

CHAPTER 10
Technical Analysis For Trunk Bus System

10. TECHNICAL ANALYSIS FOR TRUNK BUS SYSTEM

10.1. GENERAL

This Chapter analyzes the effects of introducing the trunk bus system conceptually described in Chapter 8, by carrying out the demand forecasts with or without the proposed system. As proposed in the said chapter, the trunk busway will be introduced to Avenida Almirante Barroso, Rodovia BR-316 and Rodovia Augusto Montenegro and the exclusive trunk bus lane to Avenida Independencia. The trunk bus priority lane will be introduced to six roads in the Centro: namely, Avenida Governador Jose Malcher, Avenida Visconde de Souza Franco, Avenida Nazare, Avenida Marechal Hermes, Avenida Mario Covas and Travessa Cristovao Colombo. The trunk bus system will use the fleet of articulated buses (double-body buses) with capacity of 200 passengers. The conventional bus system will continue to use the fleet of single-body buses with capacity of 100 passengers. The demand forecasts for the “with” and “without” analysis are based on the peak hour OD tables projected for 2007 and 2012. The demand forecasts are used to estimate, per trunk bus route, bus passengers, service frequency or headway, boarding and alighting passengers at each integrated bus terminal, feeder bus passengers per terminal and so on.

10.2. DEMAND FOR TRUNK BUS SERVICE

10.2.1. OUTLINE OF ANALYSIS

(1) Trunk Bus Routes

The conceptual plan proposes the construction of eight integrated bus terminals in the suburbs. There will be two routing systems in 2007, each comprising a number of trunk bus routes operated from the respective terminals of origin. The routing systems will increase to four in 2012. Table 10.2-1 shows the proposed trunk bus routes. Two routing systems will use Avenida Almirante Barroso in 2007, and to these will be added two more systems using the central accessing segment of Avenida Independencia between Centro area and Rodovia Augusto Montenegro in 2012. The name of each route consists of two alphabet characters indicating its terminal of origin and two-digit numbers corresponding to one of the four routing systems. For example, two bus routes TA01 and TA03 both start from Terminal A in Icoaraci, but belong to two different routing systems (numbered 01 and 03). TA01 services inside the Centro, but TA03 stops at Sao Braz Terminal to return to its terminal of origin. The same applies to the other routes numbered 01 and 03 originating respectively from Terminals B through H. With the introduction of the trunk bus system, 61 conventional bus lines, or 37% of the existing 165 lines, will be discontinued. Avenida Independencia, now under construction, will provide two route segments accessing the Centro for two additional routing systems (numbered 02 and 04) in 2012. Figure 10.2-1 through Figure 10.2-4 respectively show the four routing systems.

Table 10.2-1 Proposed Trunk Bus Routes

Trunk Bus Route	Terminal of Origin	By Way of	Distination	Route Length (Km)	Year
TA01	Terminal A: Icoaraci	Almirante Barroso	to Centro	56.0	2007
TA02		Independencia	to Centro	51.9	2012
TA03		Almirante Barroso	to Sao Braz	46.2	2007
TA04		Independencia	to Viscon de Souza Franco	46.5	2012
TB01	Terminal B: Tapanã	Almirante Barroso	to Centro	36.1	2007
TB02		Independencia	to Centro	32.0	2012
TB03		Almirante Barroso	to Sao Braz	26.2	2007
TB04		Independencia	to Viscon de Souza Franco	26.6	2012
TC01	Terminal C: Mangueira	Almirante Barroso	to Centro	26.6	2007
TC02		Independencia	to Centro	29.8	2012
TC03		Almirante Barroso	to Sao Braz	16.7	2007
TC04		Independencia	to Viscon de Souza Franco	24.4	2012
TD01	Terminal D: Coqueiro	Almirante Barroso	to Centro	32.1	2007
TD02		Independencia	to Centro	36.2	2012
TD03		Almirante Barroso	to Sao Braz	22.2	2007
TD04		Independencia	to Viscon de Souza Franco	30.8	2012
TE01	Terminal E: Aguas Lindas	Almirante Barroso	to Centro	30.2	2007
TE02		Independencia	to Centro	39.4	2012
TE03		Almirante Barroso	to Sao Braz	20.3	2007
TE04		Independencia	to Viscon de Souza Franco	34.1	2012
TF01	Terminal F: Marituba	Almirante Barroso	to Centro	41.1	2007
TF02		Independencia	to Centro	51.8	2012
TF03		Almirante Barroso	to Sao Braz	31.2	2007
TF04		Independencia	to Viscon de Souza Franco	46.4	2012
TG01	Terminal G: Independencia 1	Almirante Barroso	to Centro	35.2	2007
TG02		Independencia	to Centro	31.1	2012
TG03		Almirante Barroso	to Sao Braz	25.3	2007
TG04		Independencia	to Viscon de Souza Franco	25.7	2012
TH01	Terminal H: Independencia 2	Almirante Barroso	to Centro	40.9	2007
TH02		Independencia	to Centro	36.8	2012
TH03		Almirante Barroso	to Sao Braz	31.0	2007
TH04		Independencia	to Viscon de Souza Franco	31.4	2012

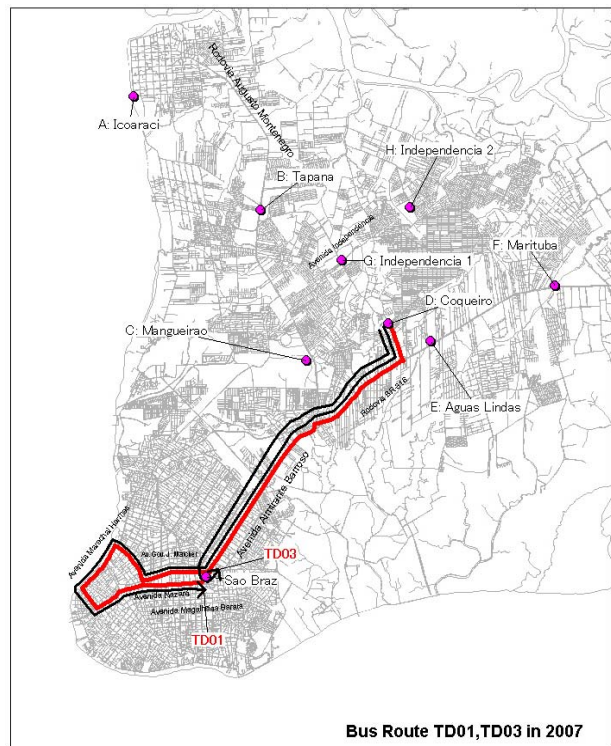
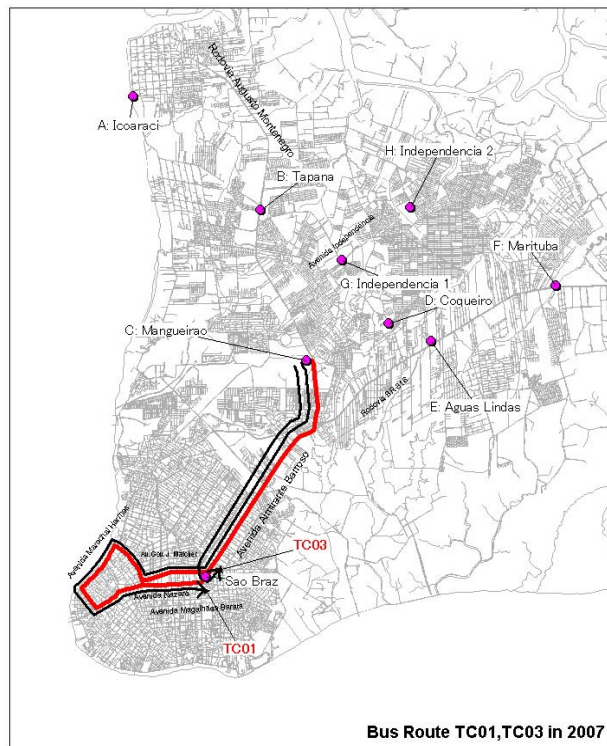
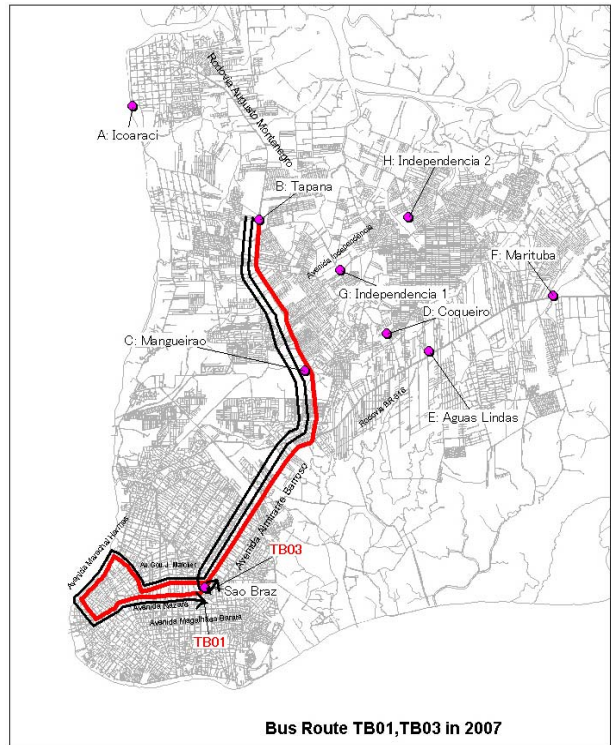
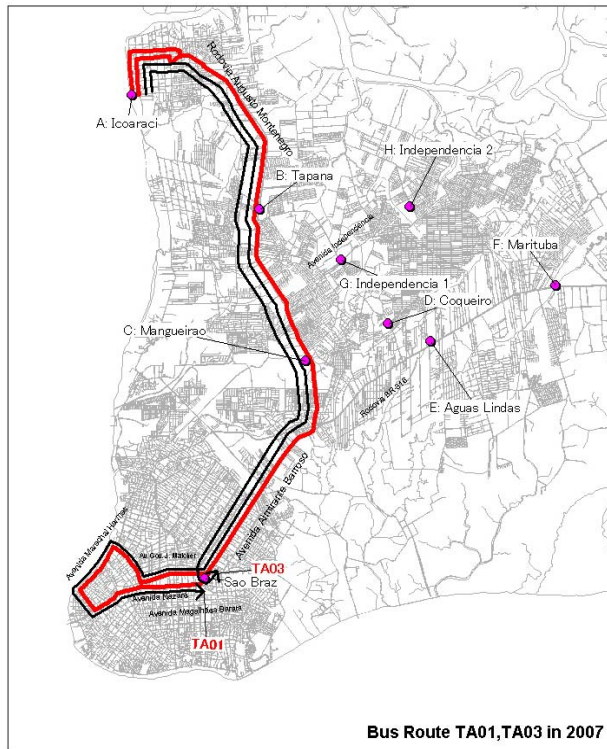


Figure 10.2-1 Trunk Bus Routing System (TA, TB, TC and TD) in 2007

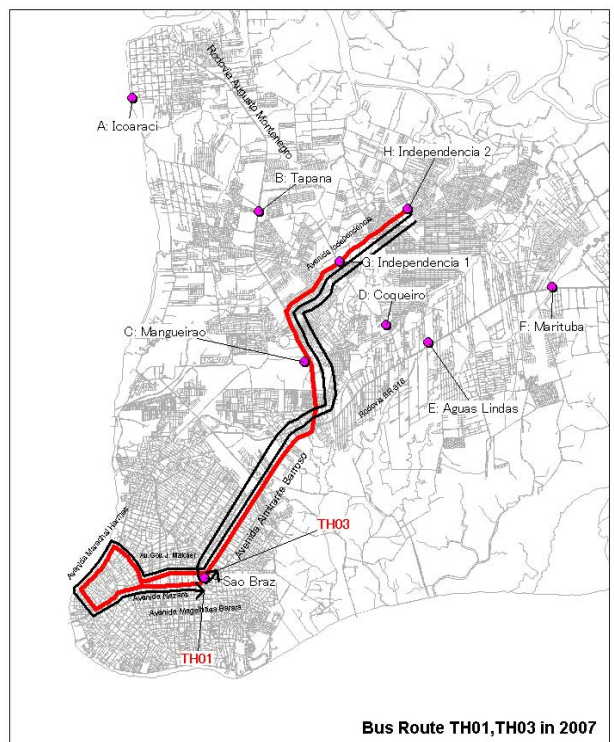
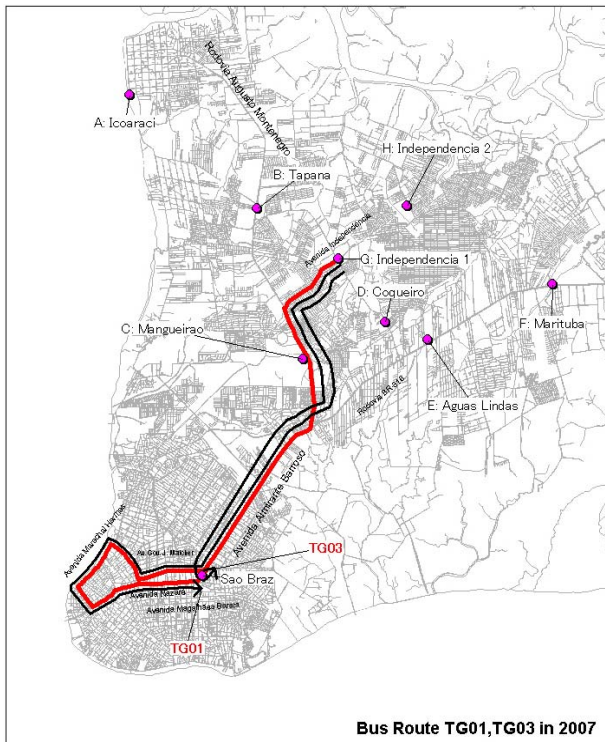
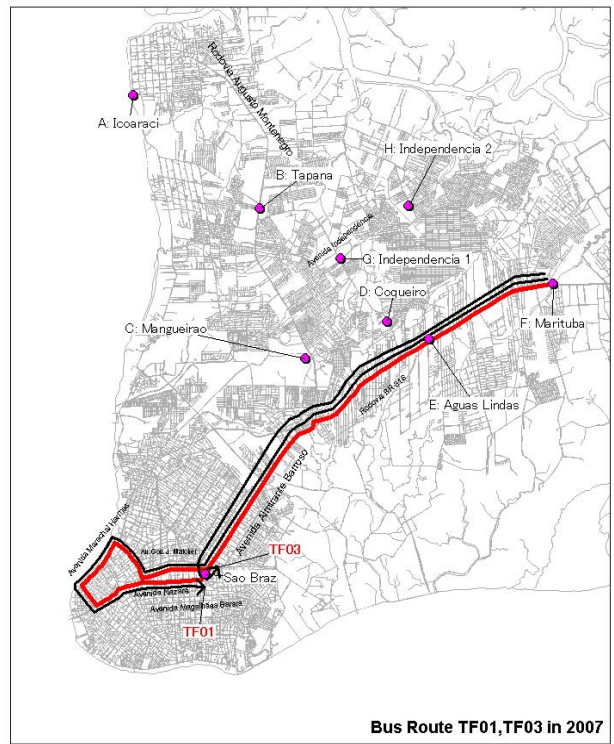
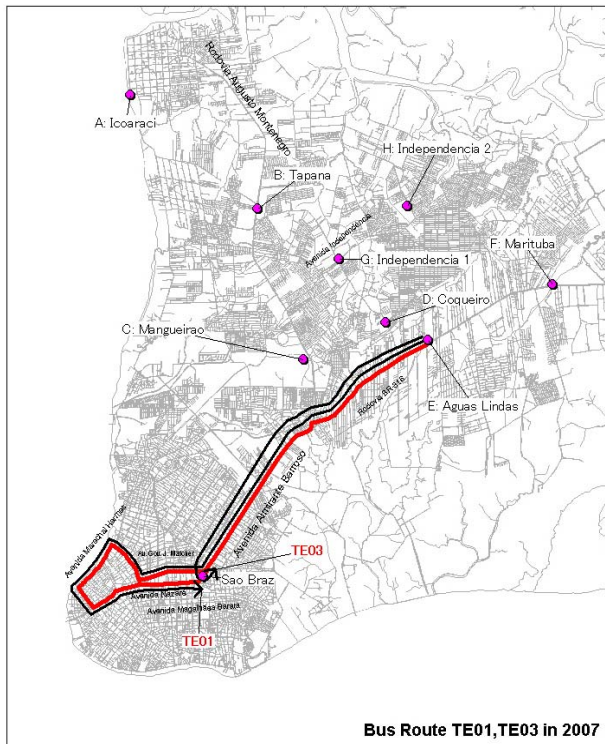


Figure 10.2-2 Trunk Bus Routing System (TE, TF, TG and TH) in 2007

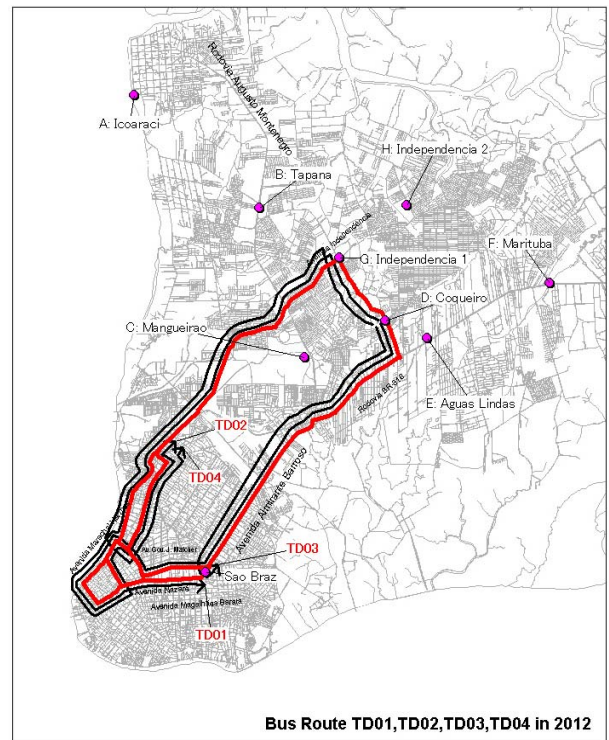
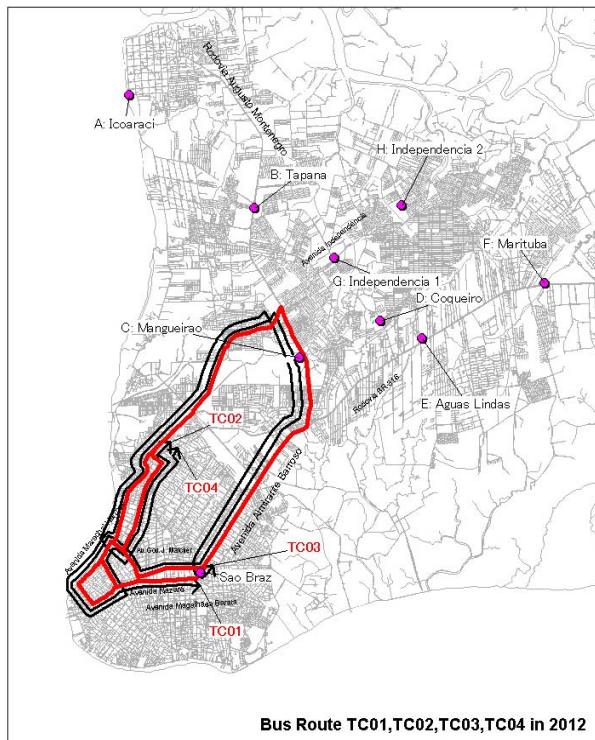
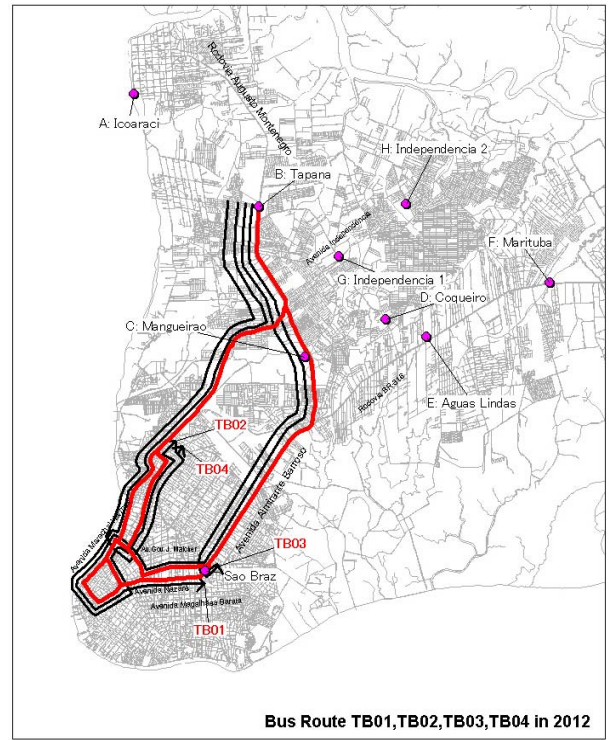
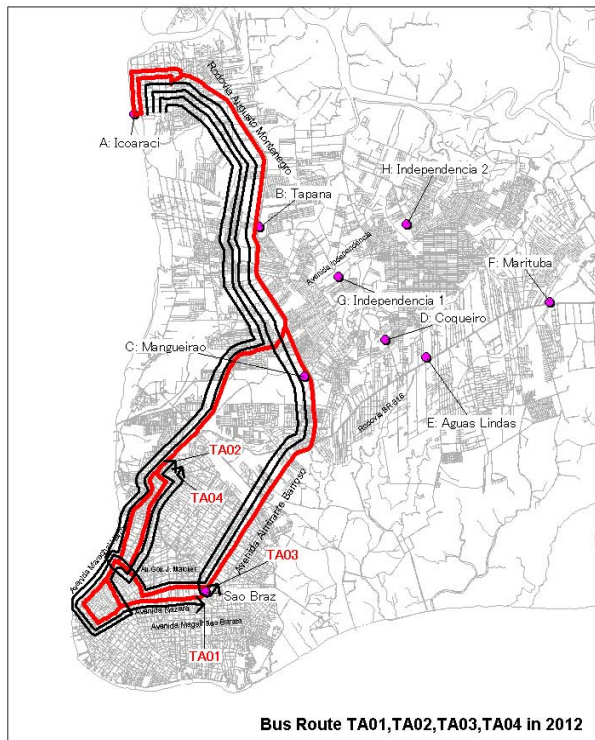


Figure 10.2-3 Trunk Bus Routing System (TA, TB, TC and TD) in 2012

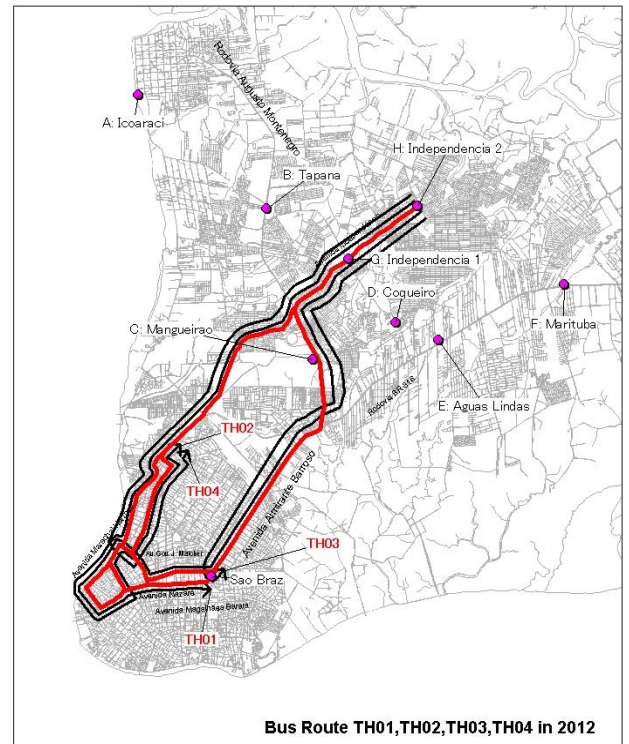
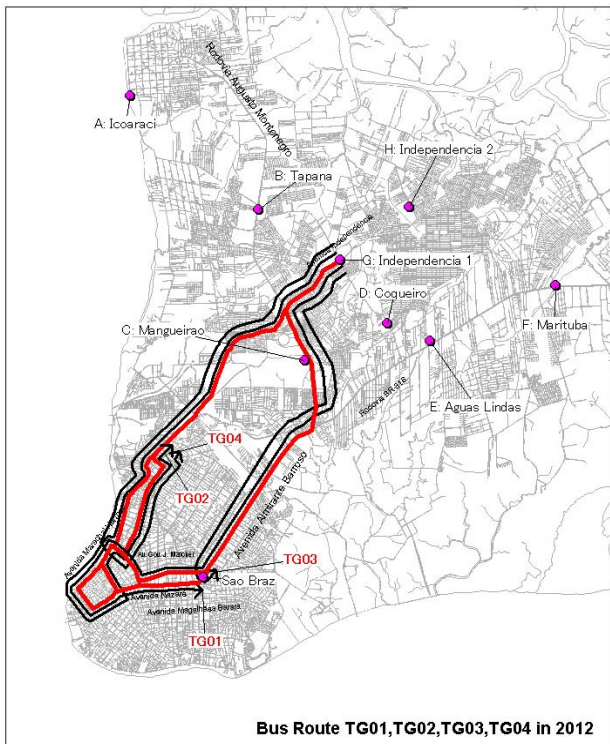
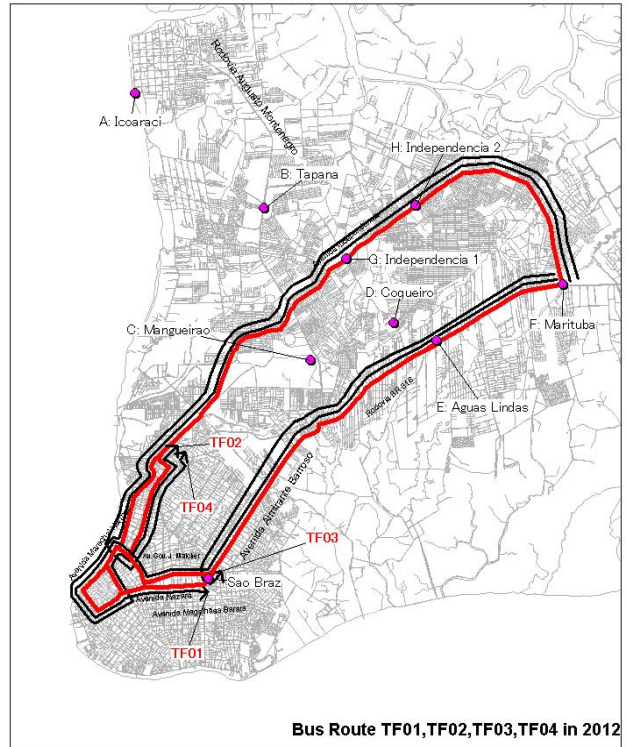
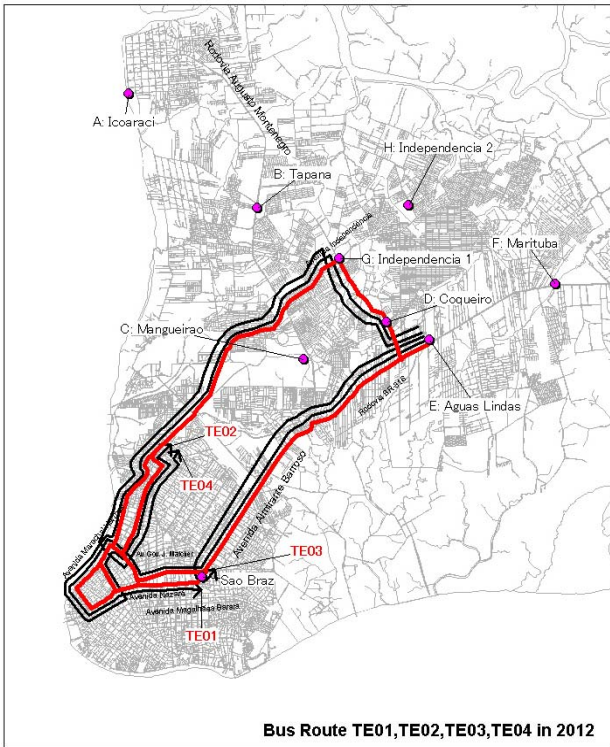


Figure 10.2-4 Trunk Bus Routing System (TE, TF, TG and TH) in 2012

(2) Alternative Cases

The demand forecasts are carried out on six alternative cases shown in Table 10.2-2.

Table 10.2-2 Alternative Cases

Alternative Case	Trunk Bus System	Demand Forecast	Remarks
Case-1	Without	2002	Present bus system (conventional bus service only)
Case-2	Without	2007	- ditto-
Case-3	Without	2012	- ditto-
Case-4	With	2007	Introduction of trunk bus service only on the suburban segment of Av. Independencia
Case-5	With	2012	Introduction of trunk bus service on entire length of Av. Independencia
Case-6	With	2020	- ditto-

Case-1 is a programming exercise to recreate the present bus operation in order to adjust the parameters for demand forecasts, by using the results of various surveys conducted in June 2002 on bus passengers and operation. The case is based on the existing conventional bus system only. Case-2 assumes the same road network conditions and the same bus operation system as Case-1 to forecast the travel demand for 2007. Case-3 does the same for 2012. Case-4 assumes the operation of 16 trunk bus routes to forecast the travel demand for 2007. Case-5 forecasts the demand for 2012, assuming the operation of 32 trunk bus routes, an increase made possible by the addition of the central accessing segment of Av. Independencia. Case-6 forecasts the demand for 2020, assuming the same road network conditions and bus operation as Case-5.

10.2.2. BUS PASSENGER FLOWS

(1) Bus Passenger Forecasts by Road Segment

Figure 10.2-7 through Figure 10.2-12 show the forecasts of bus passengers by road segment from Case-1 through Case-6. The numbers in these figures indicate the inbound passengers on board per morning peak hour. Regarding the “with” forecasts from Case-4 through Case-6, trunk bus passengers by road segment are shown in the upper right corner respectively in Figure 10.2-9, Figure 10.2-11 and Figure 10.2-12. Table 10.2-5 summarizes the passenger forecasts on 27 major road segments for Case-2 through Case-5. Figure 10.2-6 shows the locations of the major segments.

Case-2, namely, the “without” demand forecast for 2007, estimates that the inbound bus passengers on the road segments of Av. Almirante Barroso will be in the range of 37,000 to 45,000 persons per morning peak hour. The estimated bus passengers on the same road segments increase to the range of 42,000 to 50,000 persons in Case-3, the “without” forecast for 2012 (see Figure 10.2-8 and Figure 10.2-9). Relative to the passengers that ranged from 35,000 to 41,000 by segment in 2002 (Case-1), this means that the demand will increase by some 20% in ten years. The increased demand would call for a suitable

increase of conventional bus fleet in operation. However, there is no proven case in which the conventional bus system could transport as many as 50,000 inbound passengers per peak hour. The estimated travel demand for 2012 exceeds the limit of the existing bus operation system in the BMA.

In Case-4, i.e., the “with” demand forecast for 2007 that assumes the introduction of 16 trunk bus routes, the inbound trunk bus passengers from Icoaraci to Entroncamento on Rodovia Augusto Montenegro increase from some 2,000 on the first segment to 16,000 on the last segment, and then jump to 25,000 on the first segment of Avenida Almirante Barroso after joining the inbound passenger flow on Rodovia BR-316. The inbound trunk bus passengers from Marituba to Entroncamento on BR-316 increase from 6,000 on the first to 14,000 on the last segment. The estimated conventional bus passengers on Avenida Almirante Barroso segments will be reduced to less than 50% of the estimates in Case-2. The conventional bus passengers on Avenida Almirante Barroso in Case-2 that reach some 45,000 in one segment are split, in Case-4, into the trunk bus service on Avenida Almirante Barroso and the conventional bus service on Avenidas Primeiro de Dezembro, Pedro Alvares Cabral and Almirante Barroso.

Case-5 assumes the operation of 32 trunk bus routes to forecast the “with” demand for 2012. The inbound trunk bus passengers on Rodovia Augusto Montenegro increase from nearly 3,000 on the first segment to some 8,700 immediately before the intersection with Avenida Independencia. The trunk bus passengers on Rodovia BR-316 from Marituba increase from about 8,000 on the first segment to 14,000 after the intersection with Avenida Mario Covas. The passenger flows join at Entroncamento to jump to 22,000 on the first segment of Avenida Almirante Barroso and then drop to 13,000 after Sao Braz Terminal. The inbound passengers on Avenida Independencia are estimated to increase after the completion of its central accessing segment. The inbound trunk bus passengers on this avenue increase to nearly 7,000 after Terminal H, and reach 14,000 to 16,000 in the segments after intersecting Rodovia Augusto Montenegro. Despite an increase by 10% in the total demand from 2007 to 2012, the conventional bus passengers by road segment drop by some 1,000 passengers from the estimates in Case-4. This mainly comes from the completion of the central accessing segment of Avenida Independencia.

Case-6 extends the forecast to 2020 on the same assumptions as Case-5. Relative to the estimates in Case-5, the inbound trunk bus passengers show an increase of 2,000 to 3,000 on all segments of Rodovia BR-316 and Avenida Almirante Barroso. Rodovia Augusto Montenegro shows an increase of around 500 passengers on its trunk bus segments over the Case-5 estimates. The inbound trunk bus passengers on Avenida Almirante Barroso increase to almost 25,000 in one segment, nearing the capacity limit of the articulated bus service on a single lane.

(2) Bus Passengers on Screen Line

Table 10.2-3 and Table 10.2-4 show the forecasts of inbound bus passengers crossing the screen line set up on five roads: viz. Avenida Almirante Barroso, Avenida Pedro Alvares Cabral, Rodovia Arthur Bernardes, Avenida Independencia (to be connected to the Centro after 2007) and Avenida Primeiro de Dezembro (see Figure 10.2-6 for the location of the screen line). Table 10.2-3 compares the passenger forecasts of Case-2 and Case-4 for 2007, and Table 10.2-4 similarly compares Case-3 and Case-5 for 2012.

Inbound bus passengers crossing the screen line per peak hour in the morning totaled about 55,000 in the base year of 2002. The passenger volume is estimated to rise to 59,000 in 2007, 67,000 in 2012 and 70,000 in 2020. In the “with” forecast of Case-4, about 25,000 passengers, or 42% of the total, use the trunk bus service. The total inbound bus passengers on Avenida Almirante Barroso in Case-4 are smaller by some 4,500 than the “without”

forecast of Case-2. This difference indicates the shift of bus passengers to Avenida Primeiro de Dezembro and to a lesser extent to Avenida Pedro Alvares Cabral as well.

In the “with” forecast of Case-5 for 2012, 38,000 passengers, or 57% of the total, use the trunk bus service. 60% of the total trunk bus passengers are on Avenida Almirante Barroso, with the remainder traveling on Avenida Independencia. The combined total inbound passengers on Avenidas Almirante Barroso and Pedro Alvares Cabral are smaller by 18,000 than the “without” forecast of Case-3. This difference points to the shift of bus passengers to Avenidas Independencia and Primeiro de Dezembro.

Table 10.2-3 Peak Hour Inbound Bus Passengers in 2007 on Screen Line

Screen-lined Road	Case-2: Without	Case-4: With			Difference of Passengers: Case-4 – Case-2
	Conventional Bus	Conventional Bus	Trunk Bus	Total	
Av. Almirante Barroso	44,577	15,169	24,905	40,074	-4,503
Av. Independencia	0	0	0	0	0
Av. Primeiro de Dezembro	0	2,840	0	2,840	2,840
Av. Pedro Alvares Cabral	12,023	13,666	0	13,666	1,643
Rod. Arthur Bernardes	2,925	2,737	0	2,737	-188
Total	59,525	34,412	24,905	59,317	-208
Share (%)		58	42	100	

Note: The location of the screen line is shown in Figure 10.2-6.

Table 10.2-4 Peak Hour Inbound Bus Passengers in 2012 on Screen Line

Screen-lined Road	Case-3: Without	Case-5: With			Difference of Passengers: Case-5 – Case-3
	Conventional Bus	Conventional Bus	Trunk Bus	Total	
Av. Almirante Barroso	50,835	14,995	22,609	37,604	-13,231
Av. Independencia	0	0	15,836	15,836	15,836
Av. Primeiro de Dezembro	0	2,222	0	2,222	2,222
Av. Pedro Alvares Cabral	13,040	8,554	0	8,554	-4,486
Rodovia Arthur Bernardes	3,462	3,442	0	3,442	-20
Total	67,337	29,213	38,445	67,658	321
Share (%)		43	57	100	

Note: The location of the screen line is shown in Figure 10.2-6.

Figure 10.2-5 shows the peak hour inbound passengers on Avenida Almirante Barroso estimated by Case-1 through Case-5. The total bus passengers on the avenue drop significantly from 2002 to 2007 in the “with” forecast of Case-4, mainly because the on-going and planned construction works on Avenida Primeiro de Dezembro will be completed by then to take part of the inbound bus passenger flow. The inbound bus passengers on Avenida Almirante Barroso in 2012, as estimated by the “with” forecast of Case-5, drop more sizably, because the central accessing segment of Avenida Independencia will be completed to take part of the bus passenger load off the avenue.

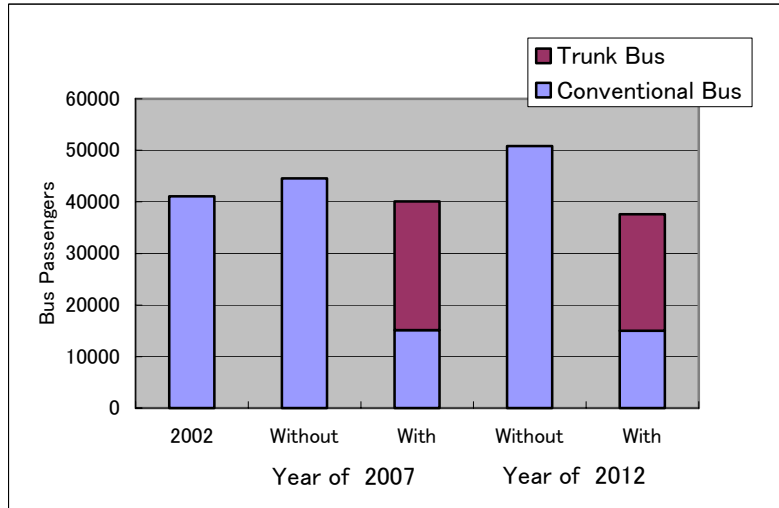


Figure 10.2-5 Inbound Bus Passengers on Avenida Almirante Barroso by Alternative Case

Table 10.2-5 Inbound Bus Passengers on Major Road Segments

(Inbound passenger/Peak hour)

Segment No.	Road	2007				2012			
		Case-2		Case-4		Case-3	Case-5		Total
		Conventional Bus Passengers	Conventional Bus Passengers	Trunk Bus Passengers	Total	Conventional Bus Passengers	Conventional Bus Passengers	Trunk Bus Passengers	
1	Rodovia BR-16	10,960	2,956	6,335	9,291	15,144	2,619	6,832	9,451
2	Rodovia BR-16	24,895	11,605	13,882	25,487	30,987	7,085	14,277	21,362
3	Avenida Almirante Barroso	44,577	15,169	24,905	40,074	50,835	14,995	22,609	37,604
4	Avenida Almirante Barroso	37,978	14,211	23,196	37,407	42,989	14,407	20,534	34,941
5	Rodovia Augusto Montenegro	4,715	2,204	2,522	4,726	7,166	2,995	4,246	7,241
6	Rodovia Augusto Montenegro	12,301	4,476	6,113	10,589	15,242	4,948	8,730	13,678
7	Rodovia Augusto Montenegro	25,942	10,350	16,008	26,358	29,750	9,593	11,854	21,447
8	Avenida Independencia	-	-	-	-	-	-	4,747	4,747
9	Avenida Independencia	-	-	2,667	2,667	-	-	7,771	7,771
10	Avenida Independencia	-	-	-	-	-	-	14,481	14,481
11	Avenida Independencia	-	-	-	-	-	-	15,836	15,836
12	Rodovia do Coqueiro	1,444	1,331	-	1,331	2,081	1,676	4,166	5,842
13	Rodovia do Coqueiro	11,882	7,003	4,178	11,181	14,389	2,466	6,604	9,070
14	Av. Primeiro de Dezembro	-	2,840	-	2,840	-	2,222	-	2,222
15	Av. Pedro Alvares Cabral	9,507	9,452	-	9,452	10,357	6,785	-	6,785
16	Avenida Julio Cesar	2,725	4,080	-	4,080	2,787	4,200	-	4,200
17	Av. Pedro Alvares Cabral	12,023	13,666	-	13,666	13,040	8,554	-	8,554
18	Avenida Pedro Miranda	2,948	1,889	-	1,889	3,302	1,936	-	1,936
19	Avenida Perimetral	5,323	4,298	-	4,298	5,598	4,315	-	4,315
20	Av. Governador Jose Malcher	22,049	10,789	16,762	27,551	23,495	9,969	13,153	23,122
21	Avenida Nazare	6,099	1,959	6,614	8,573	6,675	1,924	6,362	8,286
22	Avenida Jose Bonifacio	4,463	2,647	-	2,647	4,598	2,815	-	2,815
23	Rodovia Arthur Bernardes	2,925	2,737	-	2,737	3,462	3,442	-	3,442
24	Av. Pedro Alvares Cabral	8,770	9,368	-	9,368	9,589	8,087	13,195	21,282
25	Boulevard Castilhos Franca	11,832	6,352	3,484	9,836	13,353	6,214	3,631	9,845
26	Av. Visconde de Souza Franco	7,403	4,301	11,704	16,005	7,839	3,867	7,276	11,143
27	Screen Line No.1	59,525	34,412	24,905	59,317	67,337	29,213	38,445	67,658

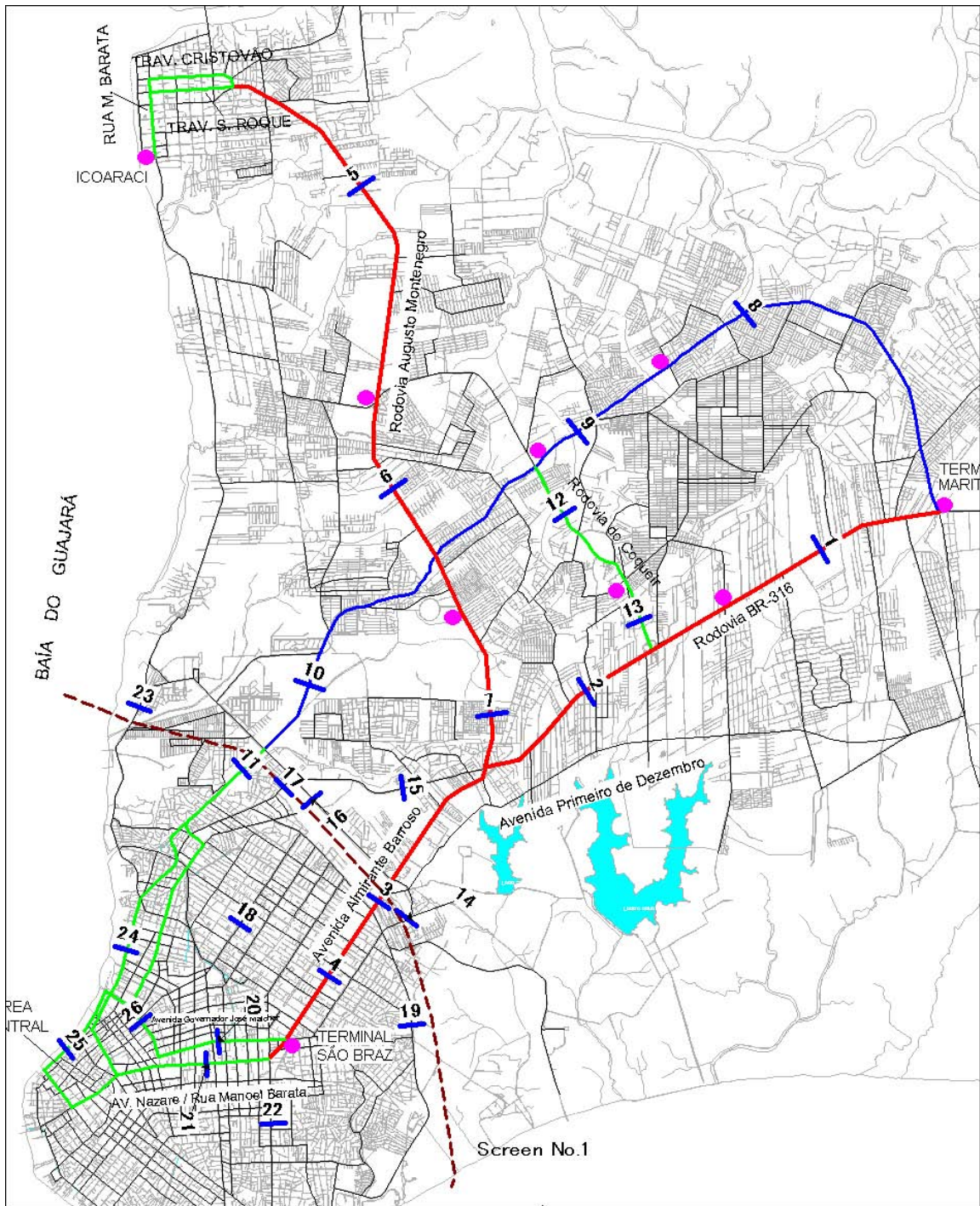


Figure 10.2-6 Locations of Road Segments and Screen Line