11.3.10 Estimate Summary

539. A summary of the estimate by project is shown in Table 11.3-6. For some of the projects, the alternative costs by lane no. are also prepared prior to the preliminary evaluation. However Table 11.3-6 shows only the representative costs.

Table 11.3-6 Road Project Cost Summary (1 US$ = 88 CR$)

ID	Project Name	Dist. (km)	Total Financial Foreign (1000US$)	Total Financial Local (1000Cr$)	Total Economic Local (1000Cr$)	(F%)	Total Financial Cost (MUS$)	Total Economic Cost (MUS$)
R001	P. Cabral	2.54	1260.55	328303	245088	25.3	4.99	4.05
R002	1o.de Dez.(6)	22.34	10934.16	3357229	2619781	22.3	49.08	40.7
R003	Rod.Belem(6)	16.54	12764.82	4590411	3525100	19.7	64.93	52.82
R004	Val de Cans B/	6.31	1854.62	559776	422715	22.6	8.22	6.66
R005	Alm. Barroso	6.1	1342.73	266492	186962	30.7	4.37	3.47
R006	BR-316(6)	8.35	5187.75	1331459	1001225	25.5	20.32	16.57
R007	PA-150	25.56	7710.76	2481443	1911065	21.5	35.91	29.43
R008	P. Miranda	5.29	2483.17	832559	663806	20.8	11.94	10.03
R009	Rod. Aura	14.63	5111.73	1456528	1091020	23.6	21.66	17.51
R010	Rod. Ind.	13.39	4029.76	1212952	915517	22.6	17.81	14.43
R011	Satelite	4.63	1397.21	423836	320421	22.5	6.21	5.04
R012	Icoaraci B/P	6.96	2096.36	599198	444025	23.5	8.91	7.14
R013	Cidade Nova	5.8	1730.68	498200	371455	23.4	7.39	5.95
R014	40 Horas	3.6	1076.19	306047	227366	23.6	4.55	3.66
R015	Alc. Cacela	0	0	0	0	0	0	0
R016	9 de Janeiro	3.86	1630.92	485224	363422	22.8	7.14	5.76
R017	B. Sayao	7.22	6270.66	2625658	2026526	17.4	36.11	29.3
R018	Inner Ring	1.92	580.59	163442	120472	23.8	2.44	1.95
R019	Humaita	1.68	506.85	231363	193850	16.2	3.14	2.71
R020	Loma	1.68	506.85	198627	161112	18.3	2.76	2.34
R021	Rio Una	4.27	3191.06	1399091	1082342	16.7	19.09	15.49
R022	14 de Marco	2.74	825.63	278838	217724	20.7	3.99	3.3
	Total	165.41	72493.04	23626677	18110995	21.3	340.98	278.3

540. The foreign currency portion shows rather low percentages between 16.7% in the case of Una River Road (R21) and 25.5% in the case of BR-316 (R06) reflecting Brazilian industrial situation.

11.4 Road Masterplan Alternatives

541. The following six masterplan cases using the combination of three radial roads; i.e. Av. 1o de Dezembro Extension, Rodvia Belem and Av. Pedro Miranda Extension, and lane numbers are examined to select the most optimal network and to check the future demand / supply balance at the most serious section of the institutional belt. In all the alternatives, the other projects are included under the same condition.

Case "A" the plan with only Av.1o de Dezembro Extension (6 lanes)
Case "B" the plan with only Av.1o de Dezembro Extension (8 lanes)
Case "C" the plan with Av.1o de Dezembro (6 lanes) and Rodvia Belem (4 lanes)
Case "D" the plan with Av.1o de Dezembro Extension (4 lanes) and Rodvia Belem (6 lanes)
Case "E" the plan with Av.1o de Dezembro Extension (4 lanes) and Rodvia Belem (4 lanes)
Case "F" the plan with Av.1o de Dezembro Extension (4 lanes), Rodvia Belem (4 lanes) and Av. Pedro Miranda Extension (4 lanes)

542. The assignment results of 2010 year demand on the various cases and alternative road networks are shown in Figure 11.4-1 through 11.4-6. In Cases A and B, where only Av. 1o de Dezembro Extension is implemented, the traffic concentrates to Entroncamento, while in cases C through E, the traffic is diverted to Rodvia Belem. In case F, the main flow turns to Rodvia Belem - Av. Pedro Miranda Extension.

543. The scattered graph by B/C and the net benefit calculated following the process described in 11.5 is shown in Figure 11.4-7. All the cases show almost the same B/C, while the net benefit varies between 75 - 88 million US$. The highest net benefit occurs in the case F, where Av. Pedro Miranda will be extended across the runway for light planes. Therefore case F was selected as the most optimal network, however if the situation does not allow to construct a road across the runway, case D, where Av. 1o de Dezembro has four lanes and Rodvia Belem has six lanes, will be the second best.

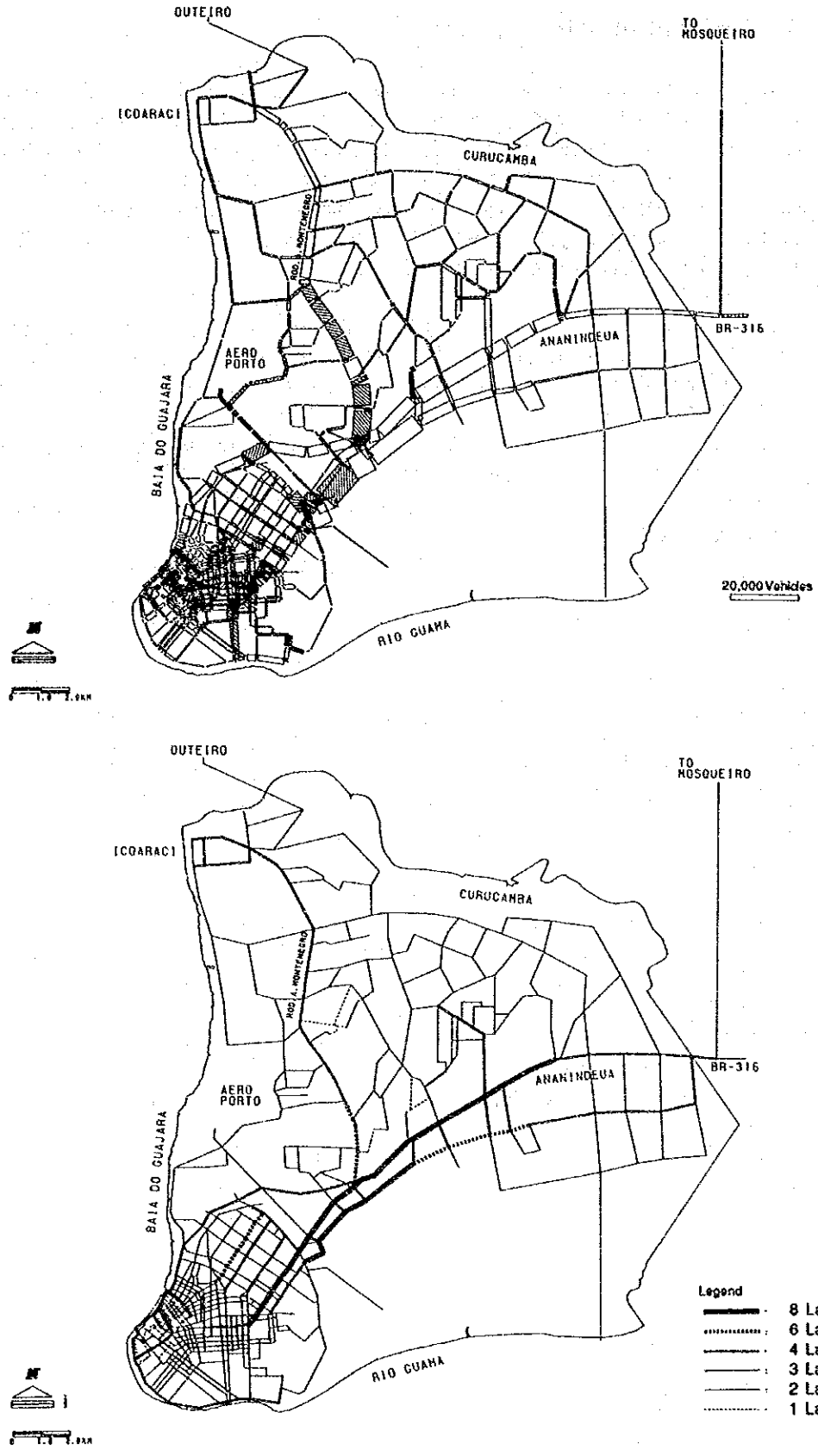
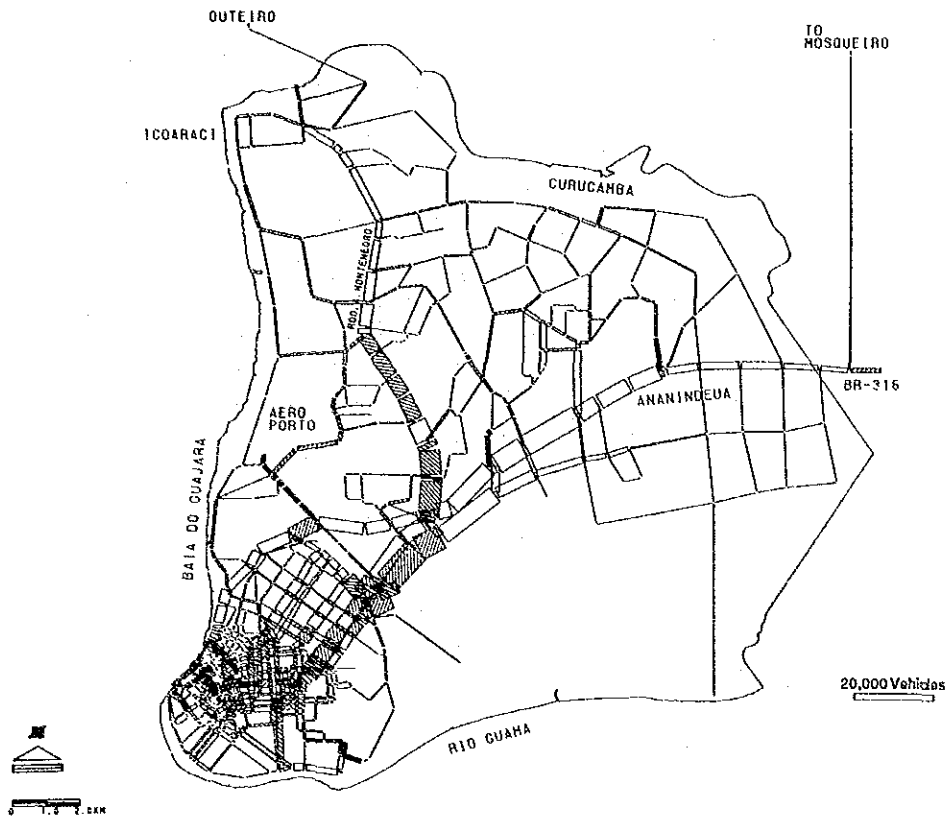


Figure 11.4-1 Result of Traffic Assignment in Yearof 2010 and Road Network under Masterplan Case "A"



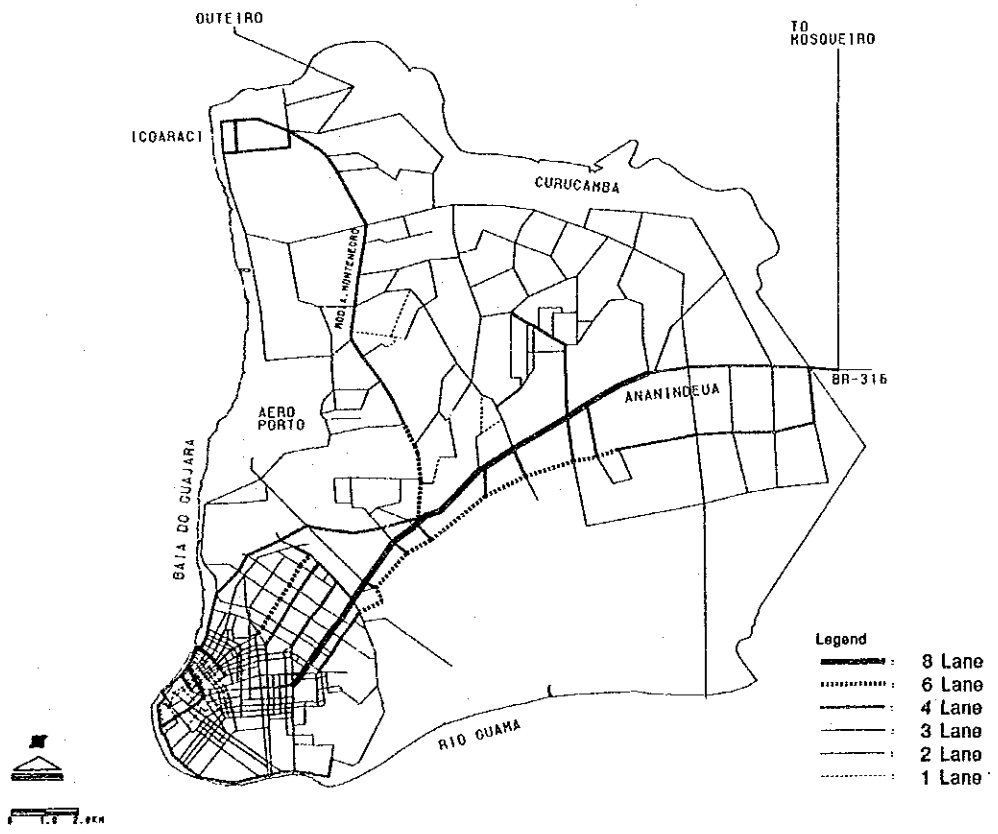
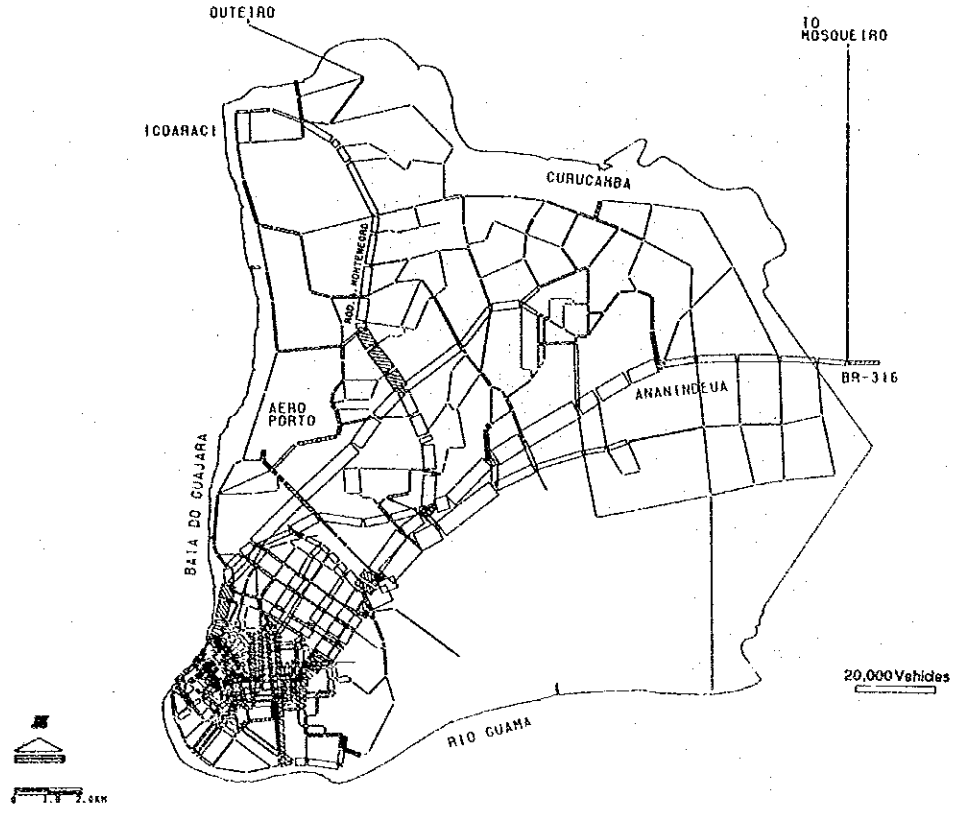


Figure 11.4-2 Result of Traffic Assignment in Yearof 2010 and Road Network under Masterplan Case "B"



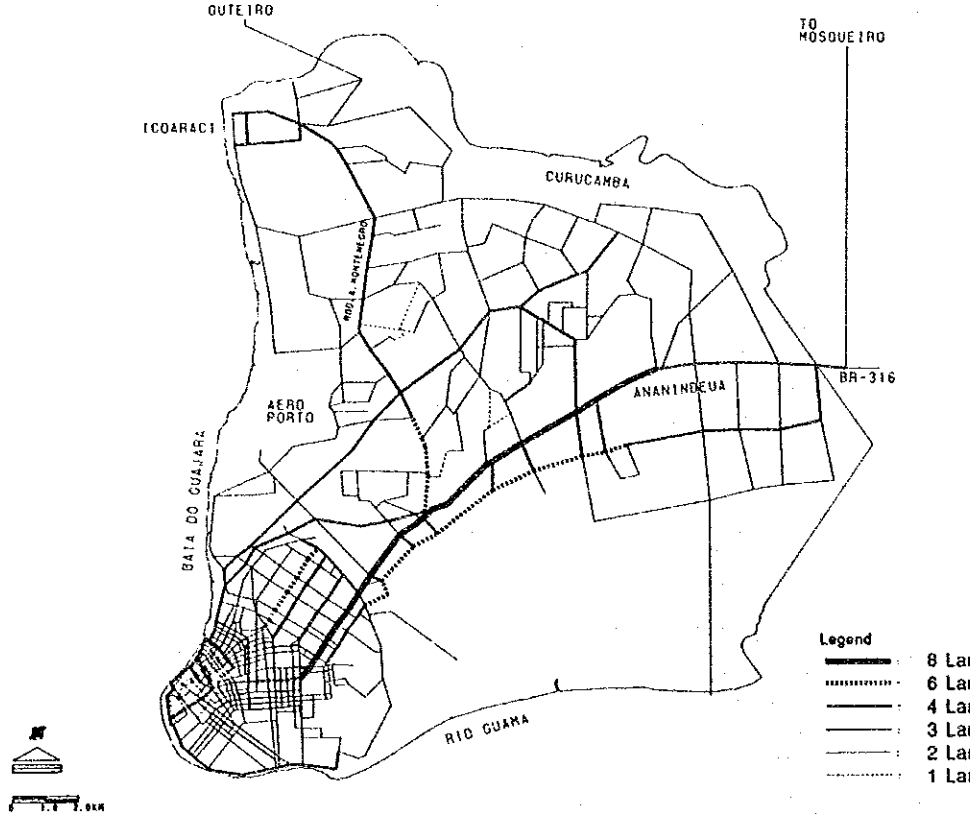
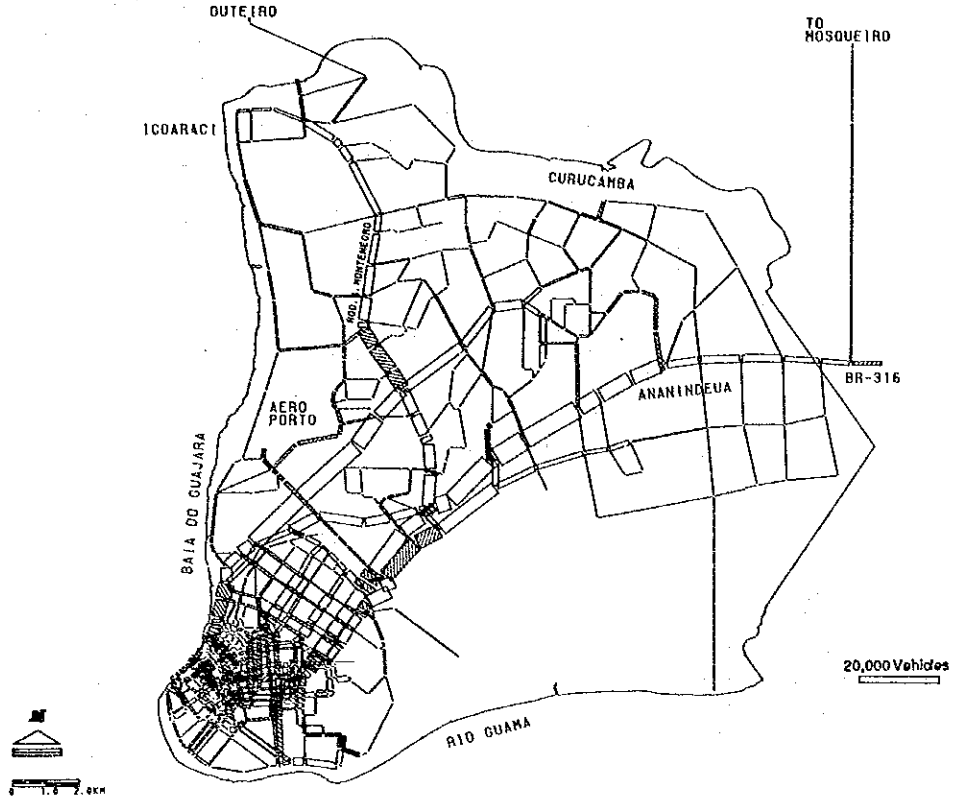


Figure 11.4-3 Result of Traffic Assignment in Yearof 2010 and Road Network under Masterplan Case "C"



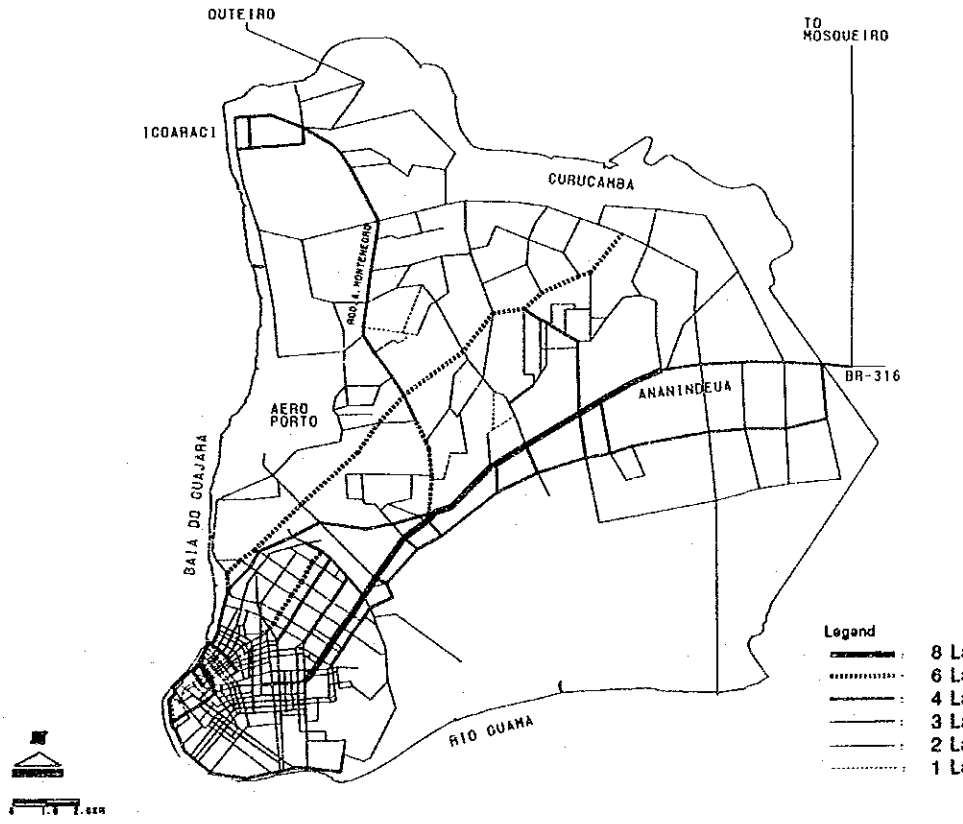


Figure 11.4-4 Result of Traffic Assignment in Yearof 2010 and Road Network under Masterplan Case "D"

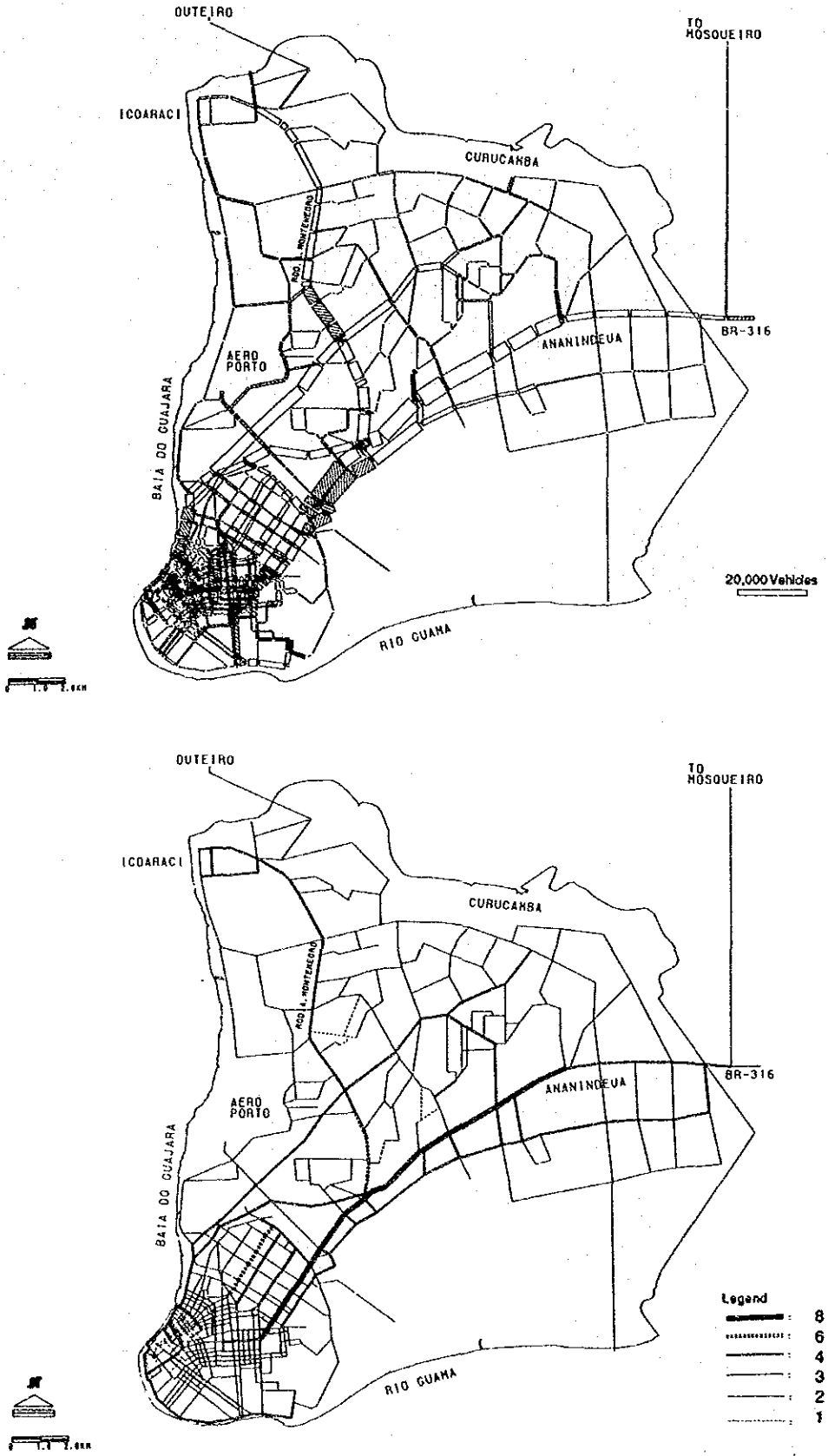


Figure 11.4-5 Result of Traffic Assignment in Yearof 2010 and Road Network under Masterplan Case "E"

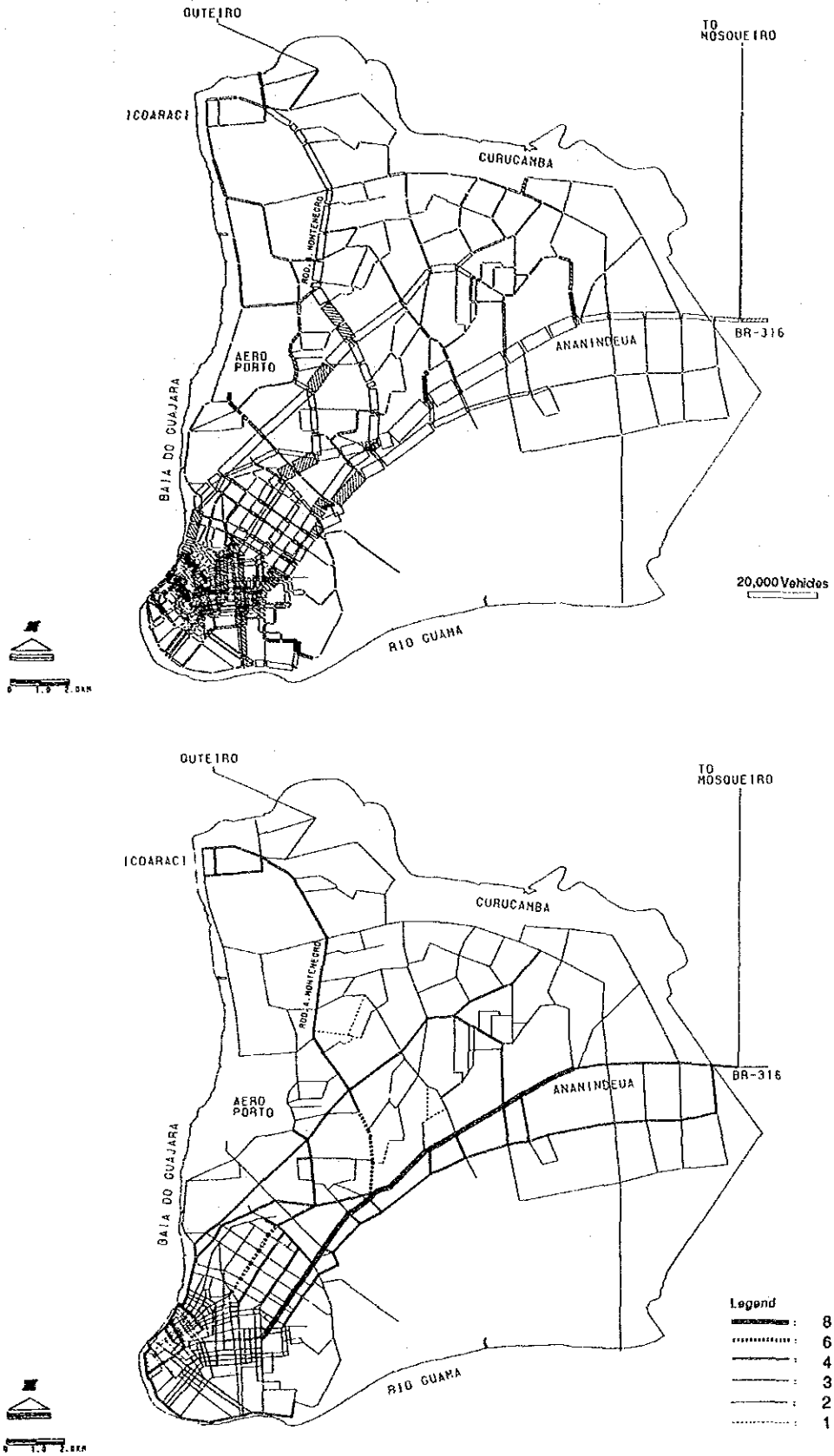


Figure 11.4-6 Result of Traffic Assignment in Yearof 2010 and Road Network under Masterplan Case "F"

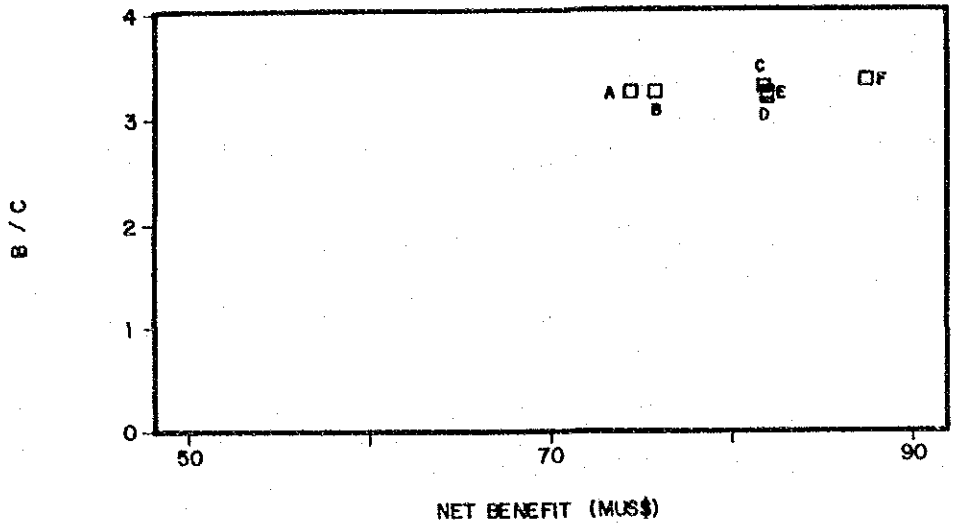


Figure 11.4-7 B/C and B-C of Alternatives

11.5 Priority Ranking and Road Project

11.5.1 Procedure of Priority Ranking

544. The priority of projects should be studied taking into consideration the following elements;

a. Effect on decreasing traffic congestion in entire road network
b. Cost performance of projects from the economic standpoints,
c. Convenience for road users,
d. Financial influence for the executing agency,
e. Influence to communities,
f. Project consensus,
g. Compatibility with policy, and
h. Ease of implementation

545. Some of these elements can be quantified while others are difficult. Therefore the Study focused mainly on the cost performance and benefit scale of projects. A project is considered to have high priority when it has good benefit scale and cost performance; otherwise, the project should be studied in further detail taking the other elements into consideration. A detailed explanation of benefit and cost is given below.

11.5.2 Factor for Calculation

(1) Annual Benefit of Project

546. The benefit of road projects is defined as the vehicle operating cost (VOC) saving in terms of economic price. The VOC saving could be calculated as either;

a. the difference between the total VOC in the Do Nothing Case and of that in the case where a project is executed, or
b. the difference between the total VOC in the case where a project in the Masterplan network will not be executed and the total VOC in the Masterplan network.

547. The VOC saved is expressed as the total VOC decrease in case A above and the total VOC increase in the case B. The Study aims to measure the influence of a project on the Masterplan network, therefore the latter method is adopted to calculate the benefit.

548. To compare the benefits of the projects, the benefits of each project in one year, the year 2010, are calculated so as to eliminate the influence by the variance of the implementation schedule.

(2) Project Cost

549. The construction cost of a project should be expressed on an annual base in calculating B/C of a project in the year 2010. For this purpose, the formula to make annual repayment of principal and interest at one rate for 25 years. An annual interest rate of 12% is applied. The annual repayment rate is calculated at 0.1275 times the principal. Residual values of the road at the 25th year are neglected.

(3) Cost Benefit Ratio (B/C)

550. The cost benefit ratio is selected to represent the cost performance of a project. The benefit in the year 2010 and the cost in the same year calculated following the procedure given above is applied to obtain the B/C ratio. The economic cost of the project is applied for the calculation.

11.5.3 Project Priority

551. Figure 11.5-1 shows the scattered graph of road projects by B/C and the net benefit. The project which has the highest net benefit is Av. Pedro Miranda Extension (R08). It also has a high B/C. However the cost to relocate the light airplane airport is not included in this project cost, and the cost of relocation will be much more than the cost of the road construction itself, therefore the result will change if it is included.

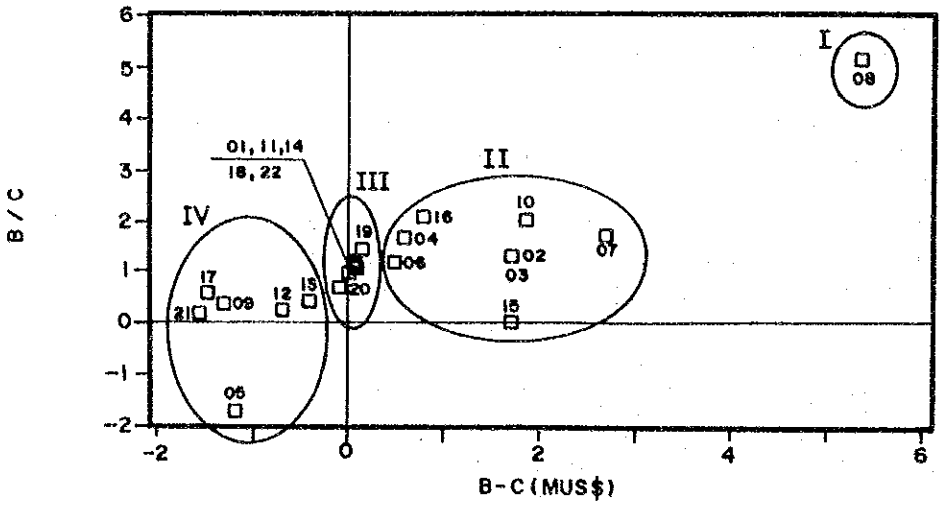


Figure 11.5-1 Project Grouping by B/C and B-C
(Unit: thousand)

552. PA-150 (R07) and Rodvia Industrial (R10) have high net benefits following Av. Pedro Miranda Extension. Since in the masterplan road network, there is no alternative route for PA-150 or Rodvia Industrial, VOC in the network without each of these two routes increased significantly. Av. Alcindo Cacella (R15) shows also a high net benefit because of the lower project cost. However this project can be implemented only after Av. 9 de Janeiro is completed, therefore the priority of Av. Alcindo Cacella can not be determined solely from this Figure.

553. Av. 1o de Dezembro Extension (R02) and Rodvia do Belem (R03) show high net benefit and B/C slightly over 1.0. The results mean that the absence of either of two routes would cause the serious increase of VOC in the masterplan network, despite the fact that these two roads are mutually competitive routes. It is noted that the masterplan network alternatives show larger net benefit and higher B/C, if Av. Pedro Miranda Extension is implemented in addition to these two projects.

554. In Av. Almirante Barroso improvement (R05), the cost includes the works necessary to convert the central four lanes out of a total of eight lanes to exclusive bus lane. VOC saving can not be expected from this project.

555. Considering the above situations, the projects can be aggregated into the following four groups.

a. The first group consists of the project with high net benefit and B/C. Only Av. Pedro Miranda Extension (R08) is included in this group.
b. The second group consists of the projects with medium net benefit and B/C beyond 1.0. Av. 1o de Dezembro Extension (R02), Rodvia do Belem (R03), PA-150 (R07), Rodvia Industrial (R10), and Tv. 9 de Janeiro (R16) are included in this group.
c. The third group consists of projects with less net benefit, and the projects with less costs. Av. Pedro Cabral (R01), Local Arteries in Satelite (R11), Estrada 40 Horas (R14) are included in this group.
d. The fourth group consists of the projects with negative net benefit, and the projects with comparatively high costs aiming to improve living environment rather than to save VOC. Una River Road (R21) and Av. Bernardo Sayao (R17) are included in this group.

556. Generally the urban road network improvement project aims to decrease the vehicle*hour, while the vehicle*Kms tends to increase by detour of the routes. The projects which show less vehicle*Km (the network without the project has advantage from the view point of Vehicle*Km) than that in the masterplan network are

two projects of Av. Bernardo Sayao and Tv. 9 de Janeiro. In the case of Tv. 9 de Janeiro, the one-way system both on Tv. 9 de Janeiro and Av. Alcindo cacella, where two-way system is operated at present, will be introduced after the improvement of Tv. 9 de Janeiro. Therefore no implementation of the project will decrease vehicle*Km.

557. However the benefit by the improvement of vehicle*hr. is much higher than the negative benefit by the decrease of vehicle*Km, and the cost is covered by the difference in benefits. While in the case of Av. Bernardo Sayao, where the most part of the project cost consists of the improvement of the canal along the road, the cost can not be covered by the benefit incurred from improvement of vehicle*hr., and therefore the net benefit shows a negative value.

11.5.4 Comprehensive Priority Ranking of the Projects

558. To calculate the priority ranking of the projects, the following elements are considered in addition to the grouping by the net benefit and B/C.

a. Consensus
   The projects which have consensus : 1
   The projects which were proposed for the first time in the Study : 3
   The projects in the intermediate stage : 2
b. Social influence
   The projects without social influence : 1
   The projects with serious social influence : 3
   The projects with intermediate social influence : 2
c. The projects stage
   The projects in the implementation stage : 1
   The projects with no action : 3
   The projects in the intermediate stage : 2

559. The comprehensive project priority is established by classifying the sum of the total points of evaluation elements into four ranks as shown in Table 11.5-1. The accumulation of the financial costs of the projects by rank is shown in Figure 11.5-2. The financial cost to implement the projects in the priority ranking one and two is estimated at 156 million US$, 246 and 341 million US$ present total costs when priority ranking 3 and priority ranking 4 respectively are considered.

Table 11.5-1 Comprehensive Project Priority Ranking

PROJECT ID	PROJECT NAME	DIST (KM)	TOTAL FINANCIAL (MUS$)	TOTAL ECONOMIC (MUS$)	GP	CONS	SOCIAL	STAGE	TOTAL	RANK
	TOTAL	165.41	340.98	278.30						
R001	P. CABRAL	2.54	4.99	4.05	3	1	1	1	30	1
R002	1 DE 12(6)	22.34	49.08	40.70	2	1	3	2	40	2
R003	ROD BELEM(6)	16.54	64.93	52.82	2	3	3	3	55	4
R004	V/C B/P	6.31	8.22	6.66	2	1	2	2	35	2
R005	ALM. BARROSO	6.10	4.37	3.47	4	1	1	3	45	3
R006	BR316(6)	8.35	20.32	16.57	2	1	2	2	35	2
R007	PA-130	25.56	35.91	29.43	2	1	2	1	30	1
R008	P. MIRANDA	5.29	11.94	10.03	1	3	3	3	50	3
R009	ROD AURA	14.63	21.66	17.51	4	3	2	3	60	4
R010	ROD IND.	13.39	17.81	14.43	2	2	1	1	30	1
R011	SATELITE	4.63	6.21	5.04	3	2	1	2	40	2
R012	ICO B/P	6.96	8.91	7.14	4	3	2	2	55	4
R013	ACC. C. NOVA	5.80	7.39	5.95	4	2	1	2	45	3
R014	40HORAS	3.60	4.55	3.66	3	3	1	2	45	3
R015	A. CACELLA	0.00	0.00	0.00	2	1	1	1	25	1
R016	9 DE 1	3.86	7.14	5.76	2	1	3	1	35	2
R017	A. SAYAO	7.22	36.11	29.30	4	2	2	2	50	3
R018	I. RING	1.92	2.44	1.95	3	3	2	2	50	3
R019	HUMAITA	1.68	3.14	2.71	3	2	1	1	35	2
R020	LOMA	1.68	2.76	2.34	3	2	1	1	35	2
R021	RIO UNA	4.27	19.09	15.49	4	1	2	2	45	3
R022	14 DE 3	2.74	3.99	3.30	3	2	2	2	45	3

560. The projects with high priority are such arteries in the sub-urban development area as PA-150 (R07) and Rodvia Industrial (R10). The projects with less priority are such arteries and local arteries also in the suburban development area as Rodvia do Belem (R03), Rodvia Aura (R09) and Icoaraci Bypass (R12), however especially in the case of Rodvia do Belem, the comprehensive priority is decreased by the aspects of land acquisition and project implementation, not by the aspect of demand / supply balance. Therefore the project remains as one of the most important projects from the aspects of demand or its magnitude of influence to the BMR urban structure. While in the case of Rodvia Aura and Icoaraci Bypass, they should be implemented in association with the development of adjacent area, and only ROW should be currently reserved for future implementation.

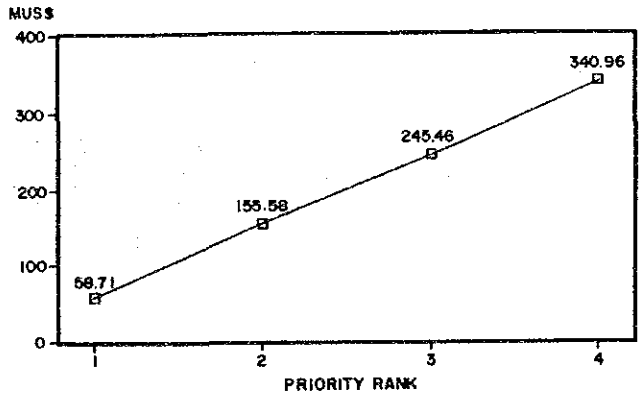


Figure 11.5-2 Financial Cost of Road Project by Priority Ranks

11.6 Implementation Schedule of Road Projects

11.6.1 Road Network in the year 2000

561. Figure 11.6-1 shows the average congestion rates (V/C) of each case. The average congestion rate in 1990 is 0.39 and it will increase up to 0.88 in the year 2010 under the "Do Nothing" case. If the projects in the priority ranking 1 and 2 are implemented by the year 2000 and all the projects by the year 2010, the average congestion rate will increase gently up to 0.53 in the year 2010, and almost the same rate as that in the present can be maintained. If the projects in the priority ranking 3 or 3 and 4 are implemented by the year 2000, the average congestion rate will decrease below the rate at present indicating over investment judging from the traffic situation at present (refer to Figures 11.6-4 and 11.6-5).

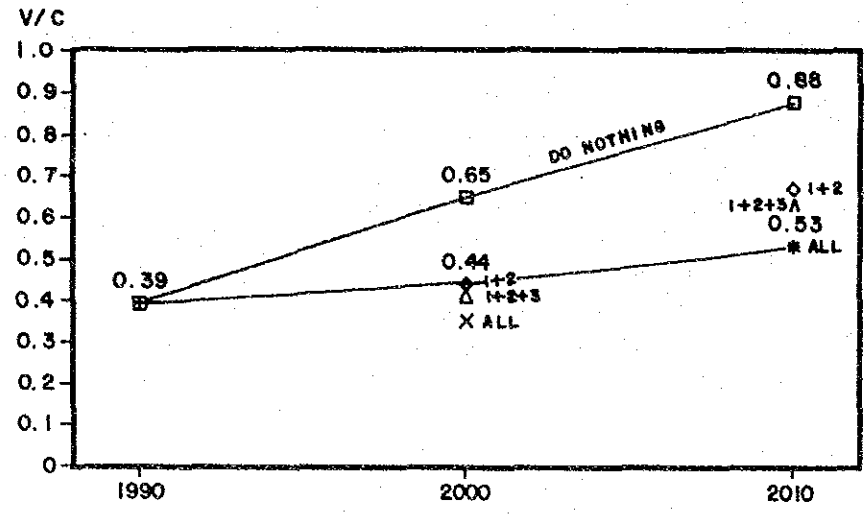


Figure 11.6-1 Average Congestion Rates by Priority Rank and Year

11.6.2 Implementation Schedule

562. Figure 11.6-2 shows the road project implementation schedule established taking the road network in the year 2000 into consideration. The annual investment amounts and accumulative curve in terms of present financial cost are given in Figure 11.6-3.

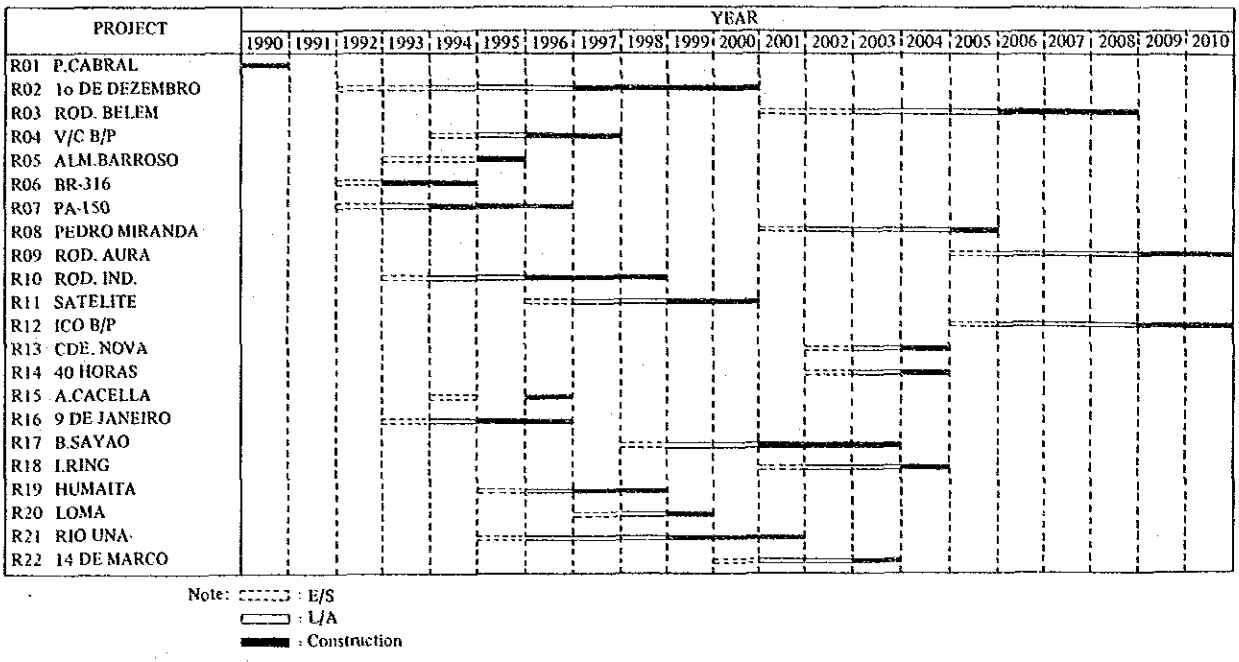


Figure 11.6-2 Implementation Schedule

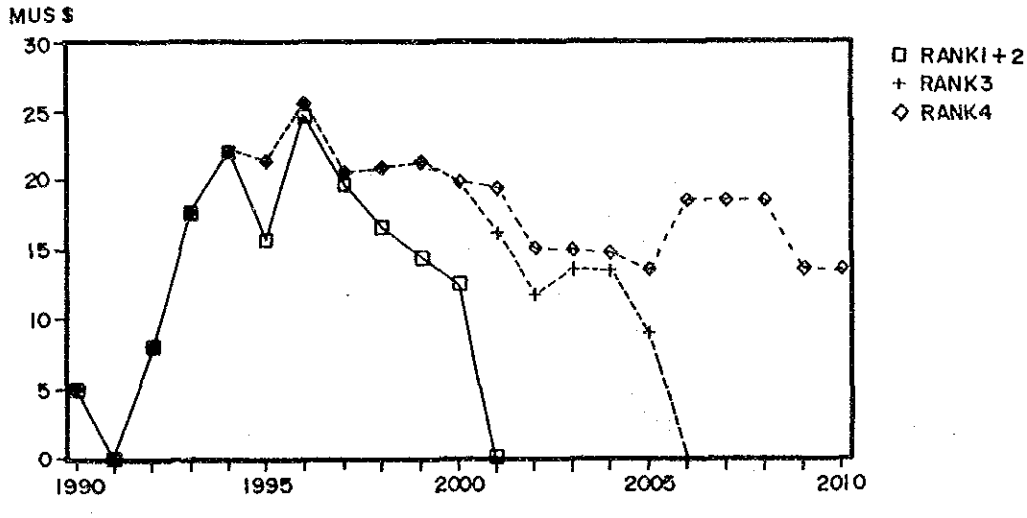


Figure 11.6-3 Annual Amount of Investment

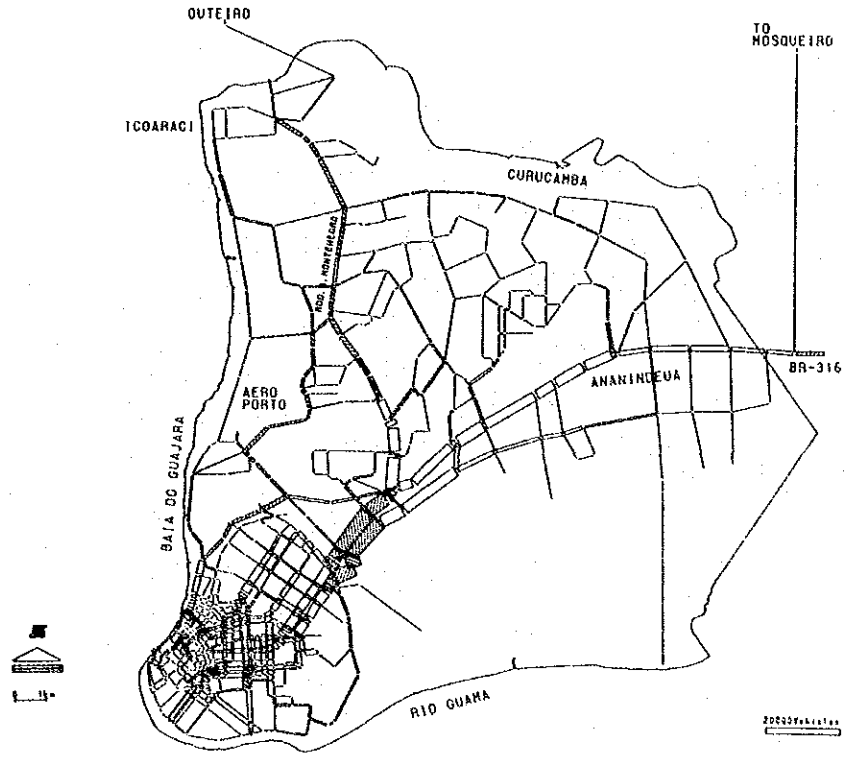


Figure 11.6-4 Result of Traffic Assignment in Year 2000 on Road Network with Project Ranks 1 and 2

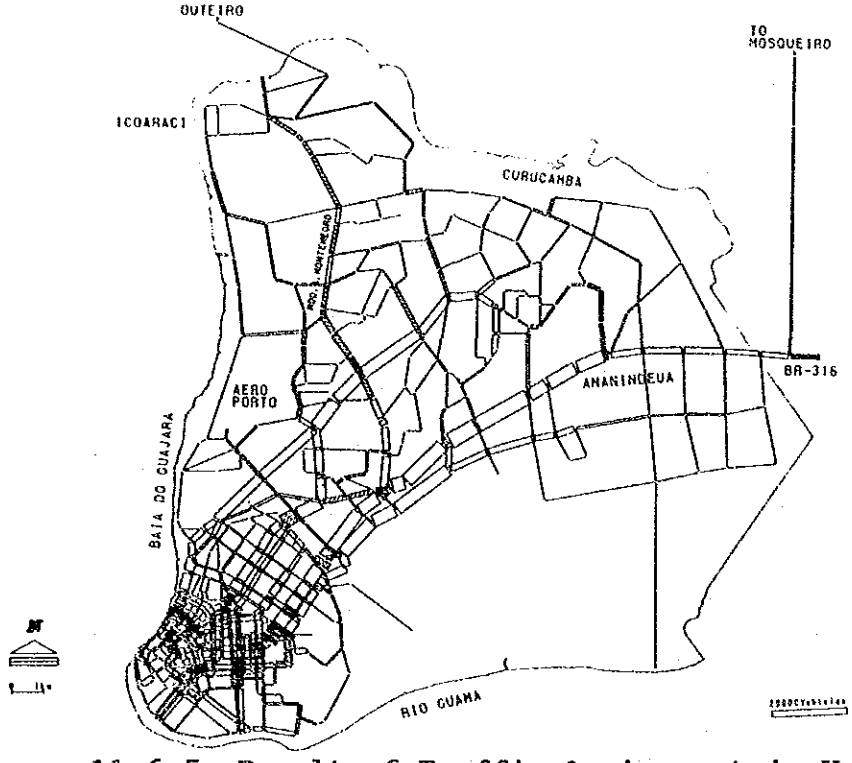


Figure 11.6-5 Result of Traffic Assignment in Year 2000 on Road Network with Project Ranks 1,2,3 and 4

11.7 Influence on Road Network Plan by Alternatives

11.7.1 Influences on Road Network Plan in case of Car Ownership Alternative

563. In case of car ownership increase by 1.5 times than the estimation, the congestion of road traffic on major roads increase. The rates of congestion of BR-316/Av. Almirante Barroso, Av. 1o de Dezembro and Rd. Belem become over 1.0 and those of Rd. Augusto Montenegro and Trans Coqueiro over 1.5 (refer to Figure 11.7-1).

564. It should be considered that the wider road widths of road network, especially of Av. 1o de Dezembro, Rd. Augusto Montenegro, Val de Cans Bypass and Trans Coqueiro road, are planned.

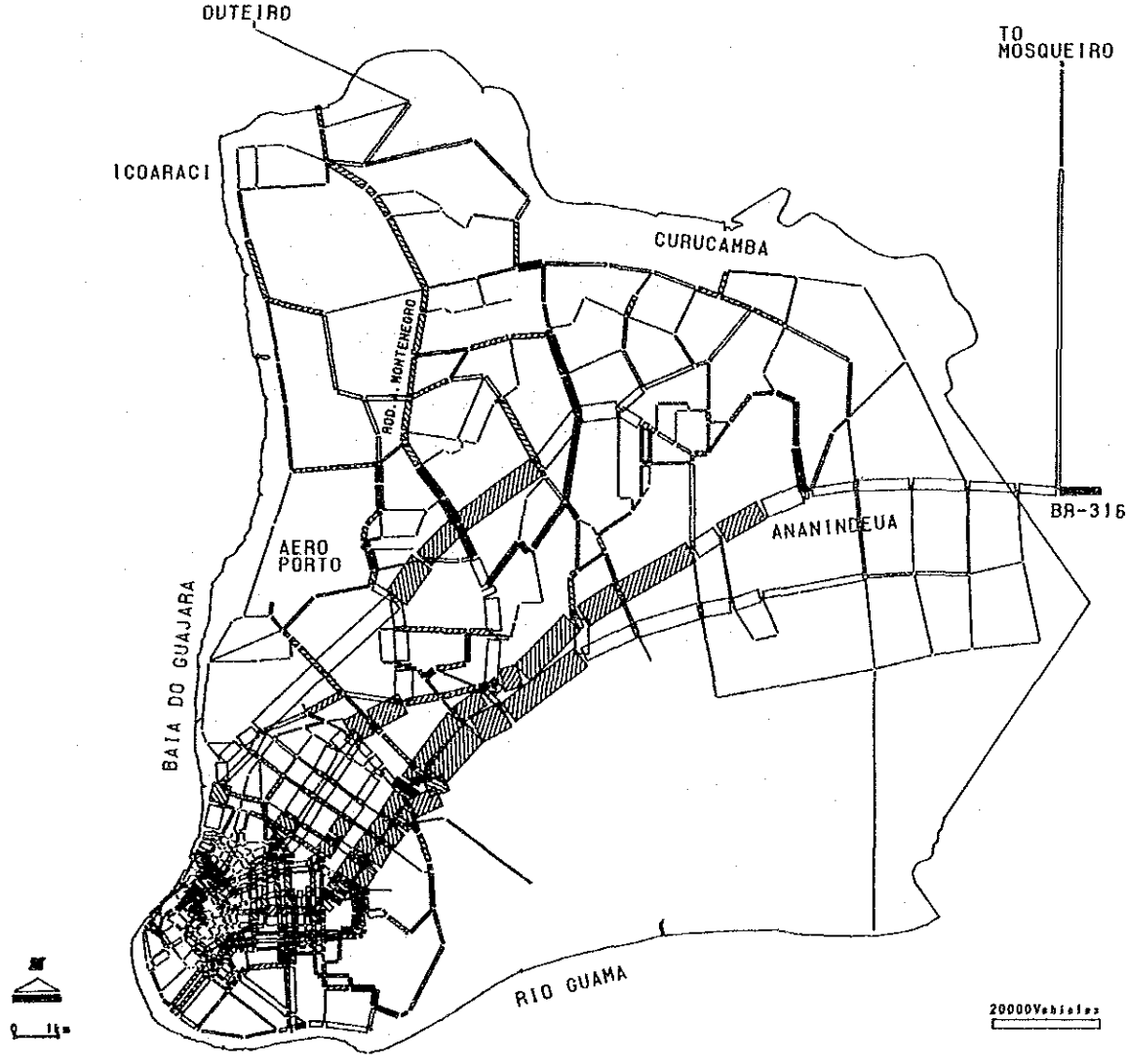
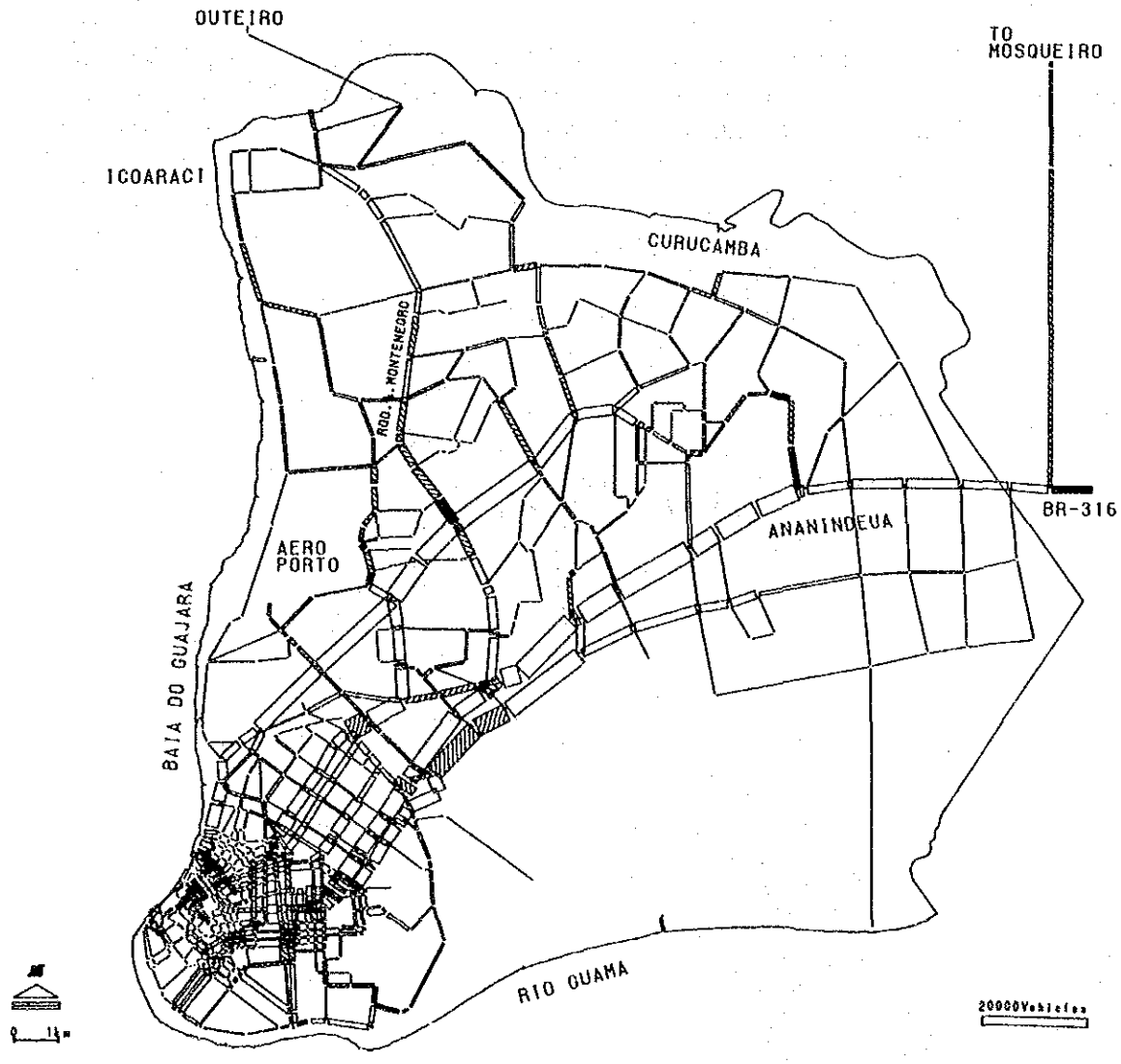


Figure 11.7-1 Traffic Assignment Result

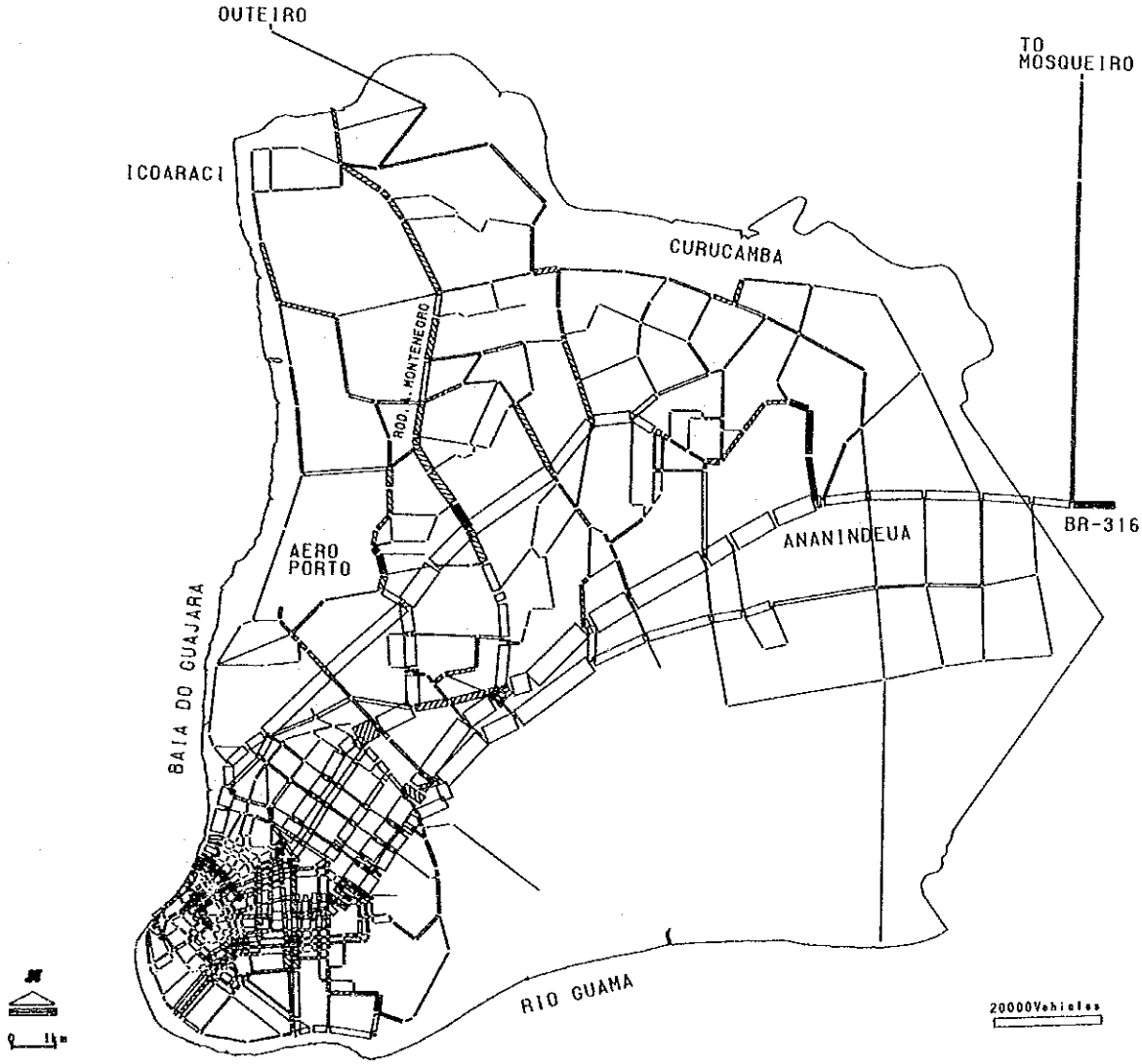
11.7.2 Influence on Road Network Plan in case of Land Use Alternative

565. Not so apparent influence on road network is obtained by land use change. On some road sections in suburban area, traffic volumes increase by little amount, but it is considered to be no effect on road network planning (refer to Figure 11.7-2(A) and (B)).



(Base Case)

Figure 11.7-2(A) Traffic Assignment Result



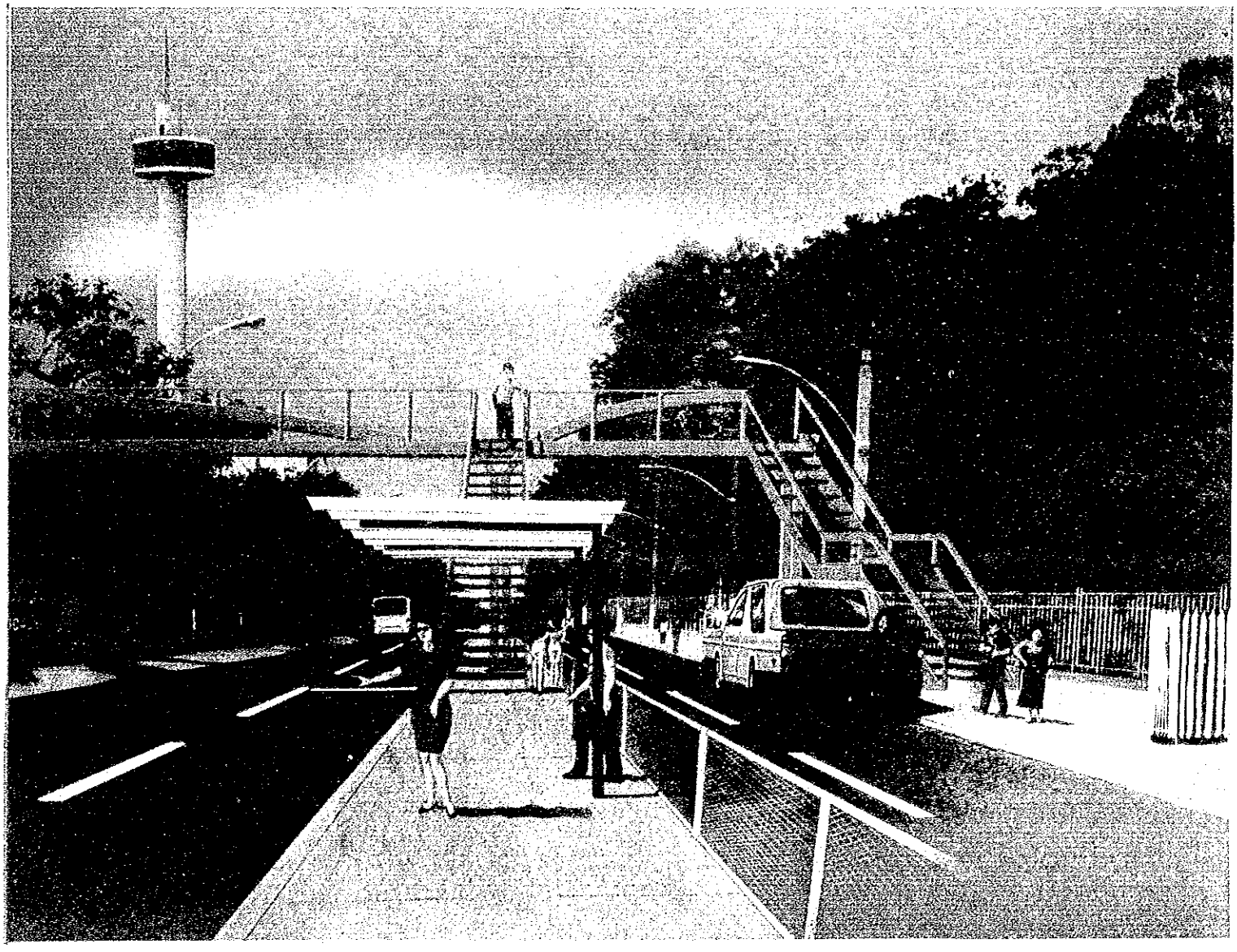
(Land Use Alternative)

Figure 11.7-2(B) Traffic Assignment Result

12. Public Transport Plan

12.1 Demand Structure 297
12.2 Requirement of the Public Transport Service 300
12.3 Strategy 302
12.4 Bus Plan 304
12.5 Minibus and Taxi Plan 335
12.6 Projects 339

Bus Stop for Exclusive Bus Lane ▼



12.1 Demand Structure

(1) Increase of Demand

566. Traffic assignment onto a spider network is shown on Figure 12.1-1. On the figure, traffic 1n 1990 is shown with two lines inside of an assignment rectangle and traffic in 2010 with two lines outside of the box. Consequently, black painted areas show an increase from 1990 until 2010.

567. The figure shows several remarkable changes. The first one is movement of a center of the city from Centro to Sao Braz - Can. It follows as a logical consequence of development of the BMR. The north - eastward spread of the city center along Av. Almirante Barroso started and might continue.

568. The second remarkable change is concentration of traffic onto the trunk axis. Pattern of traffic flow has no change but volume of increase is significant at originally high demand sections.

569. The largest volume of traffic is seen between Souza (zone 26) and Entroncamento (zone 27), and between Entroncamento (zone27) and Marco Norte (zone 20). These are nearly 940,000 movement of persons.

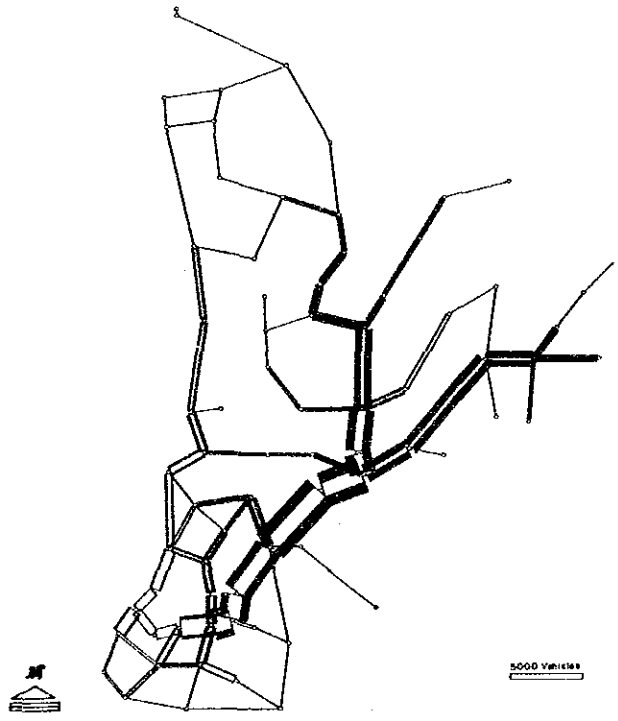


Figure 12.1-1 Traffic Assignment on Spider Network

(2) Traffic Demand and Supply Balance

570. Demand assignment on the existing network in 1990, 2000 and 2010 are shown on Figure 12.1-2 a,b,c. Traffic at A section and at B section during twenty years (1990-2010) increase 2.1 times (A section) and 2.5 times (B section).

571. Rate of passenger volume on crowded direction at peak hour to daily volume is 0.114. Assume that peak available passenger places are 40,000 (see p. VII-23, Proceedings of CODATU V), traffic at A and at B sections after the year 2000 exceed ceiling (refer to Table 12.1-1 and Figure 12.1-2 a,b,c).

Table 12.1-1 Demand-Supply Balance (unit; 1000)

Demand	Section	Year 1990	2000	2010	Supply (Ceiling)
24 Hrs	A	354	542	746	40
	B	376	679	931	40
Peak Hr	A	40	62	85	40
	B	43	77	106	40

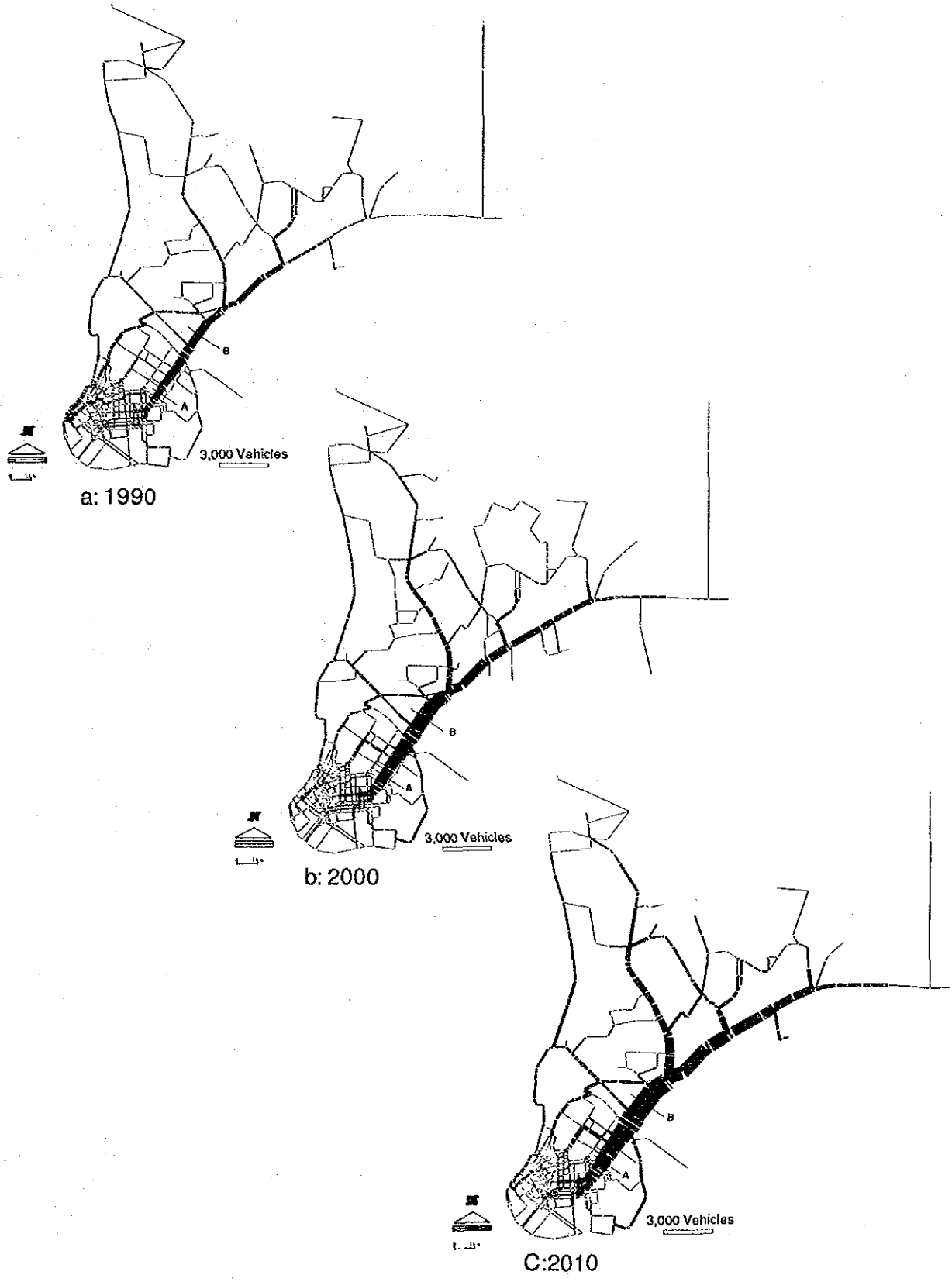


Figure 12.1-2 Demand Assignment on Existing Network

12.2 Requirement of the Public Transport Service

(1) Increase of Transport Capacity

572. Shortage of transport capacity is foreseen in future. Increase of transport capacity along trunk axis is necessary. Due to the public financial limitation, installment of railway system in the masterplan period might be out of economic range (see section 12.4.3). Some innovation is required to the conventional bus transport system.

(2) Maintenance of Reasonable Profit for Supplier

573. Only private companies are bus service suppliers in BMR at present and will be in future. To maintain their interest in investment in public transport businesses is highly important. From that point of view maintenance of reasonable profit for them is also of great concern.

(3) Maintenance of Punctuality

574. Punctual operation is fairly well maintained by existing bus transit at present. To maintain existing level of punctuality and cope with increase of road traffic in future is not easy but is strongly urged.

(4) Improvement of Service in Transport Poor Areas

575. Small demand areas are suffering low level of service. Improvement of service in transport poor areas is a social requirement even if all of transport services are carried out by private entities.

(5) Provision for Diversified Demand

576. The gap of quality of transport between private car and buses is wide. High quality public transport is needed now and will be increasing. Proposals to provide new transit modes to fit these requirements might cause substantial concern.

(6) Economy of Additional Cost

577. Financial condition of Brazilian Government are such that it can only afford to expend her tight budget for projects under the imperative necessity. Cost economy applied to all of projects is strongly recommended.

(7) Maximum Use of Existing Facilities

578. Much investment has been spent on the urban transport facilities in BMR. Applying restraint on additional costs, suggests that emphasis should be put on the maximum utilization of the existing public transport facilities.

12.3 Strategy

(1) Improvement with Each Forward Step

579. Public transport system at present is becoming out of date in response to change of requirement of public transport users. Immediate start of modernization is urgently needed in spite of shortage of investment resources. The only possible way to respond to the situation is to adopt each possible step towards modernization.

(2) Maintenance of Existing Public Transport Framework

580. Main public transport mode is bus, which transports 1.24 million passengers. The increase passengers relying on public transport is expected to be 1.7 times, 2.11 million, in the year 2010. This figure is not small for bus system, but "economy of additional cost" concept that requires bus network overcomes difficulties caused by the transportation of large volume of passengers.

(3) Inducement of Private Investment to Public Transport Field

581. Some additional investments to enhance bus transport capability are inevitable. In the case that public money sources is lacking, inducement policy of private investment money becomes important.

(4) Inducement of Trunk Line Concept

582. In the future, the most serious public and quantifiable transport problem is congestion on trunk axis composed of Av Almirante Barroso, and BR-316. Exclusive trunk lane achieves efficiency of bus transport. Possibility of its inducement should be examined.

(5) Inducement of Better Service in Quality

583. There is big difference in quality of private car trip and bus trip. Middle income class people require better quality public transit. In addition this middle income class is growing in number. Introduction of better quality mode is one of the most reasonable way to meet this demand.

(6) Establishment of New Public Transport Administration

584. It is not easy task to talk to private bus suppliers operating at present about inducement of trunk line concept. One promising proposal to achieve it is to prevent private operators from the collection of tariffs and to assure the operators of payments of operating costs with appropriate profit. Establishment of new public transport administration is recommended to handle these works. This new organization is expected to grow to have power to change bus network.

12.4 Bus Plan

12.4.1 Alternative Networks

585. Trunk/feeder integration system is well known in Brazil and some cities have partially introduced it. Exclusive bus lanes are also seen in Brazil and are performing efficiently. Basic concept of alternative creation is trunk/feeder integration system.

586. Five fundamental alternatives are proposed, which are present network (alternative no. 1 as "do-nothing case"), current operating system with future road network (alternative no.2), trunk/feeder integration network corresponding to the present road network (alternative no.3), trunk/feeder integration network corresponding to the masterplan network (alternative no. 4) and rail/bus integrated network (Alternative no. 5)..

587. The trunk/feeder integrations happen at the integration points. Physical and tariff integration are assumed in all alternatives.

(1) Alternative No. 1

588. This alternative represents the actual network, which serves as basis of comparison for evaluation of other alternatives. (refer to Figure 12.4-1)

(2) Alternative No. 2

589. Alternative 2 also follows conventional bus operation system. Changes from Alternative no.1 are applied mainly in order to fit it to the future masterplan road network. More specifically, some suburban routes are changed from on existing roads to on the proposed road. Almost all routes reach central area, same as Alternative no. 1 (refer to Figure 12-4-2).

(3) Alternative No. 3

590. Alternative no. 3 has six trunk routes, two main ones and four secondary ones.

Main Trunk Routes

- BR-316 road, Av. Almirante Barroso, Av. Magalhaes Barata, Av. Nazare, Centro, Av. Gentil Bittencout,
- Av. Augusto Montenegro road, Av.Pedro Alvares Cabral, Centro.

Figure 12.4-1 Route Network of Alternative 1

Figure 12.4-2 Route Network of Alternative 2

These two routes run through roads consolidated at present as transport corridors.

Secondary Trunk Routes

- Arthur Bernardes road until it meet with Av. Pedro Alvares Cabral.
- Cidade Nova Residential Area, 40 Hrs road, Coqueiro road, BR-316 road until it reaches Entroncamento.
- UFPA, Tv. Padre Eutiquio, Centro, Tv. Apinages.
- Av. Pedro Miranda, Av. Antonio Barreto, Av. Visconde de Souza Franco and Centro.

The secondary trunk routes are chosen from these roads in need of rationalization of the whole trunk/feeder system in BMR.

591. The short extension of the 42 feeder routes allows the maintenance of high frequency of services with a relatively small fleet of buses. A feeder route is assigned to serve the demand of a small area. (refer to Figure 12.4-3)

(4) Alternative No. 4

592. This alternative is prepared for the masterplan network in the year 2010. Three trunk routes out of six prepared for an alternative no. 3 are adopted without modification. The other three, however, were given some changes to serve other areas as follows;

- A trunk route which runs on Av. Pedro Miranda was extended until Icoaraci, passing over Marambaia, Bengui and Tapana.
- A Guama trunk route runs on Avs. Perimetral, Dr. Freitas, Senador Lemos and reaches Telegrafo integrated transfer terminal.
- A Cidade Nova trunk route is extended to the center of Ananindeua via Maguari Road.

593. In addition to those six, two new trunk routes are created, of which one connects Ananindeua and Icoaraci and another connects Cidade Nova and Telegrafo integrated transfer terminal. Consequently, eight trunk routes are lined up.

594. Modification of feeder system corresponding to the newly proposed roads, such as Av. 1o de Dezembro, roads in Icui-Guajara and Bengui area, and Tvs. Alcindo Cacela/ 9 de Janeiro, are considered (refer to Figure 12.4-4)

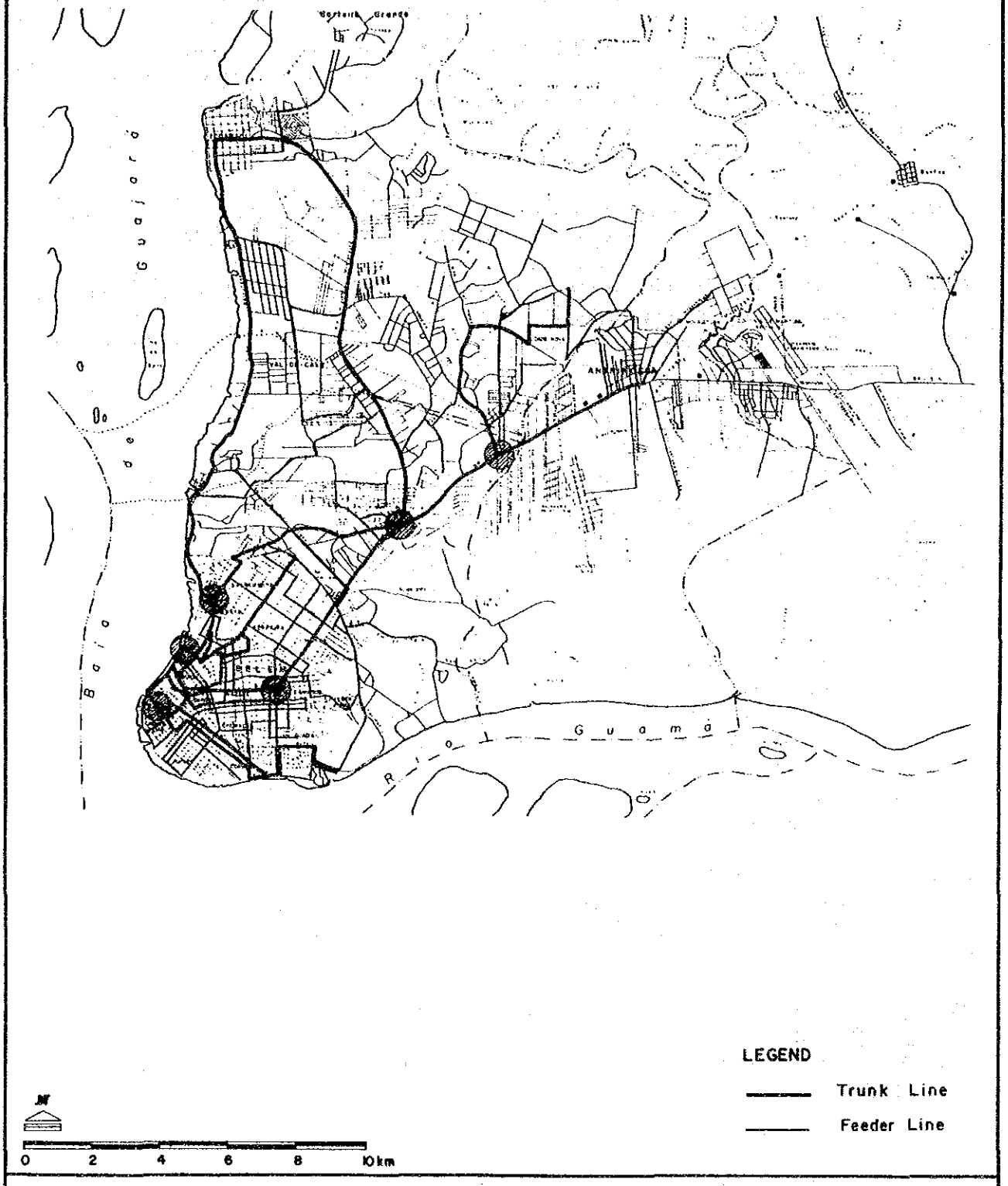


Figure 12.4-3 Route Network of Alternative 3

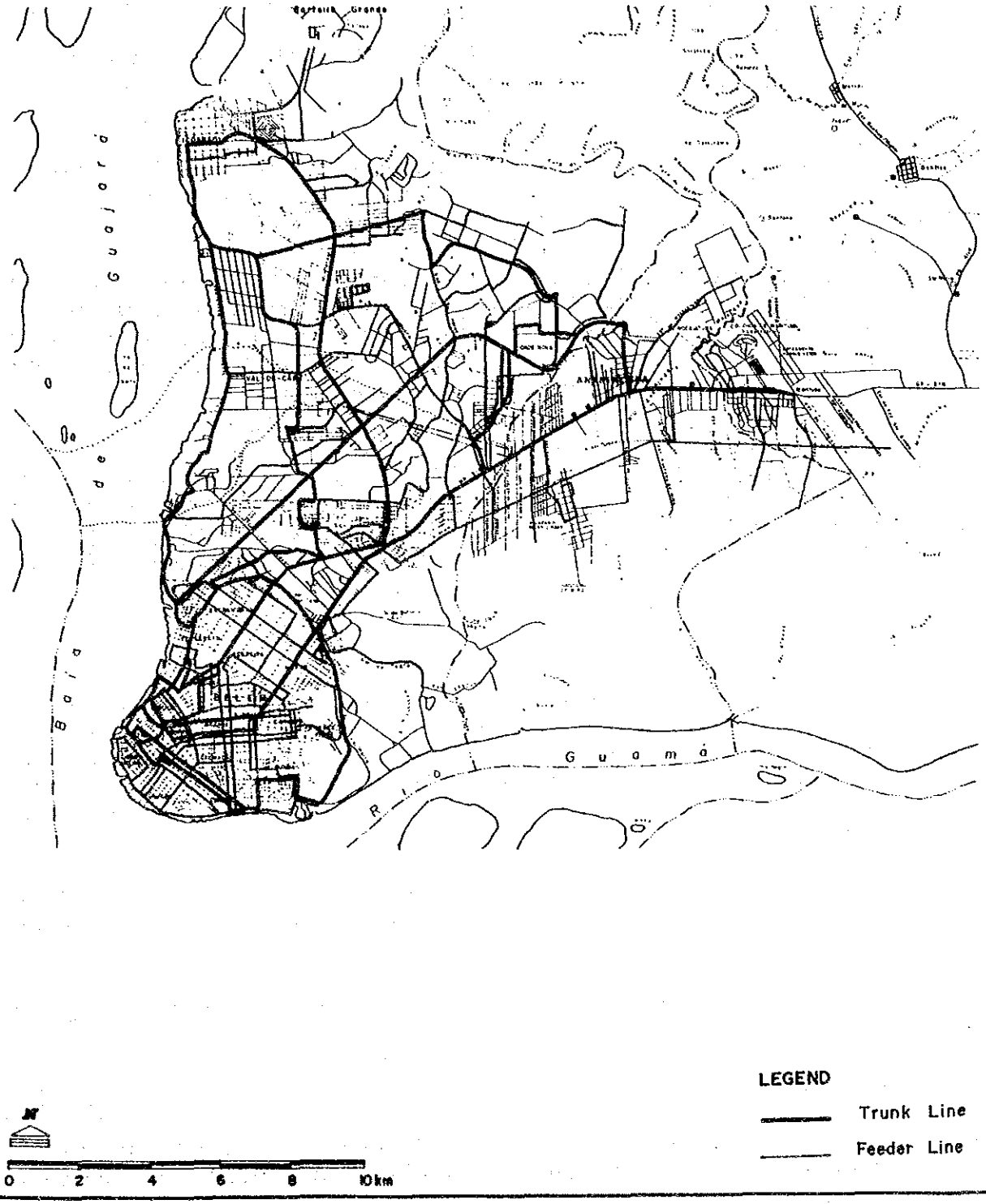


Figure 12.4-4 Route Network of Alternative 4

(5) Alternative no. 5

595. This alternative is prepared for comparative use. The significant difference from other alternatives is the introduction of a rail system. A rail serves from Ananindeua till Sao Braz through BR-316/Av. Almirante Barroso. Trunk bus routes through these roads are replaced by rail.

596. Some feeder routes parallel to the rail are prepared for local service (refer Figure 12.4-5).

12.4.2 Comparative Analysis of Alternatives in Specific Areas

(1) Icoaraci

597. This area is served at present by four conventional routes, of which 3 have destination at Centro and one at Sao Braz. These routes, due to their long route length combined with small demand along the routes, provide poor service to the users. The same characteristics are observed in Alternative no. 2

598. Alternatives no. 3, 4 and 5 provide two trunk routes (through Arthur Bernardes Road and through Augusto Montenegro Road) departing from the same terminal. In addition one feeder route serves the outskirts of Icoaraci district connecting with the trunk routes. These alternatives offer better frequency (refer Figure 12.4-6).

(2) Cidade Nova

599. This area is served, at present, by 6 conventional routes, of which five have destination at Centro and one at Sao Braz. Although this area enjoys better service than Icoaraci, frequency and punctuality of services are not sufficient. Alternatives no. 3 and 4 try to solve these problems with the adoption of trunk/feeder system.

600. Alternative no. 2 proposes the creation of a conventional route to replace the existing Guajara Centro route, and passes Belem Road as proposed in the masterplan network.

601. Alternative no. 5 has no trunk lines (refer Figure 12.4-7).

(3) Guama/Jurunas

602. Jurunas is located close to Centro. Due to its proximity to Centro, routes starting from Jurunas pass over to another

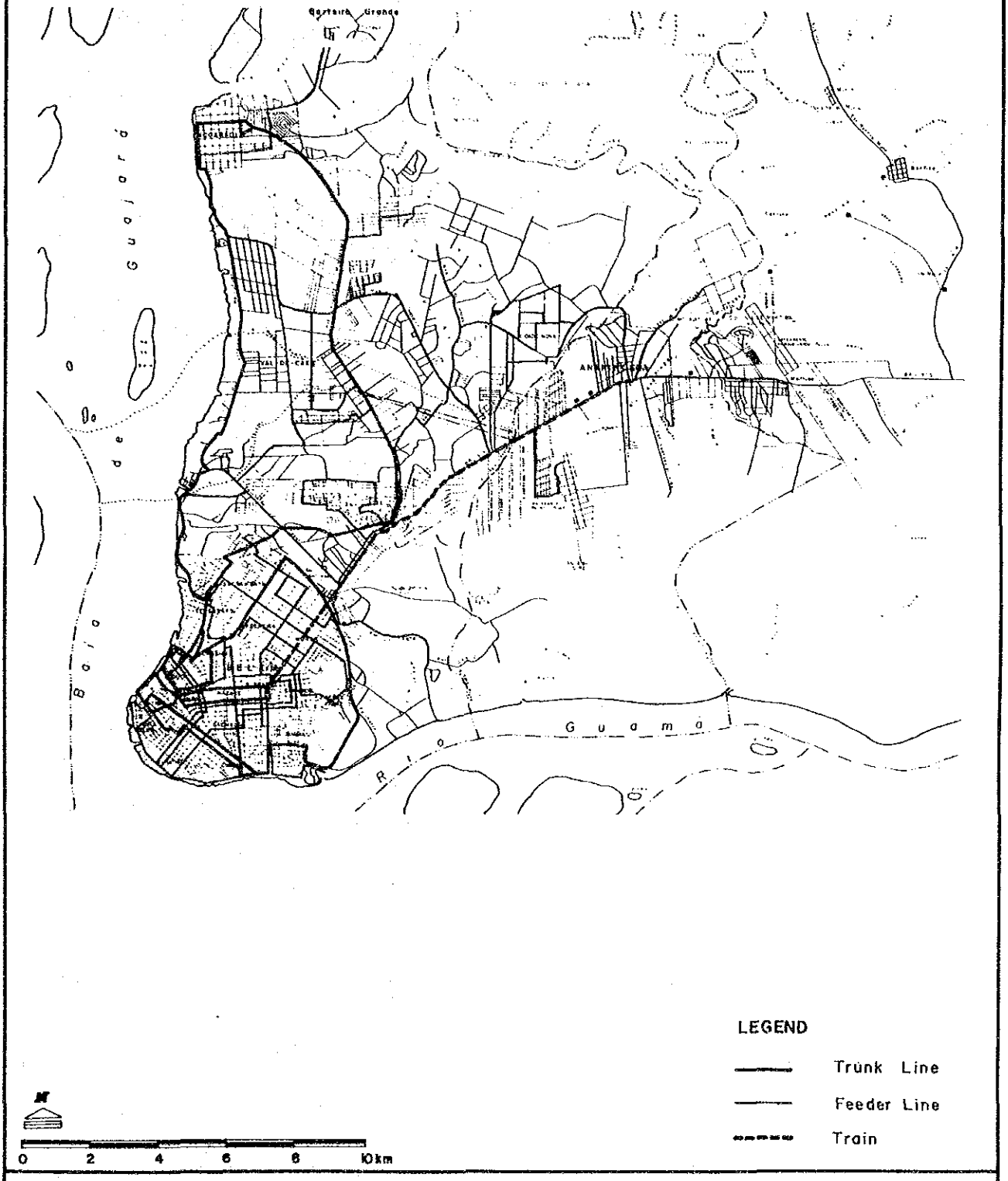
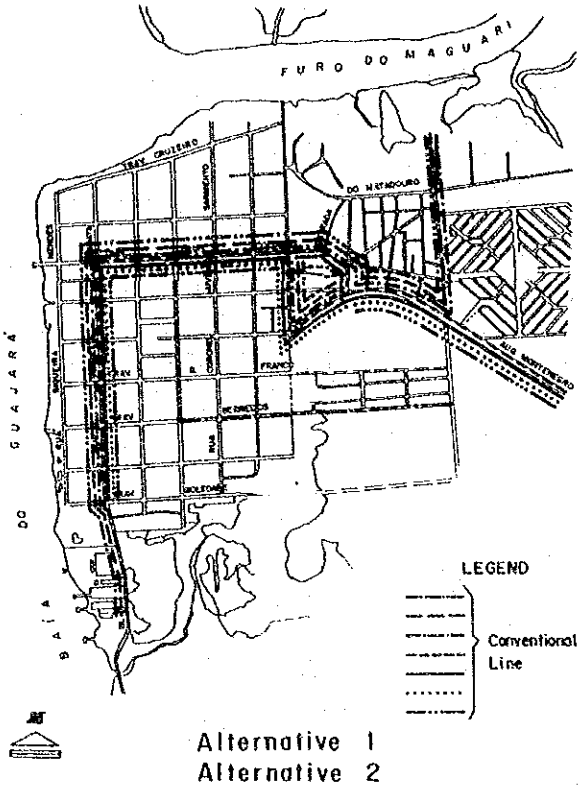
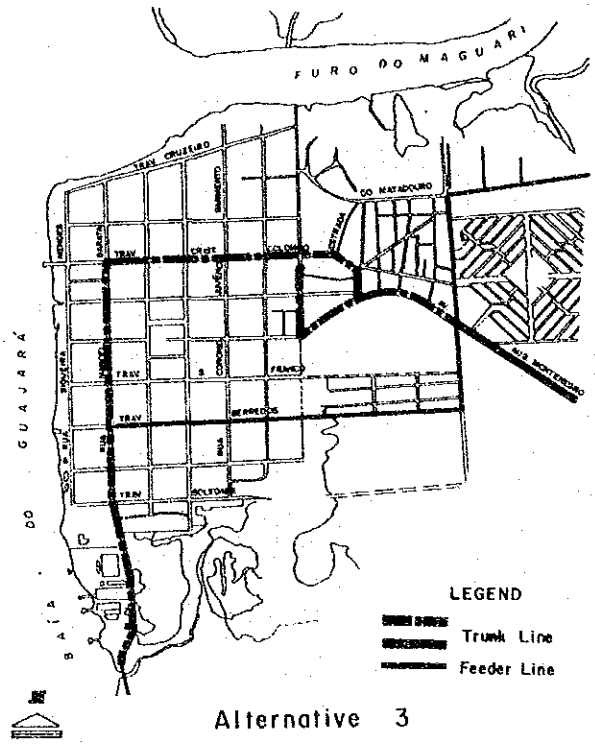


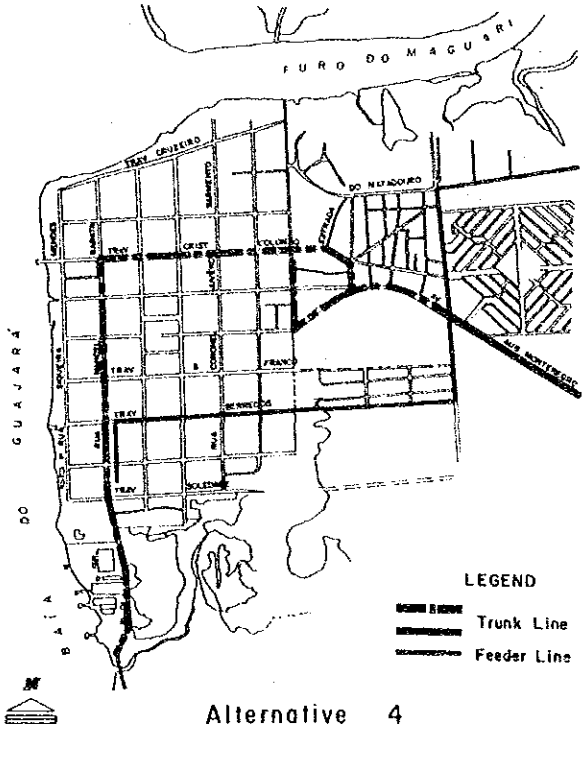
Figure 12.4-5 Route Network of Alternative 5



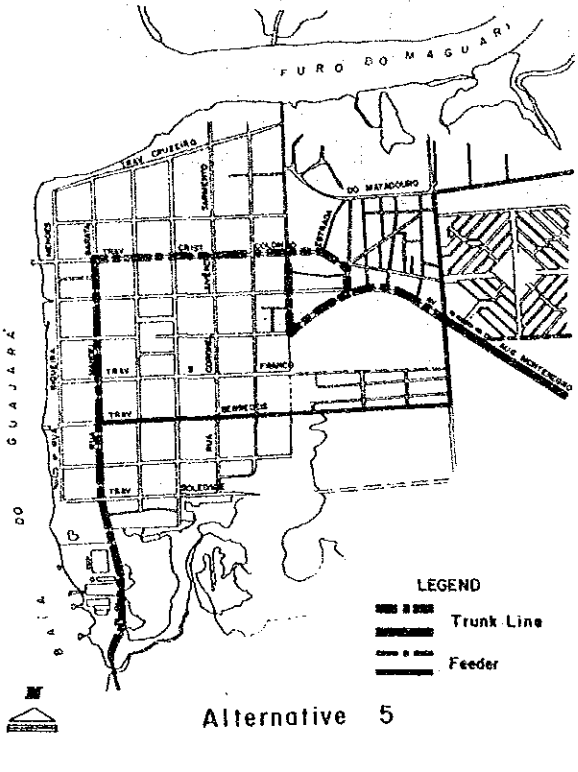
Alternative 1
Alternative 2



Alternative 3



Alternative 4



Alternative 5

Figure 12.4-6 Route Network in Icoaraci Area

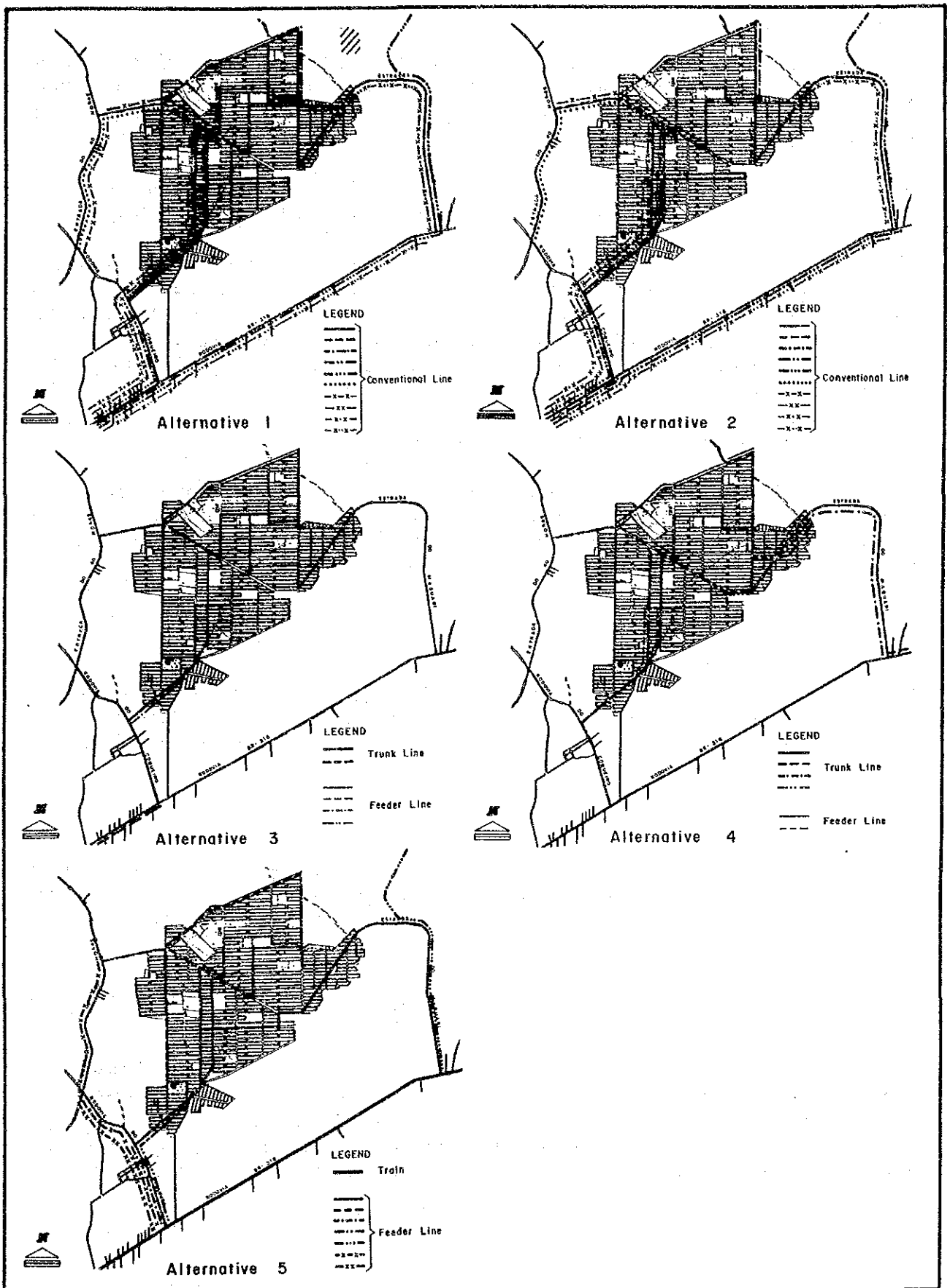


Figure 12.4-7 Route Network in Cidade Nova Area

residential area after reaching at Centro in order to collect more passengers. Guama is located at the outside of the axis of the main corridor, however, it has significant attraction because of existence of UFPA Campus.

603. Present network has overlap of routes in some sections. Overlap of routes still remains in an Alternative no. 2.

604. Alternatives no. 3, 4 and 5 propose a trunk route, which serves Cruzando, Guama, Condor, Batista Campos and Jurunas, and reaches to Centro. Feeder routes which serve the rest of the area are connected with this trunk route. Overlap of routes, therefore, does not exist in Alternatives no. 3, 4 and 5 networks (refer to Figure 12.4-8).

(4) Pedreira/Sacramenta/Telegrafo/Umarizal

605. These areas are remarkable for rapid increase of population but are not well served by public transport. The main reason is that the area surrounded by Av. Senador Lemos, Av. Pedro Miranda and Tv. Mauriti has no efficient road network.

606. In Alternative no. 2 Belem Road allows easy access to Sacramenta area.

607. Alternatives no. 3,4 and 5 suggest three trunk routes along Av. Pedro Miranda, along Avs. Senador Lemos/Pedro Alvares Cabral and along Arthur Bernardes Road, which connect these areas with Marambaia and Bengui (refer to Figure 12.4-9).

(5) Centro

608. About 90% of the bus routes at present reach Centro through Av. Magalhaes Barata, Av. Nazare and Av. Conselheiro Furtado. This concentration causes excess of supply with serious problems of traffic congestion and low efficiency of the system.

609. In Alternative no. 2, although a new route through Belem Road is added, the situation remains the same.

610. Other alternatives (no. 3, 4 and 5) try fundamental alteration of this situation. They provide four trunk routes and one feeder route to have access to Centro. Transfer points between these routes are located on Av. Presidente Vargas, and on Tv. Padre Eutiquio /Tv. Joao Diogo (refer to Figure 12.4-10).

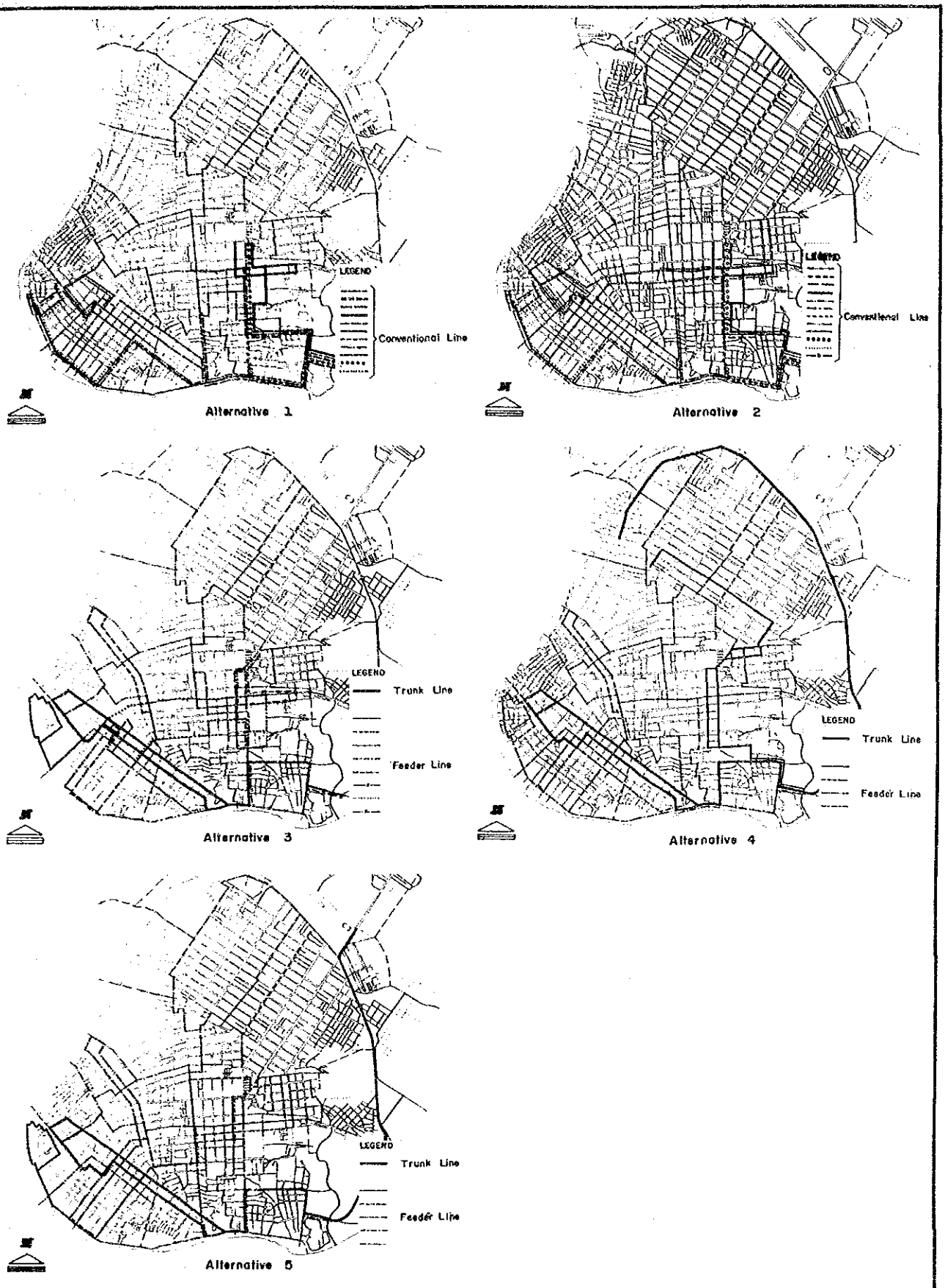


Figure 12.4-8 Route Network in Guama/ Jurunas Area

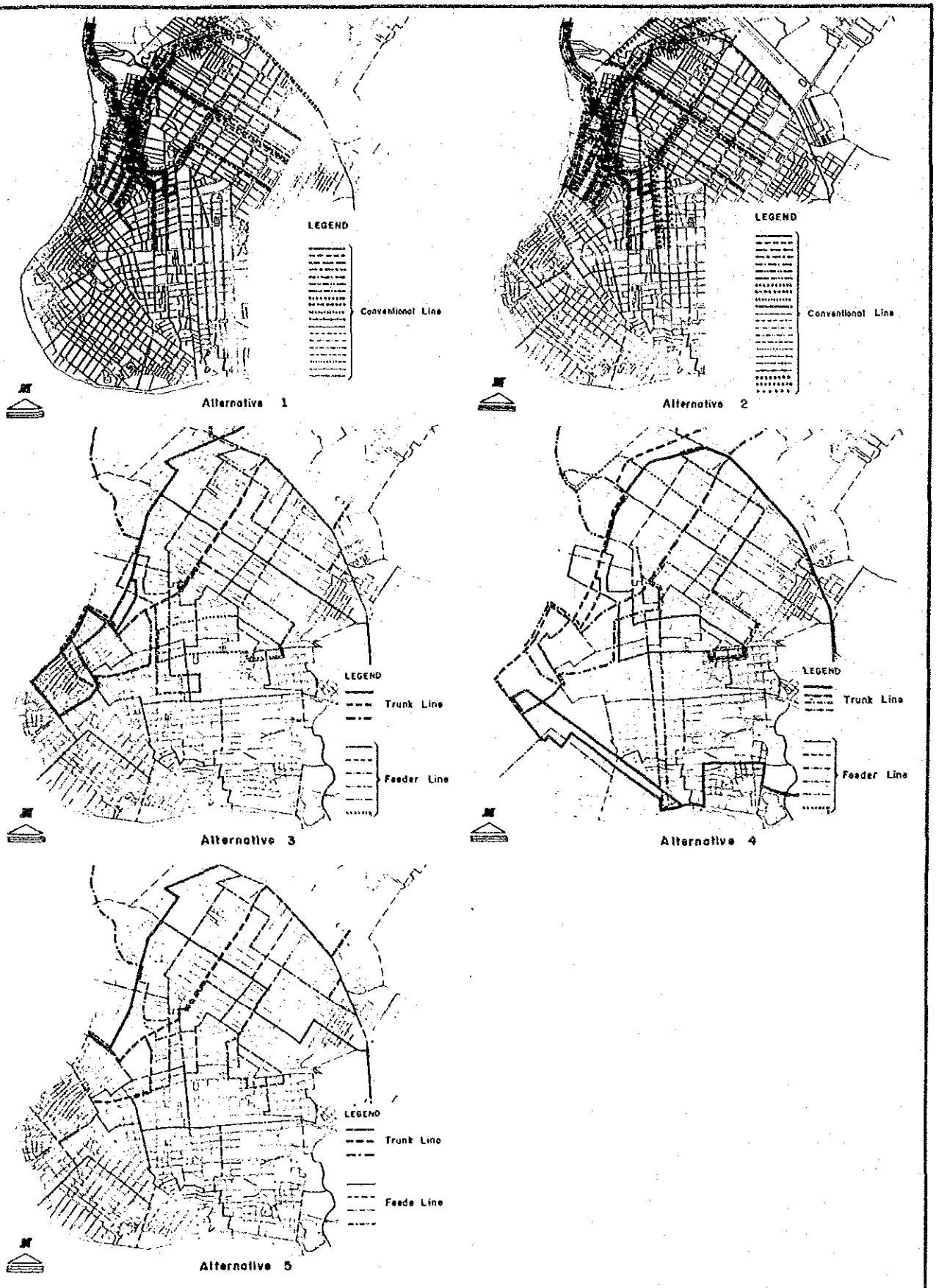
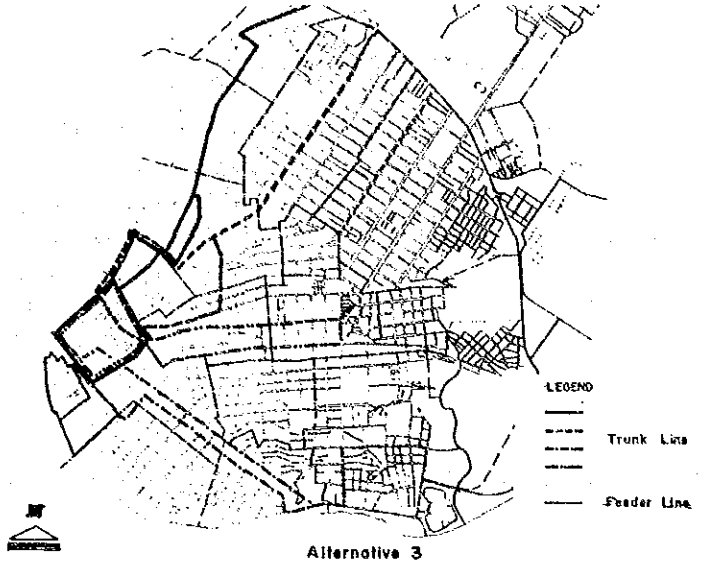
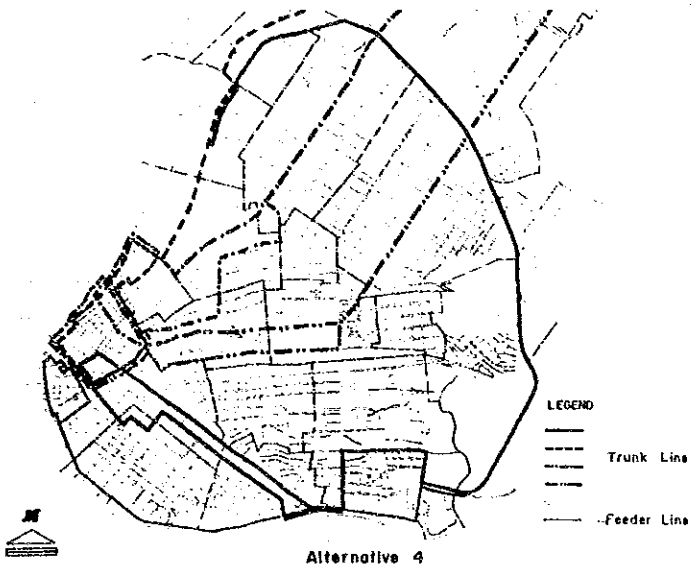


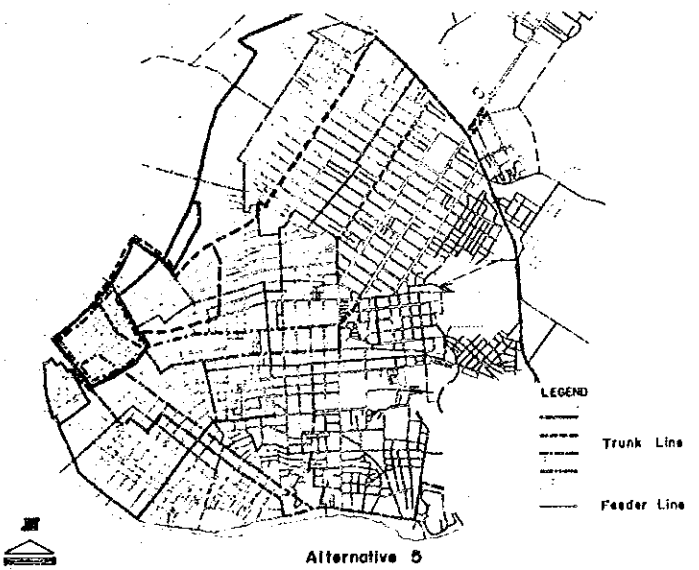
Figure 12.4-9 Route Network in Pedreira/ Sacramenta/ Telegrafo/ Umarizal Area



Alternative 3



Alternative 4



Alternative 5

Figure 12.4-10 Route Network in Centro Area

12.4.3 Measures of Alternative Priority

611. Service level of alternatives (the minimum frequency of service and the maximum congestion rate in a bus) are determined to be the same for all alternatives. Consequently, the priority of alternatives could be studied based on the following measures;

612. To make it easy to compare results of each alternative, the ratings are measured by the results of alternative no. 1.

(1) Transport Efficiency

613. Number of passengers divided by total of running kilometers of buses represents transport efficiency.

(2) Network Efficiency

614. Number of passengers divided by total length of network shows network efficiency.

(3) Managerial Index

615. Managerial index is defined as amounts of sales divided by amounts of costs. Integrated tariff system is assumed and amount of sales is identical in all alternatives. Consequently managerial index is given as product of passenger number (OD table base) and discounted tariff (see chapter 7 in detail) over total cost.

(4) Punctuality

616. Punctuality is difficult to measure with considerable accuracy because it depends on traffic situation. Assuming all alternatives are under the same condition of traffic congestion, total route length might represent rate of punctuality. Rate of total route length of each alternative to that of alternative no. 1 is adopted as punctuality measure.

(5) Transfer Times

617. Actual transfer times are counted and summed up. Also quotients of number of passengers in each alternative to an alternative no. 1 are shown as relative index to represent transfer times

12.4.4 Comparison of Alternatives

(1) Cases

618. Cases of simulation are as follows;

For the year 1990	Alternative 1
	Alternative 3
For the year 2000	Alternative 1
	Alternative 3
For the year 2010	Alternative 1
	Alternative 2
	Alternative 3
	Alternative 3 with Belem Road
	Alternative 3 with Av. P. Miranda
	Alternative 4
	Alternative 5

(2) Assumptions

619. Following assumptions are applied to each alternative.

1) Capacity of Bus

620. "Study of Bus Priority Systems in Less Developed Countries" by J.Cracknell, P. Cornwell and G. Gardner (CODATU VII-13) reported nominal capacity of buses (defined as "taken to be heavy, but acceptable, bus loading) corresponds to all seats occupied plus standers at a density of 6-9 passengers/sq. meter.

621. The prime density used in this study is 9 passengers/sq. meter with some allowance for long haul.

2) Commercial Speed

622. Four measures of commercial speed are determined:

Central Area.....15 km/hr
Transitional Area.....21 km/hr
Suburban Area.....23 km/hr
Trunk Line.....20 km/hr

The first three correspond to road network simulation results and the last to the field survey on 9 de Julho busway in Sao Paulo and Farrapos in Porto Alegre.

3) Busway Capacity

623. A passenger needs 1.5 seconds for getting on or off. It is independent from type of buses. A bus needs around 30 seconds

at a crowded bus stop. It is also independent from type of buses. These observations were obtained at Ver-o-Peso, the point where the most concentrated demand was observed, on 9 and 10 Oct. 1990.

624. Busway capacity is primarily limited by physical design of a bus stop. Assume two buses are acceptable at one booth in one minute and four booths are provided at one bus stop, and in addition busway permits bus overtaking at bus stops, 480 (2 x 60 x 4) buses per lane per hour becomes the busway capacity (Plan of bus stop at exclusive busway has six booth. One booth per each busbay is for reserve.).

625. Capacity of a busway with two lanes is considered the same as for local service but an additional center lane can provide for express service. This additional lane capacity is also limited by capacity of bus stops for express service use but may be a little bit smaller than the principal lane has, because of some interference by overtaking. Here, seventy percent of the principal lane is assumed as the maximum capacity of an additional lane, which means around 800 (480 x 1.7) buses are permitted when ideal local-express mix is achieved.

4) Local-Express Mix along BR-316 and Av. Almirante Barroso

626. Consider express service from Ananindeua to Vel-o-Peso with stop at Entroncamento, Sao Braz and two stops in the Central area as typical case.

627. Zones connected with Ananindeua Terminal through feeder bus services are Cidade Nova(zone 52), C. N. Guajara(zone 53), Curucamba(zone 63), AZPA(zone 71), Ter. de Carga(zone 74), Ananindeua(zone 75), S. Palmeira(zone 76) and Ind. Ananindeua(zone 77). Trips generated from these zones are 88705 in 1990. Of these, 5244 trips have destination at an Entroncamento transfer terminal ,which represents Souza(zone 26), Entroncamento (zone 27), Marambaia(zone 29) and Atalaia(zone 36). 5121 trips have destination at Sao Braz transfer terminal. Sao Braz terminal represents Sao Braz(zone 12) and Ropoviaria(zone 13). Trips which have destination at bus stops in the Central area including Ver-o-Peso bus stop are 23548. These bus stops represent Cidade Velha(zone 1), Comercio(zone 2), Batista Campos(zone 3), Reduto(zone 5), Nazare(zone 6), Can(zone 7).

628. Total of the said trips is 33913, 38.2 % of total generation from Ananindeua terminal. Almost all trips generated from Ananindeua terminal use BR-316. Therefore, we could estimate around 40 % of trips from Ananindeua terminal prefer to use express service.

629. The local-express mix is assumed 6:4 along BR-316 and Av. Almirante Barroso.

5) Tariff system

630. Introduction of integrated tariff system is assumed. Therefore, no restriction for transfer due to transport cost is considered. The minimum route length in the minimum transfer route group of any zone pair is, however, searched and plotted.

6) Minimum Service Times

631. Six(6) times an hour is adopted as the minimum service level.

7) Intermunicipal Bus Terminal

632. The move to Ananindeua of Intermunicipal bus terminal at Sao Braz is assumed in all alternatives except "do-nothing" case (alternative no. 1 and no. 2).

(3) Results of Calculation

1) Superiority of Trunk/Feeder System to Conventional System

a. Alternatives and Year

633. Alternatives 1 and 3 are examined mainly to clarify the difference of characteristics between a conventional network and a trunk/feeder integrated system. The year 1990 is adopted for the calculations. Results are summed up on Table 12.4-1.

Table 12.4-1 Characteristics of Alternatives(1990)

Alternative	Mag. Cong. Rate	Total R. Length	Bus*km	Psn*km	Psn/km	Psn/ (Bus*km)	(Psn*km)/ (Bus*km)	Sales/ Cost	Total Passenger
Alt-1	1	2230	1200355	40977073	1659	3.1	34.1	1.26	3700002
Alt-3	1	542	617619	29582377	11198	9.8	47.9	2.53	6069248
Alt-3/Alt-1	1	0.24	0.51	0.72	6.75	3.19	1.4	2.01	1.31

b. Service Level

634. For easy comparison, both alternatives are fixed at the same service level. The fact that Alternative 1 requires 1597 buses, and only 1212 buses work at present, shows service level at present is lower than the service level assumed in this Study. Congestion rates of both alternatives are kept at 1.0 or less.

c. Transport Efficiency

635. Passengers per bus*kilo-meter of Alternative 1 is 3.1 and of Alternative 3 is 9.8. Alternative 3 shows 3.16 times the transport efficiency of Alternative 1.

d. Network Efficiency

636. Passengers per 1 km of route is 1,659 persons for Alternative 1 against 11,198 persons at Alternative 3. It means Alternative 3 has 6.75 times the network efficiency of Alternative 1.

e. Managerial Index

637. Alternative no. 3 shows remarkable improvements in this index, around double of Alternative no. 1. It is coincident with transport efficiency rating because the number of passengers for both alternatives is the same.

f. Punctuality

638. A bold design involving restructuring of present routes yields satisfactory results in cutting duplication of routes. Alternative no. 3 reduces route length to 24 % of existing one. Using the definition of punctuality mentioned in the preceding section, Alternative no. 3 improves punctuality 4.17 times that of Alternative no. 1.

g. Transfer Times

639. Trunk/feeder systems increase number of transfer times in general. This study adopts a maximum of three times of transfer. Calculation shows a 31 % point increase when compared with the network at present.

h. Remarks in Conclusion

640. BMR is behind with investment in public transport system in comparison with other metropolitan regions in Brazil. Surplus of profit caused by change of transport network from conventional to trunk/feeder system, is expected to increase by around 100 %.

641. Alternative no. 3 is superior to Alternative no. 1 from any point except transfer times.

2) Necessity of Adoption of Trunk/Feeder System

a. Limitation of Road Capacity

642. Situation in 2010 with existing network is shown in Figure 12.4-12. Trunk axes become chaotic. Av. Almirante Barroso/BR-316 counts 2500-3000 buses at peak hour. In the central area, concentration of buses is further reduced but major streets still count 1000 to 1500 buses at peak hour.

643. Under the said situation any bus transport system can not operate efficiently. Introduction of some efficient transport mode, such as rail system, becomes necessary.

b. Difficulty of Introduction of Rail System

644. The maximum passenger number at the intersection along BR-316/Av. Almirante Barroso is expected to be 543,000 passengers per day in 2010. It is a sufficient figure to introduce rail. Introduction of train to that trunk axis was studied, and the study results are attached as Alternative no.5 at the end of this chapter.

645. Basic characteristics, which is same as Paulista line newly constructed in Sao Paulo, are summed up below in Figure 12.4-11.

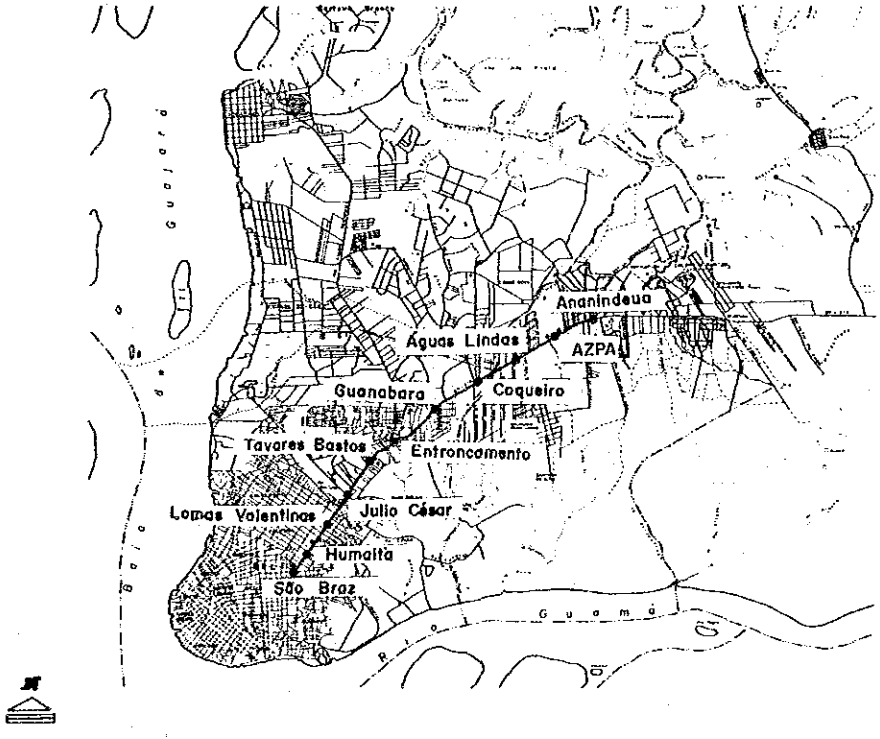


Figure 12.4-11 Railway Route and Location of Station

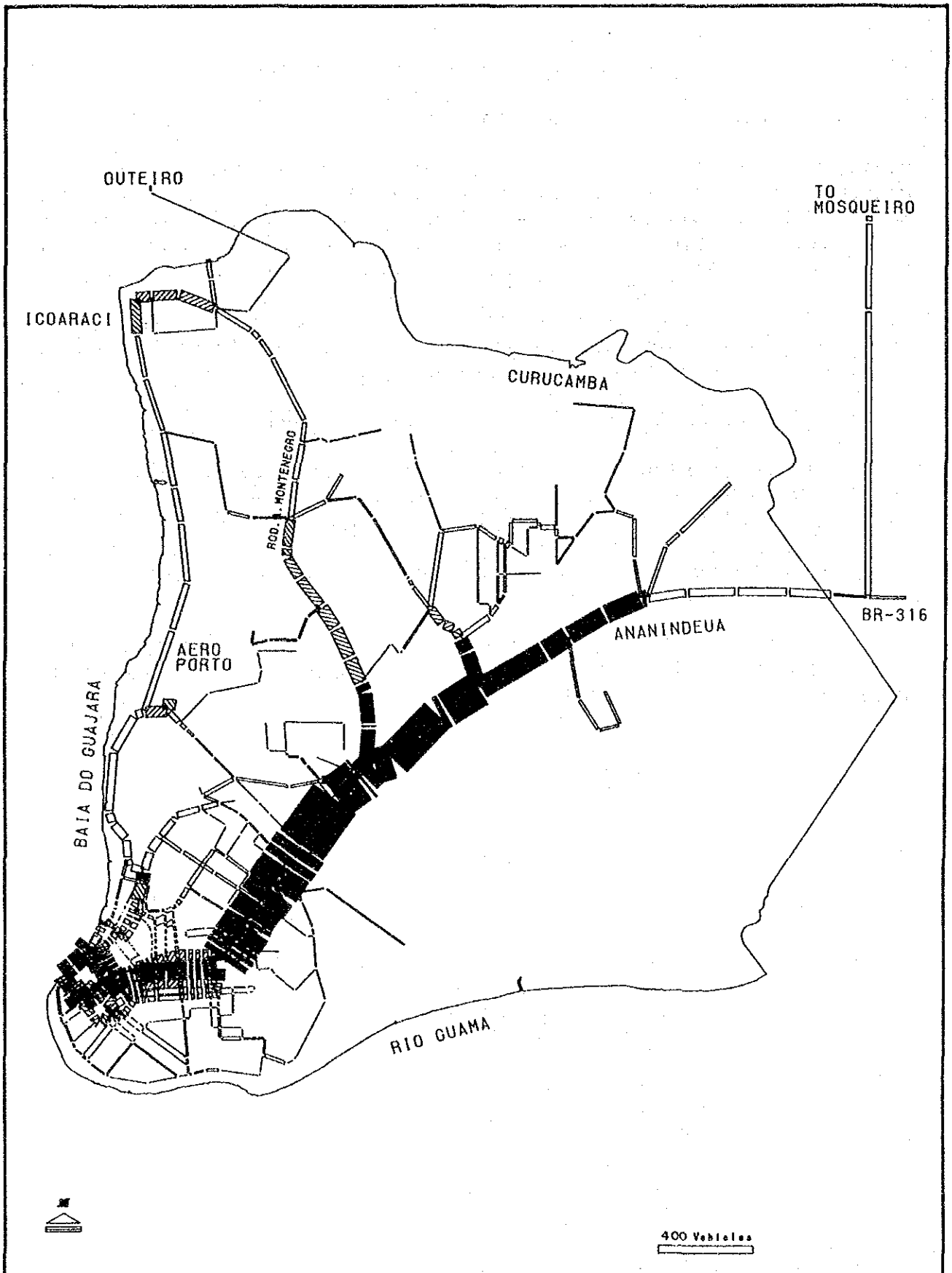


Figure 12.4-12 Do Nothing Case in 2010

646. Basic characteristics of rail system are;

- Train: composed of six cars (A-B-B-B-B-A) for 2,000 passengers/train
- Car : Type A, with driver cabin. Capacity is 316 passengers including 46 seats.
  Type B, without driver cabin. Capacity is 342 passengers including 50 seats.
- Track length: 14.2 km
- Average distance between stations: 1 km
- Gauge: 1600 mm
- Supply Voltage: 750 volt
- Maximum Speed: 80 km/hr

647. Simulation result requires 18 train services in a peak hour (3.3 minutes headway). It means a rail company needs 16 trains in operation and 2 trains for reserve.

648. Referring to Paulista line construction costs, initial investment is estimated as 933 million US dollars (refer to Table 12.4-2). When the total budget scale for the Masterplan implementation (350-500 million US dollars) is considered, the difficulty to introduce rail system in Belem becomes evident.

Table 12.4-2 Investment Cost of Rail System

Item	Unit Cost	Quantities	Cost (1000US$)
Civil Work			
Station (Elevated)	25944856 /station	6	155669
Station (Surface)	17193252 /station	5	85966
Elevated Structure	21235478 /km	6.7	142278
Surface work	874993 /km	7.6	66500
Office	59551049 /whole system	1	59551
Others	1114248 /km	14.3	15934
Sub Total			525898
Systems			
Power	4589982 /km	14.3	65637
Controle of Trains	4136748 /km	14.3	59155
Telecommunication	806918 /km	14.3	11439
Track	83892 /km	63.6	5336
Auxiliary Equipments	2082100 /km	14.3	29774
Equipments for Maint.	1894570 /whole system	1	1895
Sub Total			173335
Engineering Service	8.5% of sub total above		50435
Contingency	10% of total cost above		75867
Rolling Stocks			
Car	904150 /unit	115	103977
Trackmobil	407254 /unit	3	1222
Sub Total			105199
Total Investment Cost			939734

c. Concluding Remarks

649. Conventional type network can not continue to be viable until the year 2010 and rail system is very hard to be introduced until 2010 due to the budget limitation. Trunk/feeder system, therefore, becomes the only probable solution even though that system contains many difficulties in itself.

3) Comparison of Alternatives

a. Cases of Alternatives Studied

650. Basic alternatives are four. They are Alternatives 1, 3, 2 and 4. The first two alternative networks are based on the existing road network and the last two on the masterplan network. In addition to those, as transitional stage plan, cases of the completion of Belem Road and of the completion of Av. Pedro Miranda are studied.

Table 12.4-3 Comparison of Alternatives in 2010

Alternative	Max. Cong. Rate	Total R. Length	Bus*km	Psn*km	Psn/km	Psn/ (Bus*km)	(Psn*km)/ (Bus*km)	Sales/ Cost	Total Passenger
Alt-1	1	2230	1200355	40977073	1659	3.1	34.1	0.64	3700002
Alt-2	1	2158	832814	27135105	1606	4.2	32.6	0.92	3466621
Alt-3	1	542	617619	29582377	11198	9.8	47.9	1.24	6069248
Alt-3-Rod. Belem	1	590	607818	29205875	10110	9.8	48.1	1.26	5964853
Alt-3-Av. P. Miranda	1	556	629291	28915320	10704	9.5	45.9	1.21	5952146
Alt-4	1	719	650275	31406347	7717	8.5	48.3	1.17	5543471
Alt-2/Alt-1	1	0.97	0.69	0.66	0.97	1.35	0.95	1.44	0.94
Alt-3/Alt-1	1	0.24	0.51	0.72	6.75	3.19	1.4	1.94	1.64
Alt-3-B/Alt-1	1	0.26	0.51	0.71	6.09	3.18	1.41	1.97	1.61
Alt-3-M/Alt-1	1	0.25	0.52	0.71	6.45	3.07	1.35	1.91	1.61
Alt-4/Alt-1	1	0.32	0.54	0.77	4.65	2.77	1.41	1.85	1.5

b. Transport Efficiency

651. Passenger number divided by total running km of bus for each alternative compared to Alternative no 1 is, as mentioned before, adopted as measure of transport efficiency.

652. Alternative no.3 show the highest figure, 3.19 Alternatives no.3 with Av. Pedro Miranda routes and no.3 with Belem Road routes follow at 3.07-3.18 and Alternative no. 4 shows the relatively low figure, 2.77. Alternative no.2 is 1.35 (refer to Table 12.4-3).

c. Network Efficiency

653. Measure of network efficiency is number of passengers divided by total length of network. Alternative no.3 shows the highest indicator, 6.75. Alternative no.3 with Belem Road, with

Av. Pedro Miranda and Alternative no.4 follow with figures 6.09, 6.45 and 4.65 respectively. These differences depend on the differences of total route length. Alternative no.2 shows poor efficiency, 1.17.

d. Managerial Index

654. Alternative no.3 with Belem Roads is more successful by a slim margin over Alternative no.3. The third is Alternative no.3 with Av. Pedro Miranda and the fourth is Alternative no.4. Alternative no.2 is the last.

e. Punctuality

655. Assume total route length as substitute for punctuality, the order becomes Alternative no.3, an alternative no.3 with Av. Pedro Miranda, Belem Road and Alternative no.4. The first three have very small margins compared with each other. Alternative no.2 shows figures much different from others.

f. Transfer Times

656. Alternative no.2 involves an average of 1.34 transfers . The second group consists of Alternative no.4 and Alternative no.3 with Av. Pedro Miranda, representing 1.80 and 1.93 transfers respectively. The last group of Alternative no.3 and no.3 with Belem Road, representing 2.19 and 2.20.

4) Proposed Alternatives

657. Differences between alternatives except Alternative no.2 are small. Considering present (imminent) situation of congestion from buses, an alternative which can be put in effect immediately is recommendable. When we adopt Alternative no.3, we have the advantage of an early start of several years. From this point of view adoption of Alternative no.3 seems a natural choice.

658. Two trunk line system, however, improve the uncertainty of one trunk line (four lanes) system. When Belem Road begins to be constructed, another four lanes for exclusive use of buses shall be provided in the new road. Two four lane busway systems assure highly efficient public transport system for Belem/Ananindeua citizens.

12.4.5 Alternative No.3

(1) Major Bus Stops

659. Bus stops with large volume of passengers are listed in Table 12.4-4. Integrated terminals are marked in the table.

Table 12.4-4 Major Bus Stops

Name	Passengers Boarding	Alighting	Total	Note
Entroncamento	539288	667686	1206974	Integrated Transfer Terminal
Av. Almirante barroso/Humaita	307434	294318	601752	
Praca Felipe Patroni	189155	206601	395756	
Sao Braz Terminal Rodoviario	199358	195103	394461	Integrated Transfer Terminal
Av. Nazare/Generalissimo	145981	226523	372504	
BR 316 Ananindeua	231837	139366	371203	Terminal
Augusto Montenegro/Rod. Coqueiro	178956	148719	327675	
Senador Lemos/Coronel Luis Bentes	177646	148213	325859	Integrated Transfer Terminal
Av. Almirante Barroso/Julio Cesar	149039	139695	288734	
BR 316/Rod. Coqueiro	132676	132721	265397	Integrated Transfer Terminal
Magalhaes Barata/Castelo Branco	162109	99057	261166	
Br 316 Acesso ao Conjunto Julia Seffer	128619	128619	257238	
Rod. do Coqueiro Proximo a Greengarden	124311	124311	248622	
Av. Almirante Barroso/Lomas	110803	133965	244768	
Humaita/Av. Pedro Miranda	91784	97944	189728	
Guama Abreu/Pe: Eutiquio	93894	93894	187788	
Pe: Eutiquio/Mundurucus	88928	97393	186321	
Jose Bonifacio/Barao do Igarape Mirin	93501	88198	181699	
Alcindo Cacela/Bernarso Couto	88332	92314	180646	
Augusto Montenegro/ 3 de Maio	126034	48990	175024	
Doca/Marechal Hermes	71349	88077	159426	Integrated Transfer Terminal
40 Hrs/Rua do Conjunto Stelio Maroja	79012	79012	158024	
Pedro Miranda/Alferes Costa	73156	71420	144576	
Quintino/O de Almeida	70032	59515	129547	
Alcindo Cacela/Conceicao	70336	52000	122336	

660. Major bus stops are located along the trunk axis as can be seen in Figure 12.4-13. Entroncamento is outstanding.

(2) Transport Axis

661. Trunk axis is close to capacity limit of one lane busway with overtaking bus stops, 480 units/hour/lane (refer to Table 12.4-5). When 33 % of total services is considered as express service, around 160 buses utilize central lane of the busway which lessens the burden on the major lane.

662. Figure 12.4-14 (A) and (B) shows the calculation results of Alternative no. 3 in the year 2000 and 2010.

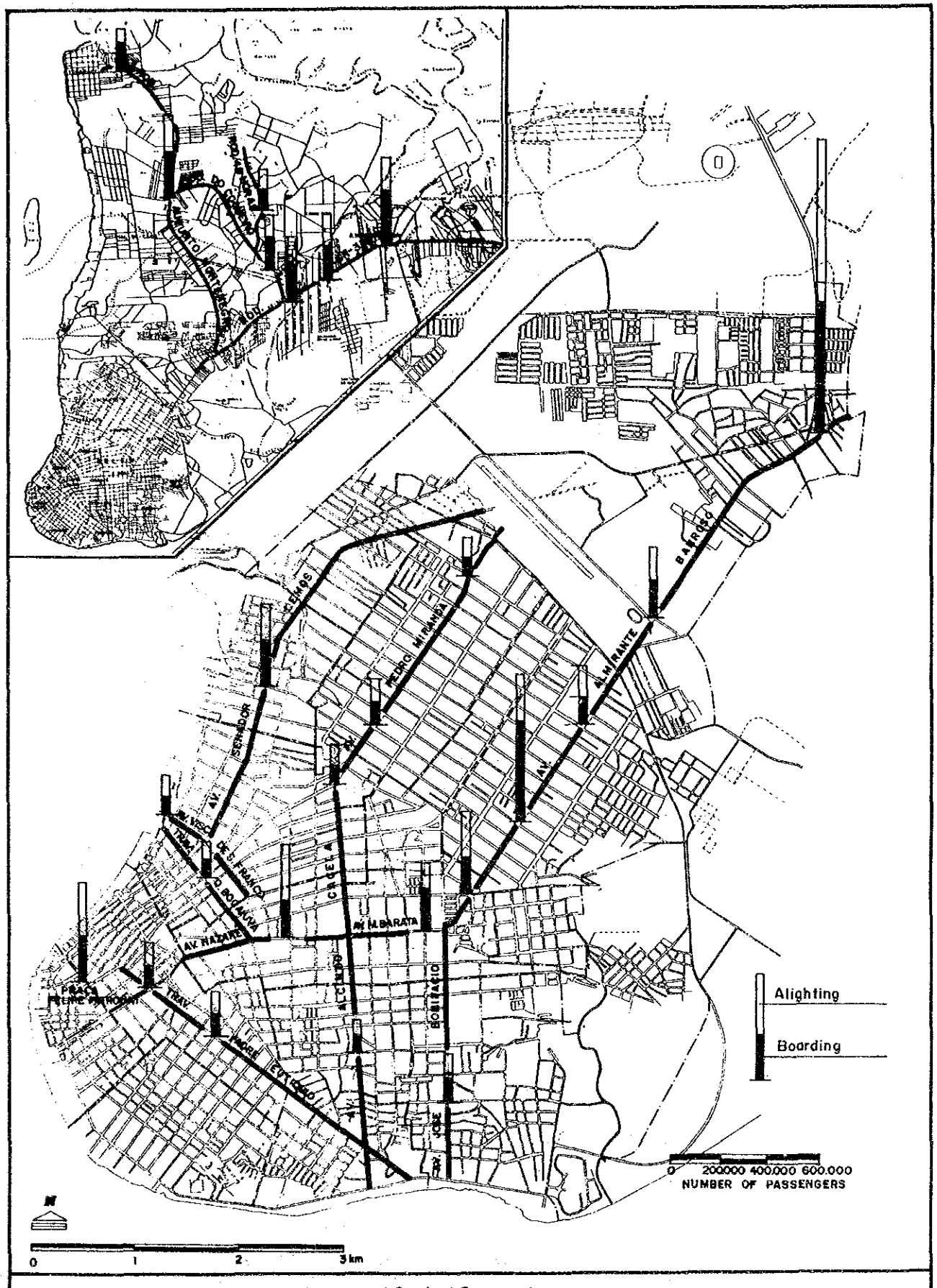


Figure 12.4-13 Major Bus Stops

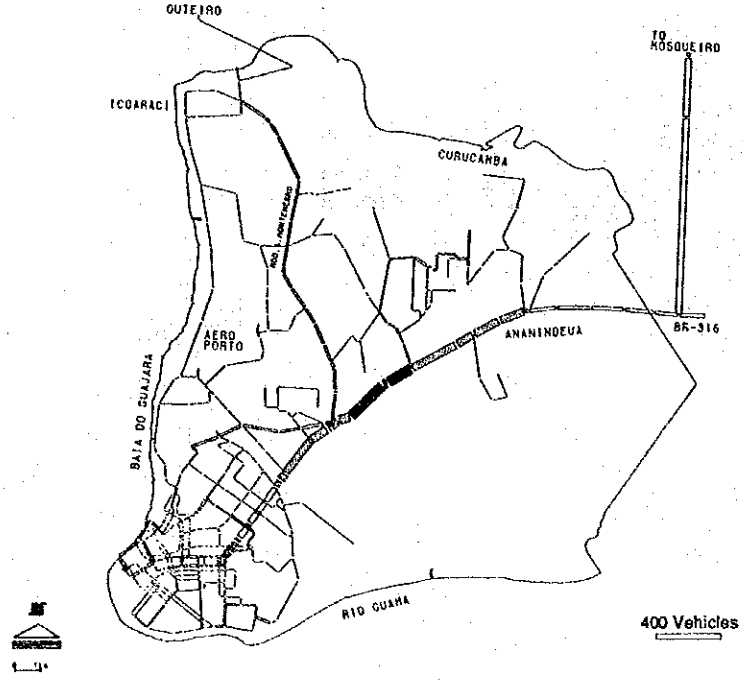


Figure 12.4-14(A) Bus Flow in 2000

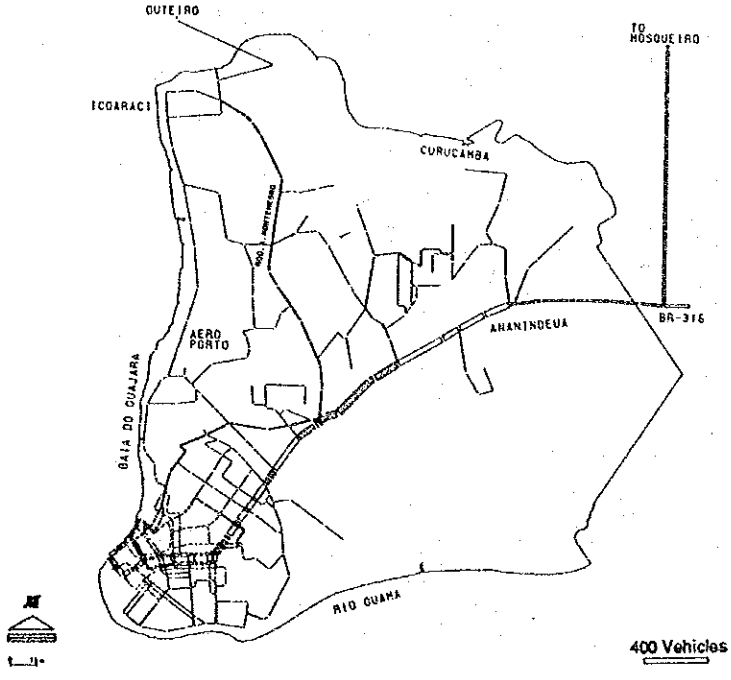


Figure 12.4-14(B) Bus Flow in 2010

(3) Bus Fleet

663. Alternative no.3 requires 2149 buses in the year 2010 (refer to Table 12.4-6), of which 1511 units are articular buses for trunk line and 453 units are regular size. To maintain necessary number of buses in response to the demand in each year, installment of around 280 buses a year is expected.

(4) Schedule

664. Five years are considered necessary for preparation and transition periods. Consequently, the year 1995 is scheduled as the first year of fully operation of Alternative no. 3 network.

(5) Cost Comparison

665. Total costs of Alternatives no. 1 and no. 3 are compared. Results are shown in Table 12.4-7. The table shows Alternative no. 3 is us$ 5.8 billion cheaper than Alternative no. 1.

Table 12.4-5 Road Sections with Large Bus Flow (Peak Hour)

Name	Buses	Rate to 480
BR 316 km 04	338	0.704
BR 316 km 03	338	0.704
BR 316 km 024	338	0.704
BR 316 km Memorial da Cabanagem	338	0.704
BR 316 km 01	338	0.704
Av. Almirante Barroso (Dalva/Tavares Bastos)	270	0.503
Av. Almirante Barroso (Dr. Freitas/Utinga)	250	0.521
Av. Almirante Barroso (Utinga/Julio Cesar)	250	0.521
Av. Assis de Vasconceilos (Nazare/Jose Malcher	378	0.788
Av. Magalhaes Barata (A. Cacela-14 de Marco)	334	0.696
Boulevard C. Franca (Assis Vasc. - P. Vargas)	439	0.915
Boulevard C. Franca	378	0.788
Av. Portugal/Av. 16 de Novembro	378	0.788

Table 12.4-6 Detail Result of Alternative No.3

Simulation Result
Case: Alt-3 (2010)

Route No	Route Name	Dist	Social Speed	Capacity	Pax No	Thru Pax No	Service (Peak Hr)	Times (Day)	Bus Fleet
1	Marituba/Ananindeua	9.6	21	110	14483	8961	9	161	5
2	Distrito Industrial/Ananindeua	7.7	21	110	67306	36303	37	628	14
3	Curucamba/Ananindeua	13.8	21	110	149199	73455	75	1271	50
4	Julia Seffer	8.1	21	110	129031	70542	72	1221	29
5	Cidade Nova/Ananindeua	14.3	21	110	44111	16697	17	289	12
6	Icui/Coqueiro	10.5	21	110	120434	65786	67	1139	34
7	Cidade Nova/Coqueiro	7.1	21	110	3877	2230	6	114	3
8	40 Horas	4.0	21	110	79012	43739	45	757	9
9	Coqueiro/Augusto Montenegro	10.2	21	110	99735	33393	34	578	17
10	Satelite/Augusto Montenegro	3.6	21	110	88814	46809	48	810	9
11	Jaderlandia/Augusto Montenegro	6.3	21	110	19540	10488	11	184	4
12	Transcoqueiro/Augusto Montenegro	6.4	21	110	9531	3519	6	114	3
13	Distrito Industrial/Icoaraci	22.4	21	130	96667	42970	37	629	40
14	Maguari/Augusto Montenegro	4.2	21	110	38596	20459	21	354	5
15	Arthur Bernardes/Augusto Montenegro	9.4	21	110	49148	24867	25	430	12
16	Cordeiro de Farias/Augusto Montenegro	9.9	21	110	43307	22179	23	384	12
17	Bengui/Augusto Montenegro	6.7	21	110	275	152	6	114	3
18	Bengui/Arthur Bernardes	19.4	21	130	24803	7768	7	124	7
19	Marambaia/Almirante Barroso	11.2	21	180	122498	59645	37	631	21
20	Tavares Bastos/Almirante Barroso	7.7	21	180	30831	17058	11	183	5
21	Aeroporto/Almirante Barroso	16.8	21	130	196879	66526	57	974	47
22	CEASA/Almirante Barroso	8.9	21	110	26494	12870	13	223	6
23	Universidade/Almirante Barroso	12.1	18	110	35831	18807	19	326	14
24	Perimetral/Senador Lemos	12.4	18	110	65895	22194	23	384	17
25	Bernardo Sayao/Nazare	6.4	14	110	144616	69718	71	1207	33
26	Bernardo Sayao/Marechal Hermes	11.4	14	110	186804	76761	78	1329	65
27	Universidade/Sao Braz	10.8	14	130	134799	72540	62	1062	49
28	Dr. Freitas/Sao Braz	8.4	16	110	47981	23663	24	410	13
29	Pedro Alvares Cabral/Almirante Barroso	7.4	16	110	3285	2040	6	114	4
30	Perimetral/Sao Braz	6.5	15	130	40423	20267	17	297	8
32	Pedro Miranda/Sao Braz	8.6	16	130	190989	99760	86	1461	47
33	Pedro Alvares Cabral/Perimetral	11.4	16	110	108524	43577	44	754	33
34	Pedro Alvares Cabral/Gentil	8.3	15	110	69715	40722	41	705	24
36	Princesa Isabel/Padre Eutiquio	9.1	15	110	30486	7966	8	146	6
38	Cremacao/Nazare	6.5	15	110	12407	12407	13	215	6
39	9 de Janeiro/Sao Braz	6.9	16	110	40031	23164	24	401	11
41	Montepio/Batista Campos	8.9	15	110	18451	18451	19	319	12
42	Troncal BR-316/Almirante Barroso	42.7	16	180	1512427	356669	222	3773	593
43	Troncal Augusto Montenegro/Pedro Alvares Cabral	51.2	18	180	853683	250393	156	2649	444
44	Troncal Icoaraci/Pedro Alvares Cabral	35.5	18	180	190535	72427	45	766	90
45	Troncal Cidade Nova	27.6	18	180	398707	186637	116	1974	179
46	Troncal Pedro Miranda/Presidente Vargas	13.2	16	180	209721	98568	61	1043	52
47	Troncal Universidade/Padre Eutiquio	18.7	15	180	319367	117429	73	1242	92
Average		12.6	-	-	141145.3	53966.9	43.5	741.6	49.7
Total		542.1	-	-	6069248	2320576	1871	31890	2139

Table 12.4-6 Detail Result of Alternative No.3 (continued)

Simulation Result
Case: Alt-3 (2010)

Route No	Route Name	Cong Rate	Bus*Km	Psn*Km	Psn/Km	Psn/ (Bus*Km)	(Psn*Km)/ (Bus*Km)	Cost	Ticket Sales	Sales/ Cost
1	Marituba/Ananindeua	1.0	1541	43765	1512	9.4	28	978	-	-
2	Distrito Industrial/Ananindeua	1.0	4838	113748	8741	13.9	24	3071	-	-
3	Curucamba/Ananindeua	1.0	17495	460566	10843	8.5	26	11106	-	-
4	Julia Seffer	1.0	9890	434740	15930	13.0	44	6278	-	-
5	Cidade Nova/Ananindeua	1.0	4127	170389	3089	10.7	41	2620	-	-
6	Icui/Coqueiro	1.0	11934	631074	11492	10.1	53	7575	-	-
7	Cidade Nova/Coqueiro	0.4	814	11273	543	4.8	14	517	-	-
8	40 Horas	1.0	3059	159604	19557	25.8	52	1942	-	-
9	Coqueiro/Augusto Montenegro	1.0	5919	266410	9740	16.9	45	3757	-	-
10	Satelite/Augusto Montenegro	1.0	2917	159865	24671	30.4	55	1852	-	-
11	Jaderlandia/Augusto Montenegro	1.0	1164	48951	3092	16.8	42	739	-	-
12	Transcoqueiro/Augusto Montenegro	0.6	725	13760	1499	13.1	19	460	-	-
13	Distrito Industrial/Icoaraci	1.0	14097	305537	4315	6.9	22	8949	-	-
14	Maguari/Augusto Montenegro	1.0	1480	67163	9233	26.1	45	940	-	-
15	Arthur Bernardes/Augusto Montenegro	1.0	4063	102646	5206	12.1	25	2579	-	-
16	Cordeiro de Farias/Augusto Montenegro	1.0	3808	81633	4366	11.4	21	2417	-	-
17	Bengui/Augusto Montenegro	0.0	759	783	41	0.4	1	482	-	-
18	Bengui/Arthur Bernardes	1.0	2411	101064	1280	10.3	42	1530	-	-
19	Marambaia/Almirante Barroso	1.0	7041	609254	10977	17.4	87	4470	-	-
20	Tavares Bastos/Almirante Barroso	1.0	1403	87945	4025	22.0	63	891	-	-
21	Aeroporto/Almirante Barroso	1.0	16369	653878	11719	12.0	40	10391	-	-
22	CEASA/Almirante Barroso	1.0	1992	104183	2964	13.3	52	1264	-	-
23	Universidade/Almirante Barroso	1.0	3932	186767	2966	9.1	47	2496	-	-
24	Perimetral/Senador Lemos	1.0	4779	216290	5297	13.8	45	3034	-	-
25	Bernardo Sayao/Nazare	1.0	7735	250107	22561	18.7	32	4910	-	-
26	Bernardo Sayao/Marechal Hermes	1.0	15147	576543	16386	12.3	38	9615	-	-
27	Universidade/Sao Braz	1.0	11485	352300	12470	11.7	31	7291	-	-
28	Dr. Freitas/Sao Braz	1.0	3424	58510	5739	14.0	17	2174	-	-
29	Pedro Alvares Cabral/Almirante Barroso	0.4	848	9207	442	3.9	11	538	-	-
30	Perimetral/Sao Braz	1.0	1932	99748	6209	20.9	52	1227	-	-
32	Pedro Miranda/Sao Braz	1.0	12522	458253	22286	15.3	37	7949	-	-
33	Pedro Alvares Cabral/Perimetral	1.0	8629	269835	9486	12.6	31	5478	-	-
34	Pedro Alvares Cabral/Gentil	1.0	5879	250383	8359	11.9	43	3732	-	-
36	Princesa Isabel/Padre Eutiquio	1.0	1323	56023	3357	23.0	42	840	-	-
38	Cremaceo/Nazare	1.0	1387	25501	1921	8.9	18	881	-	-
39	9 de Janeiro/Sao Braz	1.0	2759	83767	5818	14.5	30	1751	-	-
41	Montepio/Batista Campos	1.0	2836	76242	2078	6.5	27	1800	-	-
42	Troncal BR-316/ALmirante Barroso	1.0	161097	9035937	35420	9.4	56	102264	-	-
43	Troncal Augusto Montenegro/Pedro Alvares Cabral	1.0	135476	7522335	16690	6.3	56	86000	-	-
44	Troncal Icoaraci/Pedro Alvares Cabral	1.0	27212	1699330	5364	7.0	62	17274	-	-
45	Troncal Cidade Nova	1.0	54409	2063765	14467	7.3	38	34539	-	-
46	Troncal Pedro Miranda/Presidente Vargas	1.0	13784	769473	15864	15.2	56	8750	-	-
47	Troncal Universidade/Padre Eutiquio	1.0	23178	893832	17115	13.8	39	14714	-	-
Average		1.0	14363.2	687962.3	11197	9.8	48	-	-	1.20
Total		-	617619	29582377	-	-	-	392065	2858101	-

Table 12.4-7 Costs of Alternative No.1 vs No.3

Year	Alternative No.1				
	Bus Fleet Reinforcement	Bus Operating Cost	Facilities Construction	Total (US$)	Discounted Value (8%)
1990	0	132,912,195	0	132,912,195	132,912,195
1991	222,035,258	141,925,396	0	363,960,654	337,000,606
1992	255,370,178	150,938,596	0	406,308,774	348,344,285
1993	288,024,652	159,951,797	0	447,976,449	355,618,148
1994	322,040,018	168,964,997	0	491,005,015	360,903,344
1995	355,374,938	177,978,198	0	533,353,136	362,991,182
1996	388,709,858	186,991,398	0	575,701,256	362,789,446
1997	423,859,300	196,004,599	0	619,863,899	361,684,631
1998	494,845,560	205,017,799	0	699,863,359	378,114,396
1999	292,746,199	214,031,000	0	506,777,199	253,514,770
2000	291,038,155	223,044,200	0	514,082,355	238,119,599
2001	290,010,557	228,552,269	0	518,562,826	222,402,708
2002	271,396,015	234,060,338	0	505,456,353	200,723,672
2003	253,463,719	239,568,407	0	493,032,126	181,286,890
2004	235,530,523	245,076,476	0	480,606,999	163,627,959
2005	215,782,805	250,584,545	0	466,367,350	147,018,439
2006	160,198,269	256,092,614	0	416,290,883	121,511,340
2007	377,699,355	261,600,683	0	639,300,038	172,782,951
2008	394,809,123	267,108,752	0	661,917,875	165,644,306
2009	411,238,445	272,616,821	0	683,855,266	158,457,515
2010	463,151,786	278,124,890	0	741,276,676	159,039,582
				Accumulated Cost	Net Present Cost
				10,898,470,683	5,184,487,965

Year	Alternative No.3				
	Bus Fleet Reinforcement	Bus Operating Cost	Facilities Construction	Total (US$)	Discounted Value (8%)
1990	0	133,758,770	0	133,758,770	133,758,770
1991	38,798,978	142,829,380	1,821,412	183,449,770	169,860,898
1992	47,429,378	151,899,989	16,436,279	215,765,646	184,984,264
1993	45,306,712	160,970,599	1,104,209	207,381,520	164,626,137
1994	26,079,878	170,041,208	6,572,459	202,693,545	148,985,807
1995	58,443,878	86,882,921	2,045,058	147,371,857	100,298,810
1996	47,655,878	90,947,484	5,140,882	143,744,244	90,583,257
1997	47,744,320	95,012,047	0	142,756,367	83,296,969
1998	63,720,000	99,076,609	0	162,796,609	87,953,942
1999	56,759,157	103,141,172	0	159,900,329	79,989,974
2000	48,419,895	107,205,735	0	155,625,630	72,084,778
2001	35,474,910	110,795,517	0	146,270,427	62,732,879
2002	31,991,205	114,385,300	0	146,376,505	58,128,124
2003	51,908,910	117,975,082	0	169,883,992	62,465,991
2004	50,304,075	121,564,864	0	171,868,939	58,514,678
2005	65,316,675	125,154,647	0	190,471,322	60,044,504
2006	60,566,892	128,744,429	0	189,311,321	55,258,170
2007	53,091,486	132,334,211	0	185,425,697	50,114,809
2008	46,207,634	135,923,993	27,273	182,158,900	45,585,088
2009	47,368,440	139,513,776	245,454	187,127,670	43,359,739
2010	47,810,652	143,103,558	0	190,914,210	40,960,302
				Accumulated Cost	Net Present Value
				3,615,053,270	1,853,587,890

12.5 Minibus and Taxi Plan

(1) Overview

666. Minibus and taxi are categorized as well qualified public transport modes. Of the two modes taxi is more demand responsive, while minibus provides easier access to the public.

667. It is a generally supported policy to stimulate change from private car use to public transport mode. However, this policy can not be achieved in one stride. The first step might be to provide a well qualified, especially in security, transport mode.

668. Minibus and taxi are/will be operated by private entities. Such entities are generally more efficient than public entities, however being profit-oriented, they tend to service only high demand areas and high demand period. Some guide line and system to control their behavior is necessary.

(2) Minibus

1) Demand

669. The home interview survey shows that between 5 and 10 % (difference depends on income class) of trips generated by persons with income above 40,000 CZN$ (household income base) are taxi trips. Based on this fact we assume 15 % of total trips from households with income above 40,000 CR$ might be the potential demand base for minibus service.

2) Route and Service

670. Six routes are considered (refer to Figure 12.5-1). Direct routes connecting CBD and residential areas.

671. Middle class bus with 29 seats is considered for such service, transporting only seated passengers.

3) System

672. The new organization discussed in section 12.7 will be responsible to decide routes and operation schedule. Private enterprise/person, however, will actually operate. The tariff for minibus is assured three times of regular bus.

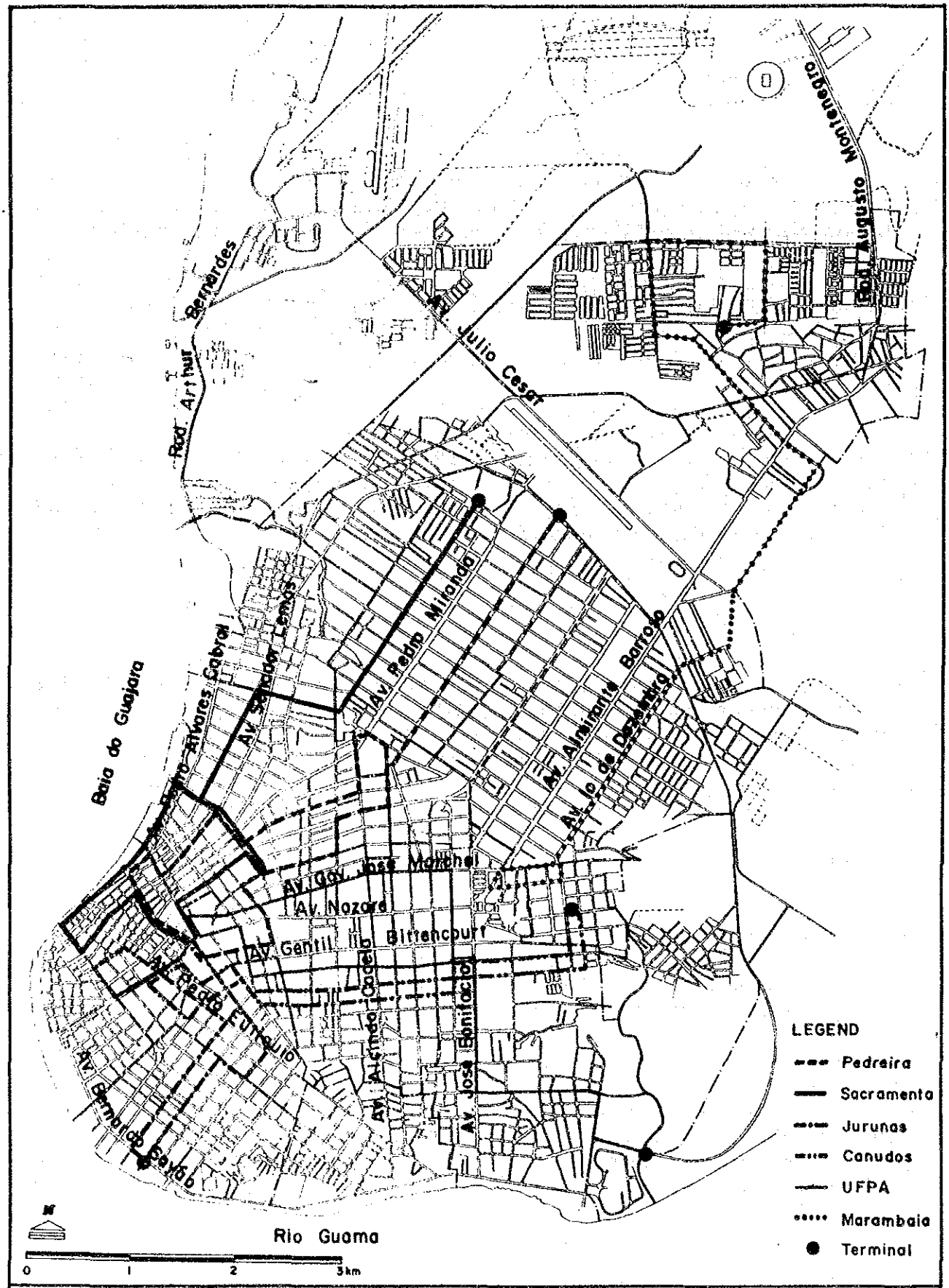


Figure 12.5-1 Minibus Routes

4) Calculation Results

673. Only two routes in six are promising at the moment, Route Pedreira and UFPA. Four routes in six, in 2010, will be promising. Five thousand passengers are expected at this moment and twenty six thousand passengers in 2010. Number of users is unexpectedly small but experiences in other cities have shown that higher quality transport service grows rapidly beyond estimate (refer to Table 12.5-1).

674. Simulation results is poor. Empirically, however, this type of service shows very rapid growth rate. The important thing is to start the service immediately.

(2) Taxi

675. The largest problem of taxi in BMR is shortage of security, eg. physical security of car itself, driving manner, system of indemnity just case of accidents and security from unreasonable charge.

676. Solution is to induce taxi owners to establish syndicates or companies which have the qualification to deal with such problems. In addition a compulsory insurance system shall be applied to the taxi business.

Table 12.5-1 Characteristics of Minibus

Route Name	Dist. (km)	Op. Speed (km/h)	Capacity (psn)	Psn. No.	Thru. Psn. No.	Service (Peak Hr)	Times (Day)
Pedreira	16.8	23	29	1508	1040	4	74
Sacramenta	16.4	23	29	473	347	1	25
Jurunas	7.6	23	29	585	427	2	30
Canudos	14.3	23	29	186	122	0	9
UFPA	14.3	23	29	2384	1802	7	128
Marambaia	23.7	23	29	145	59	0	4
Average	15.5			880.4	632.7	2.5	44.8
Total	93.1			5282	3795	15	269

Route Name	Bus Fleet	Cong. Rate	Bus*km	Psn*km	Psn/km	Psn/ (Bus*km)	(Psn*km)/ (Bus*km)
Pedreira	4	1	1236	53461	90	1.2	43
Sacramenta	2	1	402	14242	29	1.2	35
Jurunas	1	1	229	6456	77	2.6	28
Canudos	1	1	124	6476	13	1.5	52
UFPA	5	1	1829	49837	166	1.3	27
Marambaia	1	1	98	4300	6	1.5	44
Average	2.5	1	653.3	22462	57	1.3	34
Total	15		3920	134772			

Simulation Reasult
Case: Mini-2010

Route Name	Dist. (km)	Op. Speed (km/h)	Capacity (psn)	Psn. No.	Thru. Psn. No.	Service (Peak Hr)	Times (Day)
Pedreira	16.8	22	29	7510	5179	20	366
Sacramenta	16.4	22	29	2357	1727	7	122
Jurunas	7.6	22	29	2915	2124	9	150
Canudos	14.3	22	29	926	609	2	43
UFPA	14.3	22	29	11872	8975	35	635
Marambaia	23.7	22	29	724	291	1	21
Average	15.5			4384	3150.8	12.4	222.9
Total	93.1			26304	18905	74	1338

Route Name	Bus Fleet	Cong. Rate	Bus*km	Psn*km	Psn/km	Psn/ (Bus*km)	(Psn*km)/ (Bus*km)
Pedreira	16	1	6167	266225	446	1.2	43
Sacramenta	6	1	2002	70931	144	1.2	35
Jurunas	4	1	1139	32146	385	2.6	28
Canudos	2	1	617	32253	65	1.5	52
UFPA	24	1	9106	248168	828	1.3	27
Marambaia	2	1	487	21424	31	1.5	44
Average	9.1	1	3253.2	111857.8	283	1.3	34
Total	55		19519	671147			

12.6 Projects

12.6.1 Organization

677. The fundamental policy of the proposed public transport plan is the adoption of trunk/feeder integration network system. To innovate the present public transport system a new creative organization is necessary.

(1) Required Tasks

678. It is necessary that the administration of bus transport system be consolidated. To achieve this task the organization should be an independent public transport contractor. The organization should be the one which sells the tickets and arrange the transport operation contracts with private bus companies. As a result, the money flow from transport users are first collected by the organization and then delivered to each private bus company.

(2) Nature of the Organization

679. The organization shall be independent from all parties concerned. To accomplish that, the board shall be composed of representatives from the state, both municipalities, bus users, bus driver union and bus companies.

(3) Works

1) Planning and Execution

680. The following three planning functions are considered. The planning section shall bear the responsibility of execution of its own plan.

Route planning: to maintain supply-demand balance on each route, to maintain high transport efficiency on total network and to maintain a minimum service level.

Fleet planning: to maintain operative fleet, to study operating cost of each type of buses and to maintain the fleet complex and achieve the lowest operating costs.

Facility planning: to plan construction, improvement and maintenance facilities and to program these projects.

2) Ticket Sales

681. Actual ticket sales are carried out on board by each bus company and over a counter in each bank. The organization only handles a wholesale function. The details are indicated below.

Tariff system planning: to develop an integrated tariff system.
Wholesale: to prepare tickets and provide them to retailers.

3) Contracts, Supervision and Payments

682. All contracts with bus companies, supervision of operations of bus companies and payments to bus companies are organized under this grouping.

4) Organization Chart and Cost

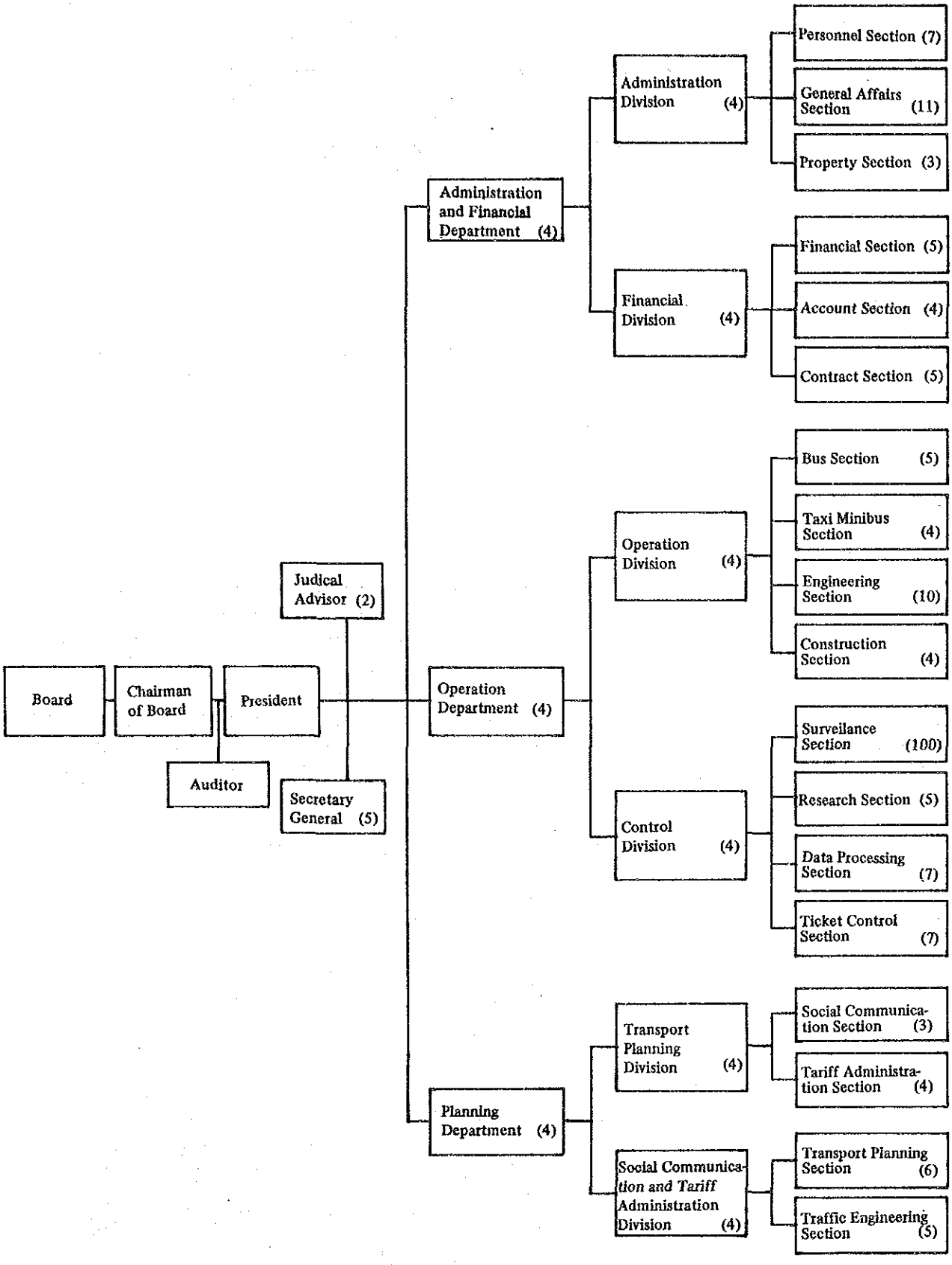
683. The state government delegated the urban transport administration function to the municipality of Belem. As a result, the municipality proposed a new urban transport administration concept, and the "Lei Organica do Municipio de Belem" was enacted in Mar. 1990. According to the act, the key concept is to create a governmental corporation to control private bus companies and to create new fleet with compulsory contribution by companies. This fleet will be leased to bus companies but in the case of strike it is operated by the organization.

684. A task force of the municipal office is proceeding to implement the concept. An organization chart shown in Figure 12.6-1, is being set up, referring to the function of the task force.

685. The cost is estimated at cr$ 32.7 million/month, which is around 2 % of total sales of bus transport business.

12.6.2 Bus Fleet

686. Bus fleet at present is composed of a total of 1212 buses in Belem Metropolitan Region. The age of buses in operation is shown in Table 12.6-1. From the Table we can assume that the average age of buses in operation is 8 years.



Note: The Number in Parenthesis is indicate the Number of Staff

Figure 12.6-1 Organization Chart

Table 12.6-1 Age of Bus in Operation

Year of Production	No. of Bus	Age of Bus
76	1	14
77	0	13
78	8	12
79	6	11
80	24	10
81	17	9
82	109	8
83	93	7
84	85	6
85	102	5
86	99	4
87	294	3
88	233	2
89	158	1
90	19	0

687. Adoption of trunk/feeder integrated system realizes economy in the bus fleet. Result of our simulation shows trunk/feeder integrated system requires 970, 1538 and 2203 buses in years 1990, 2000 and 2010 respectively.

688. Assuming the trunk/feeder system is adopted in 1995, reinforcement schedule of bus fleet becomes as shown in Figure 12.6-2, total bus fleet by year in Figure 12.6-3 and reinforcement cost in Table 12.6-2.

Table 12.6-2 Bus Fleet Reinforcement Cost (US$)

Year	No. of Reinforcement				Amount of Reinforcement				Residual Value(8%)	Discount Value(8%)
	Total	2 Doors	3 Doors	Artic.	Total	2 Doors	3 Doors	Artic.		
1990	0	0	0	0	0	0	0	0	0	0
1991	310	200	100	10	38798978	25710000	12855000	2157600	1923622	35924979.
1992	350	200	100	50	47429378	25710000	12855000	10788000	1923622	40663046.
1993	300	200	0	100	45306712	25710000	0	21576000	1979288	35965928.
1994	150	50	0	100	26079878	6427500	0	21576000	1923622	19169488.
1995	300	50	0	250	58443878	6427500	0	53940000	1923622	39775921.
1996	250	50	0	200	47655878	6427500	0	43152000	1923622	30031286.
1997	250	50	0	200	47744320	6427500	0	43152000	1835180	27858352.
1998	360	100	60	200	63720000	12855000	7713000	43152000	0	34425933.
1999	380	150	100	130	56759157	19282500	12855000	28048800	3427143	28393709.
2000	305	150	5	150	48419895	19282500	642750	32364000	3869355	22427780.
2001	200	50	0	150	35474910	6427500	0	32364000	3316590	15214580.
2002	160	10	0	150	31991205	1285500	0	32364000	1658295	12704147.
2003	260	10	0	250	51908910	1285500	0	53940000	3316590	19086798.
2004	250	10	0	240	50304075	1285500	0	51782400	2763825	17126577.
2005	360	60	50	250	65316675	7713000	6427500	53940000	2763825	20590539.
2006	380	100	100	180	60566892	12855000	12855000	38836800	3979908	17678898.
2007	310	100	10	200	53091486	12855000	1285500	43152000	4201014	14348980.
2008	250	50	0	200	46207633	6427500	0	43152000	3371867	11563415.
2009	250	50	0	200	47368440	6427500	0	43152000	2211060	10975839.
2010	250	50	0	200	47810652	6427500	0	43152000	1768848	10257689.
			Total Cost		970398952			Net Present Value		464183894

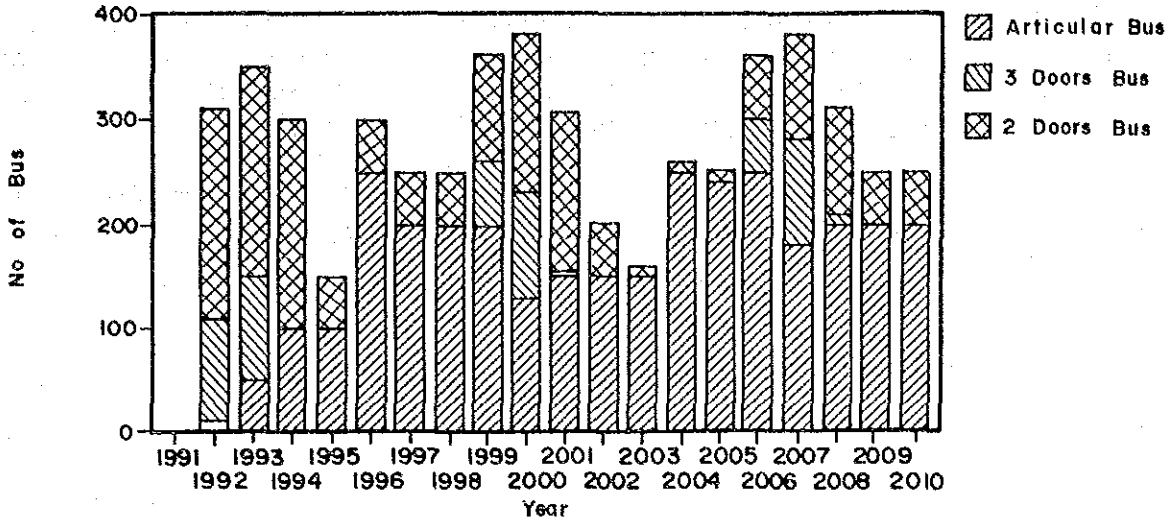


Figure 12.6-2 Reinforcement Schedule

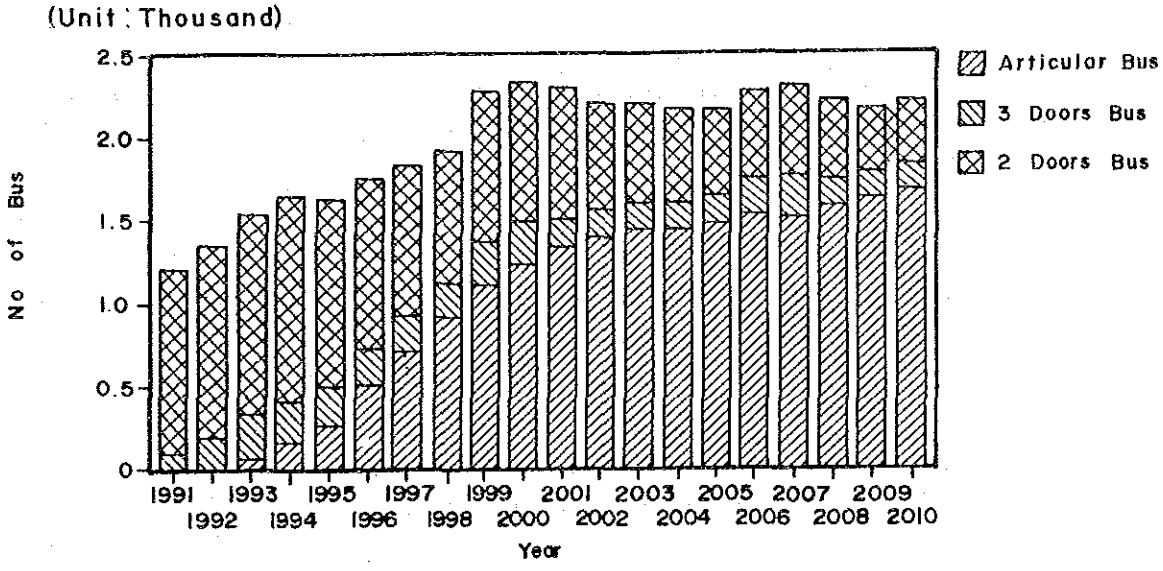


Figure 12.6-3 Bus Fleet

689. Bus fleet is expected to increase in number gradually from 1200 units till 2250 during the first decade and will be maintained at the same level in the second decade, although composition of articular type will slightly increase.

690. Reinforcement schedule shows large drop in 1995 caused by a change in the network system, which will produce large surplus of buses. This after effect will be seen each 8 years in correspondence with depreciation period.

691. Bus fleet reinforcement cost until 2010 is 460 million us$ in discounted value term and 1 billion us$ in accumulated money term.

12.6.3 Terminals and Bus Stops

(1) Terminals

1) Sao Braz

692. An existing Sao Braz intermunicipal bus terminal shall be relocated to Ananindeua area. An intermunicipal bus terminal shall be diverted to an integrated transfer terminal.

693. Sao Braz transfer terminal serves for one trunk route and four feeder routes. The total number of passengers getting on and off at the terminal will be 395,000 in 2010.

694. An approach to the terminal and number of buses by direction, and proposed plan of terminal are illustrated in Figure 12.6-4 under the assumption that one berth can handle 120 buses per an hour. Construction cost estimate is shown in Table 12.6-3.

2) Entroncamento

695. Entroncamento transfer terminal serves three trunk routes and two feeder routes. The total number of passengers getting on and off in 2010 is expected to be 1,206,974.

696. An approach to the terminal and number of buses by direction, and proposed plan of terminal are illustrated on Figure 12.6-5 under the same assumption as is used at Sao Bras transfer terminal plan. Construction cost estimate is shown in Table 12.6-4.

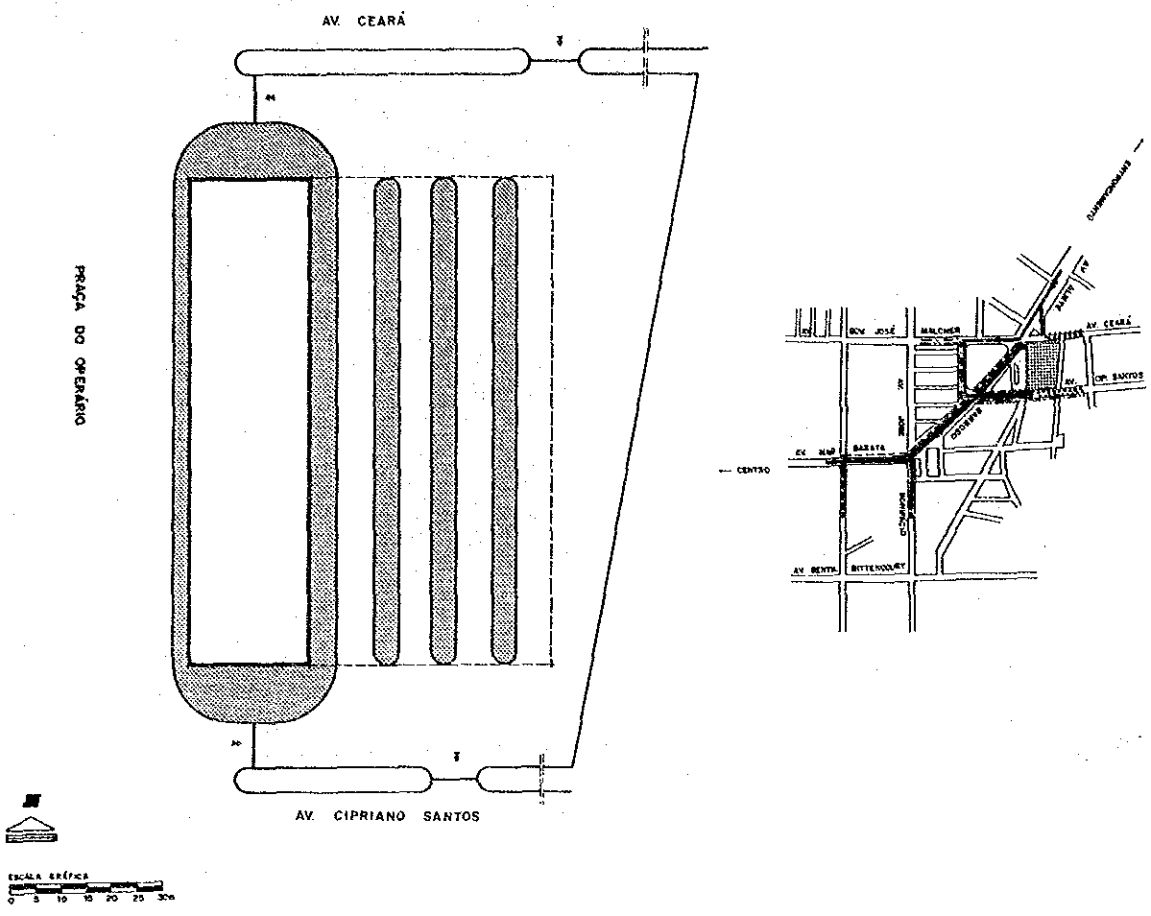


Figure 12.6-4 Sao Braz Terminal Plan

Table 12.6-3 Construction Cost Estimates

Item	Unit	Qty	Price(Cr$) Unit	Total
1. Dispossess	M2	0		0
2. Roof	M2	0	20000	0
3. Construction	M2	0	35000	0
4. Pavement	M2	0	4222	0
5. Visual Signs	LS	0	2000	0
6. Pedestrian Deck	UNIT	0	19230000	0
7. Guard Fence	ML	0	5000	0
8. Improvement	M2	370	755	279350
9. Landscape	M2	0	160	0
10. Indirect Cost	LS			0
11. E/S	LS			0
12. Contingency	LS			0
Total				279350
			Total	US$ 3174

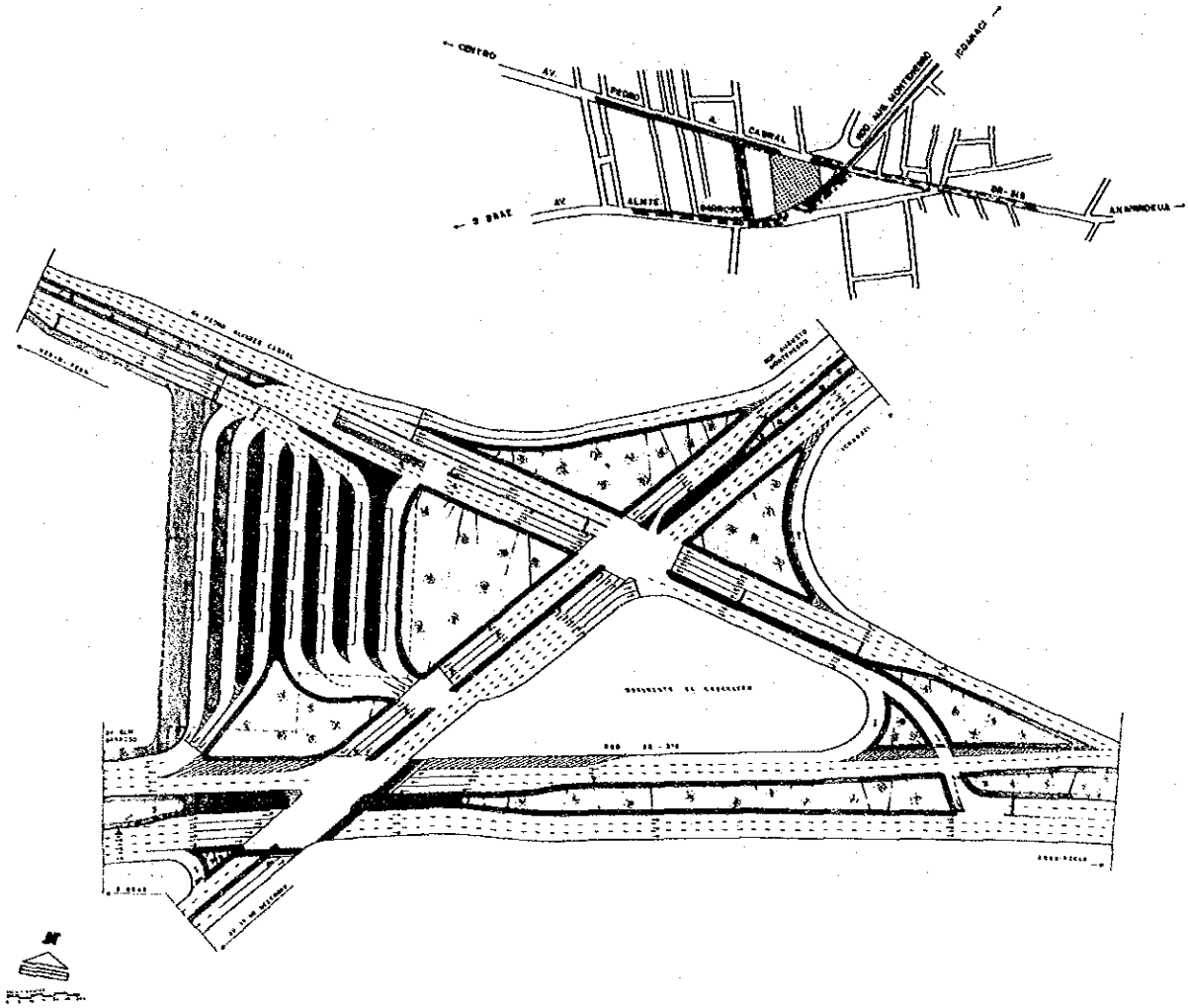


Figure 12.6-5 Entroncamento Terminal Plan

Table 12.6-4 Construction Cost Estimates

Item	Unit	Qty	Price(Cr$) Unit	Total
1. Dispossess	M2	8000	18000	144000000
2. Roof	M2	10000	20000	200000000
3. Construction	M2	10000	35000	350000000
4. Pavement	M2	5700	4222	24065400
5. Visual Signs	LS	0	2000	20000000
6. Pedestrian Deck	UNIT	0	19230000	0
7. Guard Fence	ML	0	5000	0
8. Improvement	M2	0	755	0
9. Landscape	M2	0	160	0
10. Indirect Cost	LS			29703250
11. E/S	LS			218319027
12. Contingency	LS			80100023
Total				1066187700
			Total	US$ 12115769

3) Ananindeua

697. Ananindeua terminal functions as terminal of BR-316/Almirante Barroso route, the largest trunk line. In addition, it serves four feeder line. Rapid growth of outskirt population and movement of an intermunicipal bus terminal will give great importance in future as well as at this moment.

698. The intermunicipal bus terminal will be located at an area adjacent to this terminal. This consolidated transport facility may make a remarkable impact on the city of Ananindeua.

699. The number of passengers per day is estimated at 371,000. An approach to the terminal and number of buses by direction, and proposed plan of the terminal are illustrated in Figure 12.6-6. Construction cost estimate is shown in Table 12.6-5.

4) Telegrafo

700. Telegrafo transfer terminal functions for transfer passengers between one trunk route and one feeder service. This terminal is used by 326,000 passengers a day. An approach to the terminal and number of buses by direction, and proposed plan of the terminal are illustrated in Figure 12.6-7 under the assumption that one berth can handle 120 buses per an hour. Construction cost estimate is shown in Table 12.6-6.

5) Coqueiro

701. Coqueiro transfer terminal functions for transfer passengers between two trunk routes. A total of 265,000 passengers use this terminal. An approach to the terminal and number of buses by direction, and proposed plan of the terminal are illustrated in Figure 12.6-8. Construction cost estimate is shown in Table 12.6-7.

6) Doca

702. Doca transfer terminal functions for transfer passengers between two trunk routes and one feeder route. This terminal is rather small in scale. 160,000 passengers use this terminal. An approach to the terminal and number of buses by direction, and proposed plan of the terminal are illustrated in Figure 12.6-9. Construction cost estimate is shown in Table 12.6-8.

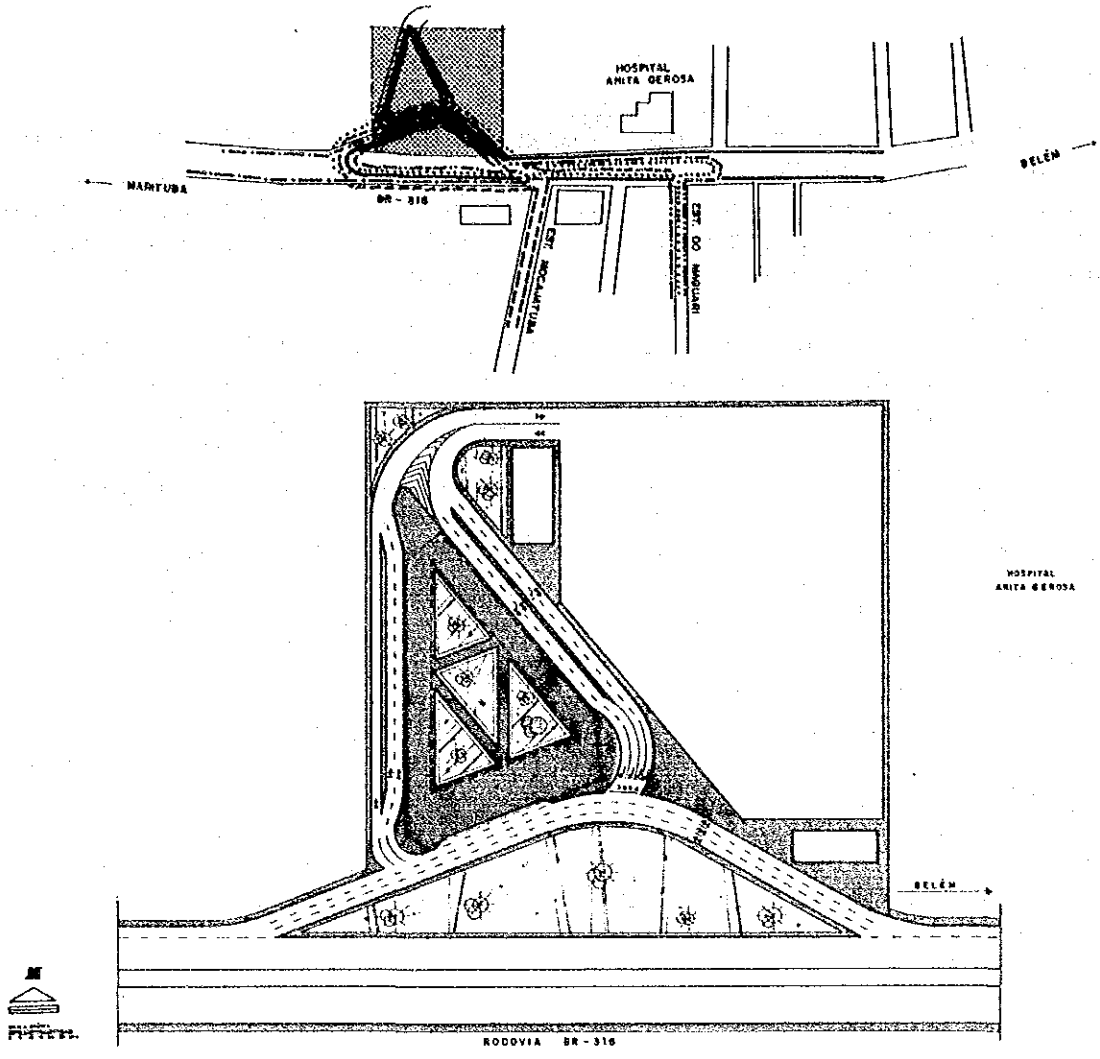


Figure 12.6-6 Ananindeua Terminal Plan

Table 12.6-5 Construction Cost Estimates

Item	Unit	Qty	Price(Cr$) Unit	Total
1. Dispossess	M2	50000	3500	175000000
2. Roof	M2	6000	20000	120000000
3. Construction	M2	2000	35000	70000000
4. Pavement	M2	32000	4222	135104000
5. Visual Signs	LS	0	2000	0
6. Pedestrian Deck	UNIT	0	19230000	0
7. Guard Fence	ML	0	5000	0
8. Improvement	M2	0	755	0
9. Landscape	M2	16000	160	2560000
10. Indirect Cost	LS			25133000
11. E/S	LS			184729000
12. Contingency	LS			71253000
Total				783779000
			Total	US$ 8906580

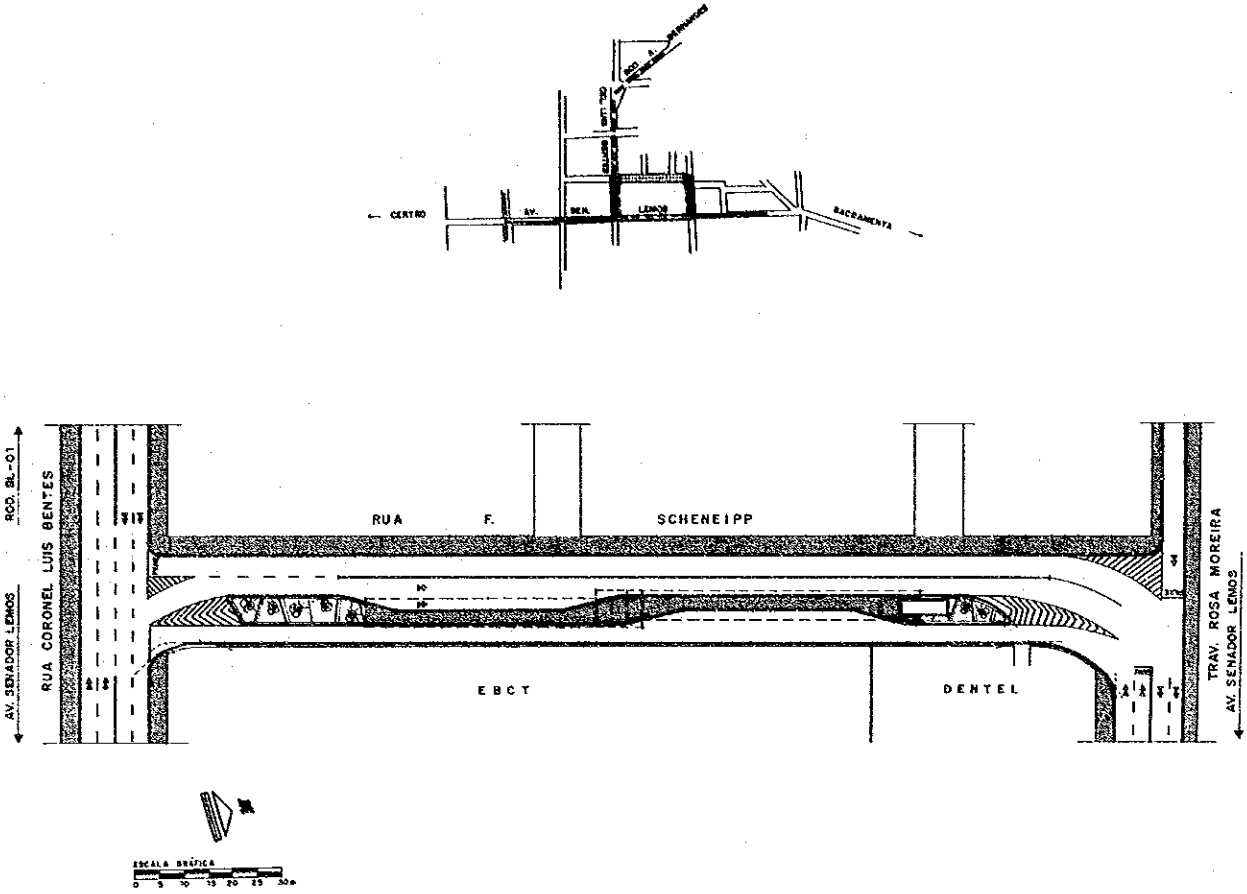


Figure 12.6-7 Telegrafo Terminal Plan

Table 12.6-6 Construction Cost Estimates

Item	Unit	Qty	Price(Cr$) Unit	Total
1. Dispossess	M2	0	3500	0
2. Roof	M2	630	20000	12600000
3. Construction	M2	50	35000	1750000
4. Pavement	M2	2080	4222	8781760
5. Visual Signs	LS	630	2000	0
6. Pedestrian Deck	UNIT	0	19230000	0
7. Guard Fence	ML	230	5000	1150000
8. Improvement	M2	1740	755	1313700
9. Landscape	M2	0	160	0
10. Indirect Cost	LS			1342000
11. E/S	LS			9865000
12. Contingency	LS			1260000
Total				38062460
			Total	US$ 432528

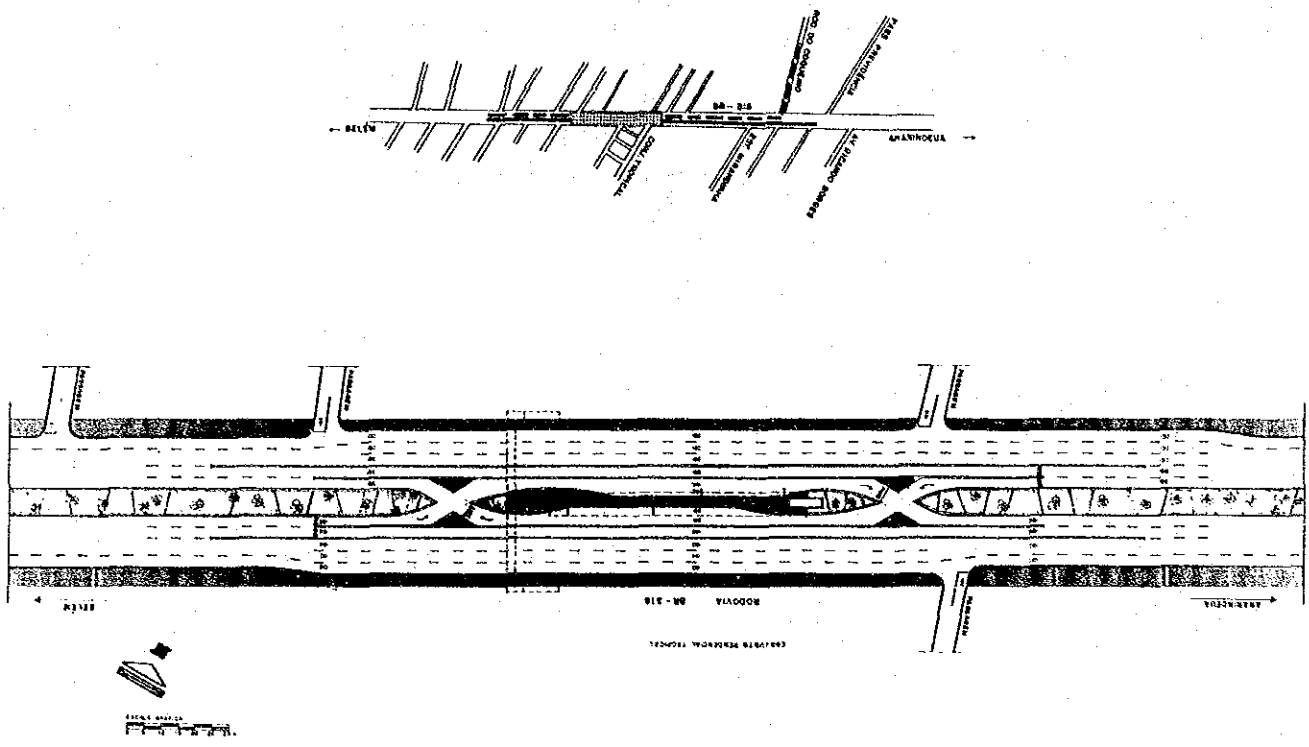


Figure 12.6-8 Coqueiro Terminal Plan

Table 12.6-7 Construction Cost Estimates

Item	Unit	Qty	Price(Cr$) Unit	Total
1. Dispossess	M2	0	3500	0
2. Roof	M2	440	20000	8800000
3. Construction	M2	50	35000	1750000
4. Pavement	M2	3450	4222	14565900
5. Visual Signs	LS	400	2000	0
6. Pedestrian Deck	UNIT	2	19230000	38460000
7. Guard Fence	ML	3000	5000	15000000
8. Improvement	M2	0	755	0
9. Landscape	M2	800	160	128000
10. Indirect Cost	LS			3929000
11. E/S	LS			28876000
12. Contingency	LS			11138000
Total				122646900
			Total	US$ 1393714

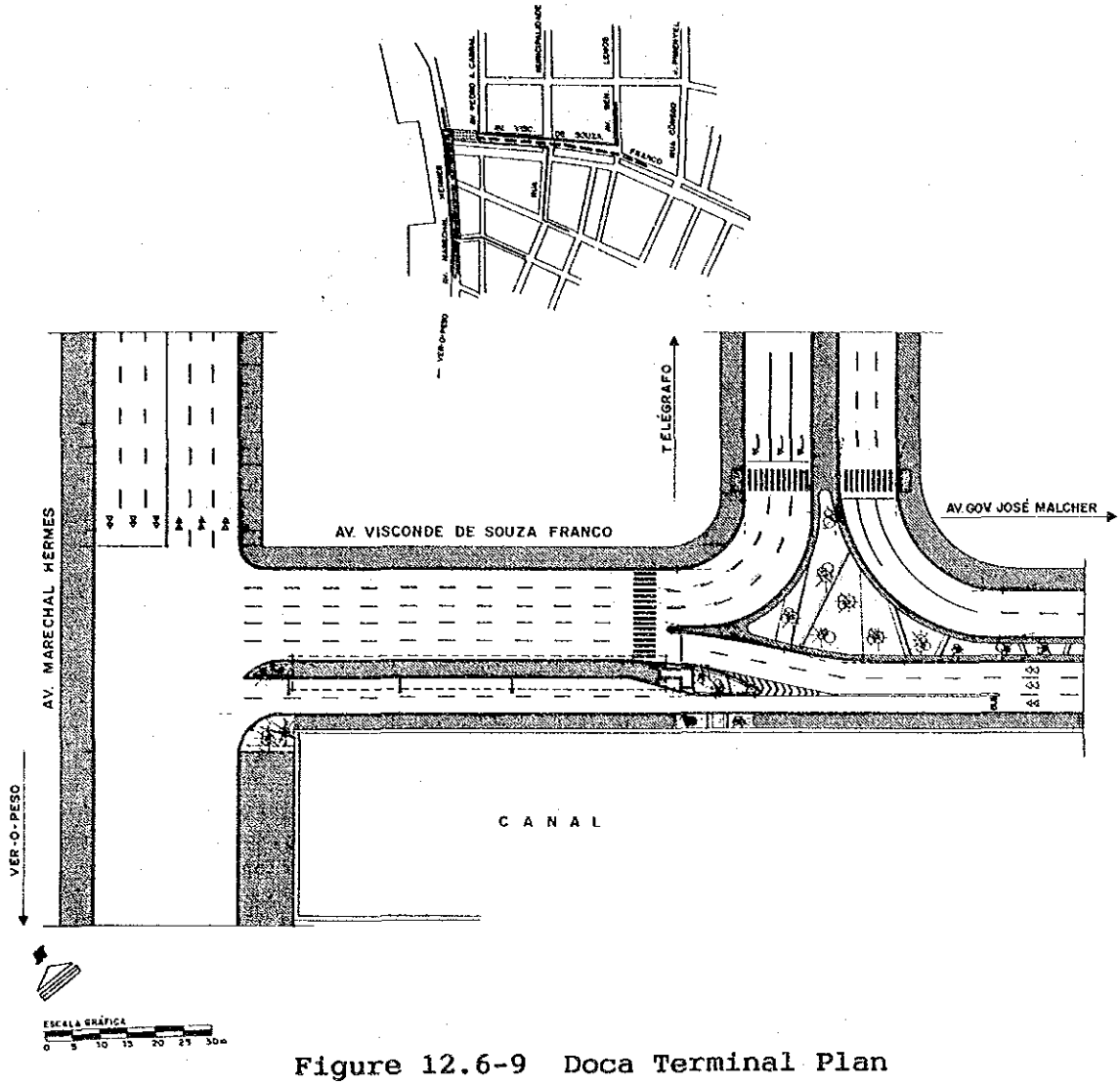


Figure 12.6-9 Doca Terminal Plan

Table 12.6-8 Construction Cost Estimates

Item	Unit	Qty	Price(Cr$) Unit	Total
1. Dispossess	M2	0	3500	0
2. Roof	M2	360	20000	7200000
3. Construction	M2	50	35000	1750000
4. Pavement	M2	970	4222	4095340
5. Visual Signs	LS	360	2000	0
6. Pedestrian Deck	UNIT	0	19230000	0
7. Guard Pence	ML	0	5000	0
8. Improvement	M2	0	755	0
9. Landscape	M2	0	160	0
10. Indirect Cost	LS			688000
11. E/S	LS			5058550
12. Contingency	LS			2671000
Total				21462890
			Total	US$ 243896

7) Intermunicipal Bus Terminal

703 Intermunicipal bus terminal removed from Sao Braz will be constructed in Ananindeua. Its location is planned to be near the Ananindeua bus terminal. The construction cost is shown in Table 12.6-9.

Table 12.6-9 Estimate Cost of Intermunicipal Terminal

Item	Unit	Qty	Price(Cr$) Unit	Total
1. Dispossess	M2	20000	5000	100000000
2. Roof	M2	4000	20000	80000000
3. Construction	M2	3200	35000	112000000
4. Pavement	M2	11000	4222	46442000
5. Visual Signs	LS	0	2000	0
6. Pedestrian Deck	UNIT	0	19230000	0
7. Guard Fence	ML	0	5000	0
8. Improvement	M2	0	755	0
9. Landscape	M2	0	160	0
10. Indirect Cost	LS			17722000
11. E/S	LS			130250000
12. Contingency	LS			50241000
Total				536655000
			Total	US$ 6098352

(2) Bus Stops

704. Bus stops on an exclusive busway of BR-316 and Av. Almirante Barroso is studied. Capacity of an exclusive busway is mainly restricted by the handling capacity of bus stops. Bus stops of Av. 9 de Julho busway in Sao Paulo give a model to be studied. A key feature of that bus stop is its length, typically 250 m, to accommodate a bus stop bay for 3 buses, a maneuvering length (30 m) and a further bus stop bay for 3 buses. This maneuvering length allows easier bus access to/from the two bays combined with over-taking lane. The median of a busway is fenced to discourage random pedestrian crossing.

705. Plan of a standard bus stop is illustrated in Figure 12.6-10, which is considered to handle 480 local buses an hour while allowing exclusive use of a central lane for express buses.

706. BR-316 and Av. Almirante Barroso need 15 bus stops of this type. Unit construction cost is provided in Table 12.6-10.

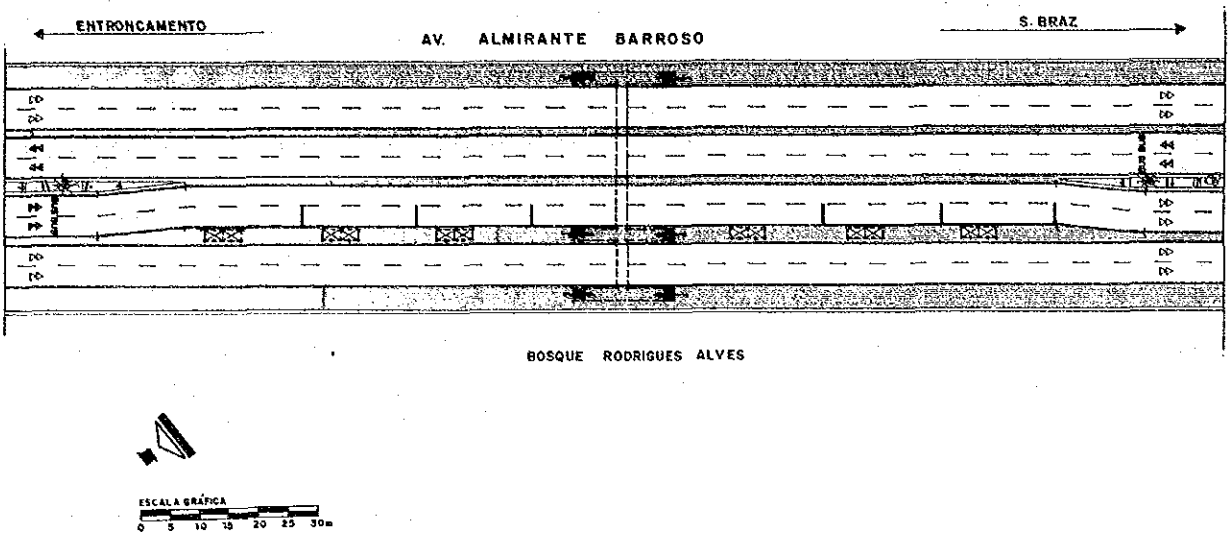


Figure 12.6-10 Standard Bus Stop Plan

Table 12.6-10 Estimates of Standard Bus Stop

Item	Unit	Qty	Price(Cr$) Unit	Total
1. Dispossess	M2	0	5000	0
2. Roof	M2	0	20000	0
3. Construction	M2	0	35000	0
4. Pavement	M2	2088	9000	18792000
5. Visual Signs	LS	0	2000	0
6. Pedestrian Deck	UNIT	0	19230000	0
7. Guard Fence	ML	540	5000	2700000
8. Improvement	M2	12	1000000	12000000
9. Landscape	M2	0	160	0
10. Indirect Cost	LS			1674000
11. E/S	LS			12306000
12. Contingency	LS			4747000
Total				52219000
			Total	US$ 593398

12.6.4 Busway

707. Busway is classified in the following three categories;

a. completely separated busway with two lanes in each direction,
b. exclusive busway with two lanes and
c. exclusive busway with one lane.

708. Detailed discussion is shown in Section 13.4 traffic management plan.

12.6.5 Schedule

709. Figure 12.6-11 is the recommended implementation schedule for public bus system. Existing network shall be switched over in 1995 according to this schedule.

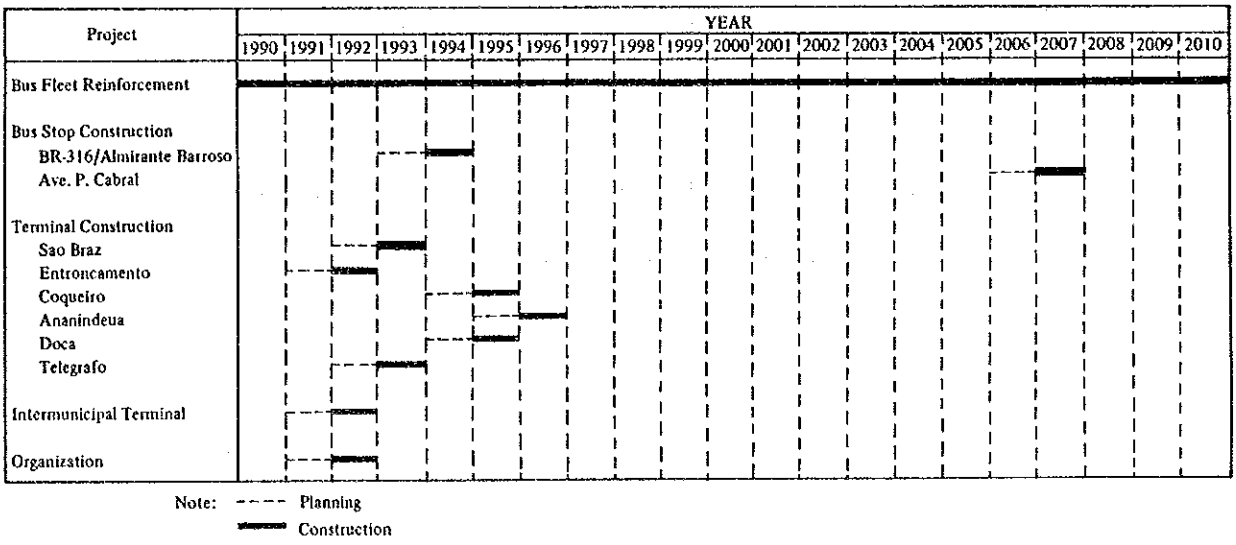


Figure 12.6-11 Implementation Schedule of Public Bus System

13. Traffic Management Plan

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Roadside Parking ▼

13.1 The Objectives of Traffic Management Plan

710. The problems on the actual traffic management in Belem are summarized as follows;

a. No definition of road function in the central area,
b. No traffic signal system adaptable to the fluctuation of traffic flow,
c. No consideration for the safety of pedestrians,
d. Poor condition of the traffic management facilities due to poor maintenance, and
f. The drivers' low sensitivity for traffic safety

711. As for future traffic flow in the central area, it will not be much different from the current condition and furthermore there is no problem about the traffic capacity of the road (refer to Figure 13.1-1). Therefore the main objectives of traffic management planning are to provide solutions to actual problems.

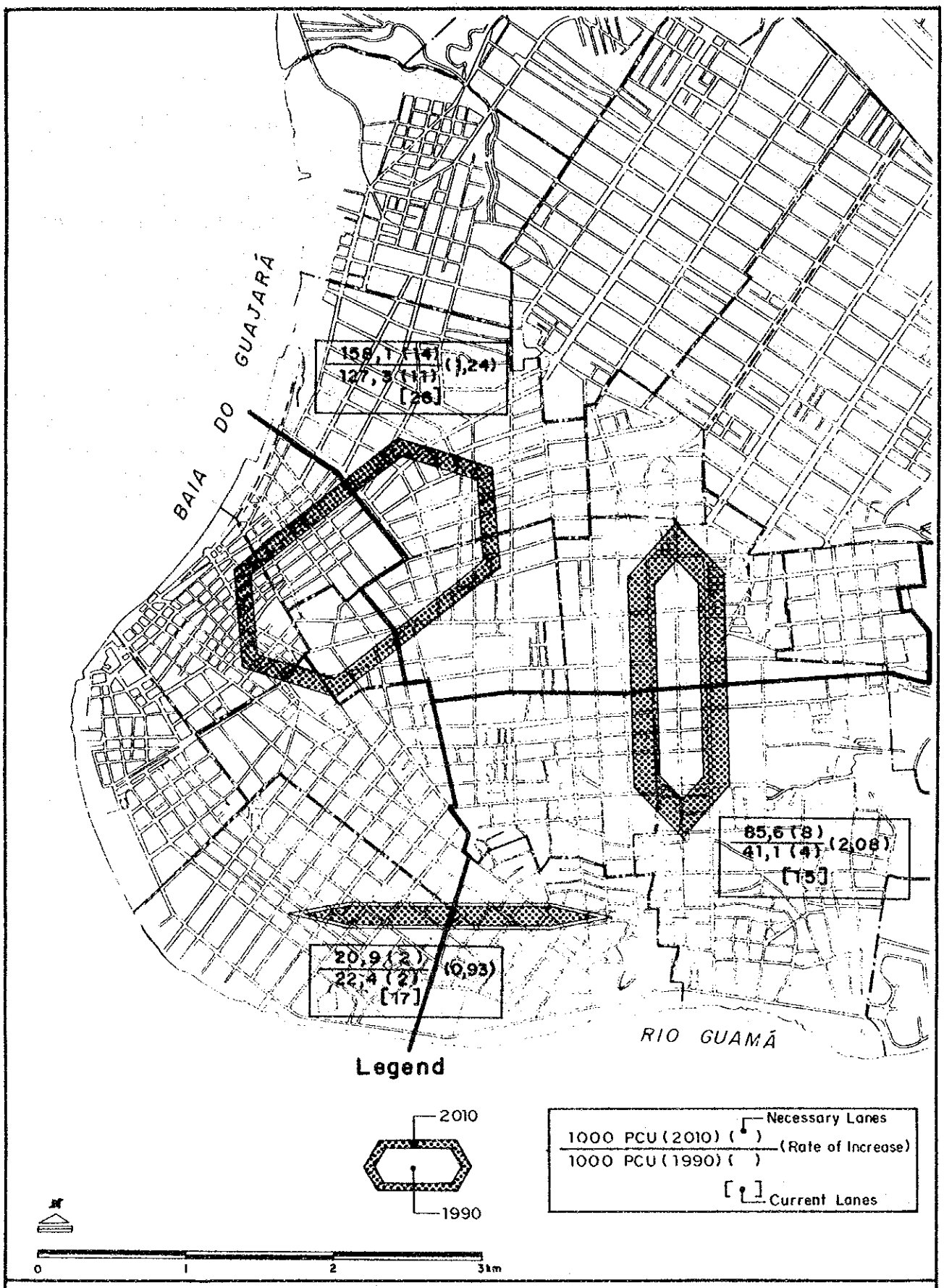

Figure 13.1-1 Traffic Demand and Necessary Lanes

13.2 Basic Concept for Planning

712. The purpose of the traffic management is to maintain traffic safety and smooth traffic flow. In the central area it's possible to keep the smooth traffic flow due to the high road network density as long as the road network is used efficiently.

713. Therefore the main theme of traffic management plan is the software counterplan without any heavy hardware investment. The prime conditions for planning are as follows;

a. The main planning area is the future CBD area (Comercio Batista Campos, Reduto, Nazare, Can, and Sao Braz)
b. The traffic management plan is based on the road network plan and the public transportation plan. Therefore, its target year is 2010. The urgent and middle range plans are intermediate steps of the master plan.

714. In the future CBD area, traffic flow will concentrate into the only few arteries, in spite of the existence of many roads. Therefore the different kinds of traffic such as public traffic, private one, inter-zone one and intra-zone one will be mixed on the same road. This mixed condition will create the conditions for the decrease in traffic safety and the initiation of traffic congestion. (refer to Figure 13.2-1)

715. Therefore the basic concept for the master plan of traffic management is 'separation' of traffic. By 'separation' of traffic flow, it is possible to maintain traffic safety and smooth traffic flow due to the existence of the same type of traffic on the roads. The type of traffic flow to be separated are as follows;

a. Public traffic and private traffic,
b. Inter-zone traffic and intra-zone traffic, and
c. Vehicles and pedestrians

716. In the Study Area, public bus traffic and pedestrians which are part of the public traffic flow are very important because of their large trip shares of the total. Therefore public bus traffic has the highest priority in the traffic management.

13.3 Traffic Flow Plan

13.3.1 Classification of Road Function

717. Road function plays a role in the separation of the traffic flow. The roads are classified into three types: public traffic artery, private traffic artery, and secondary street. Each road function is shown in Table 13.3-1.

Table 13.3-1 Classification of Road and Its' Function

Type	Objective Traffic			Function	
	Public Traffic	Private Inter-zone	Traffic Intra-zone	Travel	Parking
Public Traffic Artery	M	x	o	low	middle
Private Traffic Artery	N	M	N	high	low
Secondary Street	o	x	M	low	high

Note: M; Main objective Traffic
o; Consideration
N; No consideration
x; Exclusion

718. Public traffic arteries are defined for buses. On these roads, buses are able to operate punctually with little interruption from other traffic. Travel speed doesn't need to be high, but buses have to run mixed with intra-zone traffic which is generated by residents by road-side.

719. Private traffic arteries are defined for inter-zone traffic which are important for private vehicles access between suburban area and CBD area. Therefore on these roads, vehicles are required to drive at high speed. Parking restrictions should be enforced because parked vehicles disturb the movement of traffic flow.

720. Secondary streets are defined for intra-zone traffic which distributes within the zone. On-street parking is permitted for easy distribution and high travel speed isn't required.

13.3.2 Alternative for Traffic Flow Plan

721. Traffic flow plan is based on the public transportation plan. The main trunk bus routes run through the future CBD area from east to west, circle Comercio via Ver-O-Peso, and distribute to suburban area. These routes are defined as the public traffic arteries, so that two alternatives are studied with the private traffic arteries. The concepts of these are shown in Figure 13.3-1 and explained as follows;

a. Alternative 1 (refer to Figure 13.3-2)

-	Public Traffic Artery	Trunk bus routes
-	Private Traffic Artery	Parallel routes with public Traffic artery, Access to CBD area by secondary streets from north to south

b. Alternative 2 (refer to Figure 13.3-3)

-	Public Traffic Artery	Trunk bus routes
-	Private Traffic Artery	Parallel routes with public traffic and cross route against public traffic artery from north to south

722. The above differences between these alternatives determine whether or not the north-south axis shall be a private traffic artery. Av. Alcindo Cacela and Tv. 9 de Janerio are used for these axes, wherein these roads are operated as one-way. As for ring roads surrounding Comercio, Av. Assis de Vasconcelos, Boulevard Castilho Franco, Av. Portugal, Av. Tamandare and Rua Gama Abreu, they will have mix of public traffic and private one because there are no wide roads nearby.

723. Av. Marchel Hermes also carries mixed public and private traffic, but one-way regulation is enforced to increase traffic capacity. The roads in the opposite direction of Av. Marchel Hermes are Rua Das Municipalidade and Rua Gaspar Viana.

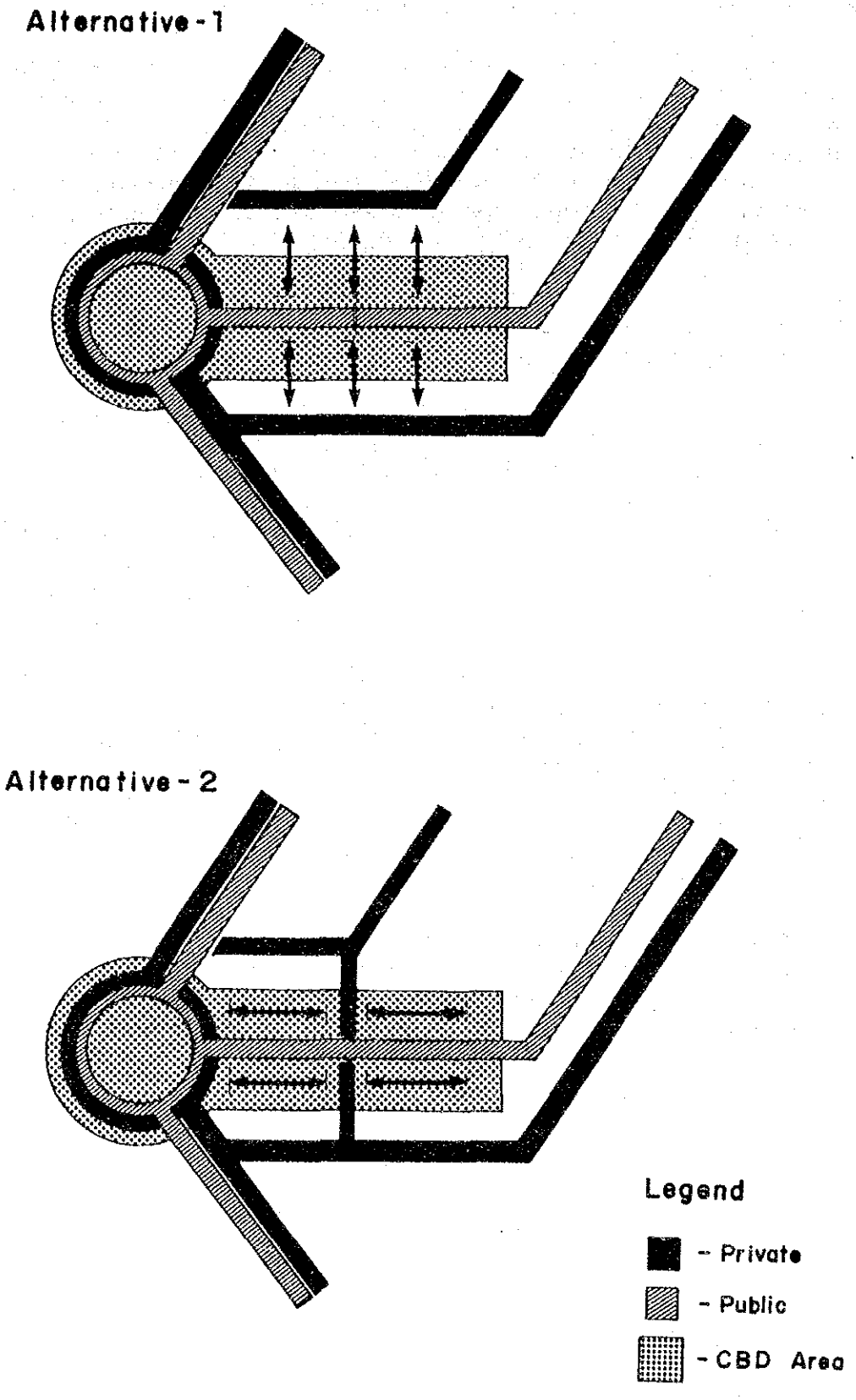

Figure 13.3-1 Concept of Traffic Flow Plan

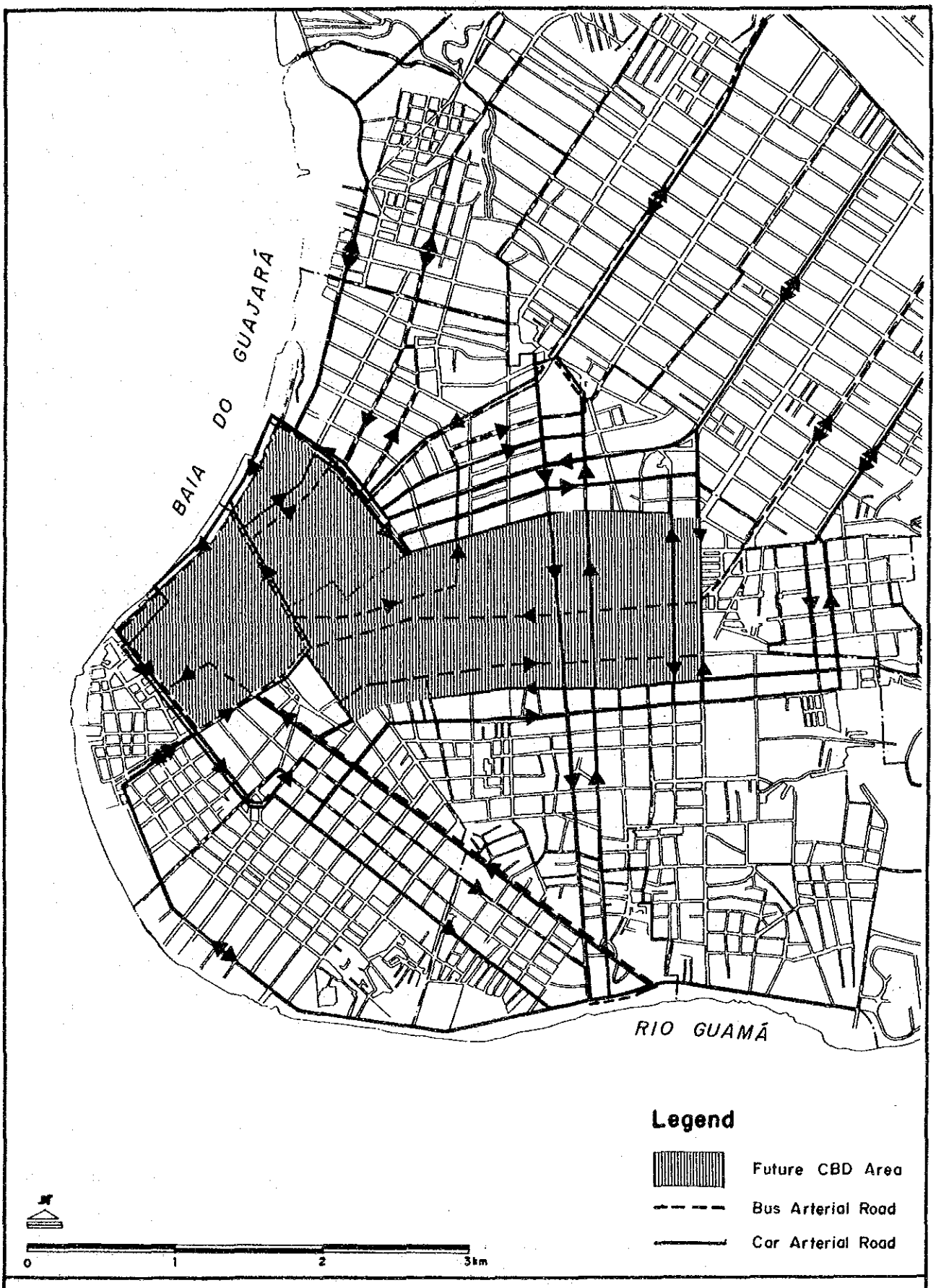

Figure 13.3-2 Traffic Flow Plan (Alternative-1)

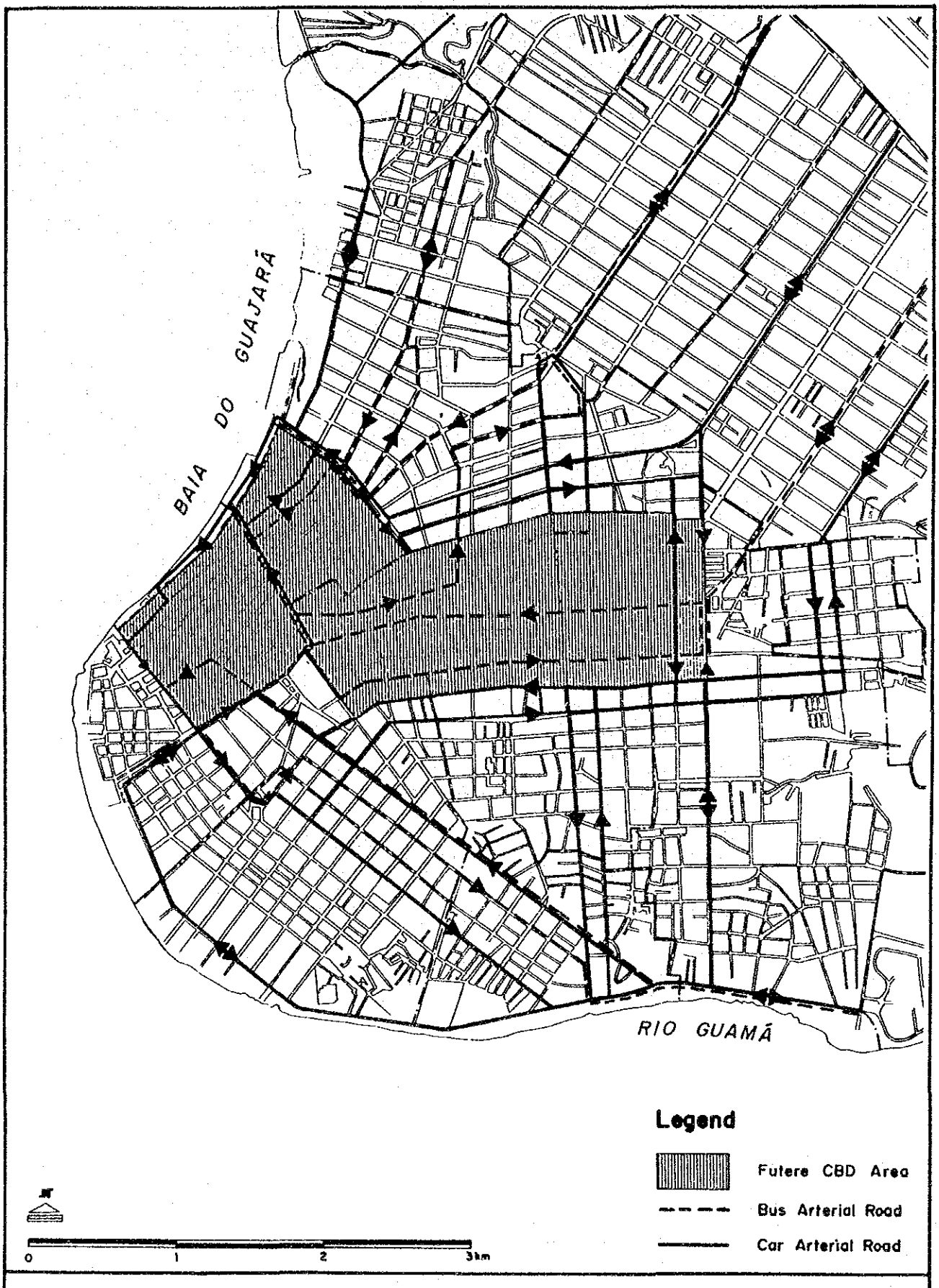

Figure 13.3-3 Traffic Flow Plan (Alternative-2)