and the direction of each fault line is as follows: (1) NW-SE, (2) NE-SN, (3) E-N, (4) N-S, and (5) ENE-WSW direction, respectively. It is unknown whether those fault lines are active or inactive. No significant earthquake event has been reported [COHAB, personal communication] although tectonic movement of the entire region, and in particular, that of Mosqueiro Island, is reported [FADESP, 1998].

(3) Inundation

As discussed earlier, most of the lowland area in Belem City is highly prone to frequent flood and inundation events due to the compound effects of both heavy rainfall and poor drainage system. In general, the elevation of those flood-prone areas is below 4.0 E.L.m and almost permanently or temporarily flooded during the rain season (January - July). Table 6.2-3 summarizes the typical flood-prone areas around the Belem City. From this table, it can be seen that about 35% of the lowland areas is always flooded. To make matters worse, the spread of waterborne disease due to the poor sanitary conditions became a major public health issue (This issue will be described later.), and this can be regarded as the second impact of the current regional inundation problem.

Table 6.2-3 Flood-prone Area around Belem City

	Basin	Total Area (ha)	Flood-prone Area
1	Armas and Reduto	274	84
2	Comercio and Tamandare	193	57
3	Estrada Nova	964	575
4	Tucunduba	1,055	603

5	Una	3,664	967
Total		6,150	2,286

(4) Flora/Fauna

According to satellite images of Belem City, taken in 1986, the total area of natural vegetation was of 1,048.53 km^2. In the continental part and several large islands such as Mosqueiro, the most predominant flora is broad-leafed secondary forest, and there is no natural vegetation left, except in small areas that due to the frequent flood events are unaffected by the human activity.

From the results of current field studies around the study area, more than 300 floral species have been registered within APEG (Ecological Research Area of GUAMA) while 29 registered species (see Table 6.2-4) are recognized within the environmental study of the "Primeiro de Dezembro" road construction project, supervised by Belem Municipality [FADESP, 1998].

Also, the variation of the fauna around the study area is rich, mainly consisting of aquatic species, and some of them were adapted to the urban area (e.g., a large population of parakeets).

According to the results of the current field study of APEG, 111 species were counted [Novaes, 1970]. A similar field study using a different methodology was carried out within APEG [Lovejoy, 1975] and it was estimated that the number of the species over entire Belem region varied between 450 and 500 species, and approximately 300 of them can be recognized in the APEG. In 1978, 79 species were registered within the entire eastern region of Para that includes Utinga and APEG [Cunha and Nascimento, 1978], and 48 species among of them were recognized around APA Belem. Thirteen species of mammals (see Table 6.2-5) have been counted [Pires, 1958], and are still widely used for the baseline data of the current fauna condition around APA Belem. Table 6.2-6 summarizes typical fauna composition usually recognized within the secondary forest formation around Belem City.

Table 6.2-4 Registered Trees Around the Study Area (29 species)

No.	Scientific Name	No.	Scientific Name
1	Vouacapoua americana (acapu)	16	Eschweilera odora (mata mata branco)
2	Parahancornia amapa (amapa amargoso)	17	Didymopanax morototoni (morototo)
3	Symphonia globulifera (anani)	18	Jacaranda copaia (para-para)
4	Dinizia excelsa (angelim pedra)	19	Caryocar glabrum (piquiarana)
5	Esterculia pruiens (axia)	20	Vochysia guianensis (Quaruba tinga)
6	Protium hepataphyllum (breu)	21	Ferreirea spectabilis (sucupira amarela)
7	Cedrela odorata (cedro)	22	Simarouba amara (Tamanqueira)
8	Goupia glabra (cupiuba)	23	Tapirita guianensis (tatapiririca)
9	Vatairea oaraensis (fava bolacha)	24	Osmosia paraensis (tento)
10	Inga paraensis (inga vermelho)	25	Piptadenia suavelens (timborana)
11	Hymenea parvifolia (jutai mirim)	26	Osteophloeum platyspermum (ucuubarana)
12	Chaunochicon sp (lacre)	27	Hieronyma alchorneoides (urucurana)
13	Cordia glabrata (louro preto)	28	Vantanea guianensis (uxirana)
14	Byrsonima sp (mangabarana)	29	Virola surinamensis (virola)
15	Simaruba amara (marupa)		

Note: Name in parentheses indicates local Portuguese name.

Table 6.2-5 Typical Mammals Around the Study Area

Class	Scientific Name
Marsupial	Caluromys philander, Marmosa murina, Philander opossum, Chironectes minimus
Rodent	Rattus ratts, Orysomyus goeldi, Holochilus brasiliensis, Nectomys squamipes, Zygodontomys fuscinus, Proechimys guyanensis
Primate	Leontocebus tamarin, Saguinus midas
Carnivore	Felis pardalis

Table 6.2-6 Typical Fauna Composition Around the Study Area

No.	Scientific Name	No.	Scientific Name
1	Tapaza pella L (Hummingbird)	18	Bodianus rufus (Parrot)
2	Pitanguese sulphuratres (Bem-te-vi)	19	Celulus jumana (Red headed wood pecker)
3	Dasyprocta aguti L (Agouti)	20	Bradypus tridactylus (Preguica bentinha)
4	Butteo albonotatus colnus Berle Prich (Hawk)	21	Choloepus didactylus (Preguica real)
5	Pilherodius pileatus Boddaert (Heron)	22	Coelogenis paca (Paca)
6	Formi carius sp (Waterfowl)	23	Arremon sileus (Pai-pedro)
7	Cassidix otyzivora (Grackle)	24	S. aestuans quelchii (Quatipuru)
8	Testudo tabulata spix (Turtle)	25	Nasus socialis (Quati)
9	Tupinambis nigropunctatus (Jacuraru)	26	Sisopygis so NI (Sui)
10	Oreopeleia montana L (Juruti)	27	Crypiturus soni (Sururina)
11	Tupinambis teguixim (Blue lizard)	28	Turdus fumigatus Lichtenstein (Sabia)
12	Saimiri sciurea (Yellow monkey)	29	Aramides cayennensis (Saracuru)
13	Cebus sp (Black monkey)	30	Tolypeuteis tricinctus (Armadillo)
14	Cebus apella (Prego monkey)	31	Lachesia sp (Surucucu pico-de-jaca)
15	Sua lencogastra (Mergulhao)	32	Constrictor constricton (Jiboia)
16	Didelphis marsupialis (Mucura)	33	Lachesia sp (Surucucurana)
17	Tachyphonum melaleucus (Pipira)	34	Lachesia muta L (Surucucu)

Note: Some of species name in parentheses are written in Portuguese.

(5) Air Quality

There is no periodical air quality monitoring study or program in Belem yet. In PDTU 2001, a preliminary roadside air quality survey was carried out at three points across the metropolitan area of Belem. In this field survey, only one parameter, daily-averaged PM10, was measured. Table 6.2-7 summarizes the major outputs of this survey.

Table 6.2-7 Air Quality Survey at PDTU 2001

	Location	Sampling Period	PM10 (ug/m3)	Comments
1	COHAB	Dec.11, 2000	34.24	
		Dec.13, 2000	30.17	
		Jan.23, 2000	25.94	
		Jan.24, , 2001	20.38	
		Jan.25, , 2001	25.33	
		Jan.26, , 2001	22.39	
		Jan.27, 2001	36.95	Weekend
		Jan.28, 2001	42.23	Weekend

		Jan.29, 2001	27.64	
2	P. Estiv.	Dec.17, 2000	37.89	Weekend
		Dec.18, 2000	38.62	
		Dec.19, 2000	41.51	
		Jan.18, 2001	50.98	
		Jan.19, 2001	41.36	
		Jan.20, 2001	20.56	Weekend
		Jan.21, 2001	29.64	Weekend
		Jan.22, 2001	45.81	
3	Sao Braz	Dec.14, 2000	52.94	
		Dec.15, 2000	51.84	
		Dec.16, 2000	45.67	Weekend
		Jan.14, 2001	47.18	Weekend
		Jan.15, 2001	50.60	
		Jan.16, 2001	55.41	
		Jan.17, 2001	56.39	

(6) Water Quality

Monthly water quality monitoring study at Lake Bolonha is conducted by COSANPA for the purpose of conserving water resources (COSANPA, 2002). This monitoring study started in January 1997, and sixteen parameters such as pH, BOD and COD are of concern. Figure 6.2-1 shows the time variation of pH value for last 5 years. Another 5-years periodical water quality monitoring study by SECTAM started in April 2001. Within this survey, 17 parameters are of concern, and 15 sampling points around APA Belem are chosen.

However, no periodical city-wide surface and/or subsurface water quality monitoring system has been established yet. When shallow or deep wells are installed for drinking water, only a one-time water quality test prior to the full-service of tap water is mandatory. After that, no follow-up, periodical W/Q test is to be/or has been carried out. However, when W/Q is accidentally changed for some reason and residents of the community file complaints to the COSANPA (e.g., recognition of strange taste, colored-water, and other symptoms), a supplemental W/Q test is to be conducted for the further verification [COSANPA, personal communication, 2002].

A preliminary water quality survey was carried out within the environmental study of the "Primeiro de Dezembro" road construction project, supervised by Belem Municipality [FADESP, 1998]. Seven parameters such as pH, conductivity, Cl, nitrite, nitrate, NH3, and phosphate were of concern, and ten sampling points were chosen. All samples were taken in July 1998.

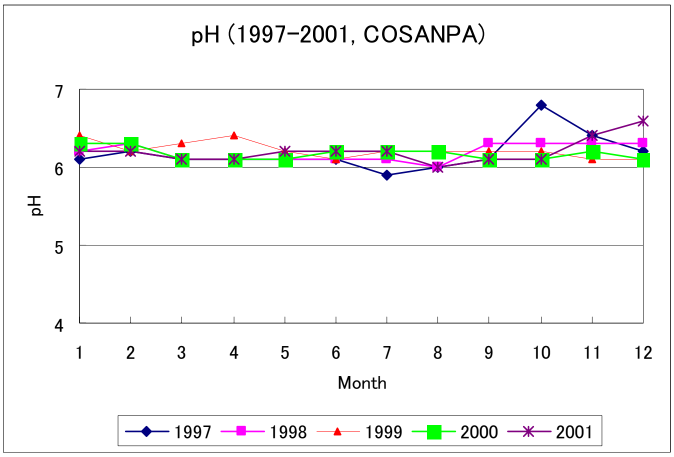


Figure 6.2-1 Water Quality Data (pH, 1997 - 2001, Lake Bolonha, courtesy of COSANPA)

(7) Groundwater Usage

The groundwater pumping activity of 34 deep wells across Belem City are registered at COSANPA (see Table 6.2-8). The averaged well length and groundwater pumping rate is 235 meters and 193 m^3/hr, respectively.

Table 6.2-8 Deep-well Locations in Belem City

	Location	Length (m)	Q (m^3/hr)
1	Ananindeua	240	*
	Same as above	240	*
3	Ariri	247	151
4	Bengui	263	212
5	Same as above	263	212
6	Same as above	276	182
7	Benjamin Sodre	250	315
8	Canarinho	263	65
9	Catalina	251	65
10	Same as above	268	208
11	CDP	259	309.6
12	Same as above	271	309.6
13	Cidade Nova	258	321
14	Same as above	256	294
15	Coqueiro	268	209.1
16	Same as above	248	209.7
17	Cordeiro de Farias	240	164
18	Same as above	280	184
19	Guanabara	270	184
20	Jaderiandia	250	191
21	Same as above	280	184
22	Mosqueiro	88	129
23	Same as above	118	176
24	Same as above	256	176
25	Marituba	42	100
26	Quteiro	50	50
27	PAAR	207	288
28	Same as above	282	250
29	Pratinha	279	93
30	Sabia	280	130
31	Satelite	200	215
32	Same as above	244	313
33	Tenone	276	*
34	Uirapuru	255	100
Mean		235 m	193 m^3/hr

(Source: COSANPA, 2002)

6.2.2. SOCIO-CULTURAL ENVIRONMENT

(1) Land Use

The first settlement in Belem was established around current Centro region in 1616. From this initial settlement area, the city started to develop along the Guama River first, then, extended its boundary toward the highland regions (e.g., current areas around Avenida. Nazare).

There are several small commercial areas for low-income people around Sao Braz, Entroncamento, Icoaraci, Ananindeua and Marituba whereas Padre Eutiquio, Braz de Aguiar, Nazare/Magalhaes Barata for the high-income class. The industrial sectors are mainly located along the coastline of Guajara Bay (Amazon River) and some industrial districts of Icoaraci and Ananindeua. All residential area can be divided into the following two types of regions; i.e., (1) the highland regions for the high-income class, and (2) lowland, swampy areas for low-income people. Most of those low-income people living around low, swampy, flood-prone areas are classified as illegal squatters, and that issue will be discussed later. Recently, some low-income communities have also been developed in the suburban area of Belem City. Table 6.2-9 summarizes the land-use condition of Belem, Ananindeua, Marituba and Santa Barbara.

Table 6.2-9 Land Use [km2]

	Belem	Ananindeua	Marituba	Santa Barbara
Urban Area	103.96	83.67	21.62	7.06
Future Urban Area	142.08	0	0	0
Rural Area	264.89	88.36	78.19	271.82
Total	510.93	172.03	99.81	278.88

Source: Environmental Report of Metropolitan Area of Belem, [COHAB-DAU, 1997]

(2) Environmental Reserves

There are two environmental reserves preserved by Para State and Belem Municipality around the study area: i.e., (1) Presidente Medici II, preserved by Belem Municipality, and (2) APA Belem, preserved by Para State (see Table 6.2-10). Besides those two parks, some portion of the wetland around the downstream side of Paracuri River, Icoaraci, is currently being investigated for preservation [SECTAM, personal communication, 2002]. Recently, water quality degradation due to the direct discharge of the household wastes into the tributaries running through those parks has become a big environmental concern. Also, the amount of the illegal waste dumping inside of those parks is increased due to the improved accessibility into those parks from the nearest residential area. In order to protect those areas, several measures were taken. For example, a long-wall that would protect the water resource area of APA Belem is currently under construction (APA Belem Protection Project).

FUNVERDE, a municipal environmental organization, is planning to extend their environmental conservation policy of the Medici II ecological park toward the upstream neighboring region that has a strong ecological continuity to the currently preserved area. Some portion of the Marinha project route is to cross along this boundary line (L = 0.7 km), and, thus, careful investigation will be required to lessen the potential environmental impacts on those areas.

Table 6.2-10 Environmental Reserves

	Name of Preserve	A (ha)	Relevant Laws, Bylaws and Regulations
1	Presidente Medici II	44.0	Bylaw 7539 of 1991
2	Icoaraci Paracuri River	Unknown	Under investigation [SECTAM, personal communication, 2002].
3	APA Belem	1,284.0	Decrees of 1551 & 1552 of 1993

(3) Illegal Squatters

In Belem, it was in the 1950s when an original illegal squatter's community was developed around low swampy areas that are highly prone to frequent flood or regional inundation events, as described in the previous section. It was in the 1960s that a large migration into Belem City occurred and most of the low land, floodplain and other swampy areas inside Belem were illegally occupied by those new migrants.

According to the results of the social survey of the APA Belem Protection Project, conducted by COHAB, a resident without the official land certificate is defined as an illegal squatter. Within this survey, almost 1,200 residents were interviewed, and it was found that 90% of all residents do not have legal documents that authorize the ownership of their real estate [COHAB, personal communication, 2002]. A similar social study was conducted within the Macro-Drainage project, and it was found that almost 98% of residents of concern were classified as illegal squatters [COSANPA, personal communication, 2002]. Similar observations were made within the social survey of the "Primeiro de Dezembro" road construction project, supervised by Belem Municipality. Within this survey, it was found that more than 90% of residents of concern were classified as illegal squatters [Fernand, personal communication, 2002].

(4) Clean Fuel Policy

The Brazilian emissions control program, PROCONVE, was introduced by the national environmental board, CONAMA, in May 1986. The fist emission standards for light-duty vehicles took effect in 1987, but these standards were lenient enough to be met by engine modifications alone. More stringent emission standards, comparable to those adopted by the USA in 1975, took effect in 1992. The Brazilian Congress has also enacted new legislation (No. 8723) effective October 1, 1993, setting strict emission standards for passenger vehicles for the rest of the decade. The Brazilian fuel program, Pro-Alcohol program, also promotes the use of ethanol, both in pure form and as an additive for gasoline. Ethanol, although considered as a cleaner-burning fuel than gasoline, can result in excessive emissions of aldehydes, especially aceto-aldehydes. For this reason, the 1992 and 1997 standards limit aldehyde emissions as well as hydrocarbons, carbon monoxide, and nitrogen oxides. Beside this PROCONVE, no additional or supplemental state- or municipality-level vehicle emission policy, regulation and/or standard exists.

The auto manufacturing industry invested heavily in tooling and R&D on ethanol-fueled vehicles. However, the first generation ethanol-dedicated new vehicles and retrofits caused great customer dissatisfaction because of the lack of technical expertise by auto manufacturers in producing alcohol-fueled cars and by unauthorized mechanics in conducting poor vehicle conversions. However, the auto manufacturing industry regained public confidence by improving engine quality considerably. In addition, the government has introduced several incentives (e.g., set the price of ethanol cheaper than that of gasoline and reduced the tax related with buying ethanol-fueled vehicles) in order to make the public acceptance of the ethanol-fueled vehicles more popular (COHAB, personal communication, 2002). Table 6.2-11 summarizes the vehicle registration number by fuel type in Belem, Ananindeua, Marituba, and Santa Barbara.

Table 6.2-11 Vehicle Registration by Fuel-Type (2001)

	Belem	Ananindeua	Marituba	Benevides	Santa Barbara
Alcohol	15,165	2,089	160	71	14
Gasoline	113,877	15,119	1,177	486	81
Diesel	12,966	3,569	271	219	31
Total	142,008	20,777	1,608	776	126

(COHAB, personal communication, 2002)

(5) Car Inspection and Maintenance

An organized nation-wide vehicle registration system was initiated in 1995, and all vehicle number plates were changed from the previous yellow-colored plate to new 7-digit gray-colored plates. Before that, each state had its own unique vehicle registration system that were all somewhat different from one another, and the inter-state exchange of vehicle registration information was not simple and straightforward work.

During this same period, a new car inspection system was also implemented, and most poor maintained, ill-conditioned vehicles could not pass this new inspection. As a result, owners of poorly maintained, ill-conditioned vehicles could not obtain new car plates, and eventually those old cars were scrapped and/or replaced with new well-conditioned ones instead [COHAB, personal communication, 2002].

Basically, all vehicles used as taxis and buses as well as passenger vehicle must be inspected every year (Article 104, Federal Law 9503 of 97) under some situations. For example, when people want to sell or retrofit their own cars, they have to take the inspection for the quality assurance (Resolution 005/98).

In Resolution 084/98, comprehensive inspection policy, methods and standards were specified, but cancelled immediately in following Resolution 101/98. The main reason of this cancellation is the shortage of workforce and budget. Due to this historical background neither governmental agencies nor organizations are yet responsible for the inspection of this vehicle type. So, this inspection system does not seems to work properly [COHAB, personal communication, 2002].

All buses used for public transport purpose in Belem must take the vehicular emission test every six months. This inspection system is operated by SESMA (Secretariat of Health and Environment of Belem Municipality), and any vehicles that fail to pass this test have to be out-of-service temporarily until those vehicles' emission systems are properly repaired. Table 6.2-12 summarizes the number of the vehicle registrations by the vehicle age. These statistics include the number of registered carriages without engine, also.

Table 6.2-12 Vehicle Registration by Age (2001)

Vehicle Age	Belem	Ananindeua	Marituba	Benevides	Santa Barbara do Para
Less than 1 yr	11,869	1,565	152	68	12
1 - 5 yrs	60,235	8,139	768	316	53
6 - 10 yrs	33,401	4,988	310	155	27
11 - 15 yrs	15,713	2,792	197	110	14
16 - 20 yrs	12,077	2,376	143	70	10
21 - 30 yrs	10,389	2,060	119	66	10
More than 30 yrs	588	135	9	5	1
Total	144,272	22,055	1,698	790	127

(COHAB, personal communication, 2002)

(6) Noise/Vibration

In PDTU 2001, a preliminary roadside noise/vibration survey was carried out at nine points across the metropolitan area of Belem. In this field survey, a 15-minute continuous measurement was conducted twice a day at each point (see Table 6.2-13).

Table 6.2-13 Noise/Vibration Survey at PDTU 2001

	Locations	Date	Leq (dBA)	L10 (dB)
1	Avenida Gentil Bittencourt.	Jan.16, 2001	79.7	43.0
		Jan.17, 2001	79.5	42.8
2	Quintino B. St. and Avenida. Nazare	Jan.16, 2001	77.3	37.8
		Jan.18, 2001	77.8	39.1
3	Avenida Generalissimo Deodoro and Bernal do Couto	Jan.17, 2001	73.9	36.2
		Jan.18, 2001	75.0	36.8
4	Avenida Gov. Jose Malcher and Almirante Barroso.	Jan.17, 2001	79.0	39.0
		Jan.18, 2001	78.0	38.7
5	Avenida Visconde Sousa Franco and Antonio Barreto	Jan.17, 2001	77.0	55.4
		Jan.17, 2001	76.4	55.8
6	Avenida Castilhos Franca	Jan.17, 2001	76.0	51.3
		Jan.18, 2001	75.6	51.4
7	Avenida Nazare and Generalissimo Deodoro	Jan.17, 2001	75.9	38.7
		Jan.18, 2001	74.8	38.4
8	Rodovia BR-316 (near Parador St.)	Jan.18, 2001	78.7	39.9
		Jan.19, 2001	79.0	38.2
	Rodovia Augusto Montenegro (near WE2 St.)	Jan.18, 2001	77.3	46.6
		Jan.19, 2001	79.2	54.5

(7) Waste Disposal Site

There is only one landfill-type disposal site around Belem City (located at Aura), and all garbage collected in Belem, Ananindeua and Marituba are conveyed to this site. After this site started its operation, this waste disposal site became fully saturated with tons of dark-colored liquids soon. Eventually, those liquids were leaked from dumped wastes. From the topographical point of view, this disposal site is located within the watershed of APA Belem and is very close to both APA Belem and the Guama River. So, the potential risk of water-resource contamination by the hazardous plume leaked from this site seemed to be quite high, and consequently this problem raised wide public environmental awareness in Belem. To avoid serious surface/sub-surface water contamination accidents around this disposal site, several mitigation measures were taken as precautions. One of them was to construct a treatment ditch in which all hazardous liquids were stored temporarily, and then, discharged into the Guama River without proper treatment. This operation only shifted the contamination sources to another place and did not solve the essential part of this problem, and eventually stopped about two years ago. Currently, this leaked dirty liquid is conveyed to oxidation-process-based treatment facilities, and then, discharged into nearby channels [COHAB, personal communication, 2002].

(8) Water Supply

According to the statistics of COSANPA, a current city-wide water supply system covers 83% of residents in the Belem Metropolitan Area (COSANPA, personal communication, 2002). Most of the water comes from the Guama River via the Bolonha water treatment complex. Four pumps are installed at the Guama Complex, and the operation of this flow diversion (Qmax = 5.8 m^3/s) is carried out around the year except the periods when the water levels of both Lakes Bolonha and Agua Preta increase rapidly due to the torrential rain, and then, become higher than that of the Guama River. Usually, this temporary water level inversion occurs in March and/or April.

Table 6.2-14 and Table 6.2-15 summarize the water treatment plants across Belem City (Two plants use surface water while 15 use subsurface water.).

Table 6.2-14 Water Treatment Plant (Surface Water)

	Name	Amount of Water Supply (m^3/h)
1	Complexo Bolonha	14,389.2
2	Complexo Guama	20,511.2

(Source: COSANPA, personal communication, 2002)

Table 6.2-15 Water Treatment Plant (Sub-surface Water)

	Name	Amount of Water Supply (m^3/h)
1	Ariri	133.2
2	Bengui	665.0
3	Benjamin Sodre	320.4
4	Canarinho	63.0
5	Catalina	160.2
6	CDP	1,518.4
7	Cidade Nova	612.2
8	Coqueiro	202.0
9	Cordeiro de Farias	374.3
10	Jaderiandia	493.4
11	Mosqueiro	522.0
12	Marituba	382.0
13	PAAR	481.0
14	Pratinha	95.0
15	Satelite	576.6

(Source: COSANPA, personal communication, 2002)

(9) Sewage System

According to the federal level statistics, about 40% of all effluents are conveyed to proper sewage systems, and 20% of them are discharged with relatively proper treatment (COSANPA, personal communication, 2002). In Belem, the current sewage system is still at an early development stage, and only 6% of the entire effluents are collected to a sewage treatment plant, and then discharged into the Guama River. Individual cesspits without any connections to the municipal sewage system are commonly recognized across the city [COHAB, personal communication, 2002]. Those cesspits are periodically vacated, and those wastes are delivered to final destinations such as nearby large pits without any underlining barrier, drainage and/or channels, that are not connected to the sewage system.

There was a sewage project, named "PROSANEAR (Sanitation Program for Low-income People)", funded by the World Bank and Caixa Economia Federal (The target population and area are 126,000 and 958 ha, respectively). This project started in 1995, and after its completion, Belem Municipality is doing similar sewage improvement projects at different sites. Table 6.2-16 summarizes the outline of this project.

Table 6.2-16 PROSANEAR

Parameters	Descriptions
Target Population	126,411 (16,624 houses)
Target Area	Bengui, Coqueiro and Guanabara; A = 958 ha
Total Length of sewage system	116,368 m
# of Pumping Stations	4
# of Treatment Stations	5

In the Macro-Drainage project, funded by Inter-American Development Bank, approximately 5,800 meters of conventional sewage system was constructed. Besides this system, the household effluent treatment system using a septic tank, a so-called "micro-drainage system" was installed. Currently, this micro-drainage system is installed in the residential areas within four basins out of seven across the Belem City [COSANPA, personal communication, 2002].

(10) Public Health

Due to the frequent regional inundation events and poor sanitary condition around the lowland area, the spread of waterborne epidemic diseases such as cholera, typhoid, dysentery, schistosomiasis (swimmer's itch) and others have become a major public health issue. This can be regarded as the second impact of this frequent regional inundation event. Another problem related with this inundation issue is the outbreak of mosquitoes that might transmit malaria, yellow fever and dengue. Table 6.2-17 summarizes the number of cholera patients reported in 1992. It is also reported that the total number of those patients was decreased after the regional drainage and sanitary condition was considerably improved due to the completion of the Macro-Drainage project [COSANPA, personal communication, 2002].

Table 6.2-17 Epidemic Statistics (Cholera) of 1992

City	No. of cholera patients
Belem	622
Ananindeua	74
Benevide	28

Source: Environmental Report of Metropolitan Area of Belem [COHAB-DAU, 1997]

(11)Electricity

There are 14 power substations around the study area. Some portions of the project route of Independencia are to be overlapped with the high-voltage power lines that transmit electric power between Miramar and Utinga power substations (L = 19 km). The clearance of this high-voltage power lines varies between 13 to 17 meters in width, and no construction of any road facilities are allowed within this space (COHAB, personal communication, 2002).

(12)Quarries

Table 6.2-18 summarizes quarry sites around Belem City. Besides those listed in this table, it is reported that more numerous illegal quarry sites that do not have an operation license exist around Belem City [COHAB, personal communication, 2002].

Table 6.2-18 Quarry Sites around Belem City

	Name (Site and/or Owner)	Location	Situation	Material
1	Celio Lobato	Ananindeua	Illegal	Laterite soil
2	Amadeu Begot	Same as above	Illegal	Same as above
3	Ettema	Same as above	Needs license renewal	Same as above
4	Gilberto	Same as above	Illegal	Same as above
5	Belterra	Same as above	Needs license renewal	Unknown
6	Olival S. Cunha	Same as above	Illegal	Laterite soil
7	Reinaldo Begot	Sta. Barbara	Closed	Sand
8	Toegal	Same as above	Closed	Same as above

9	Reinaldo Begot	Same as above	Illegal	Same as above
10	J. Leandro/J. Begot	Sta. Isabel	Needs license renewal	Gravel
11	Bessa	Sto. Ant. Taua	Illegal	Sand
12	Conspetrol	Same as above	Needs license renewal	Sand
13	Belterra	Sta. Isabel	Needs license renewal	Sand
14	Novo Horizonte	Ourem	Unknown	Gravel
15	Jose Nojoza	Same as above	Illegal	Same as above
16	Transjelucio	Same as above	Illegal	Same as above
17	Batuira	Same as above	Needs license renewal	Same as above
18	Pratico	Sta. Luzia	Illegal	Same as above
19	J. S. Barroso	Same as above	Needs license renewal	Same as above
20	Paulo The	Same as above	Illegal	Same as above
21	Tocos In. e. Com. Ltda	S. M. Do Guama	Illegal	Same as above
22	Seixeira Rithelli	Same as above	Illegal	Same as above
23	Seixeira Sao Geraldo	Same as above	Illegal	Same as above
24	Manasses Gervasio	Same as above	Illegal	Same as above
25	Jurandir dos Santos	Same as above	Illegal	Same as above
26	Pedro de Paiva	Same as above	Illegal	Same as above
27	Pedreira Sta. Monica	Tracuateua	Unknown	Aggregates

(Source: SETRAN, SILP, Programa de Exploracao do Sistema de Integracao do Leste Paraenese, 1998)

(13) Other Relevant Development Projects

There are several on-going development projects around the study area (see Table 6.2-19). More detailed information about three different road projects and one bike-road project, listed in this table, are described in Chapter 5.

As mentioned earlier, the main purpose of the APA Belem Protection Project is to conserve both water reservoirs, Lakes Bolonha and Agua Preta, and the surrounding watershed area that would recharge surface/sub-surface water around APA Belem greatly. The wall construction has already started, although the expropriation negotiation processes for some parts are not settled completely (All negotiations are to be terminated by the end of 2003. [COHAB, personal communication, 2002]). More detailed information about this wall construction project is described in Chapter 7.

As described earlier, some portion of Avenida. Independencia between Rodovia Augusto Montenegro and Rodovia BR-316 Road is currently under construction. No full-scale EIA study was required within this road project since SECTAM concluded that the surrounding natural environment was already degraded due to the development of the illegal squatter's community and no important environmental resources to be protected were recognized [Independencia Road Construction Office, personal communication, 2002].

A feasibility study of the Macro-Drainage Project started in 1988, while the construction itself began in 1994. Several environmental studies were carried out from 1983 through 1984 before the Brazilian EIA Law was issued. The return period of the rainfall is 20 years and its intensity to be used in the drainage design is 120 mm/hour [COSANPA, personal communication, 2002]. More detailed information about the Macro-Drainage Project is described in Chapter 7.

Table 6.2-19 Relevant Development Projects around the Study Area.

	Project Title	Responsible agency
1	APA Belem Protection Project	Para State
2	Primeiro de Dezembro Road Construction Project (L = 20 km)	Belem Municipality

3	Independencia Road Construction Project (L = 4.64 km)	Para State
4	Alca Rodoviaria Road Construction Project	Para State
5	Macro-drainage Project (Una Basin, A = 3,600 ha).	Belem Municipality, Para State
6	Almirante-Barroso Bike-Path Construction Project (1.8 m x 2 lane)	Belem Municipality

(14) Archaeological/Historical/Cultural and/or Monumental Site

Most of archaeological/historical/cultural and/or monumental facilities to be conserved exist within the downtown area of Belem City. Following three different governmental agencies such as IPHAN (Federal), SECULT-DHPAC (State) and FUMBELL (Municipality) are mainly in charge of the conservation of those facilities, and the conservation policy and/or strategy of each facility is determined through the tri-agencies consultation process (DPHAC, IPHAN, personal communication, 2002) once the request of the conservation is submitted. Damages to historical sites due to roadside vibration were reported around the Centro region, and an anti-vibration measure was implemented for some of those damaged facilities four years ago [IPHAN, personal communication, 2002].

Table 6.2-20 and Table 6.2-21 summarize the archaeological/historical/cultural and/or monumental sites conserved by IPHAN and SECULT-DHPAC, respectively. Roadside mango trees and sidewalks are also regarded as important items to be conserved. In Belem, the roadside planting of mango trees was started in the late 1800s, and cutting and/or relocation of any mango trees planted between Belem and Ananindeua is legally prohibited [DEPHAC, personal communication, 2002].

Table 6.2-20 Archaeological/Historical/Cultural and/or Monumental Site by IPHAN

	Name of Facilities
1	Conjunto Arquitetonico e Paisagistico da Praca Frei Caetano Brandao
2	Cemiterio N^a-Sr^a da Soledade
3	Conjunto N^a-Sr^a do Carmo
4	Igreja e Convento dos Mercedarios
5	Igreja de N^a-Sr^a do Rosario
6	Igreja de N^a-Sr^a de Santana
7	Igreja de Sao Joao Batista
9	Palacio Antonio Lemos
10	Solar Barao do Guajara
11	Teatro da Paz
12	Museu Paraense Emilio Goeldi
13	Conjunto Arquitetonico e Paisagistico do Ver-o-peso
14	Palacete Pinho
15	Conjunto Arquitetonico a Avenida. Nazare
16	Conjunto Arquitetonico a Avenida. Gov. Jose Malcher
17	Ruinas do Engenho Murutucu e Capela de N^a-Sr^a da Conceicao

Table 6.2-21 Archaeological/Historical/Cultural and/or Monumental Site by SECULT

#	Name	#	Name
1	Colegio Paes de Carvalho	23	Basilica de Nossa Senhora de Nazare e Imagem de Nossa Senhora
2	Palacete Bolonha	24	Residencia Jose Leite Chermont
3	Parque da Residencia	25	Universidade do Estado do Para (UEPA)

4	Mercado de Sao Bras e Caixa D'Agua de Ferro	26	Palacete Jose Julio de Andrade
5	Monumento do Marco da Legua	27	Conjunto Arquitetonico
6	Museu Paraense Emilio Goeldi	28	Faculdade de Medicina
7	Biblioteca e Arquivo Publico	29	Delegacia Regional do Mec
8	Instituto de Educacao do Para	30	Residencia do Intendente Antonio Lemos
9	Instituto Lauro Sodre	31	Praca Barao do Rio Branco, Largo da Trindade
10	Instituto Gentil Bittencourt	32	Porto de Belem
11	Bosque Municipal Rodrigues Alves	33	Instituto Carlos Gomes
12	Corpo de Bombeiros	34	Cantaria de Lioz
13	Antigo Solar Barao do Guama	35	Chalet de Ferro da Imprensa Oficial do Estado
14	Praca da Republica	36	Praca Visconte do Rio Branco
15	Praca Batista Campos	37	Chalet de Ferro do Bosque Rodrigues Alves e o Chale do Campus Universitario do Guama
16	Quartel do 1° Batalhao de Infantaria	38	98 Laminas em aquarelas de motivos marajoaras de autoria do artista plastico Manoel Oliveira Pastana
17	Poste de Ferro	39	Tela de Oleo "Os Ultimos Dias de Carlos Gomes"
18	Curro Velho	40	Acervo Arqueologico de Ceramica Marajoara
19	Asilo de Mendicidade D. Macedo Costa	41	Acervo Numismatico Composto de 802
20	Segup	42	Mangueiras e Samaumeiras
21	Grupo Escolar Floriano Peixoto	43	Conjunto Paisagistico/Ecologico e Turistico
22	E.E.E.F. Barao do Rio Branco		

(15)Schools, Churches and Hospitals

Table 6.2-22 summarizes the number of schools, churches, hospitals and parks identified within 100 meters on both sides of the major project routes.

Table 6.2-22 School, Church, Hospital and Park within the Study Area

	School	Church	Hospital	Park
Avenida. Almirante Barroso and Rodovia BR-316	17	5	9	13
Rodovia Augusto Montenegro	4	1	1	4
Avenida. Nazare and Barata	1	11	6	4
Avenida. Jose Malcher	2	10	6	4
Avenida. Visconde Souza Franco	2	0	0	2
Avenida. Gama Abreu	4	1	0	4
Avenida. Presidente Vargas	1	0	0	5
Avenida. Castilhos Franca and Mal. Hermes	0	1	0	9
Total	31	29	22	45

(16)Military Bases, Airport

One of the project routes, Rua Rodolfo Chermont, would run directly through three important facilities, listed in Table 6.2-23. Direct interference, cumulative or secondary impacts of those facilities with this project are expected to occur. Aero Clube do Para is renewing its master plan, and that renewal is to be finished by the end of July 2002. Based on that master plan, any conflicts or interference must be avoided. Large-scale expropriation might be expected to occur along some portion of Rua da Marinha between Avenida Independencia and Rodovia Augusto Montenegro [COHAB, personal communication, 2002].

Table 6.2-23 Military Base and Air Port around the Study Area

	Name of Facilities	Comments
1	Aero Clube do Para (Air port)	Rua Rodolfo Chermont (L = 0.5 km)
2	Aeronautica (Pilot school)	Rua Rodolfo Chermont (L = 1.0 km)
3	Navy Base	Rua Rodolfo Chermont (L = 1.2 km)
4	Navy Base	Rua da Marinha (L =3.9 km)

6.3. LEGAL AND ADMINISTRATIVE FRAMEWORK

6.3.1. ENVIRONMENTAL ORGANIZATIONS

(1) SISNAMA (National System of Environment).

By Law No. 6.938 of 1981, the National Council of Environment (CONAMA) and National System of Environment (SISNAMA) were established. The main objectives of SISNAMA are as follows: (1) supporting environmental protection activities and relevant technology registration policy, (2) insuring the right of every individual to enjoy a healthy environment, and (3) protecting the natural heritage and the sovereignty of the nation. The Ministry of Urban Development and Environment was established by Law No. 91.145 of 1985, and re-organized as the Ministry of Environmnet in 1999.

(2) Organizations on the National Level

1) The Ministry of Environment:

The supreme organization of environmental administration, mainly establishes environmental policy on the national level. Mainly, the ministry consists of the following five bureaus of (1) Environment of Human Society, (2) Bio-Diversity and Forests, (3) Water Resources, (4) Sustainable Development, and (5) Development of the Amazon Region.

Also, the ministry has following scientific organizations:

a) **CONAMA** (National Environmental Board): One of the ministry's environmental administration organizations.

b) **CONAMAZ** (National Council of Amazon Region): One of the ministry's organizations engaged in biological, social and ecological investigations in the Amazon Region.

c) **National Council of Water Resources**: One of the ministry's organizations engaged in water resource development and conservation of water resources.

d) **National Committee of Environmental Fund**: An organization engaged in administration of the environmental protection fund.

2) IBAMA (Brazilian Institute of Environment and Renewable Natural Resources):

The supreme organization mainly engaged in the implementation of the environmental protection and pollution control activity within the current environmental legal system on national level.

3) The Ministry of Culture:

The supreme organization conserving historical, architectural and cultural heritage on the national level. Some institutes of this ministry, in particular, **IPHAN (**National Institute of Historical/Architectural and Cultural Heritage) perform archeological/historical and cultural research, engage in conservation works, and conduct other relevant activities.

(3) Organizations on the Regional Level.

1) SECTAM (Executive Secretariat of Science, Technology and Environment):

One of the regional autonomous organizations of the Ministry of Environment, which jurisdiction covers all of Para State.

2) COSANPA (Para State Sanitation Company):

Public enterprise of the water supply and sewage system. Monthly-based continuous water quality monitoring surveys at Lakes Bolonha and Agua Preta are conducted by COSANPA.

3) SECULT (Executive Secretariat of Culture):

One of the regional autonomous organizations of the Ministry of Culture, the jurisdiction of which covers the entire Para State. Within this organization, **DPHAC** (Department of Historical, Architectural and Cultural Heritage Conservation) has overall responsibility for conservation of the entire historical/architectural/monumental and cultural heritage registered at state level.

4) FUNVERDE (Belem Green Area and Park Foundation):

Environmental organization of Belem City, administering conservation of flora at in forests, parks and gardens inside Belem City.

5) FUMBEL (Belem Cultural Heritage Foundation):

Cultural organization of Belem City, administering conservation of cultural heritage registered on the municipality level.

6) Secretariat of Agriculture and Environment of Ananindeua:

Environmental organization of Ananindeua City administering environmental conservation.

6.3.2. LEGAL FRAMEWORK

(1) Federal Level

1) Federal Constitution

The Constitution of the Federative Republic of Brazil, issued in 1988, provides the basic burdens of the state and the people's rights on environment and natural resources. Within this constitution, basically, Chapters III and IV are related with the balanced social order and environmental concern, respectively.

2) Law of Environmental Impact Assessment (CONAMA Resolution 001 of 1986)

This law provides the fundamental framework and the outline for the EIA Report and the RIMA, both required for the Environmental License Evaluation Process of development projects.

3) Law of Public Participation Process in EIA (CONAMA Resolution 009 of 1987)

This law provides the people's right of the public involvement process within any concerned development projects and specifies the framework of the public participation process within the EIA evaluation process.

4) Law of EIA and Environmental License Approval (Decree 99.274 of 1990)

This law specifies that any development project that would use environmental resources must obtain the official environmental approval from concerned agencies throughout the EIA evaluation process prior to the construction phase. Compulsory EIA subtasks such as the current environmental diagnosis, preparation of multiple alternative development plans and impact assessments of the proposed project are specified.

In Article 19 of this law, the following three different types of Environmental License, depending on the step of the project cycle such as (1) planning and design, (2) construction, and (3) operation, are specified;

a) **Preliminary License (LP)**: This license is approved after it is proven that the planning and design of the proposed project are environmentally sound and no severe negative environmental impacts exist.

b) **License for Installation (LI)**: Construction of the proposed project can be officially initiated after this license is approved.

c) **License for Operation (LO)**: It is mandatory to obtain this license prior to the operation phase of the proposed project that already obtained either both LP and LI, or only LI from SECTAM.

In Article 35 of this law, it is specified that any development projects that require earthwork activity in which the total amount of the excavation of sand, gravel, rock and/or other materials would exceed more than 100 m^3 shall apply for Environmental License prior to the construction phase.

5) Law of Environmental Crime and Penalty (Law 9.605 of 1998)

This law specifies the penal code for any scale of environmental crimes caused by human activities. The penal code specified in this law is also applicable to any level of administrative organization when serious health damage and/or loss occurred due to the negligence of appropriate measures for predictable environmental pollution event.

6) Law of Expropriation (Law 3365 of 1941)

This law describes the policy of the expropriation to be caused by a public project such as a large infrastructure development project. Originally, this law was issued in 1941 and revised twice later (revised in 1978 [Law 6602] and 1999 [Law 9785], respectively). The more detailed descriptions about this law and current studies of expropriation cases due to the public infrastructure development projects are summarized in Chapter 7.

7) Law of Drinking Water Quality (Law 1469 of 2000)

This law defines obligations and responsibilities of concerned agencies at the federal, state, and municipality levels, respectively, and lists of the drinking water quality standards and monitoring system.

(2) State Level

1) Decrees 3.251 and 3252 of 1984

These bylaws declare the area of Lakes Agua Preta and Bolonha (A = 1,598 ha) and those surrounding watershed areas (A = 1,852 ha), that are very important reservoirs for the water supply for the Belem metropolitan area, such as APA Belem (Belem Environmentally Protected Reserves).

2) Decrees 1551 and 1552 of 1993

Within this bylaw, the geographical location of APA Belem is specified as follows:

APA Belem is located between the latitude lines of 1' 22" and 1' 29", and between the longitude lines of 48'28" and 48'30", respectively. This reserve is bounded by Avenida Perimetral, the Aura River, Federal Road, Rodovia BR-316, and the Guama River.

Basically, any construction work, planning or activities that lead to environmental deterioration of APA Belem are strictly prohibited.

3) Law of Environment of Para State (Law 5.887 of 1995)

This law provides the comprehensive environmental management policy of Para State. Chapter VIII of this bylaw specifies the environmental license approval system within the EIA evaluation process prior to the construction phase. Chapter X describes the public participation program within the EIA process.

4) Decree 2909 of 1998

This bylaw authorizes the expropriation of a region that includes Section B, located at Estrada do Caixapara, Section C, located at Passagem Santa Isabel, and Sections D and E, located at Estrada de Pedreirinha. This expropriated region will be used as part of APA Belem.

5) Law of Preservation and Protection of Historical/Cultural and Patrimonial Sites (Law 5629 of 1990)

This bylaw declares DHPAC of SECULT and AMPPPC (Municipal Agency of Preservation and Protection of the Cultural Patrimony) as the responsible agencies of the preservation and protection activities, and specifies the policy and procedures of the preservation and protection of historical/cultural and patrimonial sites of Para State.

(3) Municipality Level

1) LOM of Belem

This bylaw specifies the comprehensive legal framework, policy, and directions for the urban development plan of Belem City. In Chapter VI, environmental regulations are specified for any development projects that have potential negative impacts on the environment. In Chapter V, it is stressed that high priority should be put on the road network improvement of the Belem Metropolitan Area.

2) Law 7.603 of 1993

This bylaw provides the master plan of the urban development of Belem City. In Article 2, the necessity of a comprehensive urban development strategy that combines an efficient urban land-use policy and transport network system is stressed. In Article 88, the maintenance policy of the natural river and channel is described. According to this article, any illegal occupation or house construction up to 33 m on either side of river and channel is prohibited.

Followings are major articles to potentially concerned with this development project:

Articles 257 - 260: Environmental Impact Assessment

Article 261: Expropriation policy for APA Belem.

Article 266: Important flora of APA Belem is listed

Article 269: Requirement of Environmental License for development project within the APA Belem.

Article 272: Prohibition of mining activity within APA Belem.

Article 292: Public health policy of Murutucum River Basin.

6.3.3. ENVIRONMENTAL STANDARDS

(1) Air Quality

Table 6.3-1 summarizes the A/Q environmental standard implemented in Brazil. Besides this one, neither additional nor supplemental environmental criteria are introduced in Para State.

Table 6.3-1 Environmental Standard on Federal Level (Air Quality)

Parameter	Period	Primary(μ g/m^3)	Secondary(μ g/m^3)
TSP	1 day	240	150
	Annual	80	60
SO_2	1 day	365	100
	Annual	80	40
CO	1 hr	40,000 (35 ppm)	40,000 (35 ppm)
	8 hrs	10,000 (9 ppm)	10,000 (9 ppm)
O_3	1 hr	160	160
Smoke	1 day	150	100
	Annual	60	40
PM10	1 day	150	150
	Annual	50	50
NO_2	1 hr	320	190
	Annual	50	50

(Source: CONAMA Resolution 003 of 1990)

Note that the primary standard is used as both the short-term air quality measurements and the maximum allowable one for an on-going polluted area. The secondary standard is mainly used for long-term measurement and is also the guideline value used for the environmental evaluation of new development projects in order to prevent rapid air quality deterioration.

(2) Water Quality

Table 6.3-2 summarizes the W/Q environmental standard implemented in Brazil. In Para State, neither additional nor supplemental environmental criteria are introduced beside these criteria.

Table 6.3-2 Water Quality Standard

	Parameter	Recommended Value	Criteria
1	Odor	Not detected.	Not detected.
2	Taste	Not detected.	Not detected.
3	PH	6.0 - 9.5	9.5
4	Hardness (mg/L)	< 500	500
5	Cu (mg/L)	< 15	15
6	Turbidity (mg/L)	1.0	5.0
7	DO (mg/L)	6.0	6.0
8	BOD (mg/L)	< 3.0	< 3.0
9	NH3 (mg/L)	< 1.5	< 1.5
10	Nitrate (mg/L)	< 10	10
11	Nitrite (mg/L)	<1.0	1.0
12	Cl (mg/L)	< 250	250
13	CaCO3 (mg/L)	< 500	500
14	Fe (mg/L)	< 0.3	0.3
15	SO_4 (mg/L)	< 400	400
16	Zn (mg/L)	< 5.0	5.0
17	Al (mg/L)	< 0.2	0.2
18	F (mg/L)	0.6 - 0.8	0.8

(After Decree 1469 of 2000)

(3) Noise/Vibration

1) Noise

Table 6.3-3 summarizes the noise environmental standard implemented in Brazil. Also, Table 6.3-4 summarizes the noise zone classification currently used in USA for comparison. Community Noise Leq, implemented in USA, also uses the same values listed in this table.

Table 6.3-3 Noise Environmental Standard in Brazil (dBA)

Zone	Leq (dBA)	
	Daytime	Nighttime
Rural	40	35
Hospital	50	45
Residential	55	50
Commercial and Mixed	60	55
Recreational and Mixed	65	55
Industrial	70	60

Where daytime is defined as 07:00 - 22:00 while nighttime is as 22:00 - 07:00.

Source: ABNT (NBR-10151): Brazilian Association of Technical Rules.

Table 6.3-4 Noise Zone Classification

	Noise Exposure Class	DNL (dBA)	Leq (hour)	HUD Noise Standard
A	Minimal Exposure	< 55	< 55	Acceptable
B	Moderate Exposure	55 – 65	55 - 65	
C-1	Significant Exposure	65 – 70	65 - 70	Normally Acceptable
C-2		70 – 75	70 - 75	
D-1	Severe Exposure	75 – 80	40 - 80	Unacceptable
D-2		80 – 85	80 - 85	
D-3		> 85	. 85	

(Source: Larry W. Canter, 1996)

Note: DNL: Day-Night average sound level, Ldn, defined by following formula;

$Ldn = 10 \log (0.625 (10^{(Ld/10)}) + 0.375 (10^{(Ln+10)/10})$

Where Ld is the Leq for the daytime (0700 - 2200) and Ln is the Leq for the nighttime (2200 - 0700).

HUD: Department of Housing and Urban Development.

2) Vibration

No environmental standard for vibration exists in Brazil. Table 6.3-5 summarizes the environmental standard implemented in Japan.

Table 6.3-5 Vibration Level L10 (dB)

Zone	Day (6:00 - 20:00)	Night (20:00 - 6:00)
1	65	60
2	70	65

(Source: Japan Road Association, 1988)

Zone 1: Zone that requires a moderate, calm and quiet environment. Most of the residential area uses these values.
Zone 2: Zone used for industrial and/or commercial purpose.

6.3.4. ENVIRONMENTAL LICENSE APPLICATION PROCESS IN BRAZIL

(1) License Approval Flow

There are four flows in order to obtain environmental license, and each flow requires the following different report, respectively.

1) Neither environmental study nor report are required if SECTAM and/or other concerned environmental agencies conclude that the proposed project would cause no negative environmental impact.

2) PEA (Environmental Engineering Design Report): This study is required for small development projects that would have limited environmental impacts and need only several specific environmental studies. This report requires neither environmental diagnosis nor public meetings.

3) RCA (Environmental Control Report): This also requires a limited environmental study for development projects that would cause several significant environmental impacts. This requires a general environmental diagnosis, impact

assessment and environmental mitigation program. No public meeting is required.

4) EIA: This requires a full-scale EIA study and requires a public review of EIA/RIMA (Environmental Impact Report for the public participation process) D/F reports during the EIA process. A public meeting will be held if any individuals/groups/organizations and/or third parties submit the official request for public a meeting during the public review period.

In general, the environmental study requirement for the proposed project (i.e., ToR) is determined within the first consultation process with SECTAM.

In this feasibility study, it is highly likely that the full-scale EIA will be required in order to obtain the environmental license (LP), and SECTAM is to be the principal governmental environmental agency to consult with. More detailed descriptions of the EIA process will be presented in following section.

(2) License Approval Steps

The main purpose of the EIA study is to obtain the environmental license issued by the Ministry of Environment, the Government of Brazil. Officially, any EIA work of the development project can be initiated after the term of reference (ToR) of environmental studies to be required for the EIA evaluation process is fixed. In general, this ToR of the EIA study is to be determined through consultation with SECTAM.

The following are the major steps of the EIA evaluation process:

1) Prepare for the project brief of the proposed project that contains the outline of the proposed project and its surrounding environmental information. This project brief should be written in Portuguese. Then, submit the project brief to SECTAM.

2) Determine the ToR of EIA work of the proposed project in consultations with SECTAM. Those consultations should be carried out, based on the submitted project brief.

3) Carry out relevant environmental studies of EIA, mainly based on the ToR determined in the previous step.

4) Prepare for EIA/RIMA D/F reports, and then, submit those reports to SECTAM.

5) Prepare for the public participation process. In Brazil, the public participation process consists of following two steps: (1) the public review of EIA/RIMA D/F reports, and (2) a public meeting. A public meeting will be held if any individuals/groups/organizations and/or third parties submit the official request for a public meeting during the public review period. Otherwise, it is not mandatory to have any further public meetings. When a public meeting is held, public opinions and/or comments on the proposed project are collected through this process, and then incorporated into the EIA/RIMA D/F reports, and preparations are made for the final version of the EIA/RIMA report.

6) After SECTAM receives the EIA/RIMA D/F reports, the examination of the environmental license approval by SECTAM automatically starts. If the contents of the EIA study of the proposed project are satisfactory, then, this license approval process moves to next and final step. If SECTAM requests some modifications and/or additional environmental work to the submitted EIA/RIMA D/F reports, the environmental license applicant must carry out a relevant environmental study further until the contents of EIA/RIMA D/F are satisfactory for SECTAM and other relevant groups/agencies/organizations.

7) Final examination will be made by COEMA (Conselho Estadual de Meio Ambiente), and the environmental license (Preliminary License (LP), described in the previous section) will be issued if no objections and/or further controversial discussions are presented from COEMA.

(3) Time Schedule of EIA works

The JICA Study Team had three official consultations with SECTAM after the submission of the project brief to SECTAM. Table 6.3-6 summarizes the time schedule of the EIA work of the proposed project, determined through these consultations. More detailed descriptions about the EIA working frame of this proposed project will be presented later.

Table 6.3-6 Time Schedule of EIA work for the proposed project.

Completion of EIA ToR (Final):	July 03, 2002
Due date of EIA & RIMA (D/F):	Jan.15, 2003
Public Review:	Jan.16, 2003 – March 31, 2003
Public Meeting:	April 01, 2003 – April 30, 2003
Due Date of EIA (Final)	June 30, 20/03

6.4. ROADSIDE AIR QUALITY SURVEY

6.4.1. OUTLINE OF THE FIELD SURVEY

In order to analyze the current air quality conditions in Belem, air quality field measurements were carried out by the Study Team. As stipulated by the Japan International Co-operation Agency four pollutants of concern were dust (PM-10), CO, NOx and SO_2. Ten points throughout Belem representing dominant characteristics of the public transport system, land use, and topographical conditions were chosen as the air quality measurements. Nine of these points were used for roadside air quality measurement while one served as a background “control” site. Table 6.4-1 and Table 6.4-2 summarize the basic details of the air quality measurements.

Table 6.4-1 Instruments Used for Air Quality Measurements

Pollutant	Instrument Used for Measurement
Dust (PM-10)	PM-10 High Volume Sampler, ENERGETICA
CO	CO Gas Filter Correlation Analyzer API Model 300 (Advanced Pollution Instrument Inc.)
Nox	NOX Gas Analyzer Model 400 (Advanced Pollution Instrument Inc.)
SO_2	TRI-GAS, ENERGETICA

Notes: Total number of sampling points = 10, Measuring period: June and December 2002

Table 6.4-2 Locations of the Measurement/Sampling Points

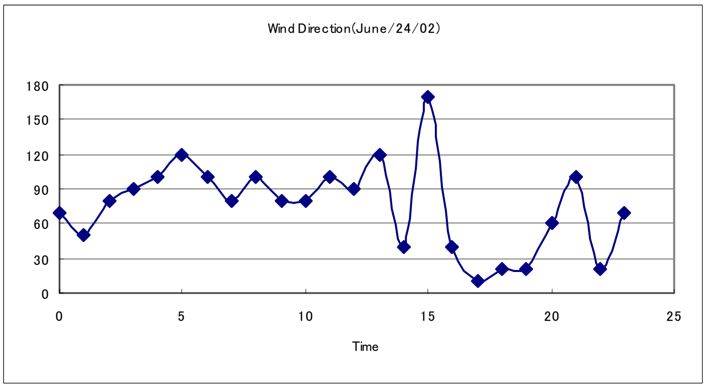
	Approximate Location of the Measurement/Sampling Point
1	Parque Bolonha – Utinga
2	Rua Primeiro de Dezembro (Rua do Fio)
3	*Avenida. Transmangueirao (Conjunto Catalina)*
4	*Rodovia BR 316 x Rua Caixa Para 2*
5	*Avenida. Nazare (Praca)*
6	*Rua Gama Abreu x Rua Padre Prudencio*
7	*Avenida. Almirante Barroso x Travessa Mercedes*
8	*Rua Joao Balbi x Avenida. Visconde Souza Franco*
9	*Avenida. Almirante Barroso em frente ao Bosque*
10	*Rodovia Augusto Montenegro*

6.4.2. PREVAILING WIND PATTERN

Figure 6.4-1 and Figure 6.4-8 show the hourly wind pattern (magnitude and direction) measured at Meteorological Station of Val-de-Caes Airport, during late June of 2002. Note that the wind direction is expressed in terms of the displaced angle from due north, in the clockwise direction.

As shown in these figures, the prevailing wind direction is easterly (i.e., 90 degrees) and the maximum wind speed reaches around 10.0 - 14.0 KT (approximately 5.0 – 7.0 m/sec) throughout this period. This tendency is also observed in current reports (e.g., Cabral C, 1993).

Basically, there is no strong wind in the early morning and it can be said that regional atmospheric conditions seem to be stable. Then, after 8:00 or 9:00 a.m., the wind starts blowing gradually and ceases at evening. Usually, this wind blows for 12 – 14 hours every day. This is the typical wind pattern observed in Belem during this dry season although there are several exceptional cases of exceptional winds. Also, several short-term wavelength fluctuation patterns (T = 3 – 4 hours) are recognized within each daily wind pattern, and these might be caused by meso-scale climatological conditions such as the occurrence of torrential rain. It is recommended to collect more regional meteorological data sets for more detailed meteorological study such as a correlation study between wind and rainfall patterns.



Note: 0 degree: north, 90: east, 180: south, 270: west.

Figure 6.4-1 Wind Pattern (Direction, June 24, 2002)

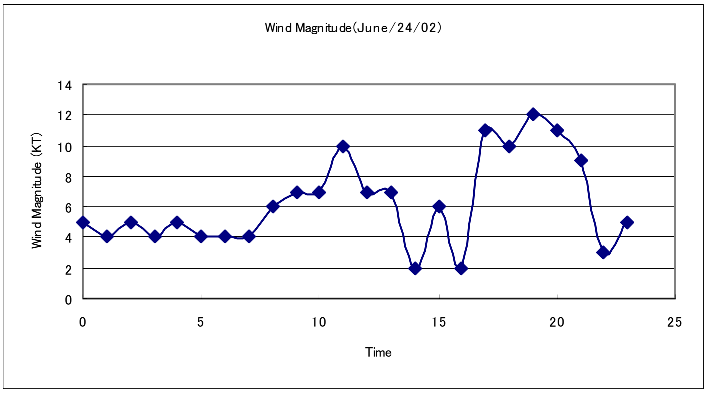
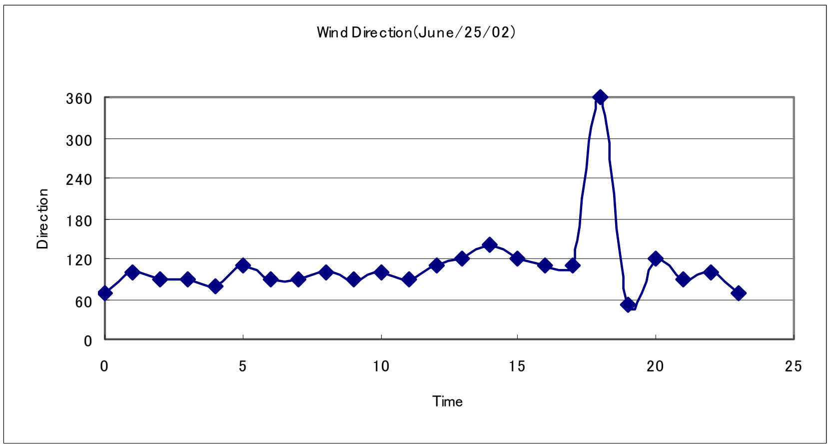


Figure 6.4-2 Wind Pattern (Magnitude (KT), June 24, 2002)



Note: 0 degree: north, 90: east, 180: south, 270: west.

Figure 6.4-3 Wind Pattern (Direction, June 25, 2002)

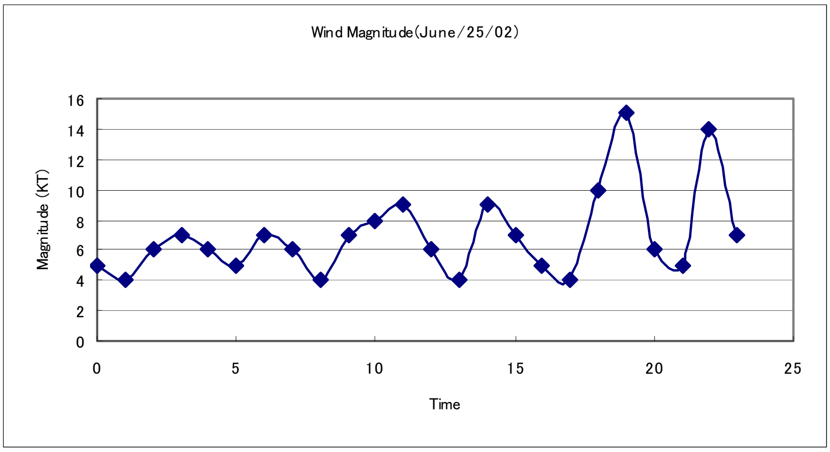
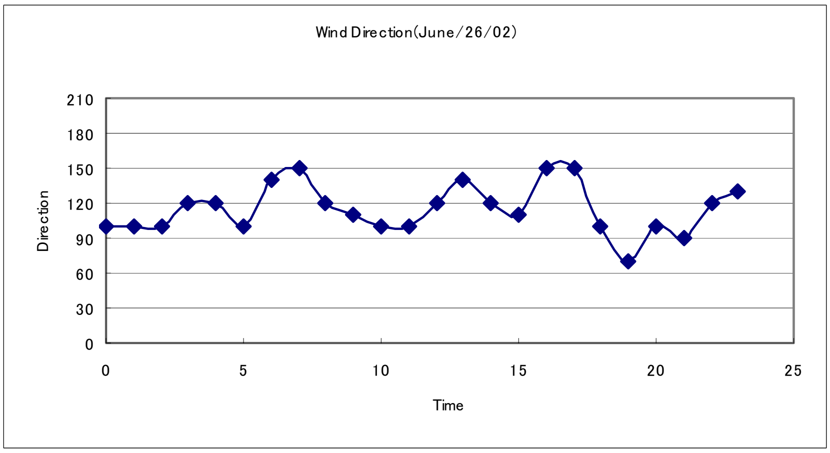


Figure 6.4-4 Wind Pattern (Magnitude (KT), June 25, 2002)



Note: 0 degree: north, 90: east, 180: south, 270: west.

Figure 6.4-5 Wind Pattern (Direction, June 26, 2002)

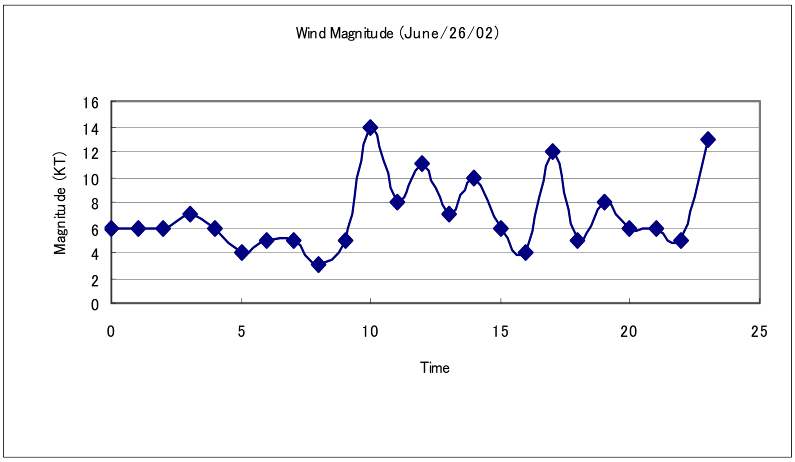
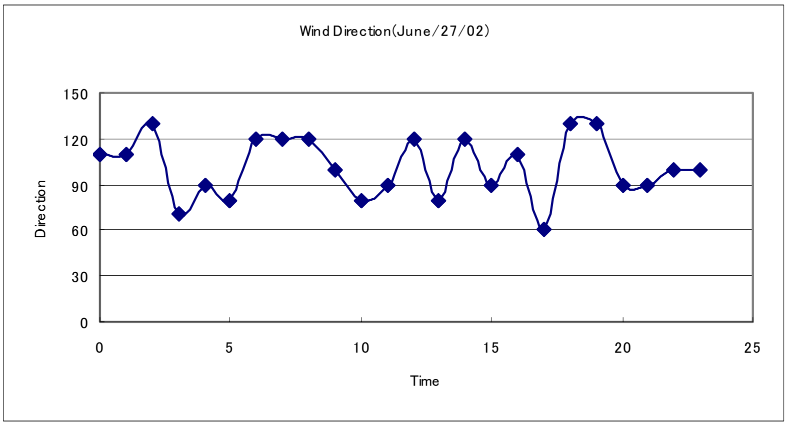


Figure 6.4-6 Wind Pattern (Magnitude (KT), June 26, 2002



Note: 0 degree: north, 90: east, 180: south, 270: west.

Figure 6.4-7 Wind Pattern (Direction, June 27, 2002)

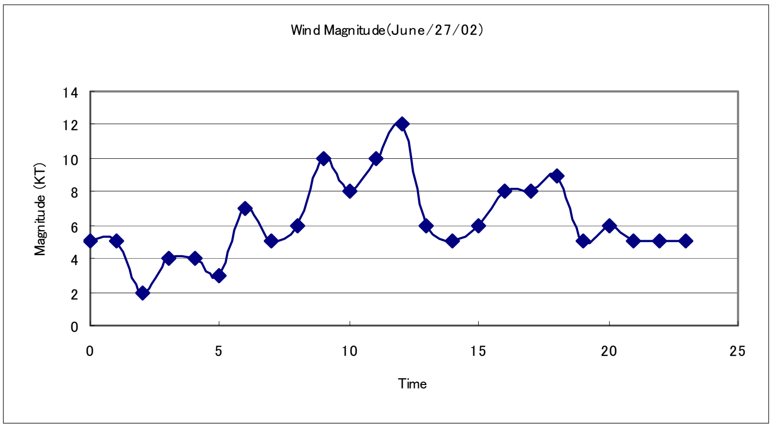


Figure 6.4-8 Wind Pattern (Magnitude (KT), June 27, 2002

6.4.3. RESULTS AND DISCUSSIONS

(1) PM-10

Figure 6.4-9 and Figure 6.4-10 show 24-hour-averaged measured PM-10 concentration values at each sampling point. As shown in these figures, all measured values (maximum measured value = 65.1 $\mu g/m^3$) are below the current air quality standard (1-day-averaged standard = 150 $\mu g/m^3$). Throughout this survey, relatively large PM-10 values are detected along the heavily trafficked roads such as Points 4 of Rodovia BR-316, 5 of Nazare, 7 of Avenida. Almirante Barroso (Sao Braz), 9 of Avenida. Almirante Barroso (Bosque) and 10 (Rodovia Augusto Montenegro). So, it can be said that there is a strong correlation between the current traffic condition and the spatial variation of PM-10 concentration.

(2) CO

Figure 6.4-11 – Figure 6.4-14 shows the temporary variation of measured CO concentration values at three sampling points. All figures displaying a time variation pattern at all ten points are attached in Appendix-A. From these figures, it can be seen that all measured CO values are below the current air quality standard (1-hour-averaged standard = 35 ppm). Throughout this survey, relatively large CO values were detected along the heavily traffic roads running through relatively crowded residential area such as Points 5 (Avenida. Nazare), 6 (Rua Gama Abreu), 7 (Avenida. Almirante Barroso), 8 (Rua Joao Balbi), and 9 (Avenida. Almirante Barroso). Most of measured CO values tended to decrease during the night-time and reach the lowest values around the early morning. Then, they start to increase from 4:00 to 6:00 in the morning. After that, CO concentrations increase gradually during the morning, and reach peak values around midday. After reaching a midday peak, CO concentrations decrease gradually, sometimes increasing again, and then reach their evening peak from 6:00 to 8:00 p.m. Basically, several peaks are found within this survey result (maximum measured peak value = 2.4 ppm), and this fluctuation pattern may be due to the current transport mode around the sampling points (e.g., each concentration peak seems to correspond to the current transport peaks such as morning, noon and evening, respectively).

Short-term wavelength fluctuation pattern (T = 3 – 4 hours), discussed in the wind data previously, is recognized within several results, and this implies that there is a correlation between daily roadside air quality variation and wind blowing pattern.

Figure 6.4-11 shows the CO concentration variation measured at Utinga. As shown in this figure, measured CO concentration values are very low compared with results measured at other sites and no peaks that are recognized at other roadside survey sites can be found.

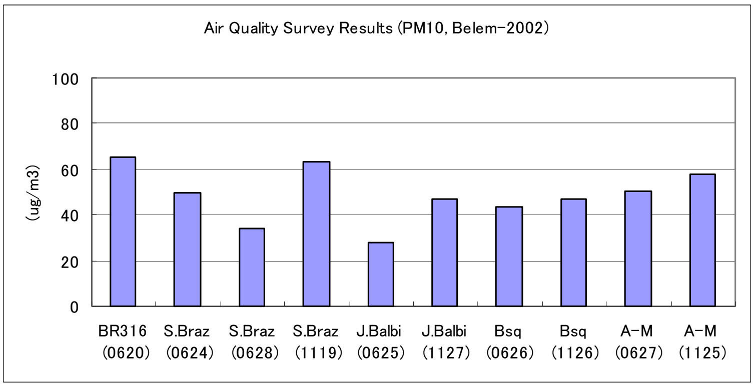
(3) NO_2

Figure 6.4-15 to Figure 6.4-18 shows the temporary variation of measured NO_2 values at four sampling points. All figures displaying time variation pattern at all ten points are attached in the Appendix-A. From these figures, it can be seen that all measured NO_2 values are below the current air quality standard (primary 1-hour-averaged standard = 320 $\mu g/m^3$). Throughout this survey, relatively large NO_2 values were detected along the heavily traffic roads within relatively crowded residential areas such as Points 4 (Rodovia BR-316), 6 (Rua Gama Abreu), 7 (Avenida. Almirante Barroso), 8 (Rua Joao Balbi), 9 (Avenida. Almirante Barroso) and 10 (Rodovia Augusto Montenegro). Also, a similar diurnal fluctuation pattern observed in measured CO values discussed previously can be observed within this NO_2 measurement. NO_2 concentration starts to increase from 4:00 to 6:00 a.m. and reaches those peak values around mid-morning (maximum measured peak value = 246.8 μg/m^3). Also, there seem to be three peaks that may correspond to the current traffic mode (morning, afternoon and evening peaks, respectively). Similarly, a short-term wavelength fluctuation pattern (T = 3 – 4 hours), discussed previously, is also recognized within several results.

Figure 6.4-15 shows the NO_2 concentration variation measured at Utinga. As shown in this figure, measured NO_2 concentration values are very low compared with results measured at other sites and no peaks that are recognized at other roadside survey sites can be found, although a minor peak around early morning is recognized.

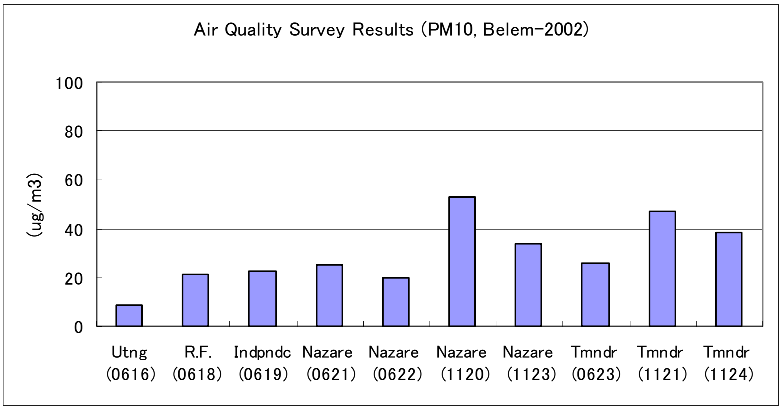
(4) SO_2

Figure 6.4-19 and Figure 6.4-20 show 24-hour-averaged measured SO_2 concentration at each sampling point. As shown in these figures, all measured values (maximum measured value = 31.1 μg/m^3) are far below the current air quality standard (1 day-averaged standard = 365 μg/m^3). Since the current atmospheric SO_2 concentration across the city is quite low and hydro-desulfurized fuel is already marketed, it was quite rare to detect large a SO_2 concentration within this study (minimum range of SO_2 monitoring equipment used within this study is of 6.9 ug/m^3). Also, it can be found that four survey results show several values that are drawn by the blue-colored bar although those values are far below the current air quality standard.



Note: Figures in the parentheses indicate the survey date

Figure 6.4-9 Roadside A/Q Survey (PM 10, June & December 2002), Part 1



Note: Figures in the parentheses indicates the survey date

Figure 6.4-10 Roadside A/Q Survey (PM 10, June & December 2002), Part 2

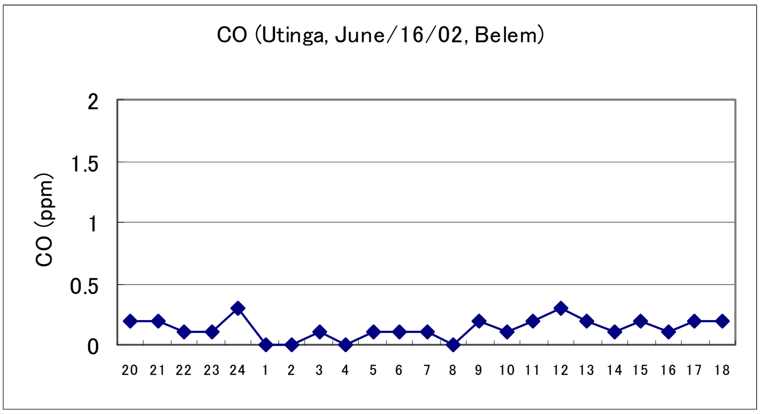


Figure 6.4-11 Roadside A/Q Survey Results (CO, Utinga, June 16, 2002)

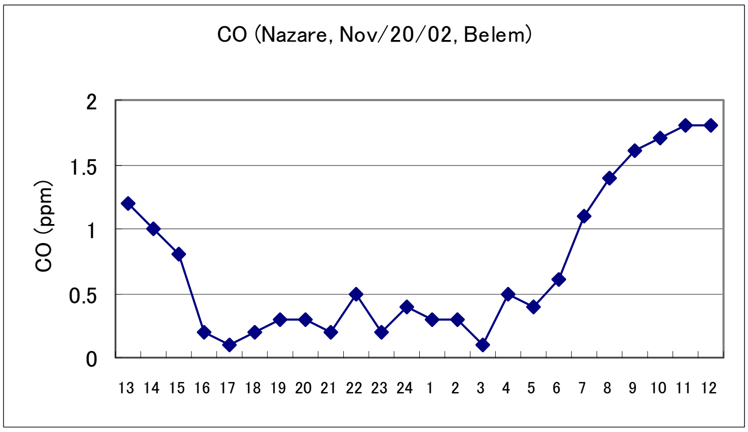


Figure 6.4-12 Roadside A/Q Survey Results (CO, Nazare, Nov. 20,, 2002)

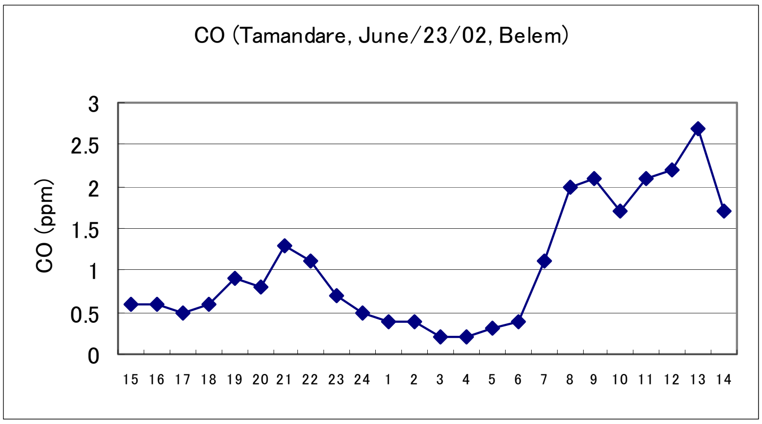


Figure 6.4-13 Roadside A/Q Survey Results (CO, Tamandare, June 23, 2002)

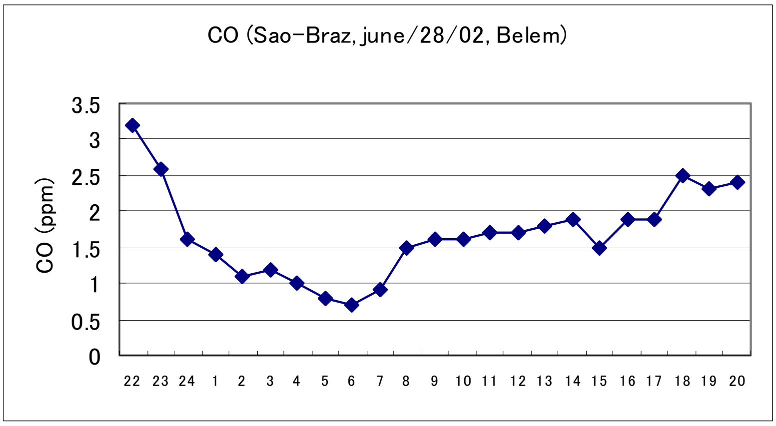


Figure 6.4-14 Roadside A/Q Survey Results (CO, Sao-Braz, June 28, 2002)

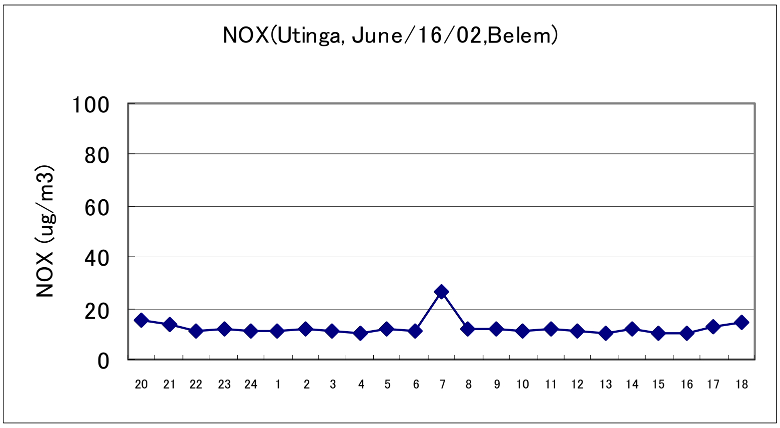


Figure 6.4-15 Roadside A/Q Survey Results (NOX, Utinga, June 16, 2002)

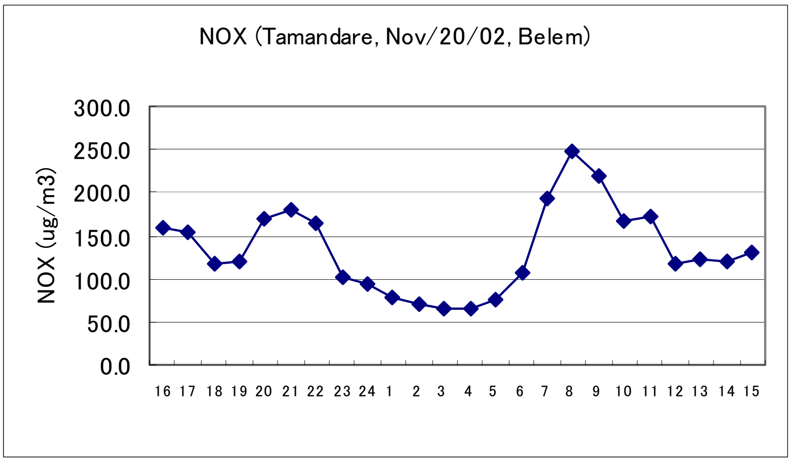


Figure 6.4-16 Roadside A/Q Survey Results (NOX, Tamandare, Nov. 20, 2002)

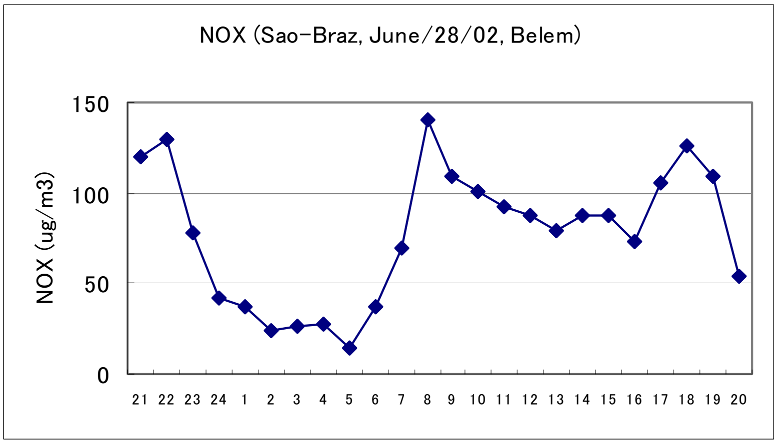


Figure 6.4-17 Roadside A/Q Survey Results (NOX, Sao-Braz, June 28, 2002)

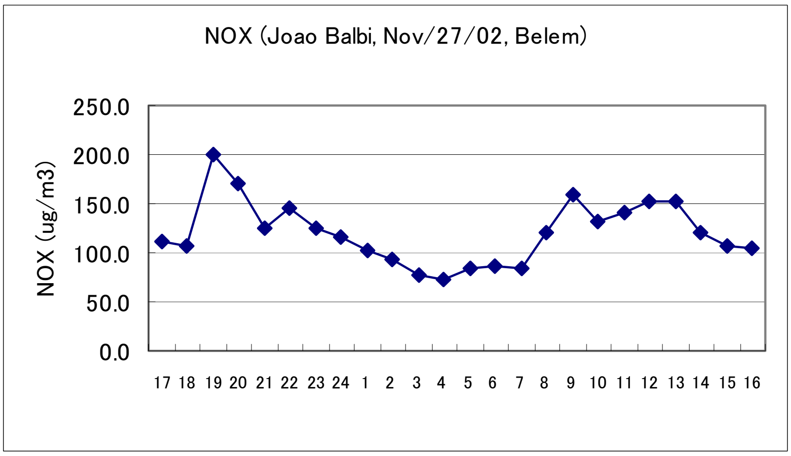
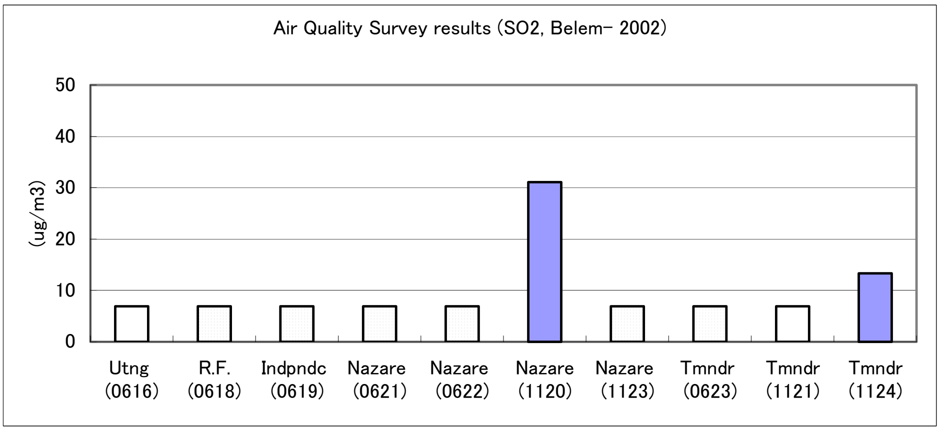
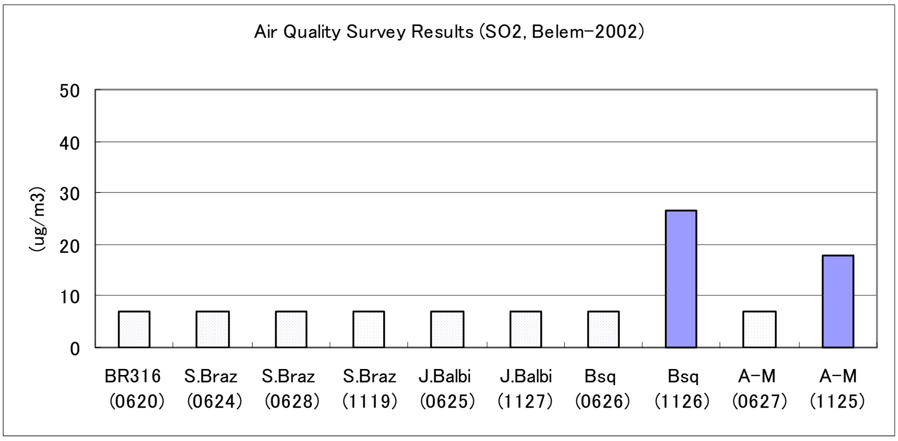


Figure 6.4-18 Roadside A/Q Survey Results (NOX, Joao Balbi, Nov. 27, 2002)



Note: Figures in the parentheses indicate the survey date. White-bars indicate measured concentration is less than 6.9 ug/m3, the minimum monitoring range of this survey equipment.

Figure 6.4-19 Roadside A/Q Survey (SO_2, June &December 2002), Part 1



Note: Figures in parentheses indicate the survey date. White-bars indicate measured concentration is less than 6.9 ug/m3, the minimum monitoring range of this survey equipment.

Figure 6.4-20 Roadside A/Q Survey (SO_2, June &December 2002), Part 2

6.5. ROADSIDE NOISE SURVEY

6.5.1. OUTLINE OF FIELD SURVEY

To investigate the current roadside noise condition of Belem City, the roadside noise survey was conducted by the Study Team. Within this measurement, the noise parameter, Leq, is of concern. Based on the current traffic condition of Belem City, ten points were chosen for this measurement. Among of them, nine points were used for the 24-hour continuous roadside noise measurement while the remaining one for background. Table 6.5-1 and Table 6.5-2 summarize the outline of this noise measurement

Table 6.5-1 Noise Measurement.

Total number of survey points = 10. Measuring period: June - November 2002	
Parameter	Instrument
Leq	1. Real Time Vibration and Sound Analyzer, Model SVAN 912, SVANTEK 2. Sonorous Level Meter (IEC 60651, IEC60804) 3. Spectrum Analyzer (IEC 225) 4. Microphone (IEC 61094-1, IEC 61094-3, IEC 61094-4) 5. Calibrator/Acoustic Reference – NORSONIC A/S Model 1251

Table 6.5-2 Measurement Point Location (Noise)

Site #	Location (approx)
1	Parque Bolonha – Utinga
2	Rua Primeiro de Dezembro (Rua do Fio)
3	*Avenida. Transmangueirao (Conjunto Catalina)*
4	*Rodovia BR 316 x Rua Caixa Para 2*
5	*Avenida. Nazare (Praca)*
6	*Rua Gama Abreu x Rua Padre Prudencio(Tamandare)*
7	*Avenida. Almirante Barroso x Travessa Mercedes (Sao-Braz)*
8	*Rua Joao Balbi x Avenida. Visconde Souza Franco*
9	*Avenida. Almirante Barroso em frente ao Bosque*
10	*Rodovia Augusto Montenegro*

Note: The site number of each survey point corresponds to that of air quality and vibration measurements.

6.5.2. RESULTS AND DISCUSSIONS

Figure 6.5-1 and Figure 6.5-4 show the time variation of the Leq values at four points. All figures displaying time variation of Leq measured at all ten points are attached in the Appendix-A. From these figures, it can be seen that Leq values measured at all roadside points vary between 40 and 80 dBA. Leq measured at Utinga, where no noise impact from the traffic conditions is expected to exist (used for the background measurement) is always around 45 dBA (see Figure 6.5-1) although several peaks that reach 60－65 dB are recognized. Upon considering the surrounding environment of the Utinga site, these peaks do not seem to be of traffic origin but those to be caused by animal activities within this environmental reserve.

The difference in measured Leq values between all roadside points and Utinga may be caused by the roadside human activities and traffic conditions around all roadside measurement points. Also, a strong daily fluctuation pattern that would correspond to the traffic flow pattern is recognized within the survey results of all roadside points. Mainly, most roadside Leq variation patterns seem to have three peaks that would correspond to traffic peaks (i.e., morning, noon and evening), and tend to subdue to around 40 – 60 dBA during the nighttime. A similar tendency is also recognized within the survey results of roadside vibration and air quality measurements.

In Brazil, the daytime noise standards (7:00 – 22:00) for the commercial/mixed and residential zones are 60 and 55 dBA, respectively, and most Leq measured at all roadside points exceeds those standards. So, it can be said that the current daytime roadside environment is noisy and might cause some disruptions in human health such as hearing changes or loss, interference with speech communication and/or annoyance. By the same token, nocturnal noise standards (22:00 – 7:00) for the commercial/mixed and residential zones are 55 and 50 dBA, respectively. Similarly, most nocturnal Leq measured at all roadside points exceeds those standards, so it can be said that the current nocturnal roadside noise environment is not good either.

Table 6.5-3 summarizes the Day-Night Average Sound Level, Ldn, computed at all points. From this table, it can be seen that most Ldn values are higher than 60 dBA, and sometime exceed 70 dBA at several points along heavily trafficked roads. Using the noise zone classification criteria summarized in Table 6.5-4, the current roadside noise condition of Belem City can be classified as either “significant exposure” or “severe exposure”-level. Note that Ldn values along Almirante Barroso (i.e., Sao-Braz and Bosque) are the worst, whereas Ldn of Utinga is the lowest within this survey. These classification results also support the previous discussions in that the current roadside environment in Belem City is noisy and maybe harmful to human health. Figure 6.5-5 and Figure 6.5-6 show major survey results summarized in Table 6.5-3.

Table 6.5-3 Roadside Noise Survey Results

	Location	Date	Ld (dBA)	Ln (dBA)	Ldn (dBA)
1	Nazare	Nov/18	72.26	68.81	75.92
		Nov/19	71.91	68.72	75.76
		Nov/24	70.19	67.05	74.07
2	Tamandare	June/24	74.9	66.6	75.6
		Nov/23	71.71	67.09	74.54
		Nov/27	72.45	67.98	75.38
3	Joao Balbi	Nov/19	75.38	67.21	76.16
		Nov/20	75.15	72.62	79.79
4	Rodovia Augusto Montenegro	June 28	74.4	70.4	77.7
		Nov. 26	71.71	66.70	74.28
5	BR316	June 21	72.1	67.1	74.7

		Nov. 25	71.85	68.43	75.52
6	Sao Braz	June 27	76.4	73.5	80.4
		Nov. 21	84.89	75.20	85.01
7	Bosque	June 26	72.4	70.3	77.1
		Nov. 29	72.75	68.45	75.80
8	Rua do Fio	Nov. 20	65.43	53.98	64.94
		Nov. 28	62.43	57.40	63.98
9	Independencia	June. 17	68.7	52.5	67.2
		Nov. 21	71.49	62.59	71.94
10	Utinga	Nov. 21	58.13	47.30	57.84

Table 6.5-4 Noise Zone Classifications

	Noise Exposure Class	DNL (dBA)	Leq (hour)	HUD Noise Standard
A	Minimal Exposure	< 55	< 55	Acceptable
B	Moderate Exposure	55 – 65	55 – 65	
C-1	Significant Exposure	65 – 70	65- 70	Normally Acceptable
C-2		70 – 75	70 – 75	
D-1	Severe Exposure	75 – 80	40 – 80	Unacceptable
D-2		80 – 85	80 – 85	
D-3		> 85	. 85	

(Source: Larry W. Canter, 1996)

DNL: Day-Night average sound level, Ldn, defined by following formula:

$Ldn = 10 \log (0.625 (10^{(Ld/10)}) + 0.375 (10^{(Ln+10)/10}))$

Where Ld is the Leq for the daytime (0700 - 2200) and Ln is the Leq for the nighttime (2200 - 0700).

HUD: Department of Housing and Urban Development, USA.

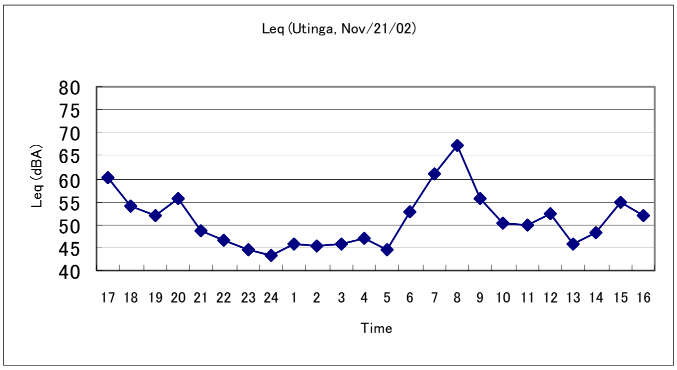


Figure 6.5-1 Noise Measurement Results (Utinga, Nov. 21, 2002)

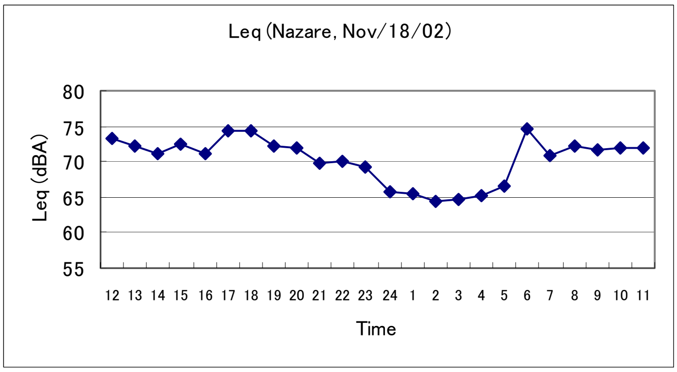


Figure 6.5-2 Noise Measurement Results (Nazare, Nov. 18, 2002)

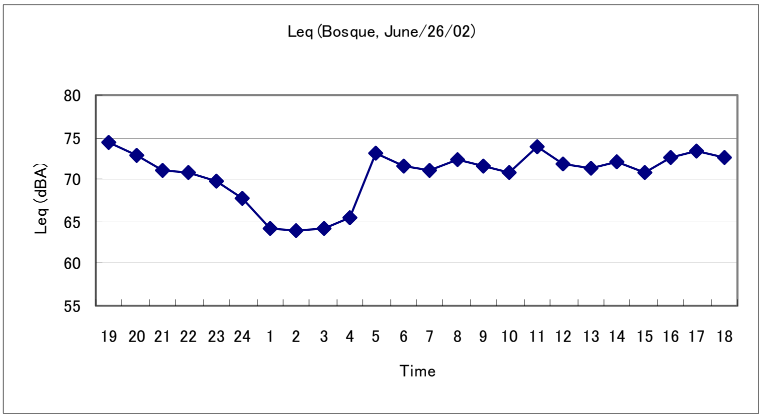


Figure 6.5-3 Noise Measurement Results (Bosque, June 26, 2002)

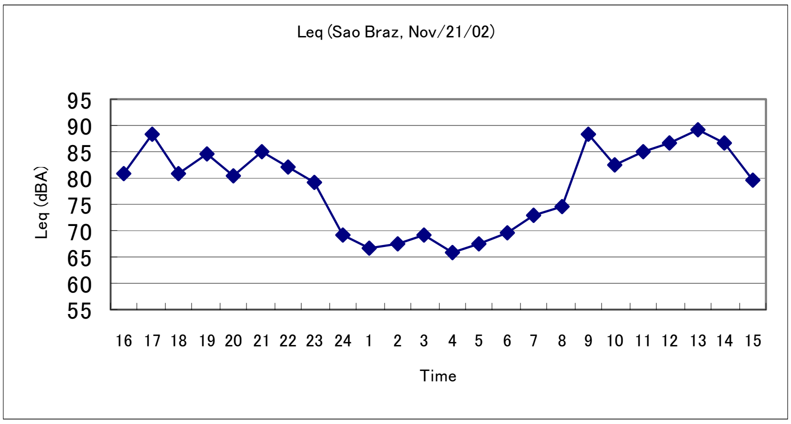
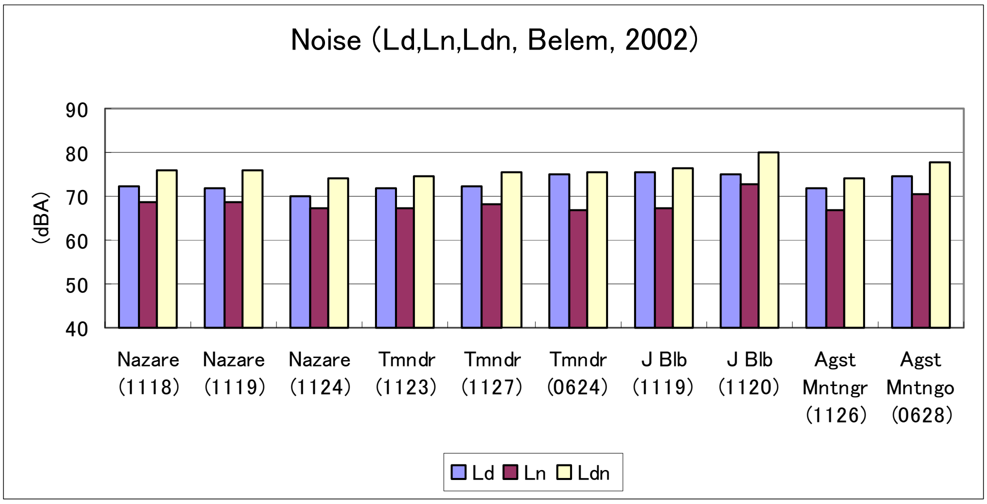
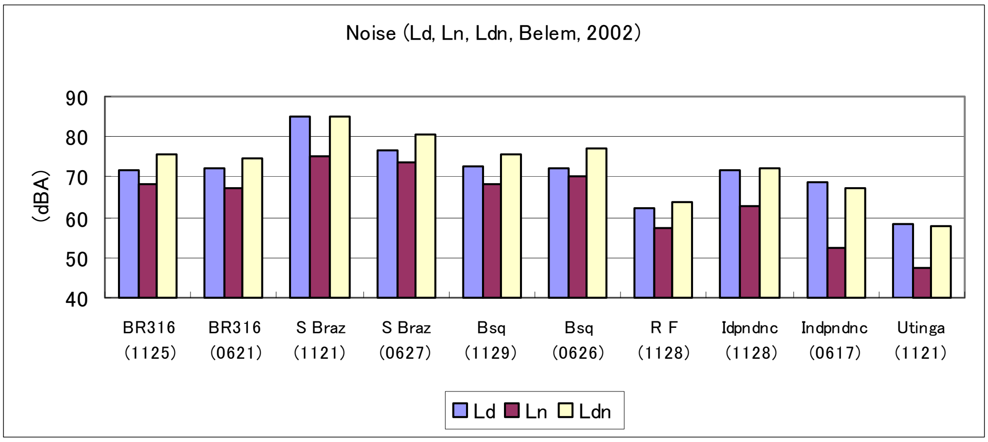


Figure 6.5-4 Noise Measurement Results (Sao Braz, Nov. 21, 2002)



Ld, Ln and Ldn, Belem 2002
Note: Figures in parentheses indicate the survey date.

Figure 6.5-5 Roadside Noise Level (dBA), Part 1



Ld, Ln and Ldn, Belem 2002

Note: Figures in parentheses indicate the survey date.

Figure 6.5-6 Roadside Noise Level (dBA), Part 2

6.6. ROADSIDE VIBRATION SURVEY

6.6.1. OUTLINE OF FIELD SURVEY

To grasp the current roadside vibration condition of Belem City, the roadside vibration survey was carried out by the Study Team. Within this measurement, the following two parameters of vibration acceleration and vibration velocity are of concern. In general, the vibration parameter, L10, is directly measured and used for the quantitative evaluation of the vibration impact. However, due to the technical difficulties and limitations of equipment used within this survey, another parameter, the vibration acceleration level (VAL), is computed instead. All VAL values are computed using those measurement results mentioned earlier. It is empirically known that there is a strong correlation between L10 and VAL, and L10 is somewhat lower than VAL value (6 – 8 dB less, Watanabe, personal communication, 2002).

Based on the current transport situation of Belem City, ten points are chosen for this measurement. Among of them, nine points are used for the 24-hour continuous roadside vibration measurement while the remaining one is for the background. Table 6.6-1 and Table 6.6-2 summarize the outline of this vibration measurement.

Table 6.6-1 Vibration Measurement.

Total number of sampling points = 10. Measuring period: November 2002	
Parameter	Instrument
Vibration Velocity Vibration Acceleration	Real Time Vibration and Sound Analyzer, Model SVAN 912, SVANTEK

Table 6.6-2 Measurement Point Location (Vibration)

Site #	Location (approx)
1	Parque Bolonha – Utinga
2	Rua Primeiro de Dezembro (Rua do Fio)
3	*Avenida. Transmangueirao (Conjunto Catalina)*
4	*Rodovia BR 316 x Rua Caixa Para 2*

5	*Avenida. Nazare (Praca)*
6	*Rua Gama Abreu x Rua Padre Prudencio(Tamandare)*
7	*Avenida. Almirante Barroso x Travessa Mercedes (Sao Braz)*
8	*Rua Joao Balbi x Avenida. Visconde Souza Franco*
9	*Avenida. Almirante Barroso em frente ao Bosque*
10	*Rodovia Augusto Montenegro*

Note: The site number of each survey point corresponds to that of air quality measurement.

6.6.2. Results and Discussions

Figure 6.6-1 - Figure 6.6-4 shows the time variation of the vibration acceleration level (VAL) values at four points. All figures displaying time variation of VAL measured at all ten points are attached in the Appendix-A. As described earlier, all VAL values are computed, using both vibration velocity and acceleration measured at all points.

From these figures, it can be seen that VAL values computed at all roadside points vary between 40 and 80 dB whereas VAL measured at Utinga where no vibration impact from surrounding traffic conditions exists (used for the background measurement) is always around 40 dB (see Figure 6.6-1). This difference in the VAL may be caused by the difference of roadside human activities and traffic condition around the measurement points. Also, strong daily fluctuation pattern that would correspond to traffic flow pattern is recognized. Most of the roadside VAL variation patterns seem to have three peaks that would correspond to traffic peaks (i.e., morning, noon and evening), and tend to be subdued to around 40 dB during the nighttime.

As described earlier, no vibration environmental standard has been introduced in Brazil yet. The permissible daytime (6:00 – 22:00) and nighttime (20:00 – 6:00) vibration standard for residential areas, implemented in Japan, is 65 and 60 dB, respectively. Note these Japanese vibration standards are based on the L10 concept. Here in Belem, most of daytime VAL values are less than 60 dB, so it can be assumed that L10 values at all points would be less than 54 dB or 52 dB, provided that the strong correlation between L10 and VAL, mentioned previously, exists. Thus, it can be said that daytime roadside vibration environment is not so severe.

By the same token, most nighttime VAL values are varied around 40 dB, so it can be said that the nighttime roadside vibration environment is not so significant, either.

Table 6.6-3 summarizes the major vibration parameters obtained from this survey. From this table, it can be seen that all daytime-averaged VAL values are less than 65 dB while all nighttime-averaged VAL values are less than 60 dB. So, based on the vibration standards implemented in Japan, mentioned above, it can be said that both daytime and nighttime vibration environments are not so deteriorated and those impacts on the human activity are small. Figure 6.6-5 and Figure 6.6-7 show major survey results summarized in Table 6.6-3.

Table 6.6-3 Roadside Vibration Survey Results

	Location	Date	Max (dB)	Min (dB)	Daytime (dB)	Nighttime (dB)
1	Nazare	Nov. 18	68.9	42.8	52.6	43.9
		Nov. 19	67.4	42.8	52.3	47.1
		Nov. 24	56.2	42.6	46.9	43.5
2	Tamandare	Nov. 23	45.0	42.6	43.5	42.7
		Nov. 27	45.5	42.5	43.5	42.7
		Nov. 28	52.0	35.0	39.0	45.1
3	Joao Balbi	Nov. 19	62.3	49.7	54.5	50.5

		Nov. 20	69.0	49.3	56.6	49.8
4	Rodovia Augusto Montenegro	Nov. 23	62.4	50.2	54.3	50.8
		Nov. 26	43.7	42.5	43.0	42.6
5	BR316	Nov. 24	64.0	50.2	55.9	51.4
		Nov. 25	56.9	50.5	54.6	51.6
6	Sao Braz	Nov. 22	84.4	30.9	54.3	40.0
		Nov. 26	76.2	50.0	61.0	53.8
7	Bosque	Nov. 25	49.0	42.7	44.3	43.2
		Nov. 29	47.2	42.9	44.6	43.4
8	Rua do Fio	Nov. 20	43.1	42.5	42.6	42.5
		Nov. 28	45.8	42.5	42.8	42.5
9	Independencia	Nov. 18	58.2	49.5	53.7	49.8
		Nov. 27	79.0	49.5	57.4	51.2
10	Utinga	Nov. 21	43.5	42.5	42.9	42.6

Note: Permissible daytime (6:00 – 22:00) and nighttime (20:00 – 6:00) vibration standards for residential areas, implemented in Japan, are 65 and 60 dB, respectively, and those Japanese vibration standards are based on the L10 concept.

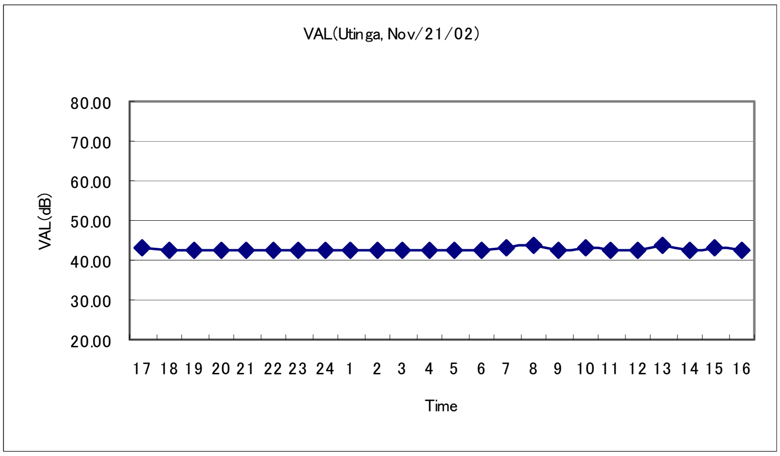


Figure 6.6-1 Vibration Measurement Results (Utinga, Nov. 21, 2002)

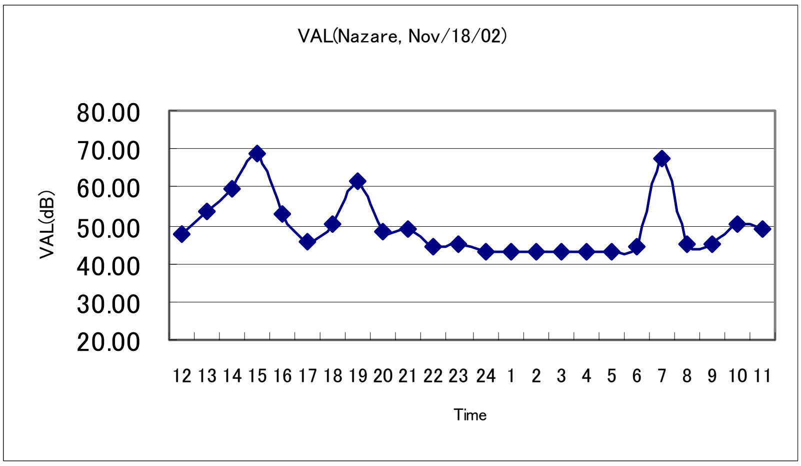


Figure 6.6-2 Vibration Measurement Results (Nazare, Nov. 18, 2002)

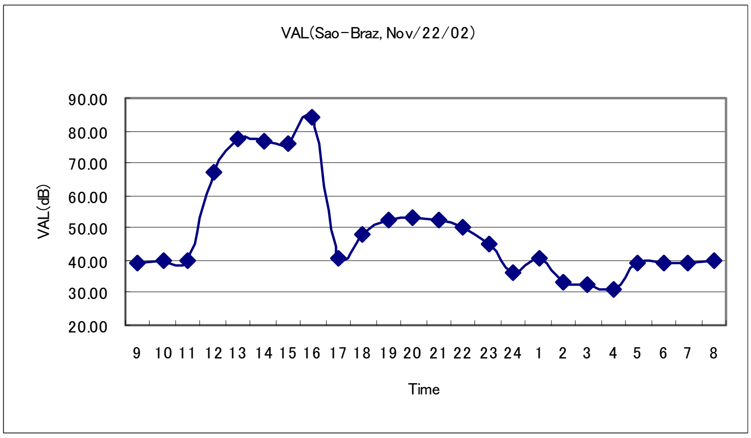


Figure 6.6-3 Vibration Measurement Results (Sao-Braz, Nov. 22 2002)

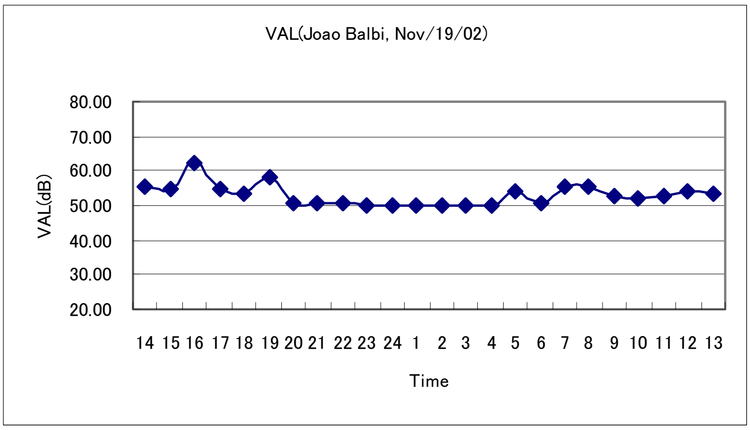
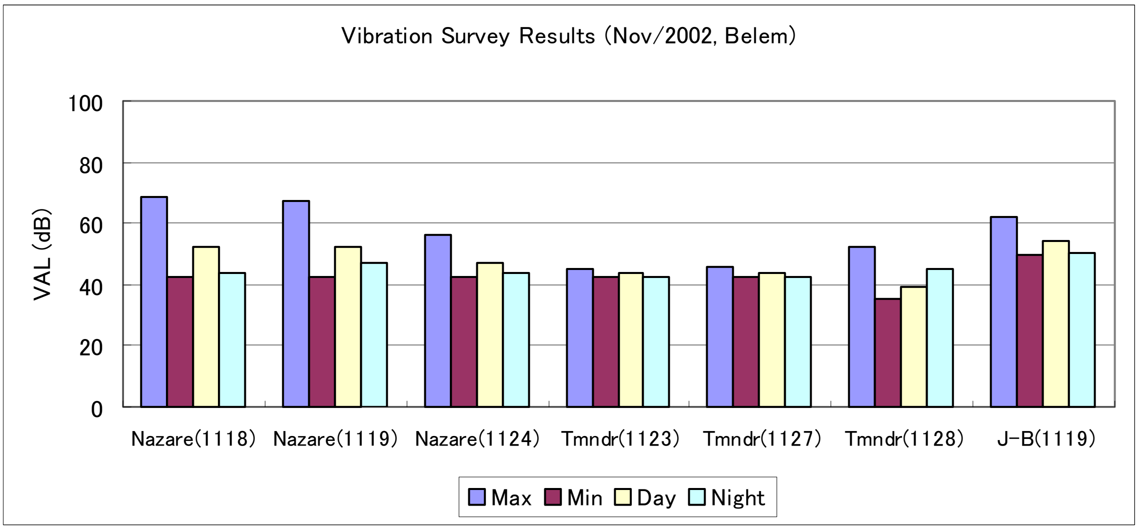
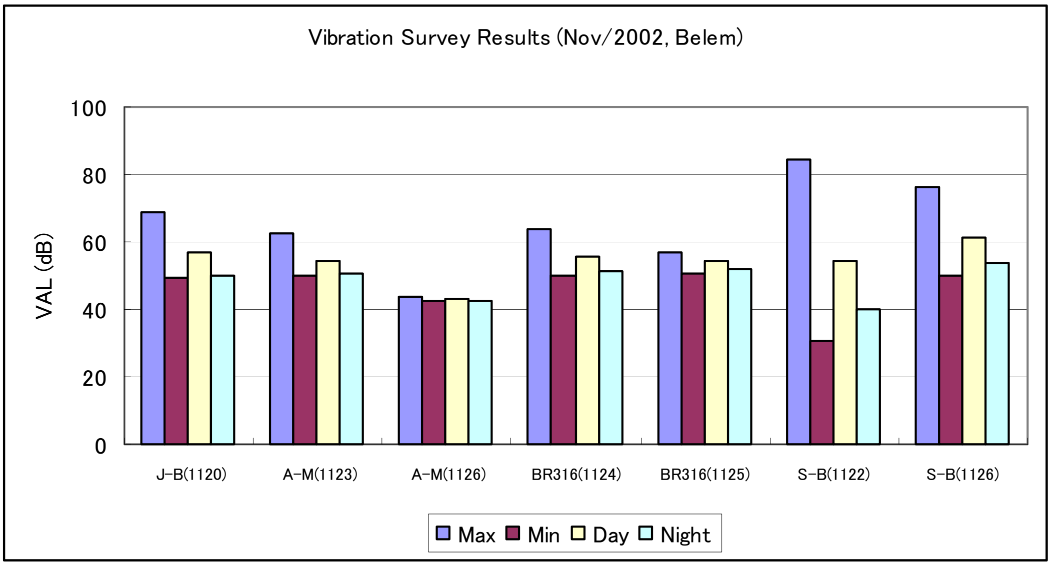


Figure 6.6-4 Vibration Measurement Results (Joao Balbi, Nov. 19, 2002)



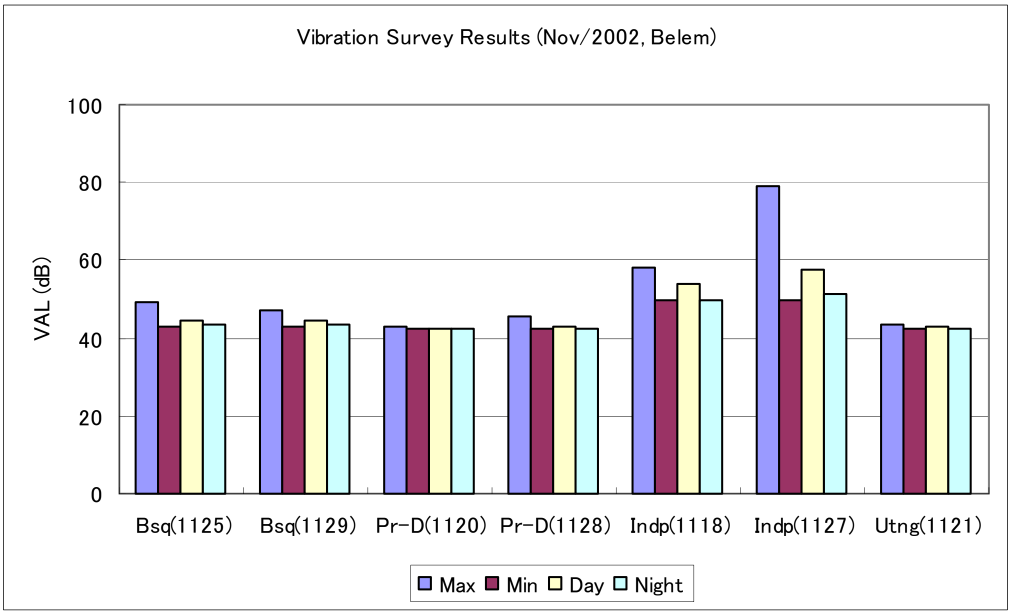
Note: Figures in the parentheses indicate the survey date.

Figure 6.6-5 Daytime/Nighttime averaged VAL (part 1)



Note: Figures in the parentheses indicate the survey date.

Figure 6.6-6 Daytime/Nighttime Averaged VAL (part 2)



Note: Figures in the parentheses indicate the survey date.

Figure 6.6-7 Daytime/Nighttime Averaged VAL (part 3)

6.7. WATER QUALITY SURVEY

6.7.1. OUTLINE OF FIELD SURVEY

In order to grasp the current water quality condition around the study area, the field measurement of the water quality was carried out by Study Team. Within this measurement, the following eight parameters are of concern: coli-form, turbidity, grease, BOD, COD, pH, conductivity and DO.

Upon considering the current transport situation of the study area, about 30 points that represent major characteristics of the public transport—the bus route, land use, and topographical condition—were selected initially. Then, based on results of several field observations and interviews with local residents, twenty-one points were chosen as sampling points for these measurements. Among of them, eleven points were used for surface water quality measurement (i.e., sup01 - sup11, see Table 6.7-2) and ten for the groundwater (i.e., sub01 - sub10, see Table 6.7-2). Actual measurements were carried out twice within this study (the first measurement in August and the second in December). Table 6.7-1 and Table 6.7-2 summarize the outline of this water quality measurement. Each measurement location is shown in Figure 6.7-1.

Table 6.7-1 Water Quality Measurement.

Total number of sampling points = 21. Measuring period: 1st measurement: August – September 2 2nd measurement: December 2	
Parameter	Coli-form, Turbidity, Grease, BOD, COD, pH, Conductivity and DO
Lab	Analyzed at SECTAM Water Quality Laboratory

Table 6.7-2 Measurement/or Sampling Point Location

Site #	Location (approx.)	Location (approx.)
Surface Water (**Sup**)		Subsurface water (**Sub**)
1	Corrego	Poco Amazonas
2	Esgoto	Poco Amazonas
3	Igarape Pato Macho Mare Baixa	Poco Artesiano
4	Igarape das Toras entre Rua Jerusalem e Dom Bosco	Poco Artesiano Terminal Tod.
5	Canal Sao Joaquim	Poco Amazonas
6	Canal Agua Cristal	Poco Amazonas Rua Sao Bento
7	Captacao Rio Guama	Poco Amazonas
8	Lago Bolonha	Poco Artesiano Lava Jato
9	Canal do Bengui	Poco Artesiano Rua Barato do Triunfo
10	Igarape das Toras Final da Rua 02 Junho	Poco Amazonas
11	Na foz do Igarape Burrinho	******

Note: "**Sup**" is used for the surface water-sampling site ID while "**Sub**" for subsurface water.

6.7.2. RESULTS AND DISCUSSIONS

(1) Surface Water (Dry Season)

Figure 6.7-2 through Figure 6.7-6 show laboratory results of the surface water quality obtained from the first measurement (dry season). From these figures, it was found that most measured water quality parameters indicate relatively high values. So, it can be said that water quality at all sampling points are not in good condition. In particular, water quality of Point 2 is the worst within this survey. Point 2 is located at the small creek that runs into Lake Bolonha, the main water reservoirs for Belem Metropolitan Area (APA Belem). Several illegal squatter communities that do not have proper sewage systems exist within the watershed of APA Belem, so it is likely that household effluents are discharged into this creek directly without any treatment. Point 1 is at the upstream side of Point 2 along the same creek and its water quality is not so bad as that of Point 2. This may indicate that the loading of the household effluent generated between the two points causes considerable water quality degradation and, consequently shows in the deteriorated water quality condition at Point 2, the downstream side of this creek.

Water samples of Points 7 and 8 are taken from Lake Agua Preta and Lake Bolonha, respectively. Generally, the water pumped up from the Guama River is dischraged into Lake Agua Preta first, and conveyed to Lake Bolonha via the water channel that connects both lakes, while several tributaries discharge run-off water flows that may contain untreated household effluents from the current watershed area of APA Belem. Both survey results show that the water quality condition at Point 8 is worse than that of Point 7. Point 7 is located at the outlet of the diversion channel originating from the Guama River. So, it can be assumed that the water body around this point is less contaminated than household effluents discharged from the entire watershed area of APA Belem. On the other hand, Point 8 is located near the water intake point of the water supply station at Lake Bolonha, so it is highly likely that the complete mixing of household effluents with the diverted water mass is completed by around Point 8. Thus, it can be said this water quality degradation between the two points is mainly due to the pollutant loading by contaminated flows of all tributaries running into both lakes.

Water samples of Points 5, 6 and 9 are taken from Canal Sao Joaquim, Canal Agua Cristal and Canal Bengui, respectively, and all points are located within same watershed area. Note that Point 5 is located at the most downstream side within this watershed while Points 6 and 9 are at upstream sides. Compared with water quality results of APA Belem discussed previously, the water quality of this watershed area that covers Points 5, 6 and 9 is in a relatively better condition, although not suitable for drinking. Especially, the tributary where Point 9 is located shows a relatively high Coli-form value. By the same token, some watershed area around Point 9 does not have a proper sewage system and the household effluent discharged from surrounding community may cause this severe water quality deterioration around this point.

(2) Subsurface water (Dry Season)

Figure 6.7-7 through Figure 6.7-11 show laboratory results of sub-surface water quality of the first measurement (dry season). Compared with the water quality condition of the surface water, pH values of entire samples are somewhat lower than those of surface water. In addition, all BOD, COD and Coli-form values are considerably low.

Among of them, the water quality of Points 2 and 8 (Coli-form value is relatively high while DO value is low) and is worse than others, and this water quality deterioration might be caused by the untreated discharge of the household effluents.

Point 5, located near the project route of Avenida Primeiro de Dezembro, shows relatively high values of grease and turbidity. Many shallow wells are found within low-income residential zones such as the area along the current Avenida Primeiro de Dezembro and/or Rua Rodolfo Chermont, and most of them do not have an appropriate well-protection system, so those wells are highly prone to house-effluent-origin contamination.

(3) Surface Water (Rain Season)

Figure 6.7-12 through Figure 6.7-16 show laboratory results of the surface water quality obtained from the second measurement (rain season). Compared with dry-season results, there seems to be no significant change in the entire water quality condition. Especially, the water quality around Points 2, 5, 6 and 9 still remains in relatively bad condition, as recognized in the dry season. It should be noted that all of BOD, COD and grease are increased.

The effect of non-point contaminant loading from the watershed area of APA Belem, discussed earlier, is also recognized from the comparison of measurement results of Points 7 and 8 [e.g., BOD and COD values of Points 7 and 8]. It is noted that slight decreases in measurement results of the following two parameters, such as grease and turbidity, between Points 7 and 8, that did not exist in the dry-season's measurement results, are recognized this time. This indicates the water directly diverted (i.e., pumped) from the Guama River might be diluted by relatively less-contaminated run-off water discharged from the watershed of APA Belem. It is recommended to carry out a more detailed hydrological study around APA Belem as well as continuous water quality monitoring work further.

(4) Subsurface water (Rain Season)

Figure 6.7-17 through Figure 6.7-21 show laboratory results of sub-surface water quality of the second measurement (rainy season). Compared with dry-season results, there seems to be no significant change in the entire water quality condition (except COD and turbidity), and the water quality at Point 5 still remains in relatively bad condition, as recognized in the dry-season's results. Note that COD values at all sampling points are reduced considerably. Grease was newly detected at Point 1 and 3 while it was increased at Point 10. Turbidity values are increased at all sampling points (except Point 1 and 8). Significant Coli-form values were detected at Points 5, 6 and 7, whereas they decreased considerably at both Points 8 and 10 where high Coli-form values were detected in the first measurement. Upon considering the well conditions of each sampling site, it is difficult to conclude whether these are accidental (i.e., temporary) or not, and it is recommended to continually monitor water quality for the verification

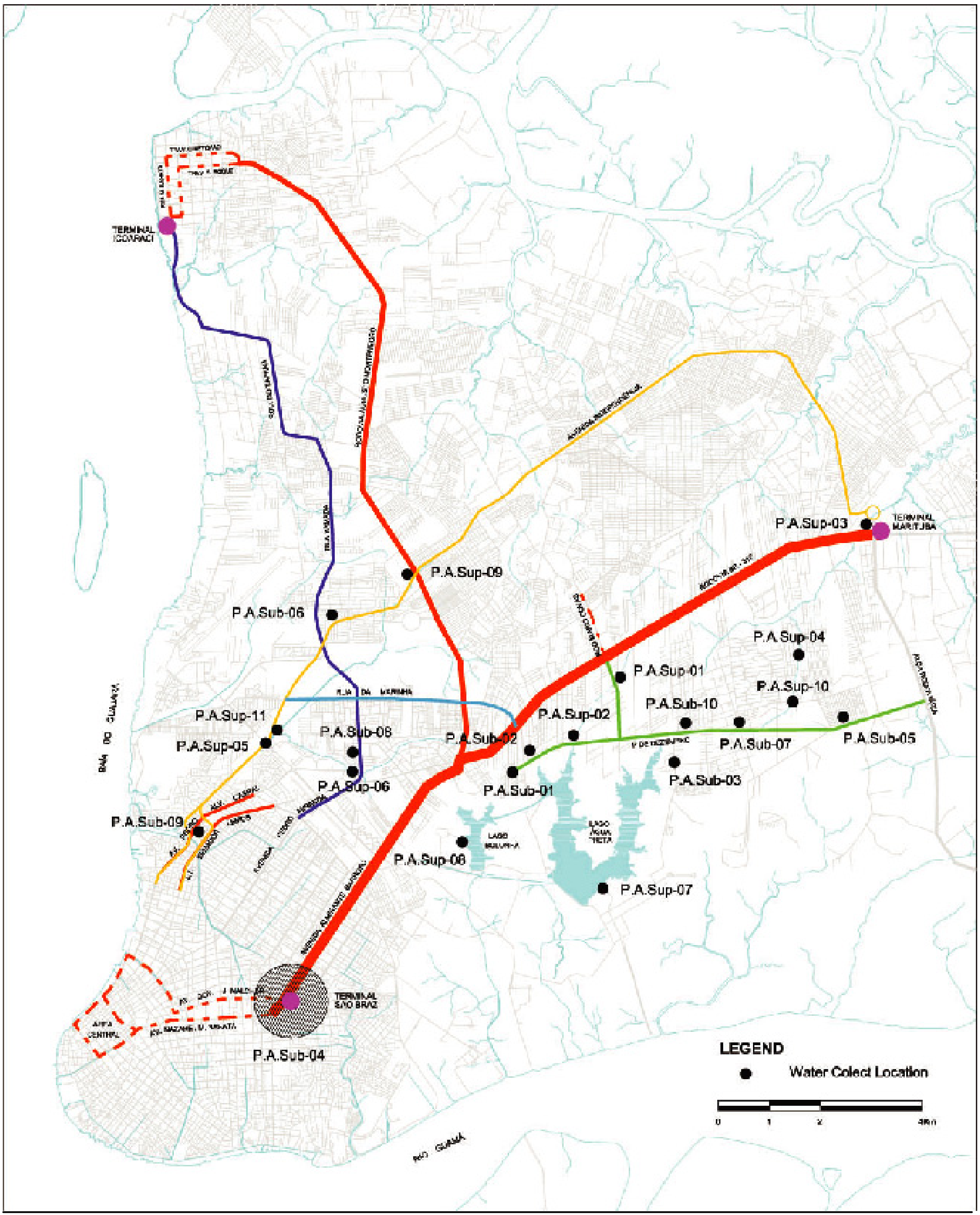


Figure 6.7-1 Water Sampling Locations

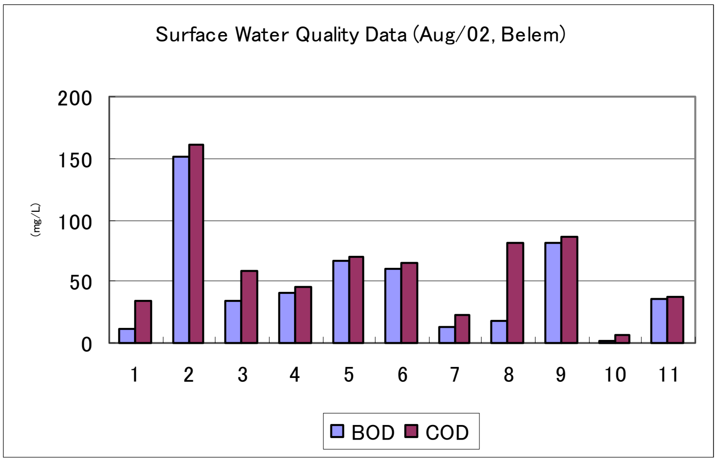


Figure 6.7-2 Water Quality Results (Surface Water, BOD and COD, August 2002)

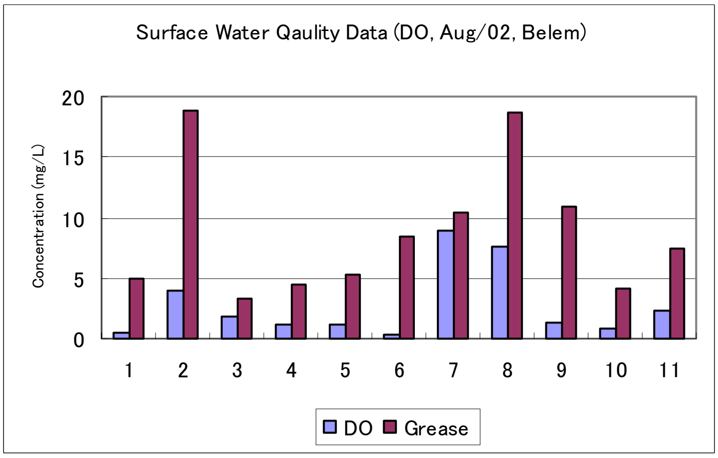


Figure 6.7-3 Water Quality Results (Surface Water, DO and Grease, August 2002)

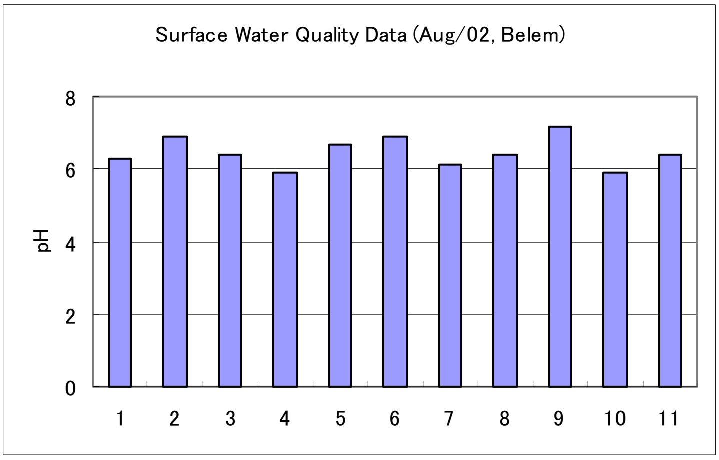


Figure 6.7-4 Water Quality Results (Surface Water, pH, August 2002)

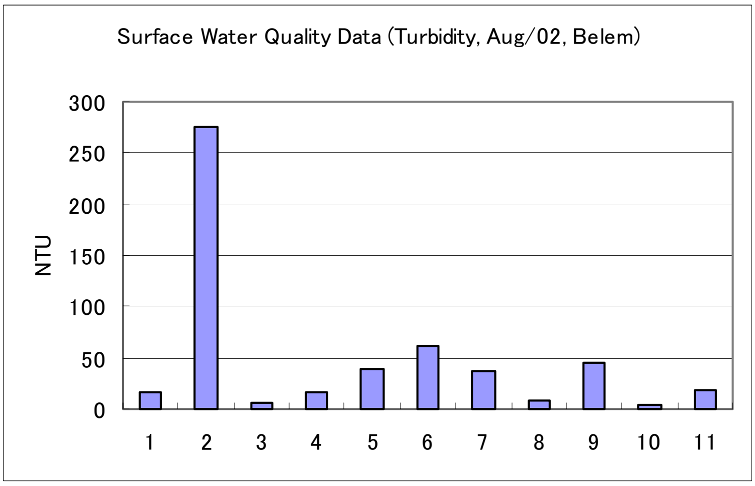


Figure 6.7-5 Water Quality Results (Surface Water, Turbidity, August 2002)

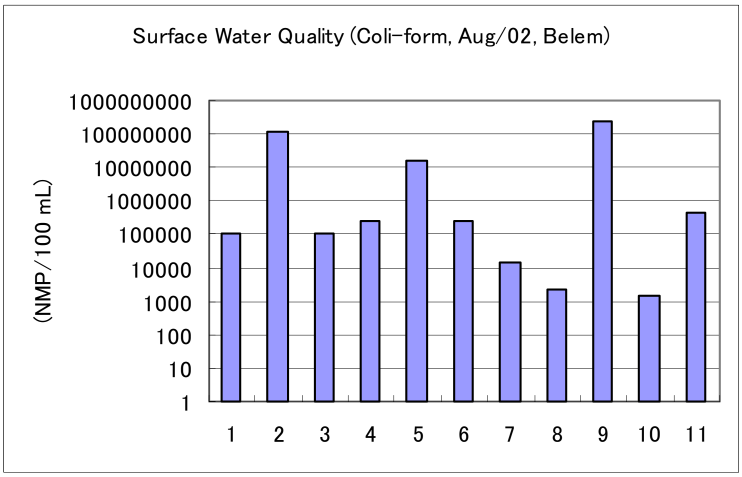


Figure 6.7-6 Water Quality Results (Surface Water, Total Coli-form, August 2002)

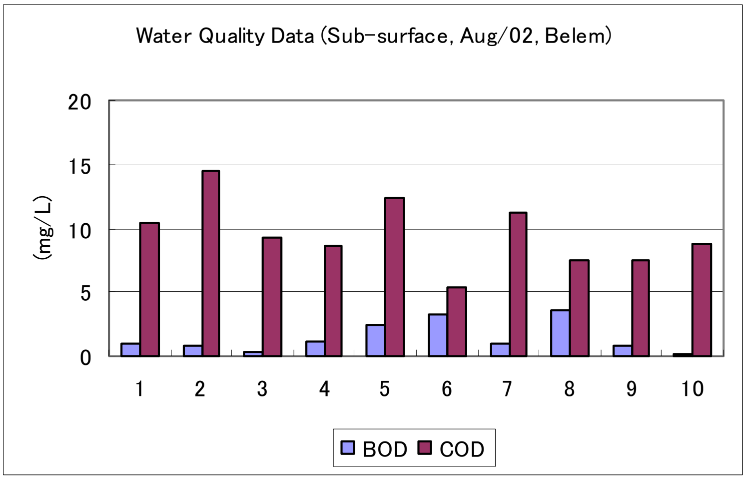


Figure 6.7-7 Water Quality Results (Sub-surface Water, BOD and COD, August 2002)

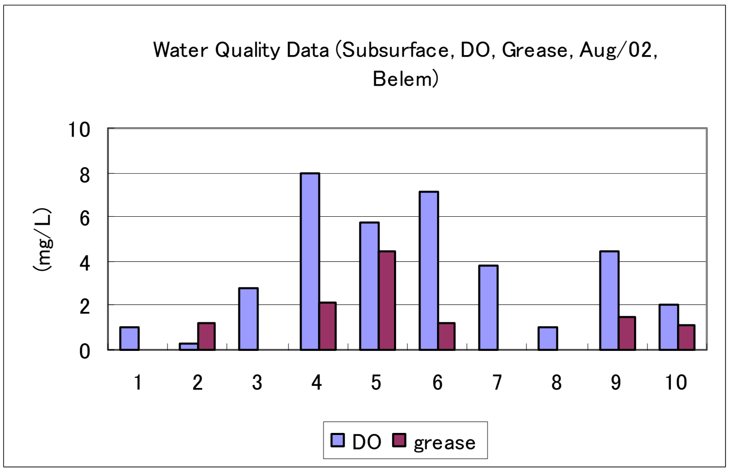


Figure 6.7-8 Water Quality Results (Sub-surface Water, DO and Grease, August 2002)

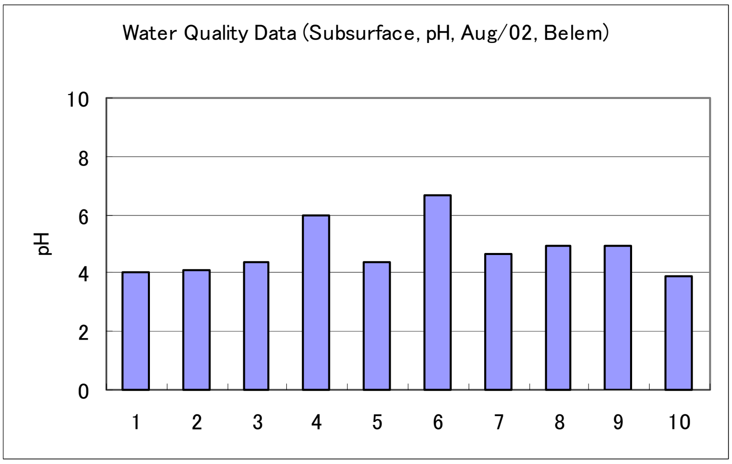


Figure 6.7-9 Water Quality Results (Sub-surface Water, pH, August 2002)

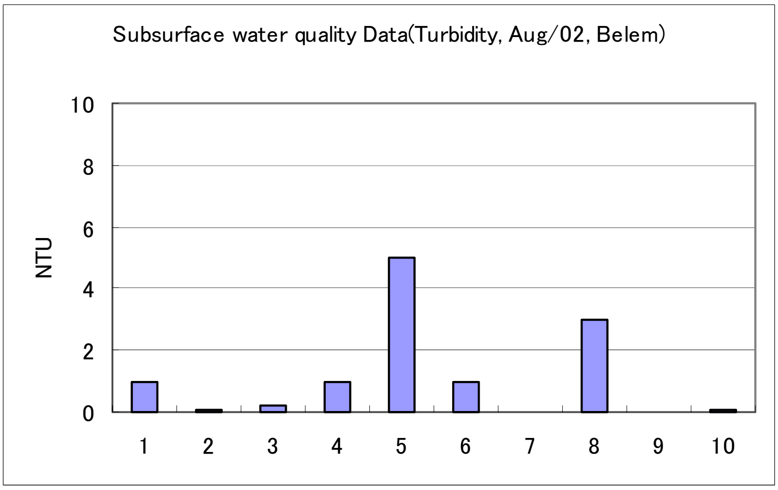


Figure 6.7-10 Water Quality Results (Sub-surface Water, Turbidity, August 2002)

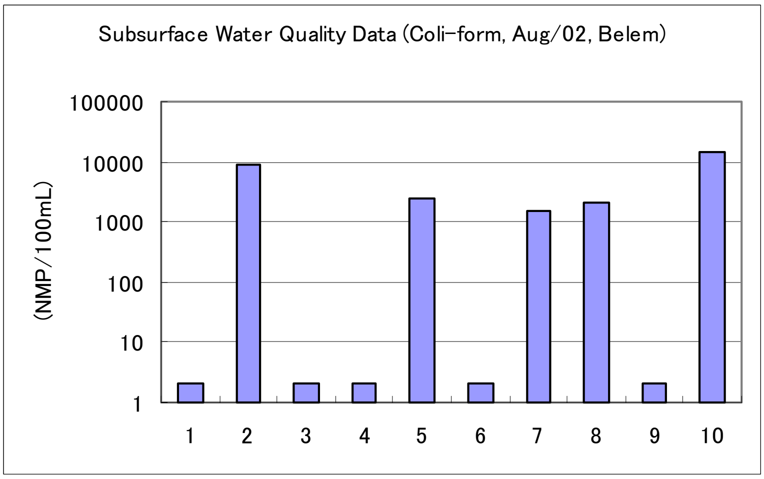


Figure 6.7-11 Water Quality Results (Sub-surface Water, Total Coli-form, August 2002)

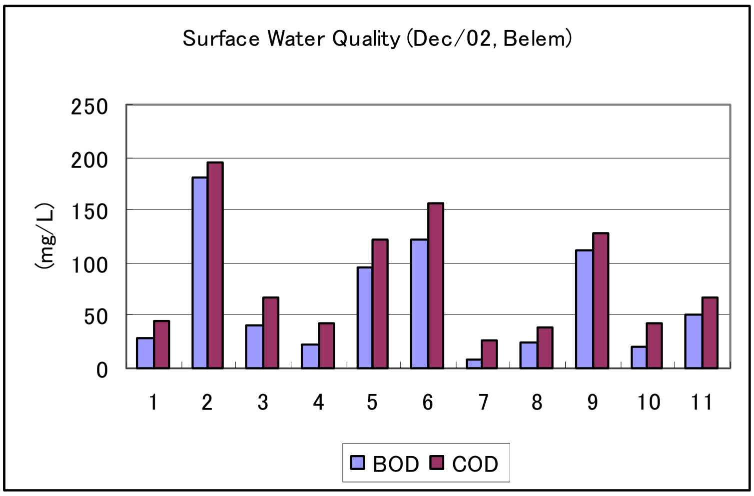


Figure 6.7-12 Water Quality Results (Surface Water, BOD and COD, December 2002)

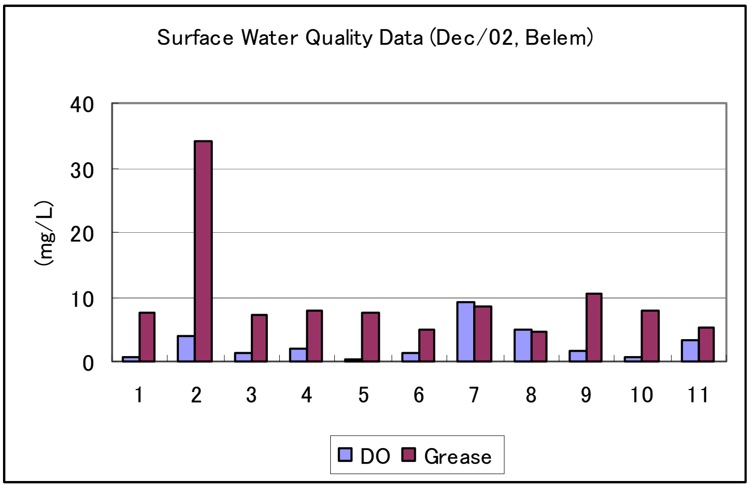


Figure 6.7-13 Water Quality Results (Surface Water, DO and Grease, December 2002)

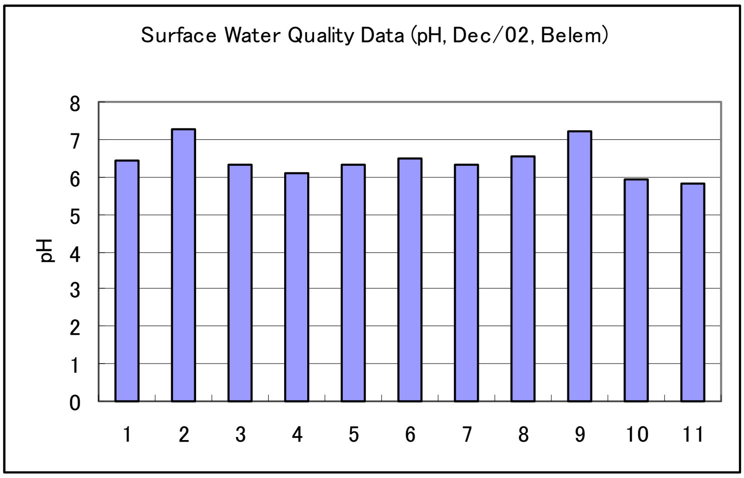


Figure 6.7-14 Water Quality Results (Surface Water, pH, December 2002)

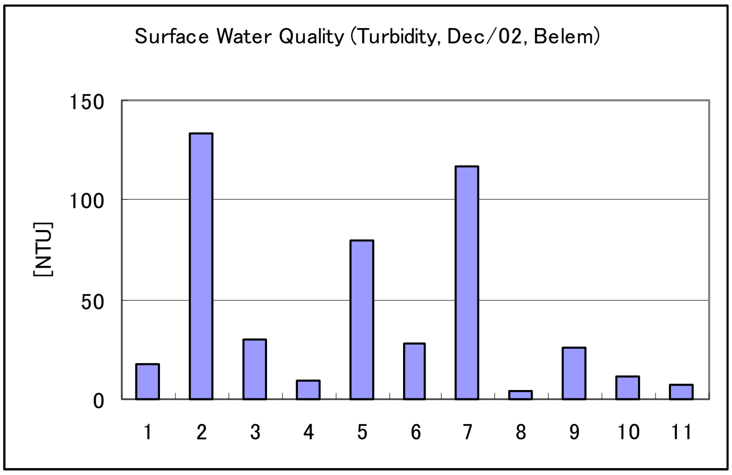


Figure 6.7-15 Water Quality Results (Surface Water, Turbidity, December 2002)

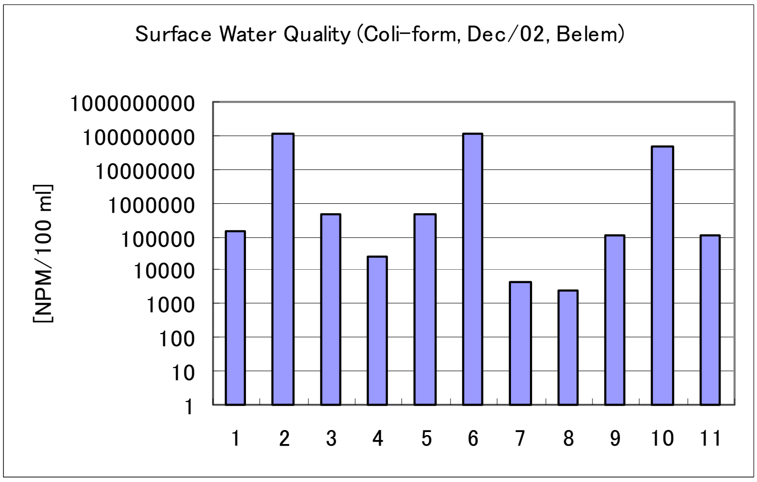


Figure 6.7-16 Water Quality Results (Surface Water, Total Coli-form, December 2002)

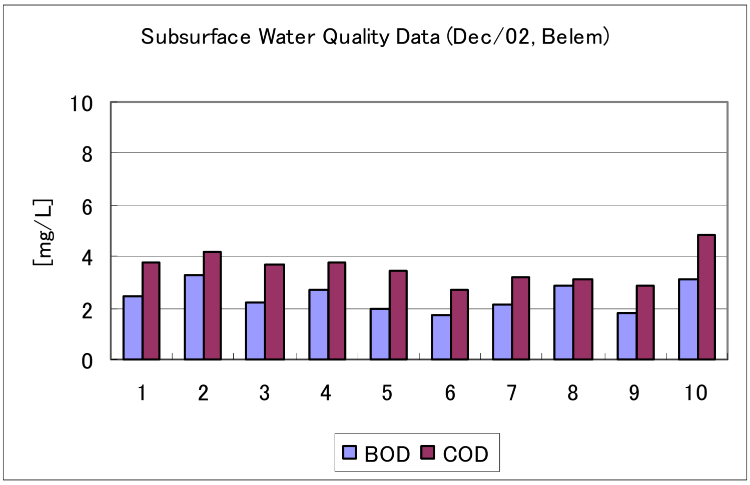


Figure 6.7-17 Water Quality Results (Subsurface Water, BOD and COD, December 2002)

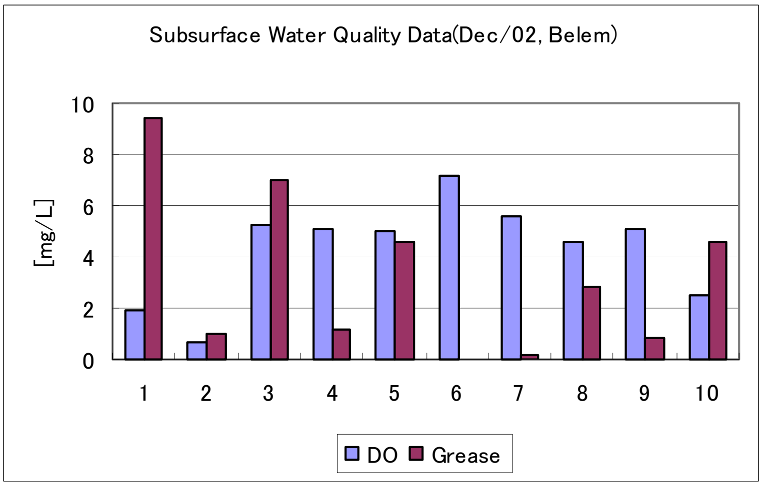


Figure 6.7-18 Water Quality Results (Subsurface Water, DO and Grease, December 2002)

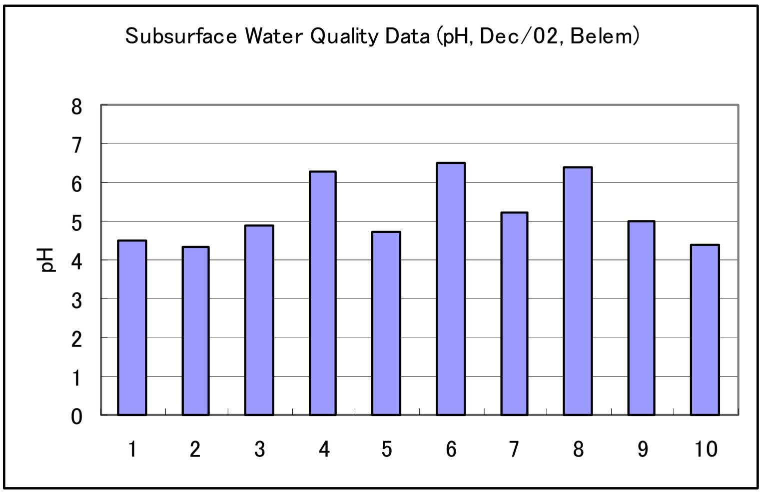


Figure 6.7-19 Water Quality Results (Subsurface Water, pH, December 2002)

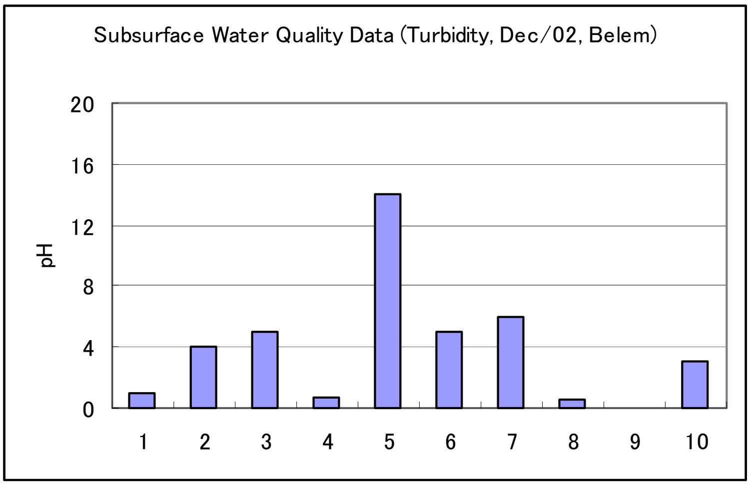


Figure 6.7-20 Water Quality Results (Subsurface Water, Turbidity, December 2002)

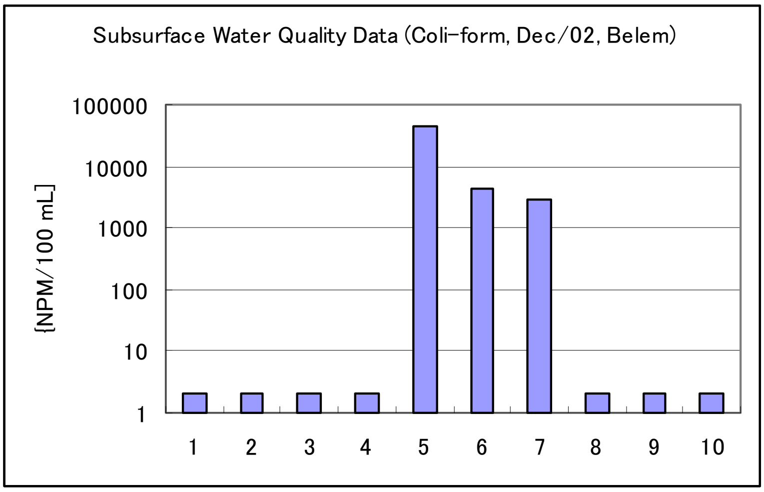


Figure 6.7-21 Water Quality Results (Subsurface Water, Total Coli-form, December 2002)

6.8. SCOPING AND SCREENING

6.8.1. INTRODUCTION

The whole route plan of the highway and bus-lane network to be considered within this study consists of following ten major road-components: (1) Avenida Almirante Barroso, (2) Rodovia BR-316/Avenida Mario Covas /Cidade Nova, (3)Rodovia Augusto Montenegro, (4) Avenida Independencia, (5) Rua da Marinha, (6) Avenida. Primeiro de Dezembro, (7) Rua Chermont, Rua Yamada and Rua Tapana, (8) Avenida. Pedro Cabral, (9) Avenida. Senador Lemos and (10) Nazare/Barata/Presidente Vargas/ Gov. J. Malcher and other major routes of the Centro region. So, the preliminary environmental examination of each major road is carried out separately, and potential environmental issues associated with each major road are summarized as follows.

(1) Avenida Almirante Barroso

Currently, bike roads along the centerline of this avenue are under construction, and conflicts between the proposed project and this bike road construction are expected to occur. Several historical/cultural and/or monumental facilities to be conserved exist along this road. Also, several hospitals, schools and other facilities that would require a calm environment exist, too. No rare flora/fauna is reported along this route. Table 6.8-1 summarizes the preliminary environmental evaluation of Avenida Almirante Barroso.

(2) Rodovia BR-316/Avenida Mario Covas /Cidade Nova

Recent urban development of Belem City has occurred mainly along Rodovia BR-316 that connects Belem, Ananindeua and Marituba, and Avenida Mario Covas that connects the Belem CBD and Cidade Nova. No rare flora/fauna is reported along this route. Table 6.8-2 summarizes the preliminary environmental evaluation of Rodovia BR-316/Avenida Mario Covas/Cidade Nova.

(3) Rodovia Augusto Montenegro

This avenue connects Icoaraci, one of the major suburban residential areas, and the Belem CBD. No rare flora/fauna is reported along this route. Table 6.8-3 summarizes the preliminary environmental evaluation of Rodovia Augusto Montenegro.

(4) Avenida Independencia

Currently, some portions of this project route on the east side (i.e., the distance between Rodovia Augusto Montenegro and Marituba) are under construction. Also, a Macro-Drainage Project that is to improve the regional drainage and its attached road network system are at the construction stage on the west side (i.e., the distance between Rodovia Augusto Montenegro and Avenida. Pedro Cabral). Some portions of this project route are to pass the circumference of the environmental reserve, Presidente Medici II. The existence of many illegal squatter's communities is reported. Some areas along this project route are flood-prone during the rainy season. Table 6.8-4 summarizes the preliminary environmental evaluation of Avenida Independencia.

(5) Rua da Marinha

Some portion of this project route is to cross along the boundary line between the current environmental reserve, Presidente Medici II, and its neighboring site of the Naval Military Base that has a strong ecological continuity to the currently preserved area. A large-scale land-taking is expected to occur within Naval Military Base sites. Table 6.8-5 summarizes the preliminary environmental evaluation of Rua da Marinha.

(6) Avenida. Primeiro de Dezembro

Some portions of this project route are to directly cross the environmental reserve, APA Belem. Currently, the wall construction of the APA Belem Protection Project has already started, although the entire expropriation negotiation process is not settled completely. Conflict between the proposed project and this protection wall construction should be avoided. The existence of many illegal squatter's communities is reported, and most of those residents use groundwater. A large-scale land-taking is expected to occur for this road construction. Table 6.8-6 summarizes the preliminary environmental evaluation of Avenida. Primeiro de Dezembro.

(7) Rua Chermont, Rua Yamada and Rua Tapana

This project route would run directly through three important facilities (one airport and two military facilities). Direct interference, and cumulative or secondary impacts of those facilities with this project are expected to occur. No rare flora/fauna is reported along this route. The existence of many illegal squatter's communities is reported. Table 6.2-7 summarizes the preliminary environmental evaluation of Rua Chermont, Rua Yamada and Rua Tapana.

(8) Avenida. Pedro Cabral

No rare flora/fauna is reported along this route. Some areas along this road are flood-prone during the rainy season. Table 6.8-8 summarizes the preliminary environmental evaluation of Avenida Pedro Cabral.

(9) Avenida. Senador Lemos

No rare flora/fauna is reported along this route. Some areas along this road are flood-prone during the rainy season. Table 6.8-9 summarizes the preliminary environmental evaluation of Avenida Senador Lemos.

(10)Nazare/Barata/Presidente Vargas/ Gov. J. Malcher and other major routes of the Centro Region

Many historical/cultural and/or monumental facilities to be conserved exist along this road network. Damage to some historical facilities due to the current roadside vibration were reported around the Centro region. Also, several hospitals, schools and other facilities that would require calm environment exist, too. No rare flora/fauna is reported along this route. Table 6.8-10 summarizes the preliminary environmental evaluation of Nazare/Barata/Presidente Vargas/Gov. J. Malcher and other major routes of the Centro Region.

Table 6.8-1 Scope (Avenida Almirante Barroso)

No.	Element	Impact	Importance
Natural Environment			
1	Soils	Potential for soil erosion during/after construction.	D
2	Vegetation	Destruction of roadside vegetation.	B
		Destruction of vegetation in environmental reserves.	D
3	Fauna	Disturbance of bird habitats during construction.	D
		Potential risk of animal-path cutting and/or habitat separation during/after construction.	D
4	Run-off/ Drainage	Mitigated roadside inundation during operation (in comparison with no-project scenario).	B
		Worsened local flooding/inundation at remote, downstream side from project route due to the discharge from newly installed roadside drainage system.	U
5	River flow	Risk of pollution of major tributaries during construction.	U
		Excessive water blockage of tributary system by bridge construction.	D
6	Groundwater	Groundwater quality degradation during construction.	D
		Groundwater level drawdown during construction.	D
		Drainage of discharged groundwater during construction.	D
		Disturbance of regional groundwater flow.	D
		Enhanced consolidation due to drawdown of groundwater level during/after construction.	D
Socio-Economic Factors			
7	Land Expropriation	Land expropriation due to road implementation.	D
		Disruption/interference to local development plan (bike-road construction).	A
		Demolition of roadside houses.	D
		Demolition of illegal squatters' lots.	D
8	School/Church/ Hospital	Disruption of school/church/hospital during construction.	B
		Mitigated disruption of school/church/hospital during the operation (in comparison with no-project scenario).	B
9	Military Base/Airport	Direct interference with facilities of military base/airport.	D
10	Road Safety	Increased risk of accidents due to increased road traffic during construction.	B
		Lessened risk of accidents during operation (in comparison with no-project scenario).	B
11	Public Health	Improved sanitary condition due to the locally improved drainage system.	D
12	Archaeological, historical, cultural and monumental sites	Conflict with the setting of historical, cultural or monumental sites.	D
13	Landscape	Visual conflict with surrounding community.	D
		Cutting of hill/use of embankment.	D
		Loss of visual continuity of townscape.	D
14	Noise, vibration	Noise, dust and vibration during construction.	B
		Mitigated noise/vibration impact during operation (in comparison with no-project scenario).	B
15	Air pollution	Increased roadside air pollution during construction.	B
		Mitigated air pollution impact during operation (in comparison with no-project scenario).	B

Note: A: significant, B: major, C: minor, D: less significant, U: unknown

Table 6.8-2 Scope (Rodovia BR-316/Rodovia Mario Covas/Cidade Nova Road System)

Element		Impact	Importance
Natural Environment			
1	Soils	Potential for soil erosion during/after construction.	D
2	Vegetation	Destruction of roadside vegetation.	D
		Destruction of vegetation in environmental reserves.	D
3	Fauna	Disturbance of bird habitats during construction.	D
		Potential risk of animal path cutting and/or habitat separation during/after construction.	D
4	Run-off/ Drainage	Mitigated roadside inundation during operation (in comparison with no-project scenario).	B
		Worsened local flooding/inundation at remote, downstream side from project route due to the discharge from newly installed roadside drainage system.	B
5	River flow	Risk of pollution of major tributaries during construction.	B
		Excessive water blockage of tributary system by bridge construction.	D
6	Groundwater	Groundwater quality degradation during construction.	D
		Groundwater level drawdown during construction.	D
		Drainage of discharged groundwater during construction.	D
		Disturbance of regional groundwater flow.	D
		Enhanced consolidation due to drawdown of groundwater level during/after construction.	D
Socio-Economic Factors			
7	Land expropriation	Land expropriation due to road alignment.	D
		Disruption of, or interference with local development plan (Independencia & Alca Rodoviaria Construction Projects).	A
		Demolition of roadside houses.	B
		Demolition of illegal squatters' lots.	B
8	School/Church/ Hospital	Disruption of school/church/hospital during construction.	B
		Mitigated disruption of school/church/hospital during the operation (in comparison with no-project scenario).	B
9	Military Base/Airport	Direct interference with facilities of military base/airport.	D
10	Road Safety	Increased risk of accidents due to increased road traffic during construction.	B
		Lessened risk of accidents during operation (in comparison with no-project scenario).	B
11	Public Health	Improved sanitary condition due to the locally improved drainage system.	C
12	Archaeological, historical, cultural and monumental sites	Conflict with the setting of historical, cultural or monumental sites.	B
13	Landscape	Visual conflict with surrounding community.	B
		Cutting of hill/use of embankment.	B
		Loss of visual continuity of townscape.	D
14	Noise, vibration	Noise, dust and vibration during construction.	B
		Mitigated noise/vibration impact during operation (in comparison with no-project scenario).	B
15	Air pollution	Increased roadside air pollution during construction.	B
		Mitigated air pollution impact during operation (in comparison with no-project scenario).	B

Note: A: significant, B: major, C: minor, D: less significant, U: unknown

Table 6.8-3 Scope (Rodovia Augusto Montenegro)

Element		Impact	Importance
Natural Environment			
1	Soils	Potential for soil erosion during/after construction.	D
2	Vegetation	Destruction of roadside vegetation.	D
		Destruction of vegetation in environmental reserves.	D
3	Fauna	Disturbance of bird habitats during construction.	D
		Potential risk of animal path cutting and/or habitat separation during/after construction.	D
4	Run-off/ Drainage	Mitigated roadside inundation during operation (in comparison with no-project scenario).	B
		Worsened local flooding/inundation at remote, downstream side from project route due to the discharge from newly installed roadside drainage system.	U
5	River flow	Risk of pollution of major tributaries during construction.	U
		Excessive water blockage of tributary system by bridge construction.	D
6	Groundwater	Groundwater quality degradation during construction.	D
		Groundwater level drawdown during construction.	D
		Drainage of discharged groundwater during construction.	D
		Disturbance of regional groundwater flow.	D
		Enhanced consolidation due to drawdown of groundwater level during/after construction.	D
Socio-Economic Factors			
7	Land expropriation	Land expropriation due to road alignment.	D
		Disruption of/interference with local development plan.	D
		Demolition of roadside houses.	D
		Demolition of illegal squatters ' lots.	D
8	School/Church/ Hospital	Disruption of school/church/hospital during construction.	B
		Mitigated disruption of school/church/hospital during the operation (in comparison with no-project scenario).	B
9	Military Base/Airport	Direct interference with facilities of military base/airport.	D
10	Road Safety	Increased risk of accidents due to increased road traffic during construction.	B
		Lessened risk of accidents during operation (in comparison with no-project scenario).	B
11	Public Health	Improved sanitary condition due to the locally improved drainage system.	D
12	Archaeological, historical, cultural and monumental sites	Conflict with the setting of historical, cultural or monumental sites.	D
13	Landscape	Visual conflict with surrounding community.	D
		Cutting of hill/use of embankment.	D
		Loss of visual continuity of townscape.	D
14	Noise, vibration	Noise, dust and vibration during construction.	B
		Mitigated noise/vibration impact during operation (in comparison with no-project scenario).	B
15	Air pollution	Increased roadside air pollution during construction.	B
		Mitigated air pollution impact during operation (in comparison with no-project scenario).	B

Note: A: significant, B: major, C: minor, D: less significant, U: unknown

Table 6.8-4 Scope (Avenida Independencia)

Element		Impact	Importance
Natural Environment			
1	Soils	Potential for soil erosion during/after construction.	B
2	Vegetation	Destruction of roadside vegetation.	B
		Destruction of vegetation in environmental reserves.	B
3	Fauna	Disturbance of bird habitats during construction (Presidente Medici II).	A
		Potential risk of animal path cutting and/or habitat separation during/after construction.	D
4	Run-off/ Drainage	Mitigated roadside inundation during operation (in comparison with no-project scenario).	B
		Worsened local flooding/inundation at remote, downstream side from project route due to the discharge from newly installed roadside drainage system.	U
5	River flow	Risk of pollution of major tributaries during construction.	B
		Excessive water blockage of tributary system by bridge construction.	D
6	Groundwater	Groundwater quality degradation during construction.	D
		Groundwater level drawdown during construction.	D
		Drainage of discharged groundwater during construction.	D
		Disturbance of regional groundwater flow.	D
		Enhanced consolidation due to drawdown of groundwater level during/after construction.	D
Socio-Economic Factors			
7	Land expropriation	Land expropriation due to road alignment.	B
		Disruption of/interference with local development plan (Macro-Drainage & Independencia Road Construction Projects).	A
		Demolition of roadside houses (Macro-Drainage).	U
		Demolition of illegal squatters’ lots (Macro-Drainage).	U
8	School/Church/ Hospital	Disruption of school/church/hospital during construction.	D
		Mitigated disruption of school/church/hospital during the operation (in comparison with no-project scenario).	D
9	Military Base/Airport	Direct interference with facilities of military base/airport.	D
10	Road Safety	Increased risk of accidents due to increased road traffic during construction.	B
		Lessened risk of accidents during operation (in comparison with no-project scenario).	D
11	Public Health	Improved sanitary condition due to the locally improved drainage system.	B
12	Archaeological, historical, cultural and monumental sites	Conflict with the setting of historical, cultural or monumental sites.	D
13	Landscape	Visual conflict with surrounding community.	D
		Cutting of hill/use of embankment.	D
		Loss of visual continuity of townscape.	D
14	Noise, vibration	Noise, dust and vibration during construction.	B
		Mitigated noise/vibration impact during operation (in comparison with no-project scenario).	D
15	Air pollution	Increased roadside air pollution during construction.	B
		Mitigated air pollution impact during operation (in comparison with no-project scenario).	D

Note: A: significant, B: major, C: minor, D: less significant, U: unknown

Table 6.8-5 Scope (Rua da Marinha)

Element		Impact	Importance
Natural Environment			
1	Soils	Potential for soil erosion during/after construction.	B
2	Vegetation	Destruction of roadside vegetation (Presidente Medici II).	A
		Destruction of vegetation in environmental reserves (Presidente Medici II).	U
3	Fauna	Disturbance of bird habitats during construction (Presidente Medici II).	A
		Potential risk of animal path cutting and/or habitat separation during/after construction (Presidente Medici II).	A
4	Run-off/ Drainage	Mitigated roadside inundation during operation (in comparison with no-project scenario).	B
		Worsened local flooding/inundation at remote, downstream side from project route due to the discharge from newly installed roadside drainage system.	U
5	River flow	Risk of pollution of major tributaries during construction.	B
		Excessive water blockage of tributary system by bridge construction.	D
6	Groundwater	Groundwater quality degradation during construction.	D
		Groundwater level drawdown during construction.	D
		Drainage of discharged groundwater during construction.	D
		Disturbance of regional groundwater flow.	D
		Enhanced consolidation due to drawdown of groundwater level during/after construction.	D
Socio-Economic Factors			
7	Land expropriation	Land expropriation due to road alignment (Navy Base).	A
		Disruption of/interference with local development plan.	D
		Demolition of roadside houses.	D
		Demolition of illegal squatters’ lots.	D
8	School/Church/ Hospital	Disruption of school/church/hospital during construction.	D
		Mitigated disruption of school/church/hospital during the operation (in comparison with no-project scenario).	D
9	Military Base/Airport	Direct interference with facilities of military base/airport (Navy Base).	A
10	Road Safety	Increased risk of accidents due to increased road traffic during construction.	B
		Lessened risk of accidents during operation (in comparison with no-project scenario).	B
11	Public Health	Improved sanitary condition due to the locally improved drainage system.	B
12	Archaeological, historical, cultural and monumental sites	Conflict with the setting of historical, cultural or monumental sites.	D
13	Landscape	Visual conflict with surrounding community.	D
		Cutting of hill/use of embankment.	D
		Loss of visual continuity of townscape.	D
14	Noise, vibration	Noise, dust and vibration during construction.	B
		Mitigated noise/vibration impact during operation (in comparison with no-project scenario).	B
15	Air pollution	Increased roadside air pollution during construction.	B
		Mitigated air pollution impact during operation (in comparison with no-project scenario).	B

Note: A: significant, B: major, C: minor, D: less significant, U: unknown

Table 6.8-6 Scope (Avenida Primeiro de Dezembro)

Element		Impact	Importance
Natural Environment			
1	Soils	Potential for soil erosion during/after construction.	B
2	Vegetation	Destruction of roadside vegetation (APA Belem).	B
		Destruction of vegetation in environmental reserves (APA Belem).	A
3	Fauna	Disturbance of bird habitats during construction (APA Belem).	A
		Potential risk of animal path cutting and/or habitat separation during/after construction (APA Belem).	A
4	Run-off/ Drainage	Mitigated roadside inundation during operation (in comparison with no-project scenario).	A
		Worsened local flooding/inundation at remote, downstream side from project route due to the discharge from newly installed roadside drainage system.	U
5	River flow	Risk of pollution of major tributaries during construction.	B
		Excessive water blockage of tributary system by bridge construction.	B
6	Groundwater	Groundwater quality degradation during construction.	B
		Groundwater level drawdown during construction.	D
		Drainage of discharged groundwater during construction.	D
		Disturbance of regional groundwater flow.	D
		Enhanced consolidation due to drawdown of groundwater level during/after construction.	D
Socio-Economic Factors			
7	Land expropriation	Land expropriation due to road alignment.	A
		Disruption of/interference with local development plan (APA Belem Protection Project, Alca Rodoviaria & Primeiro de Dezembro Road Construction Projects).	A
		Demolition of roadside houses.	A
		Demolition of illegal squatters’ lots.	A
8	School/Church/ Hospital	Disruption of school/church/hospital during construction.	U
		Mitigated disruption of school/church/hospital during the operation (in comparison with no-project scenario).	U
9	Military Base/Airport	Direct interference with facilities of military base/airport.	D
10	Road Safety	Increased risk of accidents due to increased road traffic during construction.	B
		Lessened risk of accidents during operation (in comparison with no-project scenario).	D
11	Public Health	Improved sanitary condition due to the locally improved drainage system.	A
12	Archaeological, historical, cultural and monumental sites	Conflict with the setting of historical, cultural or monumental sites.	D
13	Landscape	Visual conflict with surrounding community.	D
		Cutting of hill/use of embankment.	D
		Loss of visual continuity of townscape.	D
14	Noise, vibration	Noise, dust and vibration during construction.	B
		Mitigated noise/vibration impact during operation (in comparison with no-project scenario).	D
15	Air pollution	Increased roadside air pollution during construction.	B
		Mitigated air pollution impact during operation (in comparison with no-project scenario).	D

Note: A: significant, B: major, C: minor, D: less significant, U: unknown

Table 6.8-7 Scope (Rua Rodolfo Chermont, Rua Yamada and Rua Tapana).

Element		Impact	Importance
Natural Environment			
1	Soils	Potential for soil erosion during/after construction.	B
2	Vegetation	Destruction of roadside vegetation.	D
		Destruction of vegetation in environmental reserves.	D
3	Fauna	Disturbance of bird habitats during construction.	D
		Potential risk of animal path cutting and/or habitat separation during/after construction.	D
4	Run-off/ Drainage	Mitigated roadside inundation during operation (in comparison with no-project scenario).	B
		Worsened local flooding/inundation at remote, downstream side from project route due to the discharge from newly installed roadside drainage system.	U
5	River flow	Risk of pollution of major tributaries during construction.	B
		Excessive water blockage of tributary system by bridge construction.	D
6	Groundwater	Groundwater quality degradation during construction.	B
		Groundwater level drawdown during construction.	B
		Drainage of discharged groundwater during construction.	B
		Disturbance of regional groundwater flow.	B
		Enhanced consolidation due to drawdown of groundwater level during/after construction.	B
Socio-Economic Factors			
7	Land expropriation	Land expropriation due to road alignment.	A
		Disruption of or interference with local development plan (Aero Clube do Para M/P Renewal).	A
		Demolition of roadside houses.	A
		Demolition of illegal squatters' lots.	A
8	School/Church/ Hospital	Disruption of school/church/hospital during construction.	B
		Mitigated disruption of school/church/hospital during the operation (in comparison with no-project scenario).	A
9	Military Base/Airport	Direct interference with facilities of military base/airport (Aeronautica, Navy Base & Aero Clube do Para).	A
10	Road Safety	Increased risk of accidents due to increased road traffic during construction.	B
		Lessened risk of accidents during operation (in comparison with no-project scenario).	B
11	Public Health	Improved sanitary condition due to the locally improved drainage system.	B
12	Archaeological, historical, cultural and monumental sites	Conflict with the setting of historical, cultural or monumental sites.	D
13	Landscape	Visual conflict with surrounding community.	D
		Cutting of hill/use of embankment.	B
		Loss of visual continuity of townscape.	D
14	Noise, vibration	Noise, dust and vibration during construction.	B
		Mitigated noise/vibration impact during operation (in comparison with no-project scenario).	B
15	Air pollution	Increased roadside air pollution during construction.	B
		Mitigated air pollution impact during operation (in comparison with no-project scenario).	B

Note: A: significant, B: major, C: minor, D: less significant, U: unknown

Table 6.8-8 Scope (Avenida Pedro Alvares Cabral)

Element		Impact	Importance
Natural Environment			
1	Soils	Potential for soil erosion during/after construction.	D
2	Vegetation	Destruction of roadside vegetation.	D
		Destruction of vegetation in environmental reserves.	D
3	Fauna	Disturbance of bird habitats during construction.	D
		Potential risk of animal path cutting and/or habitat separation during/after construction.	D
4	Run-off/ Drainage	Mitigated roadside inundation during operation (in comparison with no-project scenario).	B
		Worsened local flooding/inundation at remote, downstream side from project route due to the discharge from newly installed roadside drainage system.	U
5	River flow	Risk of pollution of major tributaries during construction.	B
		Excessive water blockage of tributary system by bridge construction.	D
6	Groundwater	Groundwater quality degradation during construction.	D
		Groundwater level drawdown during construction.	D
		Drainage of discharged groundwater during construction.	D
		Disturbance of regional groundwater flow.	D
		Enhanced consolidation due to drawdown of groundwater level during/after construction.	D
Socio-Economic Factors			
7	Land expropriation	Land expropriation due to road alignment.	D
		Disruption of/interference with local development plan.	D
		Demolition of roadside houses.	D
		Demolition of illegal squatters’ lots.	D
8	School/Church/ Hospital	Disruption of school/church/hospital during construction.	D
		Mitigated disruption of school/church/hospital during the operation (in comparison with no-project scenario).	D
9	Military Base/Airport	Direct interference with facilities of military base/airport.	D
10	Road Safety	Increased risk of accidents due to increased road traffic during construction.	B
		Lessened risk of accidents during operation (in comparison with no-project scenario).	B
11	Public Health	Improved sanitary condition due to the locally improved drainage system.	B
12	Archaeological, historical, cultural and monumental sites	Conflict with the setting of historical, cultural or monumental sites.	D
13	Landscape	Visual conflict with surrounding community.	D
		Cutting of hill/use of embankment.	D
		Loss of visual continuity of townscape.	D
14	Noise, vibration	Noise, dust and vibration during construction.	B
		Mitigated noise/vibration impact during operation (in comparison with no-project scenario).	B
15	Air pollution	Increased roadside air pollution during construction.	B
		Mitigated air pollution impact during operation (in comparison with no-project scenario).	B

Note：A: significant, B: major, C: minor, D: less significant, U: unknown

Table 6.8-9 Scope (Avenida Senador Lemos)

Element		Impact	Importance
Natural Environment			
1	Soils	Potential for soil erosion during/after construction.	D
2	Vegetation	Destruction of roadside vegetation.	D
		Destruction of vegetation in environmental reserves.	D
3	Fauna	Disturbance of bird habitats during construction.	D
		Potential risk of animal path cutting and/or habitat separation during/after construction.	D
4	Run-off/ Drainage	Mitigated roadside inundation during operation (in comparison with no-project scenario).	B
		Worsened local flooding/inundation at remote, downstream side from project route due to the discharge from newly installed roadside drainage system.	U
5	River flow	Risk of pollution of major tributaries during construction.	D
		Excessive water blockage of tributary system by bridge construction.	D
6	Groundwater	Groundwater quality degradation during construction.	D
		Groundwater level drawdown during construction.	D
		Drainage of discharged groundwater during construction.	D
		Disturbance of regional groundwater flow.	D
		Enhanced consolidation due to drawdown of groundwater level during/after construction.	D
Socio-Economic Factors			
7	Land expropriation	Land expropriation due to road alignment.	D
		Disruption of/interference with local development plan.	D
		Demolition of roadside houses.	D
		Demolition of illegal squatters ’ lots.	D
8	School/Church/ Hospital	Disruption of school/church/hospital during construction.	D
		Mitigated disruption of school/church/hospital during the operation (in comparison with no-project scenario).	D
9	Military Base/Airport	Direct interference with facilities of military base/airport.	D
10	Road Safety	Increased risk of accidents due to increased road traffic during construction.	B
		Lessened risk of accidents during operation (in comparison with no-project scenario).	B
11	Public Health	Improved sanitary condition due to the locally improved drainage system.	B
12	Archaeological, historical, cultural and monumental sites	Conflict with the setting of historical, cultural or monumental sites.	D
13	Landscape	Visual conflict with surrounding community.	D
		Cutting of hill/use of embankment.	D
		Loss of visual continuity of townscape.	D
14	Noise, vibration	Noise, dust and vibration during construction.	B
		Mitigated noise/vibration impact during operation (in comparison with no-project scenario).	B
15	Air pollution	Increased roadside air pollution during construction.	B
		Mitigated air pollution impact during operation (in comparison with no-project scenario).	B

Note: A: significant, B: major, C: minor, D: less significant, U: unknown

Table 6.8-10 Scope (Avenida Nazare/Magalhaes Barata/Presidente Vargas/Gov. J. Malcher and others)

Element		Impact	Importance
Natural Environment			
1	Soils	Potential for soil erosion during/after construction.	D
2	Vegetation	Destruction of roadside vegetation.	D
		Destruction of vegetation in environmental reserves.	D
3	Fauna	Disturbance of bird habitats during construction.	D
		Potential risk of animal path cutting and/or habitat separation during/after construction.	D
4	Run-off/ Drainage	Mitigated roadside inundation during operation (in comparison with no-project scenario).	D
		Worsened local flooding/inundation at remote, downstream side from project route due to the discharge from newly installed roadside drainage system.	U
5	River flow	Risk of pollution of major tributaries during construction.	B
		Excessive water blockage of tributary system by bridge construction.	D
6	Groundwater	Groundwater quality degradation during construction.	D
		Groundwater level drawdown during construction.	D
		Drainage of discharged groundwater during construction.	D
		Disturbance of regional groundwater flow.	D
		Enhanced consolidation due to drawdown of groundwater level during/after construction.	D
Socio-Economic Factors			
7	Land expropriation	Land expropriation due to road alignment.	D
		Disruption of/interference with local development plan.	D
		Demolition of roadside houses.	D
		Demolition of illegal squatters’ lots.	D
8	School/Church/ Hospital	Disruption of school/church/hospital during construction.	D
		Mitigated disruption of school/church/hospital during the operation (in comparison with no-project scenario).	B
9	Military Base/Airport	Direct interference with facilities of military base/airport.	D
10	Road Safety	Increased risk of accidents due to increased road traffic during construction.	B
		Lessened risk of accidents during operation (in comparison with no-project scenario).	B
11	Public Health	Improved sanitary condition due to the locally improved drainage system.	B
12	Archaeological, historical, cultural and monumental sites	Conflict with the setting of historical, cultural, or monumental sites.	D
13	Landscape	Visual conflict with surrounding community.	D
		Cutting of hill/use of embankment.	D
		Loss of visual continuity of townscape.	D
14	Noise, vibration	Noise, dust and vibration during construction.	B
		Mitigated noise/vibration impact during operation (in comparison with no-project scenario).	B
15	Air pollution	Increased roadside air pollution during construction.	B
		Mitigated air pollution impact during operation (in comparison with no-project scenario).	B

Note: A: significant, B: major, C: minor, D: less significant, U: unknown

PART B

PLANNING OF TRUNK BUS SYSTEM

CHAPTER 7
Existing Public Transport Characteristics

PART-B PLANNING OF TRUNK BUS SYSTEM

7. EXISTING PUBLIC TRANSPORT CHARACTERISTICS

7.1. GENERAL CONDITIONS OF PUBLIC TRANSPORT PLANNING

JICA, the technical cooperation agency of the Japanese Government, carried out in 1991 the Master Plan Study on Urban Transport in Belem (hereinafter referred to as "PDTU1991). However, the study's recommendation remained largely unimplemented in the subsequent years because of the administrative reform of the Brazilian government, notably the disbanding of EMTU, the designated executing agency of the PDTU1991 projects. The changed, and changing, socio-economic conditions in the Belem metropolitan area (BMA) after more than a decade necessitated JICA to update in 2001 the original Master Plan Study, entitled "the Update of Master Plan for Urban Transport in the Metropolitan Area of Belem (hereinafter referred to as "PDTU2001).

This Feasibility Study focuses on the basic concept recommended by PDTU2001 for the improvement of public transportation in BMA, i.e., the introduction of a Trunk Bus System that utilizes the existing arterial roads, now heavily serviced by local bus companies. This study aims to propose an improved and efficient public transportation system, as recommended by PDTU2001, utilizing the following three arterial roads (Figure 7.1-1):

1) Avenida Almirante Barroso (Belem municipal road)
2) Rodovia BR-316 (Federal road)
3) Rodovia Augusto Montenegro (Belem municipal road)

In conjunction with the Trunk Bus System, PDTU2001 proposes the construction of three new urban bus terminals and the conversion of the existing Sao Braz Bus Terminal into another urban bus terminal as indicated in Figure 7.1-1. This Feasibility Study examines these terminal proposals as well.

1) Icoaraci Bus Terminal (new)
2) Cidade Nova Bus Terminal (new)
3) Marituba Bus Terminal (new)
4) Sao Braz Bus Terminal (conversion from the present inter-municipal bus terminal to an urban bus terminal)

In other words, the scope of work for this Feasibility Study is to propose a Trunk Bus System along the three existing arterial roads toward an efficient bus operation system in the entire MBA and to recommend a set of suitable organizational and operational arrangements that will contribute to the realization of the proposed system. In addition, the Study will propose rough designs of the related road and bus terminal facilities and conduct economic and financial evaluation thereof.

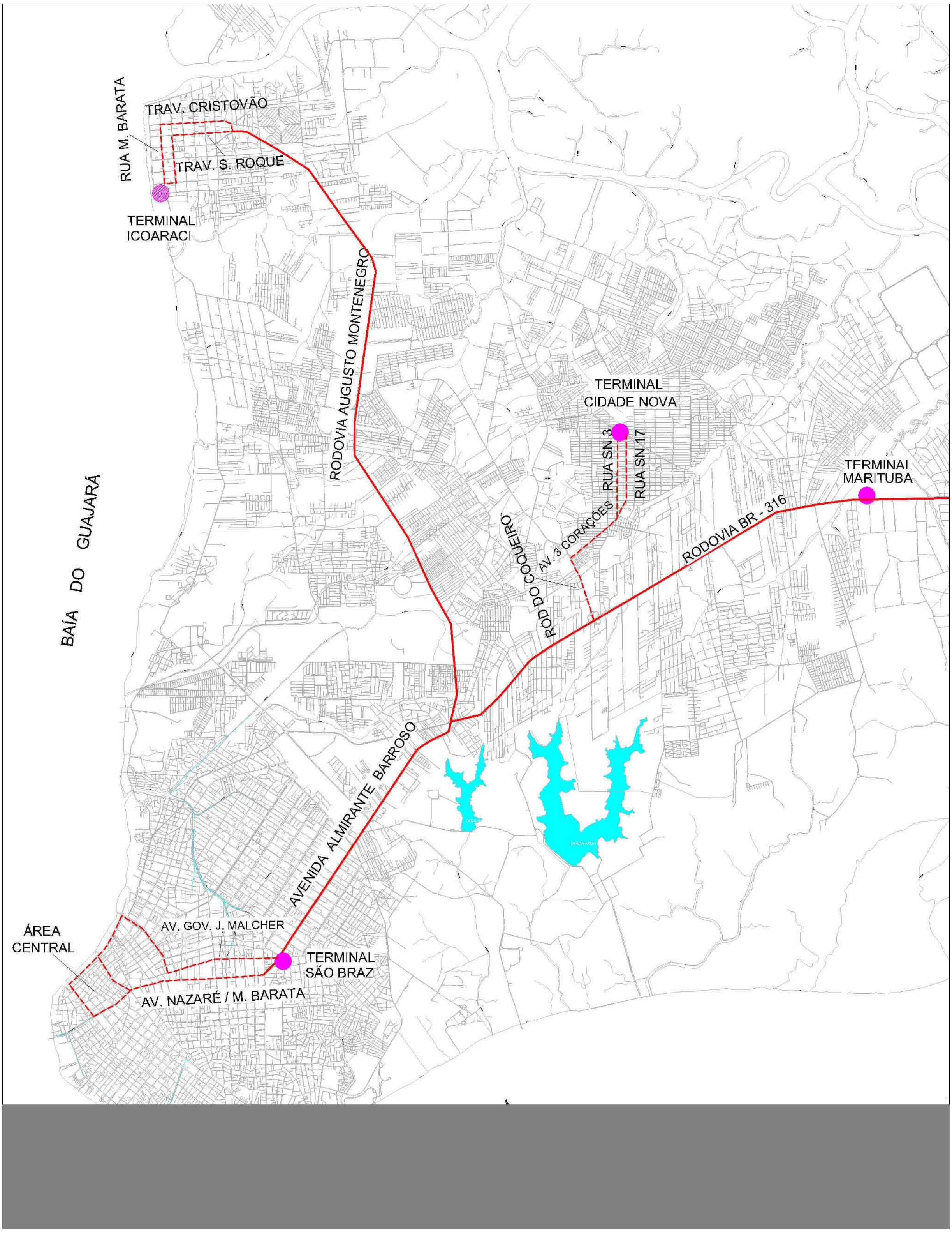


Figure 7.1-1 Location of Trunk Bus Ways and Four Bus Terminals

7.2. BUS TRANSPORT SURVEYS TO BE CONDUCTED

During the months of October and November in 2000, PDTU2001 undertook a number of bus transport surveys, e.g., a Bus Passenger Condition Survey, a Bus Passenger Survey and a Bus Passenger Interview Survey and so on. To update these findings, the following additional surveys were undertaking in June of 2002 for this Feasibility Study.

1) Bus Passenger Survey
2) Bus Operation Speed Survey
3) Bus Operation Condition Survey
4) Bus Company Survey

7.2.1. BUS PASSENGER SURVEY

A bus passenger survey is conducted to grasp the number of bus passengers and its findings are essential for planning a bus operation system. The 2002 survey was conducted over the current bus services along three routes: (1) between Icoaraci and Centro, (2) between Cidade Nova and Centro, and (3) between Marituba and Centro. Field workers rode the buses along these routes and counted boarding and alighting passengers at each bus stop during the morning peak hour, the evening peak hour and the off-peak hour, a total of three hours.

7.2.2. BUS OPERATION SPEED SURVEY

A bus operation speed survey is conducted to measure the operation speed from a bus top to the next throughout a given bus route and to calculate the average speed of bus operation per route, the average travel time and so on. Its findings are essential to determine such requirements as the frequency of bus service and the size of bus fleet and also to conduct the economic and financial evaluation. Field workers, on the same buses used for the buss passenger survey mentioned above, measured the time required to travel from one bus stop to another and from one road to another to calculate the average operation speed.

7.2.3. BUS OPERATION CONDITION SURVEY

A bus operation condition survey is conducted to review the problems and conditions of bus travel as perceived by passengers. Its findings will be reflected in the planning of the bus operation system. To obtain as varied a passenger perspective as possible, a total of ten bus stops were selected to interview waiting passengers. Five of these were located along the bus routes proposed for the Trunk Bus System and the other five were selected from the major bus stops located within the central part of Belem City. At each selected bus stop, the interview was conducted with approximately 50 waiting passengers each during the morning peak hour, the evening peak hour and the off-peak hour.

7.2.4. BUS COMPANY SURVEY

A bus company survey is conducted to review the problems and needs of bus transportation as perceived by bus companies and also to understand the salient characteristics of the current bus service. Its findings will be incorporated into the bus operation plan. A questionnaire survey was carried out covering the entire 29 companies operating in BMA. The interview survey covered such information as fleet size, age of use per bus, company performance, operation frequency, problems and needs of the present bus operation system.

7.3. BUS ROUTE CHARACTERISTICS

7.3.1. BUS ROUTE CONFIGURATION

As reported in some detail by PDTU2001, trip characteristics in the study area can be described along four major traffic axes: namely, 1) the built-up area of Belem (Centro), 2) the north-south axis connecting Centro and Icoaraci 3) the northeast-southwest axis connecting Centro and Cidade Nova and 4) the east-west axis connecting Centro and Marituba.

There are 165 bus routes in the study area, with each route serviced by a fleet of some 1,900 buses. Almost all of the buses in operation are of conventional bus type carrying approximately 100 passengers (seated and standing). Only three are articulated buses. The total operation kilometers of the conventional buses along 165 routes is about 6,200km. In 2000 when PDTU2001 was being undertaken, microbuses were in operation on 27 routes. However, they are now reduced to only five routes because of their higher fare of R$1.5 compared with R$0.85 of conventional buses among other motives.

(1) Bus Routes in Belem Centro

The bus routes in the built-up area of Belem City are provided along the major streets. These routes are roughly classified into two types: namely, 1) routes of short distance (7 to 13km) with both origin and destination inside Centro and 2) routes of longer distance (20 to 27km) connecting Centro to outlying Icoaraci, Cidade Nova, or Marituba (i.e. medium-distance bus routes). Accordingly, main streets within Centro are heavily trafficked by feeder-route and medium-distance buses vying one another. Severe traffic jams are quite common along these streets during the morning and the evening peak hour.

(2) Bus Routes Connecting Centro and Suburban Areas

There are five to six bus terminals in the residential areas around Icoaraci. Bus routes linking Icoaraci to Centro mostly originate in one of these terminals, and access via August Montenegro and Avenida Almirante Barroso and cruise the vicinity of Sao Braz or Centro areas. There are a few routes that originate somewhere around Icoaraci and access Centro from the north by using the road along Guajara River. Many of the bus routes connecting Cidade Nova to Centro originate in one of ten to thirteen terminals located in the residential areas around Cidade Nova and approach via Rodovia BR-316 and Avenida Almirante Barroso to cruise the vicinity of Sao Braz and Centro area. Marituba-Centro bus routes originate in one of three to five terminals in residential areas around Marituba and approach via Rodovia BR-316 and Avenida Almirante Barroso to cruise the vicinity of Sao Braz and Centro.

As shown in Figure 7.3-1 and Figure 7.3-2, the bus route network in the study area can be divided into four zones: namely, 1) routes servicing inner trips of Centro, 2) Centro-Icoaraci routes, 3) Centro-Cidade Nova routes, and 4) Centro-Marituba routes. Those routes accessing Centro from three outlying nodes all pass Avenida Almirante Barroso and Rodovia BR-316, causing severe traffic congestion during peak hours.

As indicated in Figure 7.3-3, the existing bus route network is adequate in its service coverage, as judged by the standard on-foot accessibility of 400m to the nearest bus stop.

Figure 7.3-1 Bus Route Network in the Built-up Area of Belem City

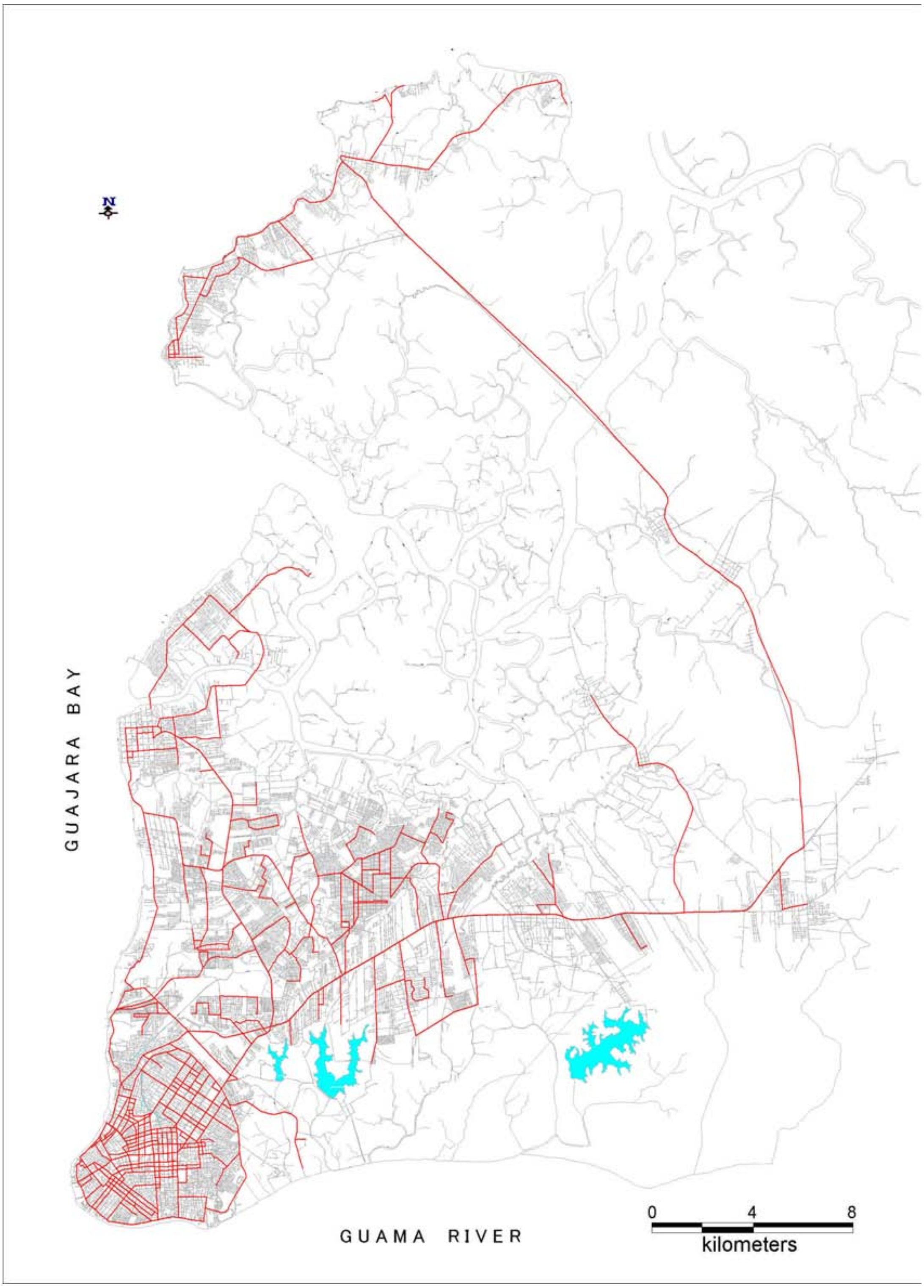


Figure 7.3-2 Bus Route Network in the Study Area

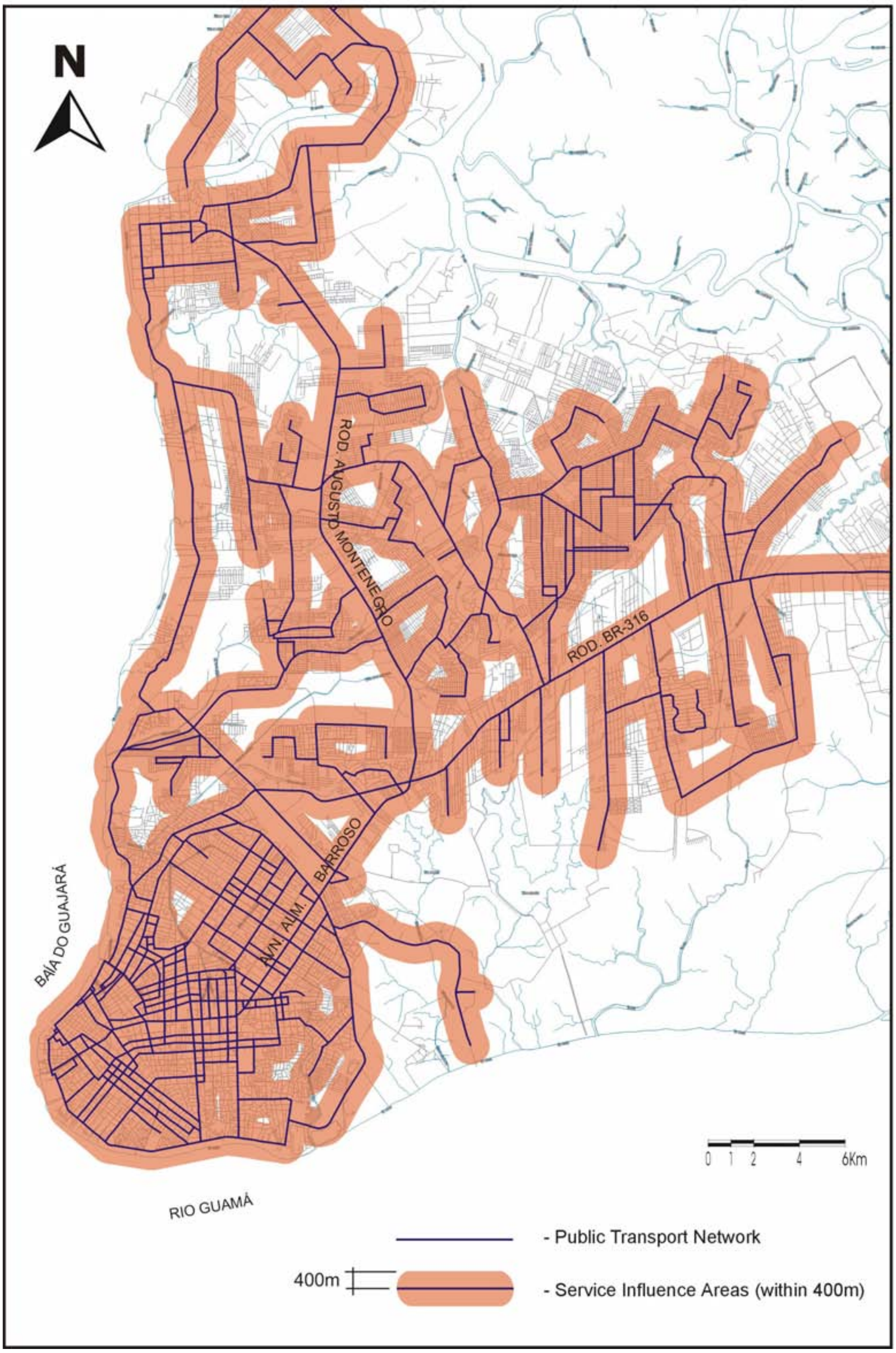


Figure 7.3-3 Service Coverage of Existing Bus Route Network (400m on-foot accessibility)

7.3.2. NUMBER OF BUS ROUTES AND ROUTE LENGTH

The bus operation requires permits from the municipal transport bureaus of Belem, Ananindeua, Marituba and other cities or towns in which it offers service. Currently, a total of 29 private companies are authorized to service 165 or so bus routes in the study area.

The fleet size of these companies varies from about 50 vehicles to over 300. Small companies service about five routes, whereas large companies cover 15 to 20 routes.

The characteristics of each bus company are summarized in Table 7.3-1. The number of bus routs in Belem centro area are about 30 bus routes, and 40 bus routes are operating in the area from Belem centro area to Icoaraci area. And the direction between centro area to Cidade Nova and centro area to Marituba also operating about 40 bus routes respectively.

The average bus route length within Belem centro area are about 10km to 15km, however, bus routes from centro to Icoaraci or Marituba are about 20km to 25km respectively.

Table 7.3-1 Characteristics of Bus Operation by Company

Name of Company	Main Service Area	Name of Bus route operated	No. of bus In company (vehicle)	Operation kilometers (km/day)	Average Bus Route Length
1. Arsenal (AA)	Centro	No.318, No 328	37	6927	11.1
2. Transbcampos (AB)	Centro	No.230, No229	39	8103	13.2
3. Belem Lisboa (AC)	Icoaraci	No.759, No753, No761, No783, No767, No755, No762, No768	94	25830	21.4
4. Alcindo Cacela (AD)	Centro	No417, No422	27	7427	14.4
5. Transurb (AE)	Centro	No321,No319,No320,No305	43	12040	20.7
6. Viacao Forte (AF)	Cidade Nova	No986,No905, No960, No900, No903, No904 No902,No906,No901, No487,No548,No985 No907,No503,No504, No999,No.754,No909 No.878, No795, No209, No1013, No210, No.211, No212, No213, No214, No215, No1012	325	88997	15.43
7. Dom Manoel (AG)	Centro	No441,No442,No439 No440,No908,No444,No1011	112	25054	16.99
8. Aero Club (AH)	Centro, Icoaraci	No996,No526	27	5609	17.25
9. Guajara (AI)	Centro	No307,No308,No309,No310,No914,No306, No321,No305,No860	92	21315	16.4
10. Beira Alta (AJ)	Mosqueiro	NoR123,NoR124,NoR125,NoR126,NoR127	15	3293	20.1
11. Perpetuo Socorro (AK)	Centro Icoaraci	No202,No549,No200,No631,No632,No634 No201,No633,No636,No638,No915,No876	151	40777	13.7

Name of Company	Main Service Area	Name of Bus route operated	No. of bus In company (vehicle)	Operation kilometers (km/day)	Average Bus Route Length
12. Monte Cristo	Centro	No227,No635,No443,No237	85	18508	12.4
13. Sao Luiz (AM)	Centro	No323,No324,No325, No664	57	9352	6.78
14. Transpara	Centro	No550	18	4627	13.3
15. Rio Guama		No311,No312,No316 No768	63	11912	12.0
16. Esperanca	Centro	No102,No103,No104	63	10226	15.5
17. Icoaraciense	Icoaraci	No870,No873,No875,No874,No872, No881,No882,No876,No758,No752, No878,No879,No880,No851,No549, No871, No877, No549,No996,	127	49430	23.1
18. Transbel Rio	Centro	No113,No114	41	5802	7.3
19. Nova	Icoaraci Centro	No845,No664,No663,No756,No654, No665,No866,No869,No862,No860, No890,No770,No868	131	42491	19.5
20.Marituba (AU)	Marituba	No.910, No.913, No.914, No.918	51	16027	23.8
21. Á guas Lindas	Marituba	No996,No992,No993,No916,No911, No1005,No1006,No1007 No1008,No1009,No915,No988	75	21875	17.6
22. Metropolitana	Marituba	No919,No920,No951,No998,No1007	56	15971	21.1
23. Barata (AU)	Marituba	No990,No991,No917,No914,No910 No913,No918,No1001,No1002 No1003,No1014	122	37202	19.7
24. N.S. do Carmo	Marituba/Mos	No924,No970	12	6931	41.1
25. Bragantina	Cidade Nova	No996,No305,No770	12	3702	23.5
26. Izabelense	Benevides /	No973,No972,No971	29	13854	44.0
27. Michele (BC)	Benevides /	No970,No.983,No.982,No.981	16	16960	47.4
28. Belem Rio (BD)	Centro	No547,No546,No795,No796, No797	75	12958	17.22
29. Pinheiro (BE)	Centro	No494	13	3196	16.5
TOTAL		165	2008	546396	20.5

7.3.3. BUS ROUTE CHARACTERISTICS

A new bus company that intends to service either the intra-city traffic of Belem or a route passing any part of the city must apply for a permit from the Transport Company of Belem Municipality (CTBel). To open a new route, either a group of interested citizens or a bus company must submit the specification of the proposed new route, and CTBel evaluates the validity of the request and issues a permit. CTBel does not have the established criteria of evaluation. Each request for a new route is examined in the ad hoc meetings between CTBel and the submitter of the request. When the proposed new route covers two or all three of these cities, the bus company must apply for a permit from each of the two or three cities. On the whole, it is not difficult to obtain a permit from the Transport Company of three cities. Bus routes have been increasing in number apace with the growth of new residential areas in the suburbs.

As examined in detail in PDTU 2001, the bus trip generation and attraction are concentrated in Centro and three suburban agglomerations of Icoaraci, Cidade Nova and Marituba where housing development has been picking up. Many residents in three outlying agglomerations hold jobs in Centro or in the vicinity of Sao Braz Bus Terminal. The existing arterial road network in the study area connects Centro to each outlying agglomeration by one arterial road. By the nature of passenger demand and the structure of network, almost all bus routes connecting the outlying agglomerations to Centro have to concentrate on the same set of arterial roads as shown in Figure 7.3-4. Table 7.3-2 summarizes the number of bus routes and passengers per major arterial road segment. Figure 7.3-5 shows the location of each road segment mentioned in the table.

Table 7.3-2 No. of Bus Routes and Passengers by Major Arterial Road Segment

Name of Road & Segment	No. of Traffic Lane(No.)	No. of Bus Route (No.)	No of Passenger (Passenger/ Day)	No. of Bus (Vehicle/Day)
① Rodovia BR-316	4	29	88,027	3,606
② Rodovia BR-316	6	43	208,971	7,160
③ Rod. Mario Covas	4	17	98,222	2,831
④ Rod. Mario Covas	4	7	15,536	1,142
⑤ Rod. Augusto Montenegro	6	30	128,910	4,968
⑥ Rod. Augusto Montenegro	6	37	198,941	6,170
⑦ Av. Almirante Barroso	8	66	343,472	12,317
⑧ Av. Almirante Barroso	8	63	283,969	11,092
⑨ Av. P.A. Cabral	6	25	71,270	3,731
⑩ Av. P.A. Cabral	4	25	66,763	3,703
⑪ Av. Senador Lemos	2	4	25,862	1,518
⑫ Av. Pedro Miranda	6	6	35,421	1,662
⑬ Rod. Arthur Bernardes	2	10	27,794	844
⑭ Boulevard Castilhos Franca	6	23	49,503	2,670
⑮ Av. Marechal Hermes	2*	50	89,157	5,974
⑯ Av. Gov. Jose Malcher	3*	44	118,749	5,154
⑰ Av. Nazare	3*	33	65,189	3,657
⑱ Av. Jose Bonifacio	2	8	34,210	1,439
⑲ Av. Perimetral	2	8	26,514	1,500
⑳ Av. Julio Cesar	4	4	15,831	781

Note: * One-way

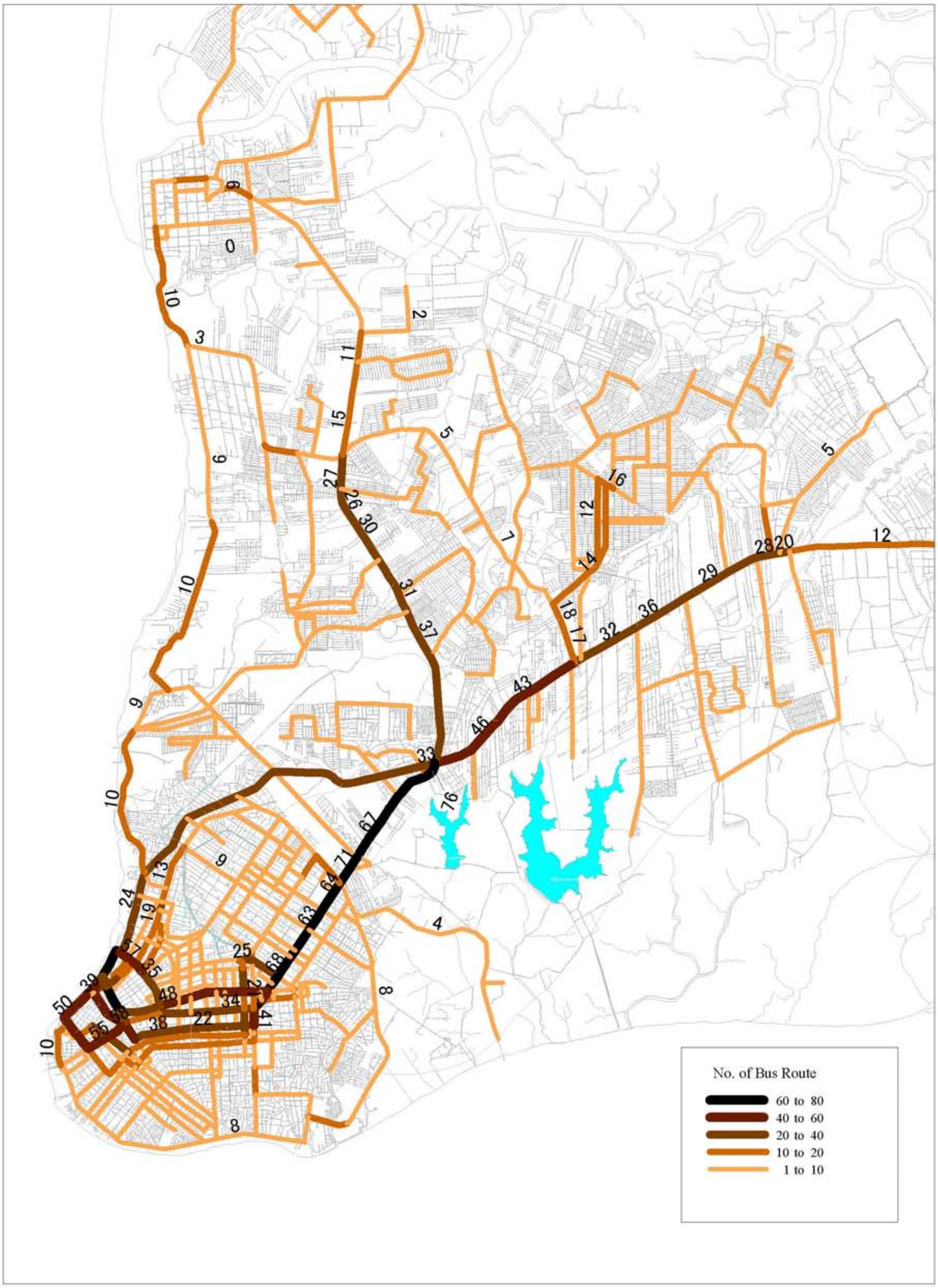


Figure 7.3-4 No. of Bus Routes Operated on Arterial Roads