c. Class C: Others

776. Design capacity for passengers is as follows;

a. Class A: 15,000/day, 720/hr
b. Class B: 6,000/day, 290/hr
c. Class C: 3,000/day, 145/hr
note: peak ratio of 8%, direction rate of 60%

777. Passengers waiting in the terminal are estimated roughly by assuming the number of boat operation frequency. For the class A terminal, the operation frequency is more than 3.5. For class B terminal it is more than 2. For class C terminal it is more than 2. Therefore, terminal capacity for passengers is determined as follows;

a. Class A: 210 passengers
b. Class B: 150 passengers
c. Class C: 80 passengers

(2) Wharf

778. Two types of wharf are considered depending on location. Table 11.6-2 shows the type and its size.

Table 11.6-2 Wharf Type and Its Size

Terminal	Wharf Type	Wharf Size
Castillogrande	Pontoon	30 x 7 x 0.8 m
Bocagrande	Pontoon	30 x 7 x 0.8 m
Centro	Pontoon	30 x 7 x 0.8 m
India Catalina	Pontoon	30 x 7 x 0.8 m
	Pontoon	20 x 6 x 0.8 m
Marbella	Pier	
San Pedro	Pier	
Barrio Chino	Pier	
Mercado Bazurto	Pontoon	30 x 7 x 0.8 m
	Pontoon	20 x 6 x 0.8 m
El Bosque	Pontoon	30 x 7 x 0.8 m
Santa Maria	Pier	
La Maria	Pontoon	20 x 6 x 0.8 m
Boston	Pontoon	20 x 6 x 0.8 m
Olaya Herrera	Pontoon	20 x 6 x 0.8 m

note: size; represents length, width and depth

(3) Fuel Supply and Storage

779. Fuel supply station is proposed to be located at Cartagena Bay, equipping the pontoon available for the boat mooring of 33 meter long. Capacity of fuel storage is minimum 100 cubic

meters enough for ten (10) days boat operation.

(4) Maintenance Yard

780. Maintenance yard requires the facilities for fiber coating (320 sq. meters), wood work (100 sq. meters), steel work (100 sq. meters), parts storage (50 sq. meters) and office building.

11.7 Local Conditions for Introduction of Water Transport

(1) Condition of Possibility of Boat-building

781. Boats are most important and fundamental facilities for water transport system. Safety, comfort, economy, easy-operation, easy maintenance, beauty and so on are needed for the boat. Considering these factors, aluminum or G.R.P.(Glassfiber Reinforced Plastics) will be recommended as material for the hull. But, there is no aluminum or suitable G.R.P. boat factory in Cartagena. In Cartagena, there is a largest steel work shipyard through out the Republic of Colombia, but they is no design section for boat.

(2) Condition of Exiting Passenger Boats in Bay of Cartagena

782. In the Bay of Las Animas, Bay of Cartagena, passenger boat business is carried on. From Centro to Punta Arena, Cano de Loro, Bocachica of Tierra Bomba Island, approximately 20 boats of two groups are put in service.

783. One group is high speed small boats. Particulars of these boats are as follows;

a. Overall length : from 7 to 10 meters
b. Maximum breath : from 1.5 to 2.1 meters
c. Main engine : from 75 ps 2 set to 100 ps 2 set (Outboard Gasoline)
d. Speed : 20-30 knots
e. Complement : approximately 25 persons

784. Another group is a bigger slow speed sightseeing boat.

785. They are mainly for the purpose of sightseeing or pleasure. However residents of Tierra Bomba Island are also using these high speed small boats for transportation.

786. The problems for residents of Tierra Bomba Island is an insufficient number of boats, especially in tourist season because boat operators prefer to take tourists on board as boat fare for tourists is twice that for residents.

(3) Approval System for Passenger Boat Business

787. The company intending to carry out passenger boat business must submit documents which describe the size of the company, insurance and navigation route to Capitania de Pueruto. Approval for passenger boat business by Capitania de Pueruto must be obtained.

788. According to information from Capitania de Pueruto, about 2000 companies are doing marine transport business in Cartagena city.

(4) Inspection System for Boat Building or Operation

789. For boats over 25 international gross ton, regulations of big merchant ships are applied regarding construction, stability, equipment and facilities. Before the construction of the boat over 25 international gross ton, Di Mar Bogota must check the papers regarding above-mentioned items. After that Di Mar Bogota gives a construction permit to the shipyard. Therefore, all shipyards that intend to build boats over 25 international gross tons must consult with naval consultant regarding above-mentioned items.

790. Boat under 25 international gross tons, must be checked by Capitania de Pueruto regarding their safety equipment.

11.8 Cost Estimate

11.8.1 Projects Required for Water Transport Operation

791. For the operation of water transport, following projects of facility construction are required;

a. Boat terminal: three (3) major terminals at India Catalina, Los Pegasos and Mercado Bazurto and thirteen (13) local terminals
b. Wharves : two types of wharves such as pontoon and pier
c. Fuel supply : one station
d. Maintenance yard: one maintenance yard
e. Channel equipments: beacons at 11 locations

792. Tables 11.8-1, 11.8-2 and 11.8-3 show the major dimensions of the facilities for the operation of water transport.

Table 11.8-1 Major Dimensions of the Terminals

Facility	Major Dimension		
Passenger Terminal	Terminal Area (m2)	Building Floor (m2)	Waiting Passenger Capacity (psn)
* Centro	562.5	324.0	210
* I. Catalina	1110.0	882.0	210
* Bazurto	562.5	324.0	210
* Bocagrande	450.0	243.0	150
* Marbella	450.0	243.0	150
* Barrio Chino	450.0	243.0	150
* Sta Maria	450.0	243.0	150
* C/grande	200.0	104.0	80
* El Bosque	200.0	104.0	80
* San Pedro	200.0	104.0	80
* La Maria	200.0	104.0	80
* Boston	200.0	104.0	80
* Olaya Herrera	200.0	104.0	80
* Albornos	200.0	104.0	80
* Alcalis	200.0	104.0	80
* Pasacaballo	200.0	104.0	80

note: Building space includes those for main office, radio room, ticket counter, passenger waiting room, kiosk, telephone booth, toilet, bus stop/taxi stand, etc.

Table 11.8-2 Major Dimensions of the Wharves

Wharf	Pontoon(A)	Pontoon(B)	Pier
(Length/Width)	30 x 7 m	20 x 6 m	20 x 1 m
* Centro	1	-	-
* I. Catalina	1	1	-
* Bazurto	1	1	-
* Bocagrande	1	-	-
* Marbella	-	-	1
* Barrio Chino	-	-	1
* Sta Maria	-	-	1
* C/grande	1	-	-
* El Bosque	1	-	-
* San Pedro	-	-	1
* La Maria	-	1	-
* Boston	-	1	-
* Olaya Herrera	-	1	-
* Albornos	-	-	1
* Alcalis	-	-	1
* Pasacaballo	-	-	1

Table 11.8-3 Major Dimensions of the Maintenance Yard and Gas Station

Yard Area (m2)	2835.0
Building Floor Area (m2)	875.0
* Maintenance Yard	
Administration Office	
Lamination Yard	Spray Machine/Crane
Carpenter Shop	Electric Machine U.
Ironworks	Electric Machine U.
Parts Storage	
* Gas Station	
Storage Tank	
Fueling Machine	
Pond	

11.8.2 Project Cost

793. Table 11.8-4 shows the cost estimate of the projects.

Table 11.8-4 Project Cost of Water Transport

Project	Project Cost (million pesos) Construction	Land Acquisition	Total
Boat terminals			
* Centro	160.75	56.25	217.00
* I. Catalina	385.22	111.00	496.22
* Bazurto	161.55	45.00	206.55
* Bocagrande	124.63	112.50	237.13
* Marbella	124.63	36.00	160.63
* Barrio Chino	124.63	36.00	160.63
* Sta Maria	124.63	36.00	160.63
* C/grande	55.52	50.00	105.52
* El Bosque	55.52	12.00	67.52
* San Pedro	55.52	16.00	71.52
* La Maria	55.52	6.00	61.52
* Boston	55.52	6.00	61.52
* Olaya Herrera	55.52	6.00	61.52
* Albornos	55.52	6.00	61.52
* Alcalis	55.52	6.00	61.52
* Pasacaballo	55.52	6.00	61.52
sub total	1,705.72	546.75	2,252.47
Wharves			
* Centro	26.88	-	26.88
* I. Catalina	42.24	-	42.24
* Bazurto	42.24	-	42.24
* Bocagrande	26.88	-	26.88
* Marbella	9.36	6.21	15.53
* Barrio Chino	9.36	6.21	15.53
* Sta Maria	9.36	6.21	15.53
* C/grande	26.88	-	26.88
* El Bosque	26.88	-	26.88
* San Pedro	9.36	6.21	15.53
* La Maria	15.36	-	15.36
* Boston	15.36	-	15.36
* Olaya Herrera	15.36	-	15.36
* Albornos	9.36	6.21	15.53
* Alcaris	9.36	6.21	15.53
* Pasacaballo	9.36	6.21	15.53
sub total	303.60	43.47	346.95
Supply station/ Maintenance yard	905.23	283.50	1,188.73
Channel Equip.	-	-	-
Total	2,914.55	873.72	3,788.27

11.9 Evaluation of Water Transport Project

11.9.1 Financial Analysis

794. Financial evaluation is made on the water transport project from the viewpoint whether the project is profitable enough to attract private enterprises to this business, because EDURBE has a basic policy that boat operation shall be managed by private sector, while infrastructure such as canals and terminals be developed by public sector. For this reason, public investment is excluded from this analysis.

(1) Boat Operating Cost

795. As for the boat types previously selected, their specifications, prices, annual operating distances and operation hours are summarized as shown in Table 11.9-1. For rapid boats of type A and B, the design speed is 20 knots and the operation speed is 14 knots and for slow boats of Type C and D, 7.4-8.6 knots and 7 knots, respectively. Annual average operating mileage is set as 50,000 nautical miles for rapid boats and 30,000 nautical miles for slow boats.

Table 11.9-1 Characteristics of Recommendable Boat

Characteristcs	unit	High Speed Boat		Low Speed Boat	
		Boat A	Boat B	Boat C	Boat D
1 Capacity	Person	200	100	100	75
2 Maximum Speed	Knot	20	20	8.6	7.4
3 Engine Power	PS	895	711	102	111
4 Cost					
Hull	mill. $	363.6	141.2	138.8	100.8
Engine	mill. $	135.1	107.4	15.4	16.8
Total	mill. $	498.7	248.6	154.2	117.6
5 Operater					
Captain	Person	1	1	1	1
Mate	Person	1	1	1	1
Crew	Person	2	2	2	1
6 Cruising Distance	N.mile/yr	50,000	50,000	30,000	30,000
7 Operating Hour	Hours/yr	4,500	4,500	4,500	4,500

796. Based on these assumptions, boat operating costs are estimated as shown in Table 11.9-2, using basic data for each cost item as follows:

a. Fuel cost: Fuel consumption of a boat is proportional to the engine capacity (SP) and running time, namely, 170 g/SP*liter. The price of diesel oil is $104/liter and its specific gravity is 0.83.

b. Oil cost: Oil consumption of a boat is proportional to the engine capacity and cruising mileage,

namely, 2 liters per each 100 SP and 1,000 nautical miles. Oil price is $990/liter.

c. Maintenance cost: Annual maintenance cost is estimated to be 5% of boat price.

d. Depreciation cost: Boat value is linearly depreciated over 12 year with 20 % salvage value.

e. Capital opportunity cost: 12% of average residual value of the boat (one half of boat price).

f. Personnel cost: Monthly wage of a captain is $600,000, a mate $250,000, a crew $150,000, and wages of office staff are disregarded.

g. Overhead cost: 5% of the total of above costs. "a" through "f" is assumed.

Table 11.9-2 Boat Operating Cost

(at 1992 price)

Characteristcs	unit	High Speed Boat		Low Speed Boat	
		Boat A	Boat B	Boat C	Boat D
1 Variable Cost					
1) Fuel	$/N.mile	953	757	253	320
2) Oil	$/N.mile	18	14	2	2
3) Maintenance	$/N.mile	499	249	257	196
Total	$/N.mile	1,470	1,020	512	518
2 Fixed Cost					
4) Depreciation	1,000$/Yr	33,247	16,573	10,280	7,840
5) Interest	1,000$/Yr	299,220	149,160	92,520	70,560
6) Personnel	1,000$/Yr	27,600	27,600	27,600	24,000
7) Overhead	1,000$/Yr	21,677	12,217	7,287	5,897
Total	1,000$/Yr	381,744	205,550	137,687	108,297

(2) Economic Comparison of Boat Types

797. Using the annual operating mileage assumed in Table 11.9-1, total daily operating cost of each boat is estimated. The highest is $1,247,000 for Type A (with 200 passengers of capacity) and the lowest is $339,000 for Type D (75 passengers). In these costs, capital opportunity cost (interest) represents the major part, that is, 66% of the cost of Type A and 57% of Type D are interest costs. Assuming the tariff of $120 /board which is the same rate as the current average bus fare, a boat of Type A must transport 10,393 passengers a day and a boat of Type D, 2827 passengers, in order to recover the cost by tariff revenue. Therefore, the turnover times (number of passengers divided by the capacity) should be 52 times for Type A and 38 times For Type D, which would not be easy to attain (refer to Table 11.9-3).

Table 11.9-3 Comparison of Daily Cost and Necessary Passengers

(at 1992 price)

Item	unit	High Speed Boat		Low Speed Boat	
		Boat A	Boat B	Boat C	Boat D
1 Operating Cost	1000$/day	1,247	703	419	339
2 Needed Passengers	Person	10,393	5,857	3,494	2,827
3 Seat Turnover	Times/day	52	59	35	38

798. Next, economic comparison is made under plausible conditions in a model route similar to the project in Cartagena. Assumed conditions are:

a. Route length (one way): 5 nautical miles (9.3 Km),
b. Tariff : $120 /board,
c. Average occupancy : 60 %, and
d. Seat turnover : 1.3 times

799. Figure 11.9-1 presents the number of boat trips (in round trips) necessary to balance the cost and the revenue. 46 round trips are needed to a boat of Type A, 66 trips to Type B, 28 trips to Type C and 34 trips to Type D. Among these, Type A as rapid boat and Type C as slow boat show relatively better performance, hence they are selected in the analysis, hereinafter.

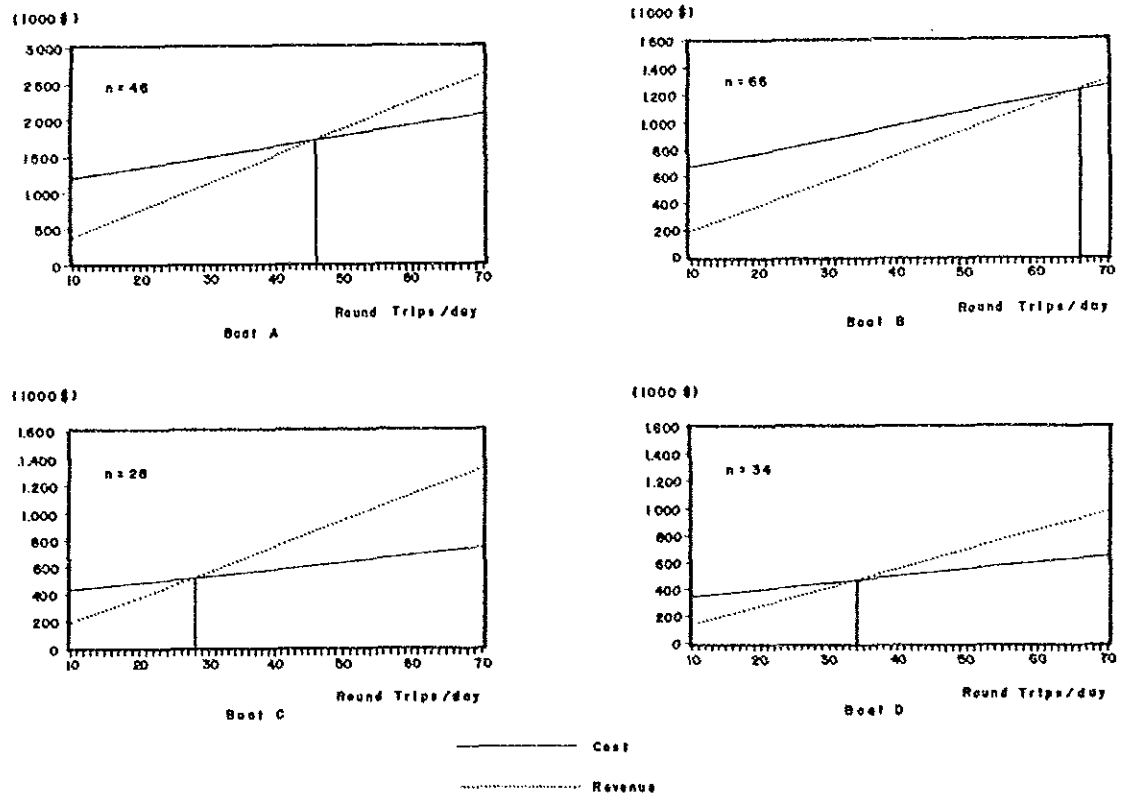


Figure 11.9-1 Breakeven Number of Daily Operation per Boat

(3) Economic Comparison of Routes

800. Financial conditions of planned three routes are compared based on the demand forecast results. Route 101 and 102 are operated by Type A boats and route 103 by Type C boat. Daily operating period is 15 hours and tariff is a flat rate of $120 /board for all the routes. Assuming the maximum headway of operation to be 30 minutes, route 101 and 102 will needs 30 times of service (total trips) each, and route 103 needs 50 times, to meet the demand. Thus, 2 boats must be assigned to route 101, 2 boats to route 102 and 7 boats to route 103.

801. The results of analysis are shown in Table 11.9-4. The transport costs per passenger of routes 101, 102 and 103 are $277, $446 and $317, respectively, all of which exceed each revenue significantly. As a result, the revenue cannot cover even one half the cost of every route. In particular, route 102 shows very low performance.

802. It is recognized that to improve the financial conditions, the tariff rate and the interest rate of capital opportunity cost are the most dominant factors. Changing these rates, the equilibrium points are searched as shown in Figure 11.9-2, which reveals that to make interest zero or to raise the tariff up to $330 will be needed to recover the cost, as long as the tariff raising does not affect the demand.

Table 11.9-4 Route-wise Evaluation of Water Transport Project

Item	Route unit	Route 101	Route 102	Route 103
1 Route				
1) Route Length (One way)	N.mile	5.59	4.20	3.80
2) No. of Station	station	5	6	5
2 Vessel				
1) Type		Boat-A	Boat-A	Boat-C
2) Capacity	person	200	200	100
3) Speed Maximum	knot	20	20	8.6
Average	knot	14	14	7
4) Operating Cost				
Variable Cost	$/N.mile	1,470	1,470	512
Fixed Cost	1,000$/yr	381,744	381,744	137,687
3 Operation				
1) Operating Hours	Hours/day	15	15	15
2) No. of Round Trip	r.trp/day	30	30	50
3) No. of Boat assigned	boat	2	2	7
4) Tariff	$/ride	120	120	120
4 Demand and Revenue				
1) No. of Passenger in 1991	person	9319	5517	8939
2) Revenue	1,000$	1118	662	1073
5 Evaluation				
1) Daily Operating Cost	1,000$	2584	2462	2835
2) Transp.Cost/Passenger	$/pax	277	446	317
3) Profit or Loss	1,000/day	-1466	-1800	-1762
4) Capital Recovery Factor	%	43	27	38

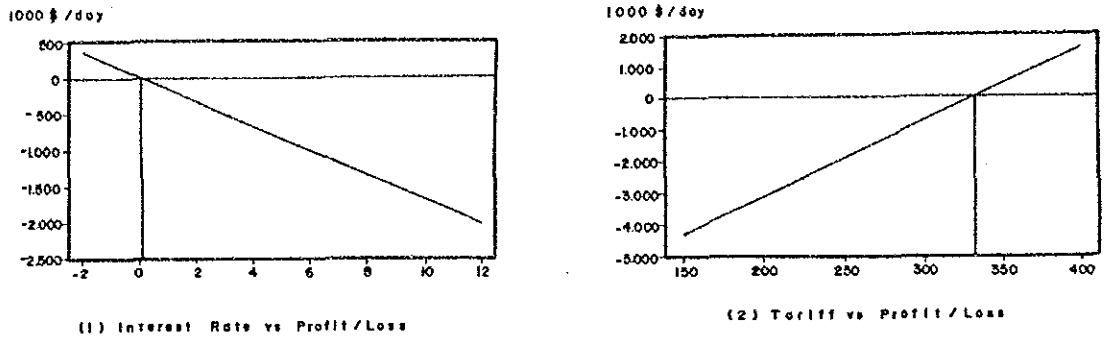


Figure 11.9-2 Sensitivity of Interest Rate and Tariff to Profit/Loss

(4) Long-term Analysis of Financial Conditions

803. As explained in demand forecast, demand for water transport will increase, as total demand for public transport increases. Long-term financial conditions until the year 2010 are analyzed to see how the demand increase affects the project financially. Here, it is assumed that all the three routes are managed by one entity.

804. Table 11.9-5 shows future demand for water transport and the required number of boats in 2010 to meet the increased demand (In this case, operated routes are limited to the above-mentioned three routes, disregarding the extension of route 103 to the airport and the Cienaga de Virgen and new route from Centro to Mamonal industrial area.). During the period of 1995 - 2010, demand for route 101 increases by 2 times and for route 103 by 1.6 times, however for route 102 the demand will increase only by 10%.

805. The number of boats required in 2010 are 6 rapid boats and 12 slow boats. Table 11.9-6 shows the number of boats needed for increase and replacement. 12 rapid boats and 21 slow boats should be introduced in total, which will cost the sum of $9,220 million.

Table 11.9-5 Future Demand for Water Transport and Boat Requirement

(Passenger /day, No. of Boat)

Year	Route 101		Route 102		Route 103		Total		
	Passenger	Boat	Passenger	Boat	Passenger	Boat	Passenger	Boat-A	Boat-C
1991	9,319	2	5,517	2	8,939	7	23,775	4	7
1995	11,250	2	5,650	2	10,128	7	27,028	4	7
1996	11,792	2	5,684	2	10,449	8	27,925	4	8
1997	12,360	2	5,717	2	10,761	8	28,859	4	8
1998	12,956	2	5,752	2	11,123	9	29,830	4	9
1999	13,581	3	5,786	2	11,475	9	30,842	5	9
2000	14,235	3	5,820	2	11,839	9	31,895	5	9
2001	14,921	3	5,855	2	12,215	10	32,991	5	10
2002	15,641	3	5,890	2	12,602	10	34,133	5	10
2003	16,394	3	5,925	2	13,002	10	35,321	5	10
2004	17,185	3	5,960	2	13,414	10	36,559	5	10
2005	18,013	3	5,996	2	13,840	11	37,849	5	11
2006	18,881	3	6,032	2	14,279	11	39,191	5	11
2007	19,791	3	6,068	2	14,731	11	40,590	5	11
2008	20,745	4	6,104	2	15,199	12	42,048	6	12
2009	21,745	4	6,140	2	15,681	12	43,566	6	12
2010	22,793	4	6,177	2	16,178	12	45,148	6	12

Table 11.9-6 Boat Procurement Plan for the Period of 1995-2010

Year	Route 101 (Boat type A)			Route 102 (Boat type A)			Route 103 (Boat type C)			Total No. of Boat to introduce				
	No. of boat to operate	To be newly procured	To be replaced	No. of boat to operate	To be newly procured	To be replaced	No. of boat to operate	To be newly procured	To be replaced	Type A		Type C		Total
										No.	Mill $	No.	Mill $	Mill $
1995	2	2	0	2	2	0	7	7	0	4	1994.8	7	1079.4	3074.2
1996	2	0	0	2	0	0	8	1	0	0	0.0	1	154.2	154.2
1997	2	0	0	2	0	0	8	0	0	0	0.0	0	0.0	0.0
1998	2	0	0	2	0	0	9	1	0	0	0.0	1	154.2	154.2
1999	3	1	0	2	0	0	9	0	0	1	498.7	0	0.0	498.7
2000	3	0	0	2	0	0	9	0	0	0	0.0	0	0.0	0.0
2001	3	0	0	2	0	0	10	1	0	0	0.0	1	154.2	154.2
2002	3	0	0	2	0	0	10	0	0	0	0.0	0	0.0	0.0
2003	3	0	0	2	0	0	10	0	0	0	0.0	0	0.0	0.0
2004	3	0	0	2	0	0	10	0	0	0	0.0	0	0.0	0.0
2005	3	0	0	2	0	0	11	1	0	0	0.0	1	154.2	154.2
2006	3	0	0	2	0	0	11	0	0	0	0.0	0	0.0	0.0
2007	3	0	2	2	0	2	11	0	7	4	1994.8	7	1079.4	3074.2
2008	4	1	0	2	0	0	12	1	1	1	498.7	2	308.4	807.1
2009	4	1	0	2	0	0	12	0	0	1	498.7	0	0.0	498.7
2010	4	1	0	2	0	0	12	0	1	1	498.7	1	154.2	652.9

806. Table 11.9-7 compares annual costs and revenues. As $2,000 to $3,000 million deficit accrues annually, the accumulated deficit up to the year 2010 will reach $40 billion without interest on the annual deficits. However, if interest and depreciation cost are excluded, $100,000 to $150,000 of annual surpluses are observed. This means that the revenue can cover at least direct expenses such as fuel cost, oil cost and personnel cost.

Table 11.9-7 Profit/Loss Statement of Water Transport Project

Year	Demand 1000 Pas.	Revenue mill $	Operating Cost (mill.$) Direct Expense	Depre-ciation	Interst	Total	Profit/Loss (mill.$) Before Dep.+Int.	Before Interest	After Interest
1995	8,108	973	827	205	1,845	2,877	146	-59	-1,904
1996	8,391	1,007	881	215	1,937	3,033	126	-89	-2,026
1997	8,683	1,042	900	215	1,937	3,052	142	-73	-2,010
1998	8,985	1,078	955	226	2,030	3,210	123	-103	-2,132
1999	9,297	1,116	1,026	259	2,329	3,614	90	-169	-2,498
2000	9,621	1,154	1,049	259	2,329	3,636	106	-153	-2,482
2001	9,956	1,195	1,107	269	2,421	3,797	88	-181	-2,603
2002	10,302	1,236	1,132	269	2,421	3,822	105	-164	-2,586
2003	10,660	1,279	1,157	269	2,421	3,848	122	-147	-2,569
2004	11,031	1,324	1,185	269	2,421	3,875	139	-130	-2,551
2005	11,415	1,370	1,248	279	2,514	4,041	122	-157	-2,671
2006	11,812	1,417	1,278	279	2,514	4,071	140	-139	-2,653
2007	12,223	1,467	1,309	279	2,514	4,102	158	-121	-2,635
2008	12,649	1,518	1,426	323	2,906	4,654	92	-231	-3,136
2009	13,089	1,571	1,460	323	2,906	4,688	111	-212	-3,118
2010	13,544	1,625	1,496	323	2,906	4,724	129	-193	-3,099
Total	169,767	20,372	18,434	4,261	38,349	61,044	1,938	-2,323	-40,672

807. It is concluded from the analyses above that the water transport project in Cartagena can hardly be feasible as a profit-oriented business by private sector, under the same tariff as buses. Infrastructure development by public sector may not be sufficient as supportive measures. Therefore, some stronger policy measures including a subsidy for interest payment will be needed, in order to foster the water transport project from the viewpoint such as mitigation of traffic congestion or promotion of better touristic environment. (For instance, if the tariff is $200 /board which is the rate of an executive bus, this project can bear to 4.5% of interest rate, and if $250, then to 7.2%.).

808 In order to make this project viable for the private sector, the following measures should be examined:

a. To set up proper subsidiary policy
b. To create non-operational revenue other than tariff revenue through commercial activity at terminals
c. To procure lower cost boats, through such measures as decrease of design speed, procurement of secondhand vessels or allowing for standing passengers
d. To make service to tourists with higher tariff-bearing capacity.

11.9.2 Socioeconomic Evaluation of Water Transport Project

809. When water transport service become available, a part of public transport demand will be converted to water transport, more or less, and as the result, road congestion will be mitigated and then it can be expected that total vehicle operating cost and

travel time be lessened. This external economies are quantified. (About the method, refer to 14.1 and 14.3)

(1) Economic Benefit

810. The magnitude for the water transport project to ease the road congestion depends on the progress of land transport projects (road development and rationalization of bus operation). Here, it is a basic assumption that the Masterplan be implemented according to the proposed schedule. In addition to this case, analyses will be made also on other cases where major projects affecting the water transport are not realized before the year 2010. The following three cases are set up;

Case 1 : (Base Case) All the road projects and bus improvement are implemented as scheduled.

Case 2 : Road projects competitive to the water transport (C-10, I-6, I-14, Br-3) are delayed beyond 2010.

Case 3 : Bus operating system improvement is not implemented, while all the roads projects are accomplished as scheduled.

811. Economic benefits are estimated for the above three cases as shown in Table 11.9-8. When water transport services is started in 1995, annual benefit will be 334 million pesos. In case 1, this benefit will increase as much as 1,587 million pesos in 2010, four times of that in 1995, while increase of demand for water transport is only two times during this time period. This suggests that benefit of water transport project will rise up rapidly as the roads become congested. The accumulated benefit until 2010 is estimated to be 15.4 billion pesos, which correspond to 6.0 billion pesos of the present value in 1995, under 12% of discount rate.

Table 11.9-8 Economic Benefit of Water Transport Project

(Million Pesos)

Year	Benefit			Discounted Benefit		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1995	334	334	334	334	334	334
1996	417	1,019	513	372	909	458
1997	501	1,705	692	399	1,359	551
1998	584	2,391	872	415	1,701	620
1999	668	3,077	1,051	424	1,955	667
2000	751	3,763	1,231	426	2,135	698
2001	835	4,449	1,410	423	2,254	714
2002	918	5,135	1,589	415	2,322	718
2003	1,002	5,820	1,769	404	2,350	714
2004	1,085	6,506	1,948	391	2,346	702
2005	1,169	7,192	2,128	376	2,315	685
2006	1,252	7,878	2,307	359	2,264	663
2007	1,336	8,564	2,486	342	2,198	638
2008	1,419	9,250	2,666	325	2,119	610
2009	1,503	9,936	2,845	307	2,033	582
2010	1,587	10,622	3,025	289	1,940	552
Total	15,361	87,641	26,866	6,001	30,534	9,906

812. In case 2, as road project delayed and road traffic conditions are worsened, demand for water transport in 2010 will become double of case 1 and by this, benefit will be five times. Although demand will increase to the same extent in case 3, economic benefit will be only 1.7 times of case 1. This fact also shows that the benefit by water transport projects is significantly affected by road development.

(2) Economic Cost of Infrastructure Development

813. Financial costs of infrastructure projects for water transport shown in the previous section are converted to the economic costs. The results are shown in Table 11.9-9 (About the method, refer to Chapter 13.). Total investment of 3,556 million pesos corresponds to 3,128 million pesos at economic cost.

Table 11.9-9 Economic Cost of Infrastructure Project for Water Transport

(Million Pesos)

Type of Facilities	Financial Cost			Economic Copst		
	Phase I	Pfase II	Total	Phase I	Pfase II	Total
1) Terminal	1,722.7	345.2	2,067.9	1,528.8	299.8	1,828.6
2) Wharf	238.6	61.6	300.2	201.6	52.0	253.6
3) Repair Yard & Gas Station	1,188.7	0.0	1,188.7	1,045.5	0.0	1,045.5
Total	3,150.0	406.8	3,556.8	2,775.8	351.9	3,127.7

(3) Conclusion

814. Even in case the Masterplan projects are implemented according to the proposed schedule (Case 1), the external economies of water transport project exceeds the infrastructure development cost by two times, that is, the benefit is estimated to be 6,001 million pesos while infrastructure cost is 3,127 million

pesos. Consequently, it will be economically justified that the water transport business could be subsidized by public financial resources up to the difference, 2,874 million pesos, in addition to the public investment to infrastructure development. However, it should be noted that the said amount is not sufficient to cover the deficit of interest payment for boat acquisition.

815. The water transport project could become economically feasible, if the road project were not carried out even in need. However it does not mean that the water transport project can be an alternative mode of public transportation. It can not be a major transport mode with the capacity limit, and the diseconomy by lack of road in need would be fur greater than the benefit by water transport project. On the contrary, if the water transport is found feasible, it should be understood as a symptom of insufficient road capacity.

816. Water transport project should be planned as a supplementary measures, as long as the road development can hardly catch up the demand increase. In addition, it should be planned to serve not only to daily trips of inhabitants, but also to demand of tourists in order to create better environment as a tourism center of the Caribbean Venice.

CHAPTER 12 TRAFFIC MANAGEMENT PLAN

12.1 General

817. Traffic management plan is influenced by the development of the transport network. Therefore, it should be planned according to the improvement progress of the road network and public bus services taking into consideration the effective use of the current traffic facilities as much as possible.

818. The Plan consists of the plans of traffic flow, intersection improvement, traffic signal and parking system. These plans have close inter-relationship with each other, however, they are described independently in the following sections due to the reporting format.

12.2 Existing Traffic Flow Improvement Plan

12.2.1 Classification of the Road

819. The roads in the Study Area are to be classified by their functions into arterial, collector and local. Figure 12.2-1 shows the major arterial and collector roads in the current urban area.

820. For the traffic management planning, arterial and collector roads are only taken into consideration due to their importance for the traffic flow in the Area.

12.2.2 Traffic Flow Plan

821. In short term stage, traffic flow plan concentrates into the section between Castillo San Felipe and India Catalina of Av. Pedro Heredia. Alternative plan involves the following changes;

a. left turn restriction of north bound on Cra.17 at intersection of Castillo San Felipe,
b. two-way system on Cra.11

822. Alternative plan intends to improve the traffic flow efficiency at intersection of San Felipe, mainly for the traffic flow of Cra. 17 (north and south bounds) by changing the phase number from three (3) to two (2) and extending the green time for such flows. The left turn flow shifts to the intersection of India Catalina.

823. Based on the computer simulation of the traffic flow using traffic ODs at 1991 and 1995, traffic flow shift and traffic

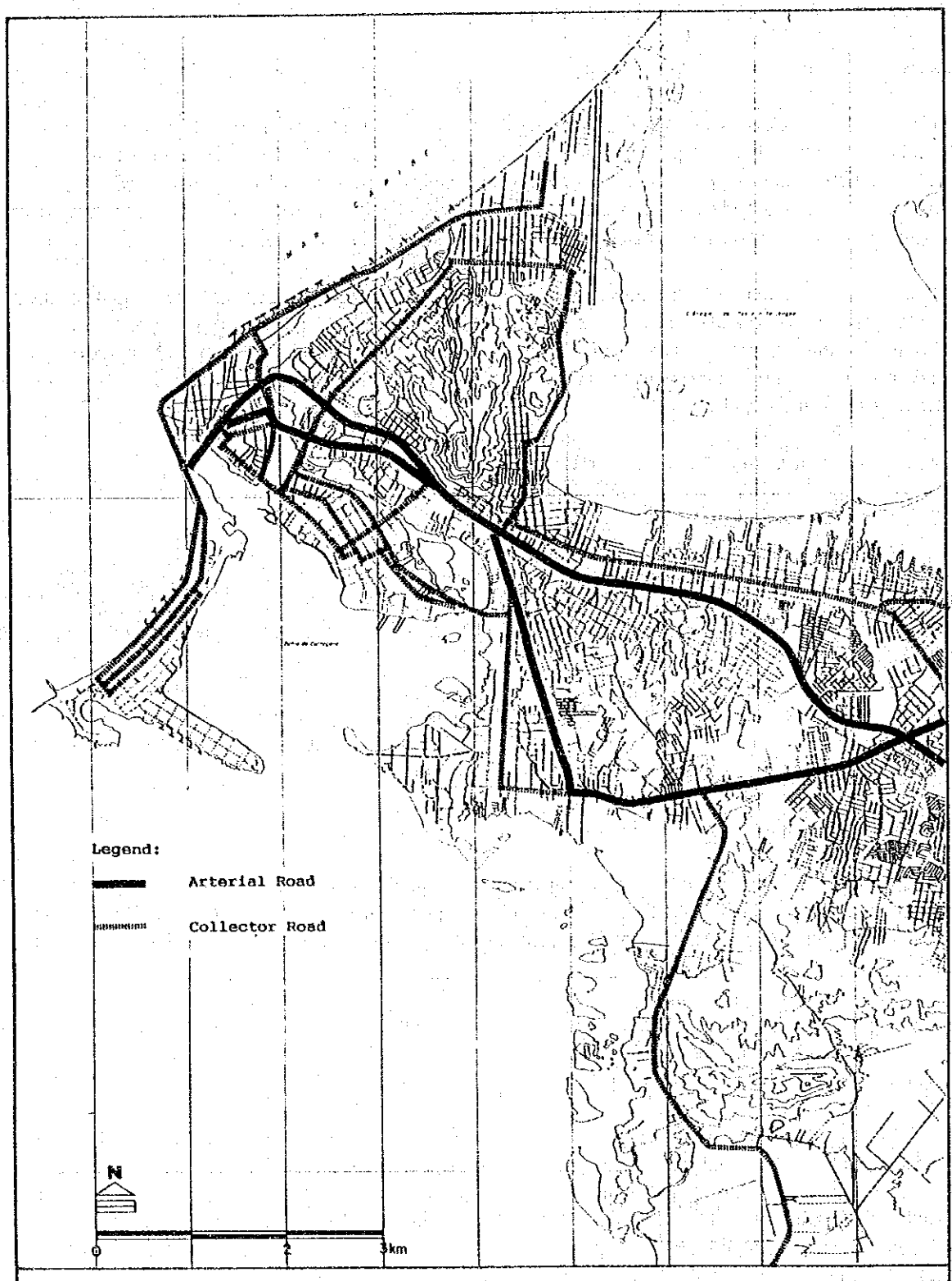


Figure 12.2-1 Classification of Road Function

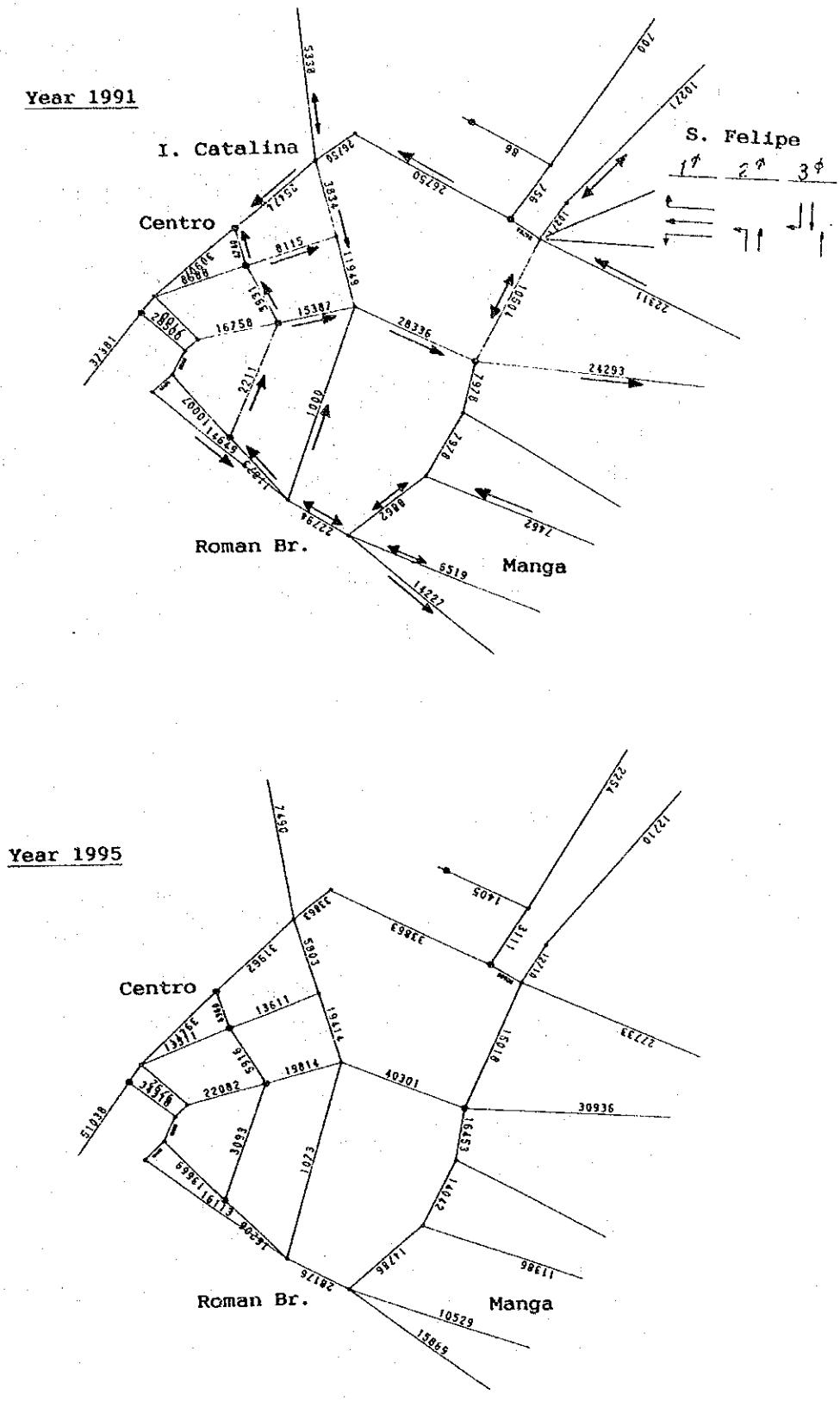


Figure 12.2-2 Existing Traffic Movement

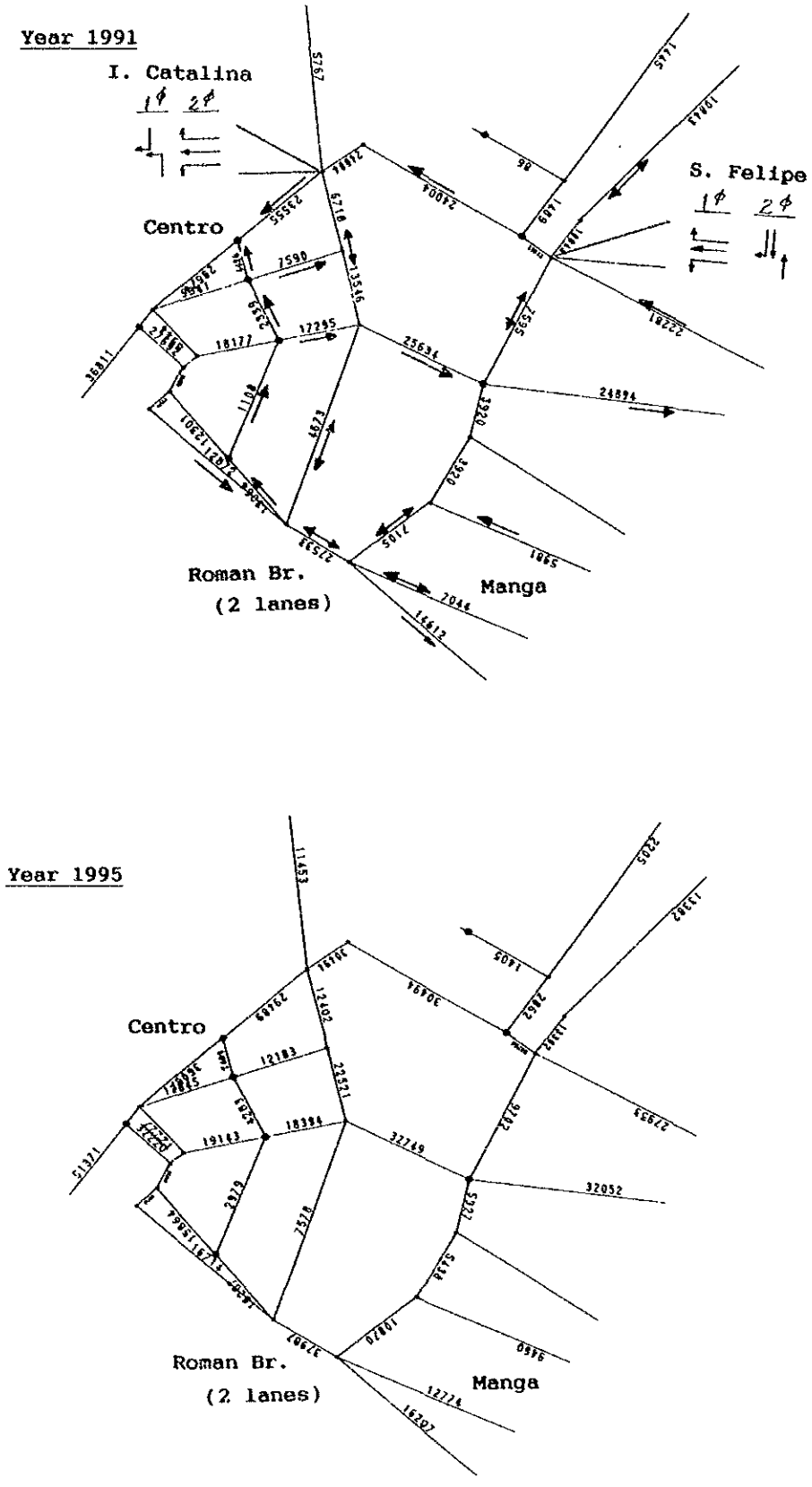
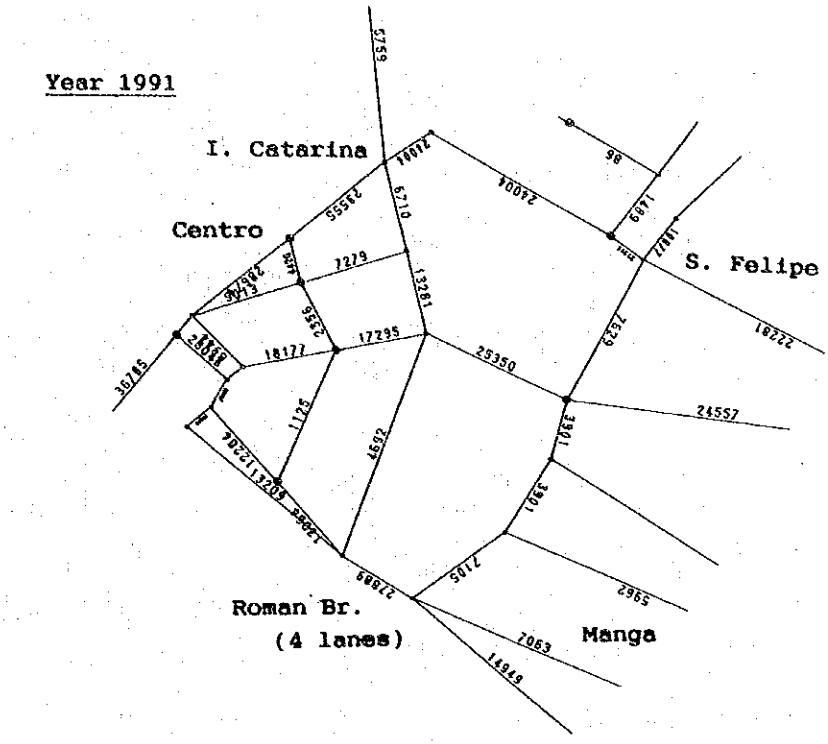


Figure 12.2-3 Alternative Plan (A)



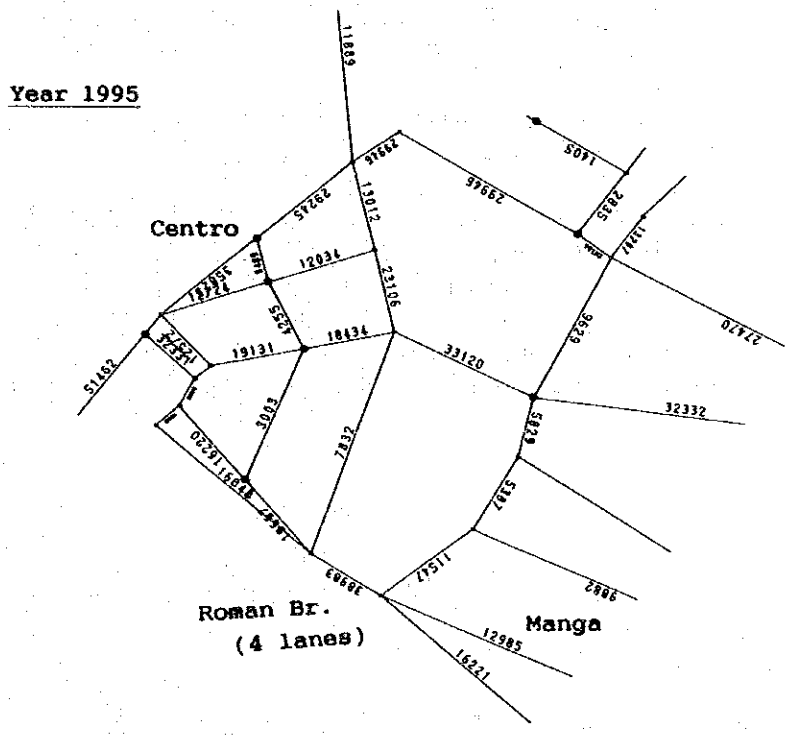


Figure 12.2-4 Alternative Plan (B)

volume on the roads around the central area are shown in Figures 12.2-2 to 12.2-4. Without any action, traffic flow of Cra.17 will suffer from low capacity due to short green period (18 seconds per 92 seconds of cycle length) at intersection of San Felipe.

824. At the intersection of India Catalina, traffic volume on Av. Pedro Heredia decreases and north bound flow on Cra. 11 increases. Almost all of the South bound flow on Cra.11 turns right to Av. Venezuela, therefore this intersection can be managed by two (2) phases signal within its capacity.

825. Traffic flow shift from Av. Pedro Heredia to Roman Bridge requires the capacity improvement of the Bridge. Current traffic capacity of the Roman Bridge is almost full and additional two (2) lanes is necessary for this alternative plan.

826. Table 12.2-1 indicates the total vehicle.kilometers and vehicle.hours at each alternative case.

Table 12.2-1 Comparison of Veh*km and Veh*hr (per day)

	Veh*km		Veh*hr	
Year	1991	1995	1991	1995
Current System	1,368,313	1,840,851	30,865	51,136
Alternative (A)	1,362,289	1,836,268	30,163	52,013
Alternative (B)	1,362,565	1,834,399	30,081	51,510
Difference (A)	6,024	4,583	702	- 877
Difference (B)	5,748	6,452	784	- 374

note: Alternative (A); Roman Bridge is assumed 2 lanes.
Alternative (B); Roman Bridge is assumed 4 lanes.

827. The savings of vehicle*kilometer is expected in both alternatives. As for the vehicle*hour savings, they will not be realized when traffic volume increases due to the time loss at Roman Bridge and beyond. However, as the time loss at intersection of San Felipe is not taken into consideration in Table 12.2-2, savings of vehicle*hour shown in the Table will become more favorable values.

Table 12.2-2 Approach Delay Comparison at San Felipe Intersection

	Current System	Alternative
Traffic Volume (veh./hr)		
east bound	1,553	1,553
north bound - through	140	140
- left t.	204	-
south bound	383	383
Cycle Length (second)	92	60
Green Time (second)		
east bound	36	32
north bound	18	20
south bound	26	20
Lane Number		
east bound	4	4
north bound - through	1	1
- left t.	0.5	-
south bound	1	1
Lane Group Capacity (veh./hr)		
east bound	2,195	2,992
north bound - through	373	565
- left t.	227	-
south bound	414	537
Approach Delay (second/veh.)		
east bound	21.4	7.8
north bound	48.2	10.8
south bound	64.5	43.9

note: Calculation is based on Highway Capacity Manual, Special Report 209, Transportation Research Board,National Research Council, Washington,D.C. 1985

12.2.3 Curb Parking Restriction

828. As explained in Chapter 5, section 5.1, road side parking is restricted on major roads and narrow streets in Central Area as well as in the whole urban area. The selection of such major roads and streets seems reasonable. Curb parking restriction shall be enforced on the arterial and collector roads in urban area at least (refer to Figure 12.2-5).

829. DATT has its own police organization of some seventy (70) persons. It can easily be understood that with this number of traffic policemen parking control is very difficult to enforce for all the urban area of Cartagena at any time. However, during the conference of UNCTAD (United Nations Conference on Trade and Development) on February 1992, several streets around the convention center which are the important traffic links between Manga island and the Centro were free from curb parking.

830. From this example, it can be said that for some road sections it is possible to control curb parking by the limited number of traffic policemen of DATT. How to select the target streets or how much to fine for illegal curb parking is a matter

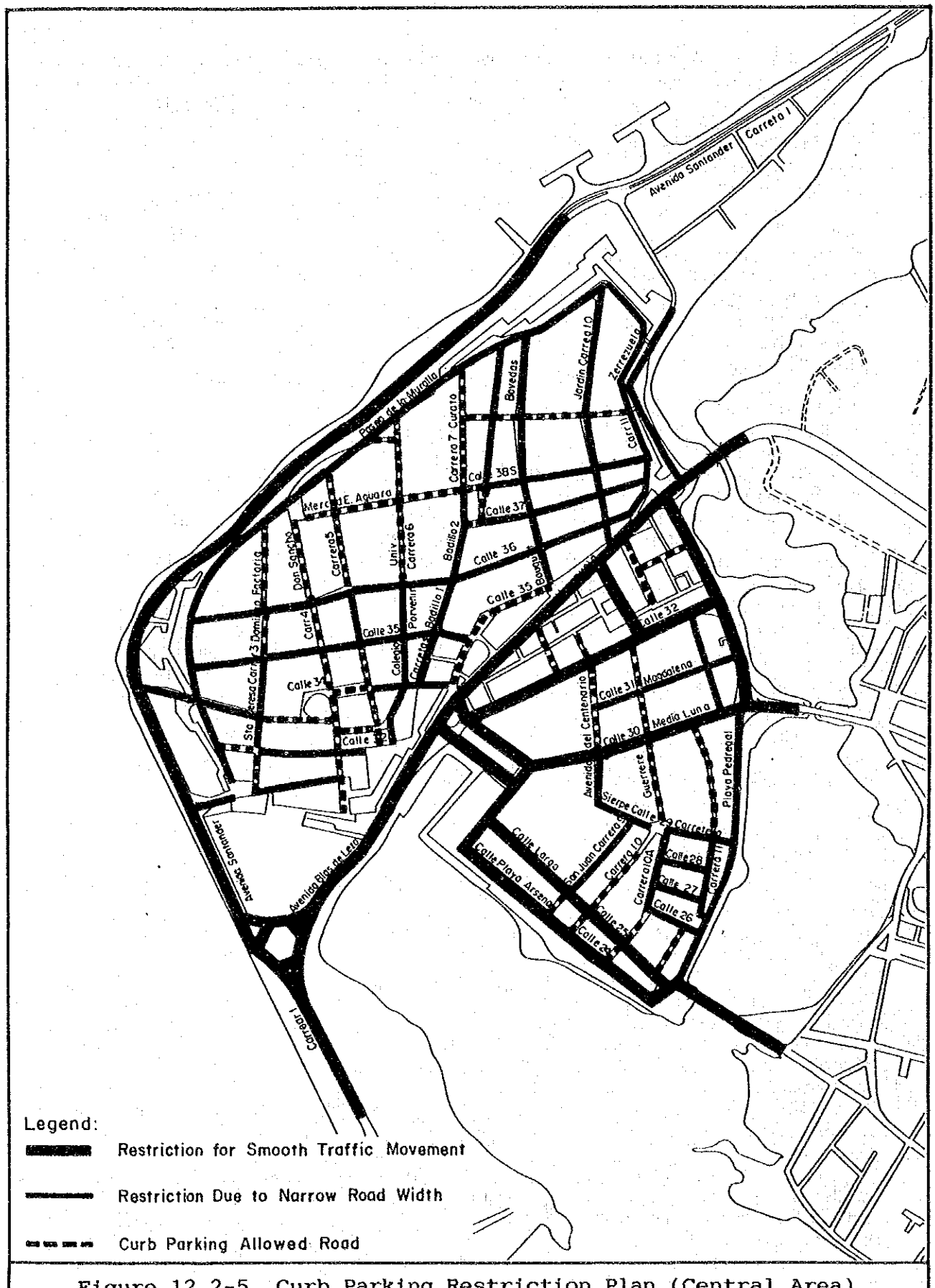


Figure 12.2-5 Curb Parking Restriction Plan (Central Area)

for investigation, however, strict enforcement of curb parking restriction at random selection of target road sections and large amount of fines are very useful tools to eliminate the illegal curb parking.

831. At the same time, curb parking spaces should be assigned near the restricted roads and streets at selected local roads of less traffic flow.

12.3 Existing Traffic Signal Improvement

12.3.1 General

832. There are 21 signalized intersections in the Study Area at present. They are installed almost all on the major traffic corridors such as Av. Pedro de Heredia, Diagonal 22 and Carretera Troncal de Occidente. However, some of their traffic capacity are at low level due to the short green time period. Table 12.3-1 shows the green time ratio of the traffic signals on major traffic corridors.

833. The green time ratio of the intersection whose signal phase number is more than 3 is almost less than 0.40 and in case of 4 phases becomes nearly 0.30.

Table 12.3-1 Green Time Ratio of Major Traffic Signal

Signal No.	Phase No.	Cycle Length (second)	Green Time (second)	Ratio (%)
6	3	93	36	39
7	3	92	31	33
8	2	52	30	58
11	2	39	20	51
12	2	70	41	59
13	4	116	29	25
14	3	86	42	49
15	3	116	42	36
16	3	89	36	40
17	2	68	32	47
18	3	90	46	51
19	2	55	29	53
20	4	110	34	31
21	4	110	34	31

source: Study Team
note : Green time ratio shown is for the main approaches.

834. Traffic signal in downtown area is to be designed to control the traffic from each approach with equal weight because of the balanced traffic in-flows into the intersection. However, at traffic signal on urban arterial, it is to be designed mainly to maintain the efficiency of the traffic flow on main approaches

because of the effective use of the existing facilities.

835. Assuming traffic capacity of the road section is 1,500 vehicles per traffic lane per hour in the urban area, the traffic capacity of the intersection for major traffic approach is estimated roughly at the level indicated in Table 12.3-2.

Table 12.3-2 Traffic Capacity of Signalized Intersection

Road Type	Green Time Ratio (%)	Direction Rate	Peak Hour Ratio	Traffic Capacity(veh/day)
One-way 4 Lanes	0.50	1.00	0.09	33,000
	0.30	1.00	0.09	20,000
One-way 6 Lanes	0.50	1.00	0.09	50,000
	0.30	1.00	0.09	30,000
Two-way 4 Lanes	0.50	0.65	0.09	26,000
	0.30	0.65	0.09	15,000
Two-way 6 Lanes	0.50	0.65	0.09	38,000
	0.30	0.65	0.09	23,000

Note: only for the main approach

836. It does not necessarily follow that when traffic volume exceeds the traffic capacity of the intersection, traffic congestion would become serious. However, to improve the signal phases and/or green time ratio is very useful to utilize the existing traffic facilities more efficiently (refer to Figure 12.3-1).

12.3.2 **Existing Traffic Signal Improvement**

837. As described above, the intersections with 4 phases signal are to be improved. As shown in Figure 12.3-2, the geometries of these intersections are very complicated with their approach legs. To improve traffic capacity of the main approach legs, the following traffic flow changes shall be planned;

a. Intersection No. 13
   Left turn flow on Diagonal 22 is restricted. Then 3 phases intersection is designed;
   Phase 1: both directions on Diagonal 22
   Phase 2: north/east bounds on Diagonal 21
   Phase 3: north/south bounds on transversal 53
b. Intersection No.20
   One-way traffic system is employed on one minor approach leg. Then 3 phases intersection is designed;
   Phase 1: east/west bounds on Transversal 54 without left turn
   Phase 2: left turn of east bound on Transversal 54
   Phase 3: east/west bound on road from Los Caracoles
c. Intersection No.21
   One-way traffic system is employed on one minor approach leg.

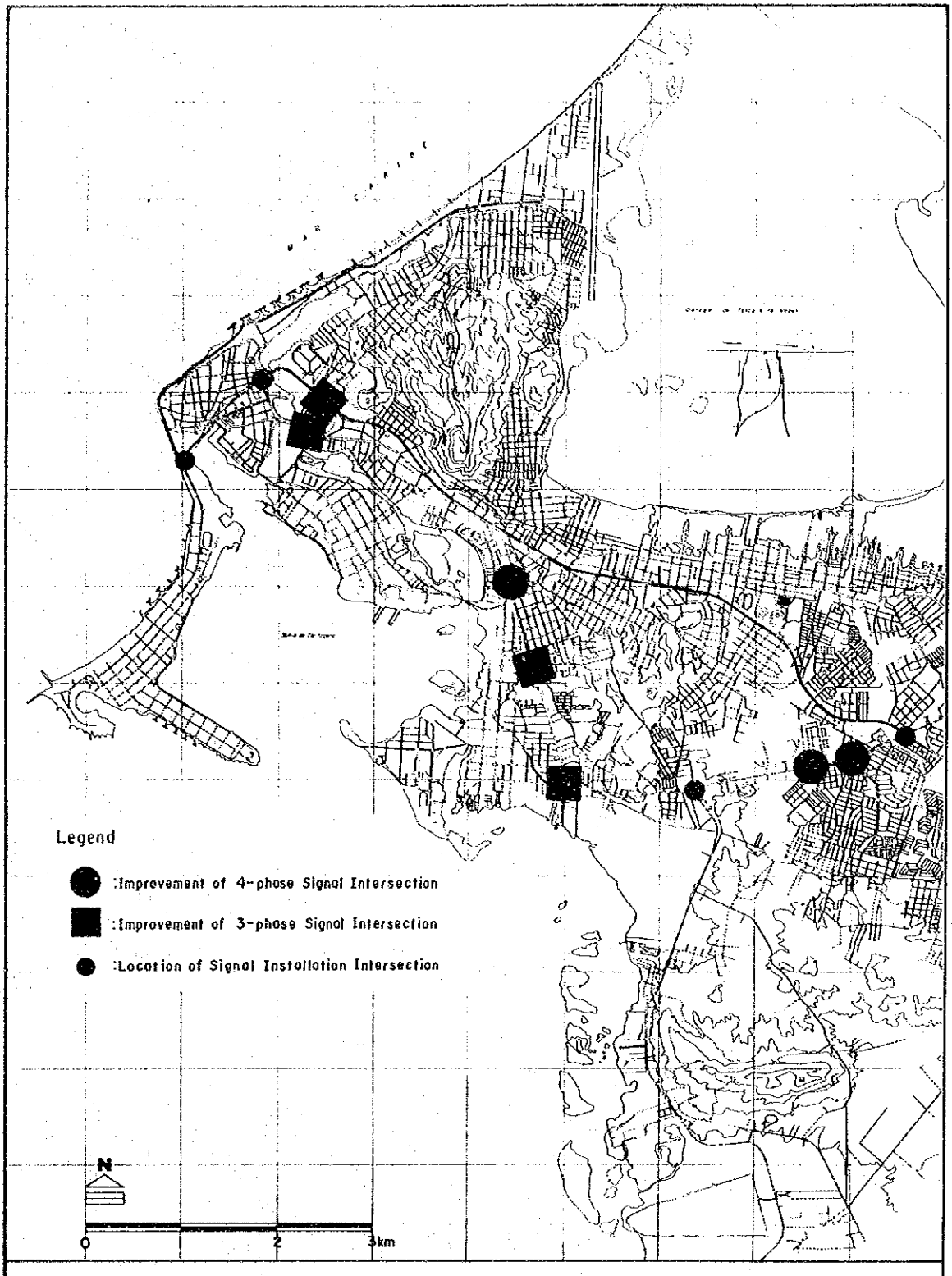
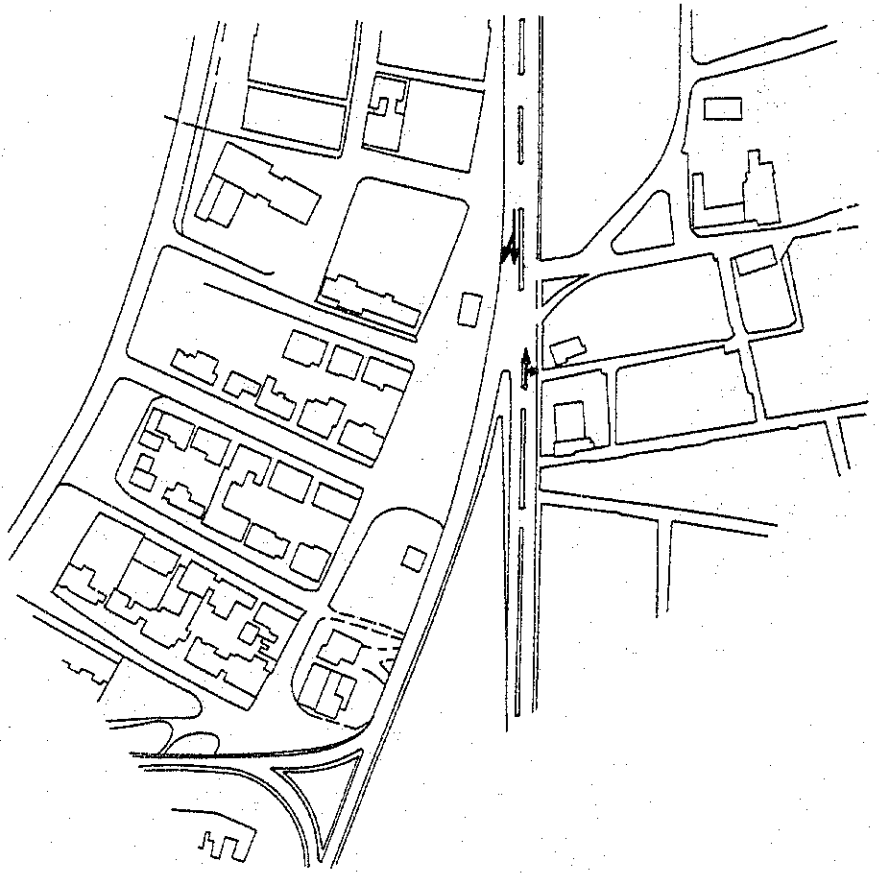
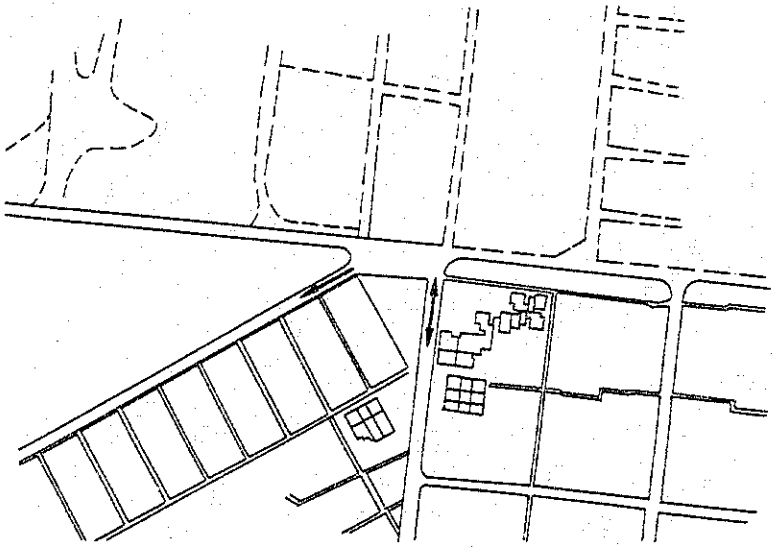


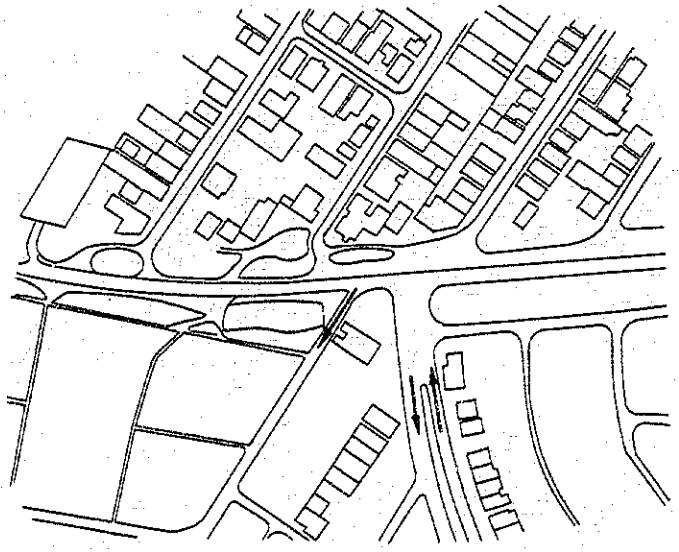
Figure 12.3-1 Existing Traffic Signal Improvement Plan



Intersection No. 13



Intersection No. 20



Intersection No. 21

Figure 12.3-2 Traffic Signal Improvement (4-Phases Signal)

Then 3 phases intersection is designed;
Phase 1: east/west bounds on Transversal 54 without left turn
Phase 2: left turn of east bound on Transversal 54
Phase 3: east/west bound on Carrera 68

838. Among the intersections of 3 phases signal, No.6, 7, 15 and 16 are the intersections of low green time ratio. As for the No. 6 intersection, the improvement plan is already described before. The following are the improvement plans for the others (refer to Figure 12.3-1).

d. Intersection No.7
Preparation for left turn lane on south bound of Carrera 17 and phasing change as an example;
Phase 1: west bound on Calle 30 including left turn (G.T.,45")
Phase 2: north/south bound on Cra.17 including right turn to Calle 30 (G.T., 24")
Phase 3: left turn on south bound of Cra.17 (G.T., 12")
Cycle Length: 90 seconds

e. Intersection No.15
Preparation of left turn lane for south bound of Diagonal 22 and left turn restriction of north bound of Diagonal 22. Then three phases signal intersection is designed.
Phase 1: north/south bounds of Diagonal 22 (G.T., 45")
Phase 2: left turn from south bound of Diagonal 22 (G.T., 15")
Phase 3: east/west bounds of Transversal 45 (G.T., 21")
Cycle length: 90 seconds

f. Intersection No.16
Left turn from west bound of Trans. 54 is restricted. Then two phases signal intersection is designed.
Phase 1: east/west bounds on Trans. 54 (right turn free)
Phase 2: right/left turns from Diag. 22

839. For the implementation of traffic signal improvement plans above described, more detailed intersection traffic volume surveys are desirable. Phasing shall be dependent on the survey results, however, green time ratio for the main approach leg is to be set at more than 0.50 considering the traffic flow efficiency of traffic corridor.

12.3.3 Installation of Traffic Signal

840. Some of the intersection on major traffic corridors are not yet signalized. Traffic conditions at these intersections are now at such levels as not to introduce traffic jams (refer to Figure 12.3-1). However in near future traffic volume will be over the capacity of un-signalized intersection. Following intersections are rotary type;

a. intersection of Av. Santander and Av. Blas de Lezo
b. intersection of Av. Pedro de Heredia and Cra. 11
c. intersection of Av. Pedro de Heredia and Carretera Troncal

These intersections have statues or monuments inside the intersection and therefore the improvement of the geometrical plan is a matter for further discussions.

841. The intersection of Carretera Mamonal and Carretera Troncal are the simple three legs type. Signalization will simplify the chance of traffic flow into intersection and is expected to decrease the traffic congestion caused by the collision accidents at the intersection.

12.4 Future Traffic Improvement Plan

12.4.1 **General**

842. Along with the development of the road network and public transport system, traffic management system is also to be changed. Traffic function of each road will be changed, therefore, road classification, parking restriction, one-way system, signal system, etc. are to be redesigned in order to control the traffic flow effectively.

843. Following are the major issues to be considered in the future traffic management plan;

a. classification of road function,
b. public bus exclusive lane on public arterials,
c. parking restriction and curb parking spaces,
d. traffic signal system development, and
e. pedestrians' traffic facilities.

844. Future road network plan and public transport network plan are shown in the previous chapters. Based on those plans, future traffic management issues are discussed.

12.4.2 **Classification of Road Function**

845. The same classification of arterial, collector and local road used at present will also be used in future. Additionally, public bus arterial road is designated for the maintenance of efficient bus operation.

846. On urban arterial/collector roads, traffic capacity shall be maintained at high level by curb parking restriction and traffic signal system improvement in order to enable the vehicles flow as planned. On urban local roads, curb parking spaces shall

be provided to make curb parking restriction on arterial/collector roads possible.

847. On the public bus arterial roads, bus priority lane or exclusive bus lane is to be established. On bus arterial road having more than six (6) lanes for both directions, inner lanes shall be assigned as exclusive bus lanes. On those having four (4) lanes, bus priority lanes are to be assigned.

848. Bus operation on bus arterial roads shall be strictly controlled to stop at bus stops only.

849. Figure 12.4-1 shows the road classification in 2010 road network plan.

12.4.3 **Traffic Signal Development Plan**

850. The number of existing traffic signals is very small in Cartagena, because of the low level of traffic volume in urban area in general. Following the traffic volume increase in Study Area, traffic signal shall be installed not only at arterial-arterial/collector road intersections but also at collector-collector road intersections. In such case, the criteria and methodology for signal introduction is to be defined.

(1) Criteria for Traffic Signal Introduction

851. The reasons to install the traffic signal are:

a. Traffic volume of minor approach becomes large.
b. Left turn traffic volume of major approach becomes large.
c. Many traffic accidents occur due to intersection geometry.

There is no apparent number of traffic volume necessary for installing traffic signal. However, from view point of possibility of vehicle flowing into major traffic from minor approach or left turn from major flow and time delay of minor approach vehicles, traffic number shown in Table 12.4-1 is considered a rough standard for the establishment of traffic signal.

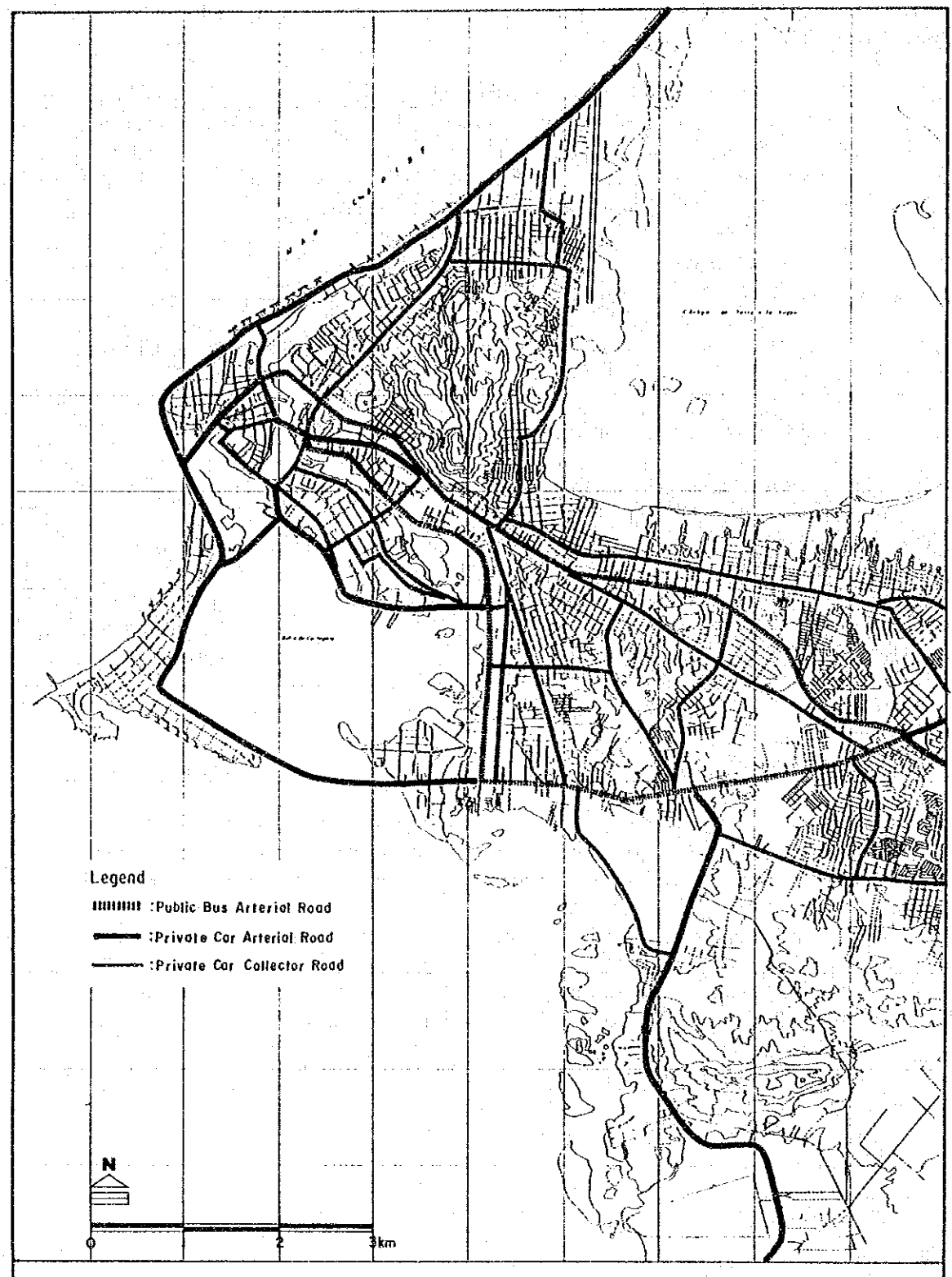


Figure 12.4-1 Road Classification for Traffic Management

Table 12.4-1 Traffic Volume for Traffic Signal Establishment

	Traffic Volume
Major Approach	> 600
Minor Approach	> 200
Left Turn Veh. Ratio	> 0.25

unit: vehicle/hour/lane

(2) Signal System Improvement

852. Signal system improvement shall be carried out based on the following steps;

a. 1st step: installation of signals (refer to Figure 12.4-2),
b. 2nd step: group control of signals, and
c. 3rd step: centralization of signal control.

853. Present signals are of the 1st step type. The current signal controller can't adapt to the fluctuation of traffic flow due to the fixed pre-timed control. When new signals are installed, the type of controller shall be the one available for variable time setting.

854. Usually one controller can control 4 - 5 traffic signals. At present in Cartagena, synchronized signal control is not operated, however, introduction of this system may be required in future on arterial roads for better traffic flow efficiency. At the time the 2nd step is put into effect, this control system shall be considered. It is very difficult to introduce this operation system in the downtown area due to the large number of pedestrians, or the existence of many cross streets over a short distance.

855. At the 3rd step, signal system center shall be established for the control of traffic signals in the Study Area. This center is equipped with a micro computer whose functions will be as follows;

a. Observation of signal sets condition,
b. Recording signal sets trouble condition, and
c. Changing signal parameter from the system center.

The necessary instruments in the signal system center are the micro computer, printers, operator consoles and graphic display for observation (refer to Figure 12.4-3).

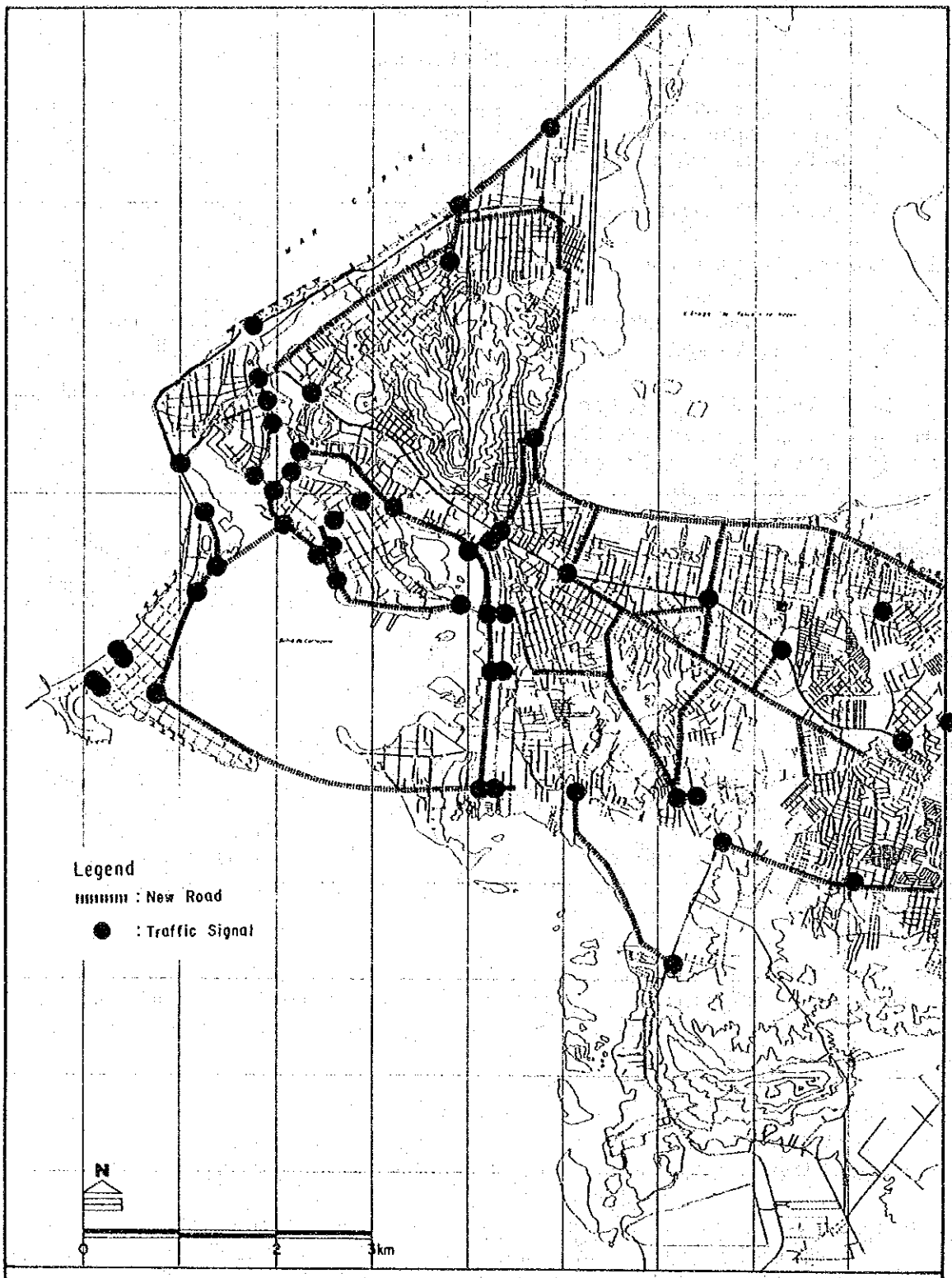


Figure 12.4-2 Traffic Signal Installation Plan

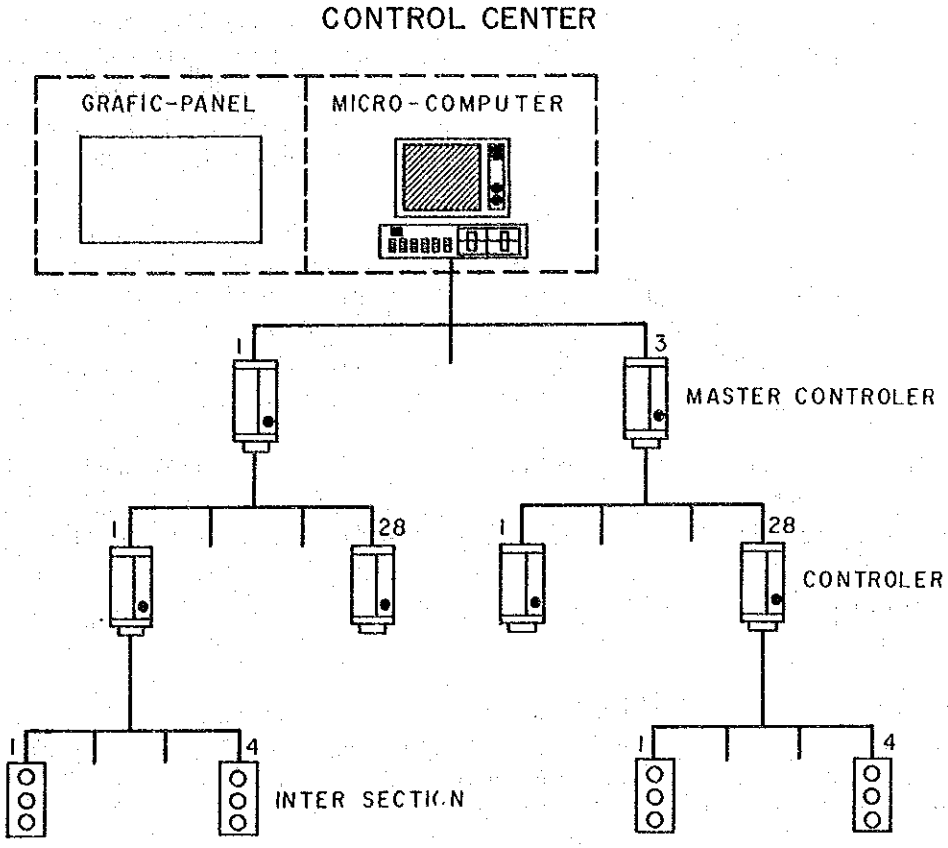


Figure 12.4-3 Future Signal Control System

12.4.4 Parking Plan in Central Area

856. There is an idea to restrict all the vehicles from entering into the Central area from view point of the conservation of historical and cultural monuments of the Area. The complete and immediate implementation of this idea is impossible due to the concentration of urban functions in the Area and socioeconomic losses caused within this Masterplan period.

857. However, it is necessary to restrict the increase of vehicle entering into the Area by diversification of urban functions of the Area, road network improvement and parking restriction for preserving the precious monuments for the future of Cartagena.

858. From the imbalance in the parking demand and capacity in Central Area described below, discussions shall be started in near future on measures for restriction of vehicles entering into

Central Area.

859. As estimated in Chapter 5, section 5.3.3, the current curb parking capacity in the Central Area is about 9,300 vehicles per day. It balances now with curb parking demand. About 90 per cent of this peak demand is by car and the balance is by other vehicles such as taxi and trucks. Parking demand by taxi is very small, less than 5 percent.

860. Table 12.4-2 shows the number of vehicles attracted into Central area by vehicle types of car and taxi in the years of 1991 and 2010. Taxi will be attracted about three (3) times as much as at present, however, its curb parking demand is considered not to be large and to be about one thousand per day.

861. In case of cars, the total parking demand will become more than 33 thousand based on the figures indicated in the Table. If the parking capacity of existing private parking lots and public parking facilities remains the same as present level, an imbalance between demand and capacity of curb parking will become 13 thousand per day in 2010.

Total Parking Demand: 33,000/day
Capacity of Private Lots/Public Parking Facilities: 12,000/day
Curb Parking Capacity for Car: 8,000/day
Demand/Capacity Imbalance: 13,000/day

Table 12.4-2 Vehicle Number Attracted into Central Area

Vehicle Type	1991	2010	Increase Ratio
Passenger Car	20,389	33,148	1.626
Taxi	8,974	27,484	3.063
Total	29,363	60,632	2.065

Source: Study Team

862. Taking into consideration current control on building construction in the Central Area surrounded by stone walls, the large amount of parking capacity increase by new private parking lots and public parking facility constructions is very difficult to expect. However, to accept the employment increase in future, several new business buildings will be built equipped with parking lots. Current public use parking facilities are expected to continue their services because of the profitable business under the large parking demand.

863. Assuming the capacity increase of private parking lots and public parking facilities through new construction as follows, parking capacity of these parking facility types in the Area will

increase about by 3,000 vehicles a day.

Employment increase	: 6,000 persons (refer to Table 6.2-5)
New office building	: 20 sites
Public parking facility	: 50 vehicles, 5 new places
Private parking lots	: 25 vehicles, 20 new lots
Parking turnover	: 5 times a day
Occupancy rate	: 80 per cent
Parking capacity	: 750 x 5 x 0.80 = 3,000 veh./day

864. Parking restriction shall be enforced on major roads such as arterial and collector roads and also on the several roads in Central Area as shown in Figure 12.2-5. In the Central Area, curb parking spaces shall be prepared in order to supplement the capacity of public/private parking facilities for growing parking demand.

865. Introducing the restriction of curb parking duration, for example less than one (1) hour (About 65 % of the total parking cars is less than 1 hour parking based on the curb parking survey done by Study Team.), can be expected to increase the capacity by some five (5) thousand.

866. Therefore, parking capacity increase for the total of about eight (8) thousand vehicles per day is available inside the Central Area by 2010. The balance of 5 thousand vehicles per day shall park outside the Central Area.

867. The locations for parking facilities outside the Central Area are designated at the following points;

a. Chambacu area,
b. Cabrero, and
c. Tourist Terminal area.

About one (1) thousand parking spaces are totally required in these locations to fulfill the demand.

868. Curb parking in the designated spaces in the Central area shall be charged. Curb parkings in other spaces than designated spaces shall be fined. This measure will become the useful tool for the restriction of vehicle entrance into Central area as well as the financial resource for the improvement of traffic management system in Cartagena.

869. As mentioned above, the curb parking space in Central area is estimated about 8 thousand at present and can be increased to 11 thousand in future if parking control is carried out strictly.

870. Toll curb parking will reduce unnecessary vehicles from entering into Central area, however, a very high parking charge may adversely influence the economic activities in the Area. Details of toll curb parking system including the fine on illegal parkings is to be carefully investigated taking into consideration the regional economy, resident opinions as well as vehicle owner behavior.

12.4.5 Pedestrian Facilities

871. Current pedestrians' traffic facilities such as pedestrian signal, crosswalk, pedestrian crosswalk overbridge, etc. are in very poor condition in the Study Area. Only one pedestrian bridge on Av. Pedro Heredia is available near the stadium. Except on Av. Venezuela, a pedestrian cross walk is not clearly assigned and a pedestrian is frequently interrupted by right/left turn vehicles when crossing at the green light.

872. The pedestrian safety facilities and traffic flow efficiency have a competing relationship which should be adjusted according to the local conditions. In the downtown area, pedestrian facilities shall have priority so that sufficient pedestrian crosswalks and exclusive pedestrian signal cycle shall be established. On the other hand, on urban arterials outside the downtown area, priority has to be put on traffic flow efficiency, followed by pedestrian safety with crosswalk overbridge to be constructed at the places where people gather (refer to Table 12.4-3).

873. For the following streets the exclusive pedestrian signal system has to be introduced (refer to Figure 12.4-4);

a. Av. Venezuela,
b. Av. San Martin, and
c. Av. del Concejo.

874. For the following arterials the pedestrian overbridges have to be constructed (refer to Figure 12.4-4);

a. Av. Pedro de Heredia,
b. Carretera Troncal de Occidente, and
c. Diagonal 22.

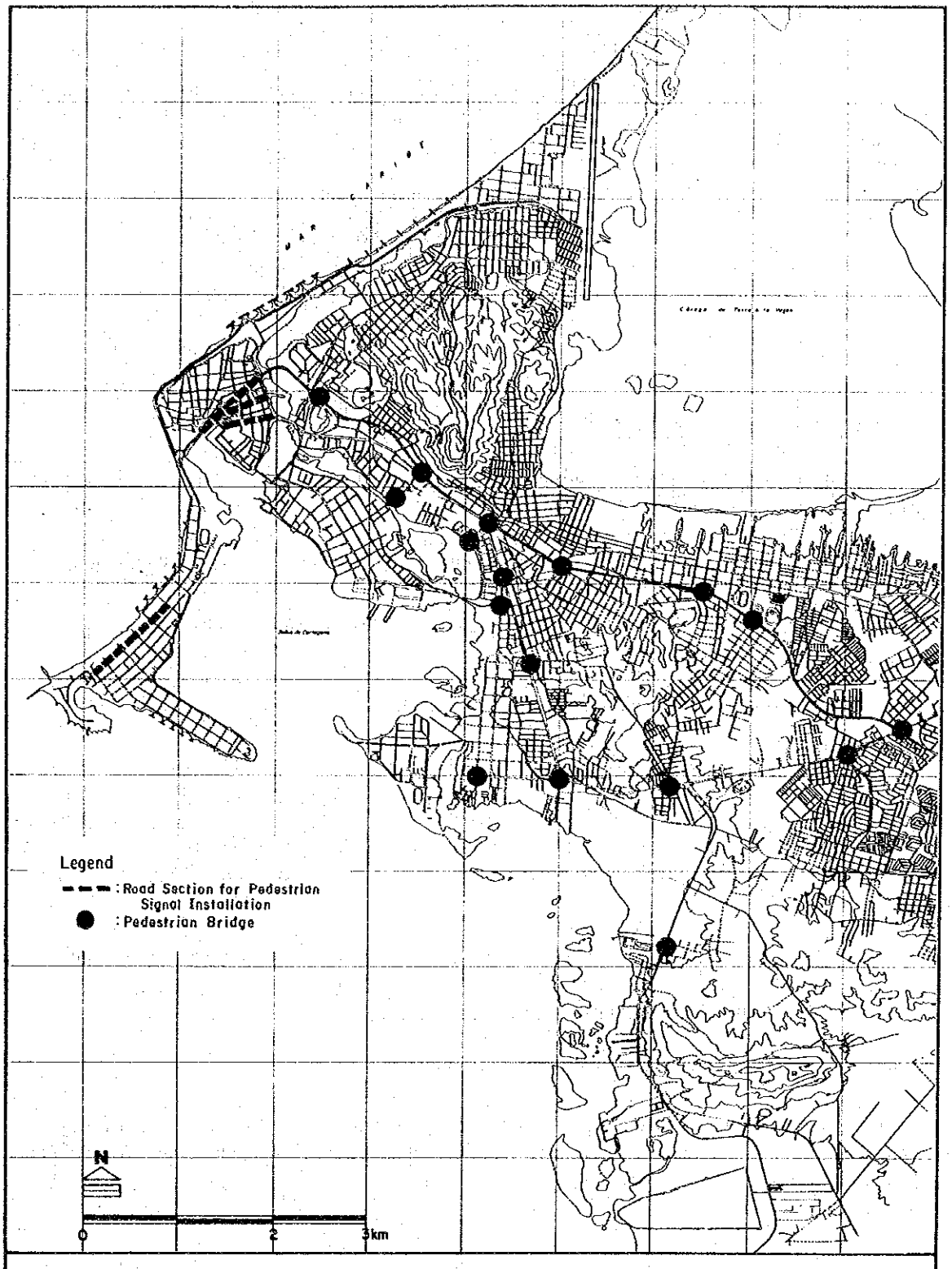


Figure 12.4-4 Pedestrian Facilities in 2010

Table 12.4-3 Installation of Traffic Signal and Pedestrian Bridge (location)

Item	Existing	New Installation	Total
Traffic Signal	21	51	72
Pedestrian Bridge	1	17	18

note: Traffic signal installation is only estimated for the arterial-arterial/collector road intersections.

12.5 Cost Estimate

12.5.1 Projects

(1) Traffic Signal Improvement

875. Traffic signal improvement will be carried out at the following three (3) steps;

1st step: Installation of traffic signals .... 51 locations

2nd step: Group control of signalized intersections .... 9 groups

3rd step: Centralization of signal control.

876. Group control aims to introduce the synchronized signal system for the adjacent 4 to 5 traffic signals on the arterial roads in order to improve the traffic capacity of the intersections. This will be carried out along with the progress of traffic signal installation and traffic volume increase on the arterial roads.

877. The purpose of the centralization of signal control is to improve the maintenance system of the signal facilities as well as to control signal phasing from the center.

(2) Pedestrian Crossover Bridge Construction

878. 17 pedestrian bridges are planned to be constructed at intersections of arterial-arterial/collector roads. Design criteria of 3 meters bridge width and 30 meters span is considered as a standard.

12.5.2 Project Cost

879. The estimated project cost is shown in Table 12.5-1.

Table 12.5-1 Project Cost for Traffic Management Improvement

Project	Financial Cost
Traffic Signal	million pesos
* Installation	142.8
* Synchronization	135.0
* Centralization	75.0
sub total	352.8
Pedestrian Bridge	
* Construction	940.1
Total	1,292.9

CHAPTER 13 IMPLEMENTATION SCHEDULE

13.1 General

880. A project is defined as a minimum unit of the Master-plan component, which can function by itself independently from other projects. For analytical convenience, all the projects are classified into four (4) categories; road network plan, public bus transportation plan, public water transport plan and traffic management plan.

881. The implementation schedule shall be determined by each project necessity as well as annual allocation of total budgetary expenditure.

13.2 Road Network Plan

(1) Identified Projects

882. In the Masterplan of road network, 17 projects of new road construction, 9 projects of bridge construction and 22 projects of existing road improvement are identified. Total cost is estimated 266,031 million pesos, equivalent to 409.28 million US$, (new road construction: 107,940 million, bridge construction: 80,064 million, and road improvement: 78,026 million).

(2) Implementation Schedule

883. The implementation schedule was formulated as shown in Figure 13.2-1, taking into consideration the priority ranks of each road project. As seen, the rank "A" projects are allocated on the period completed by the year 2000. The projects in rank "B" are scheduled to complete until year 2005 or over. The remaining projects (rank "C") will be completed by the masterplan target year 2010.

884. Those projects are broken down into engineering, land acquisition and construction periods. The sum of the investments scheduled by each year should not exceed the estimated available fund by too much, and is allocated to uniform the annual fund. The construction period for Br-3 project is established for about 10 years taking into account the investment amount. Figure 13.2-2 shows the annual investment amounts, which shows accumulative investment amounts in present financial cost by priority rank.

885. In the schedule, from the view point of network interaction, it is necessary for several projects to adjust the implementation schedule to complete within the same period. These are mainly combined the road projects with the bridge projects. If not

considering it, a missing link occurs in the road network. These package projects are following.

a. Br-1, C-10 and Br-2
b. C-4 and Br-4
c. C-8 and Br-12
d. Br-9, I-15 and Br-11
e. C-7 and Br-8

(3) Road Network in the Intermediate Years

886. According to the implementation schedule, the following corridors are strengthened in the road network in 2000:

a. Centro-Northern Part: C-1 and C-20
b. Corridor along Pedro de Heredia: C-10, C-19, I-6, I-16, and I-12
c. Corridor to Mamonal: I-14 and C-11
d. Around Cienaga de Tesca: C-1, C-8, and C-9
e. Northern Part-Mamonal: C-3

887. Figure 13.2-3 shows the fluctuation of the average volume-capacity ratio in the Study Area in the intermediate years between the present year and the target year (2010). This figure compares the V/C ratio of "with" case with "without" cases, in which the projects in the masterplan are implemented based on the implementation schedule and are not.

888. The average V/C ratio (congestion ratio) in 1991 is 0.32 and it will increase up to 2.25 in the year 2010 under "Do-Nothing" case. In case that the projects are implemented on the schedule, the average V/C ratio in 2010 will decrease to 0.67. In the intermediate years, the average V/C ratios will increase gently and at finally, reach to the value in the 2010 masterplan.

889. The average travel speed in the Study Area in the intermediate years is shown in Figure 13.2-4 which also compares the two cases: "with" and "without" cases in the same manner as that in Figure 13.2-3. The travel speed is represented the inverse relation to the V/C ratio that the travel speed decreases gently by 12 km/h in 2010, corresponding to the increase of the V/C ratio.

890. The traffic conditions in the Study Area in terms of the traffic congestion (V/C ratio) and the travel speed are maintained at the present level in the each intermediate years if the road projects will be implemented on the schedule. It will be said that if the road improvement is not done, the traffic congestion will increase and by 2000 its V/C ratio will exceed 1.0 in the

whole Study Area. At the same time, the travel speed becomes a half of that at the present.

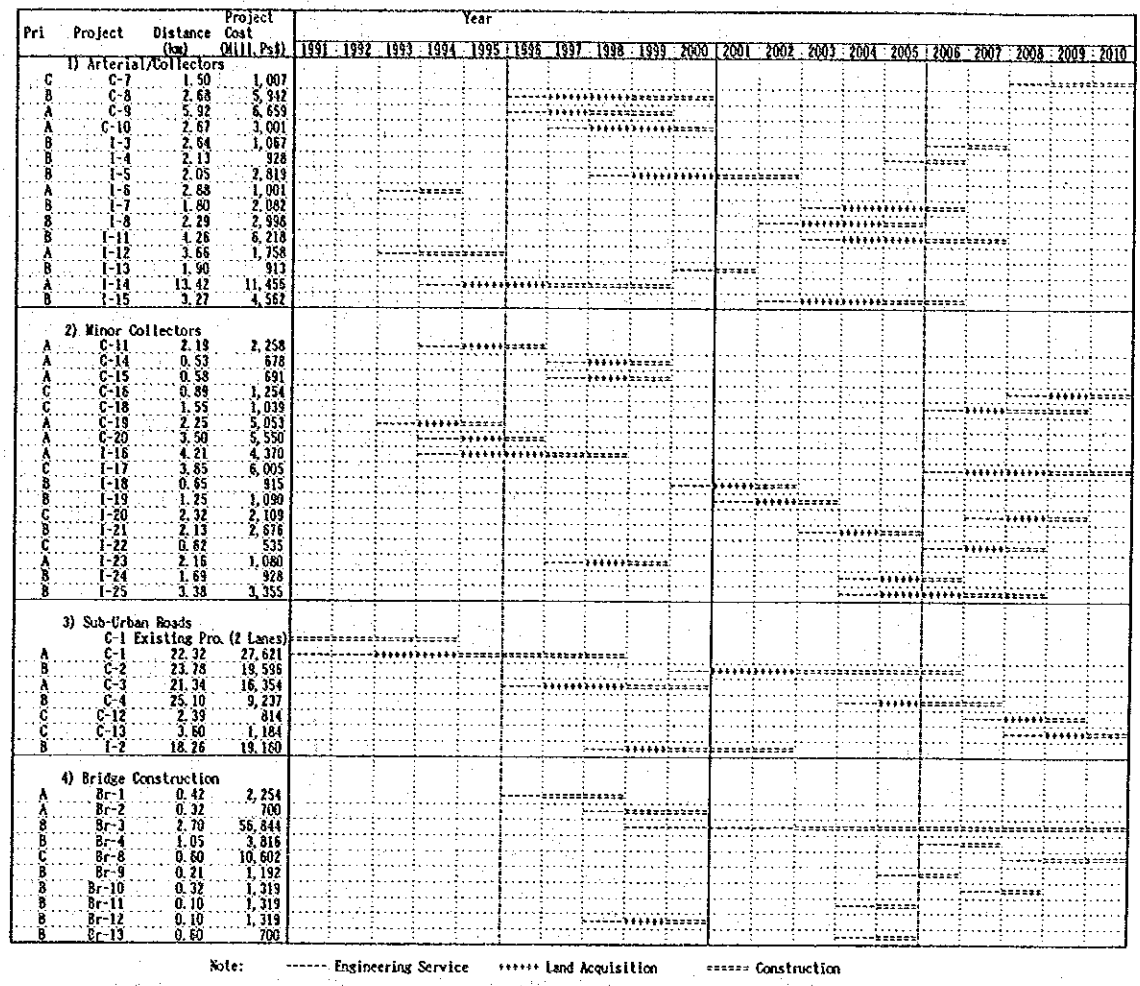


Figure 13.2-1 Implementation Schedule

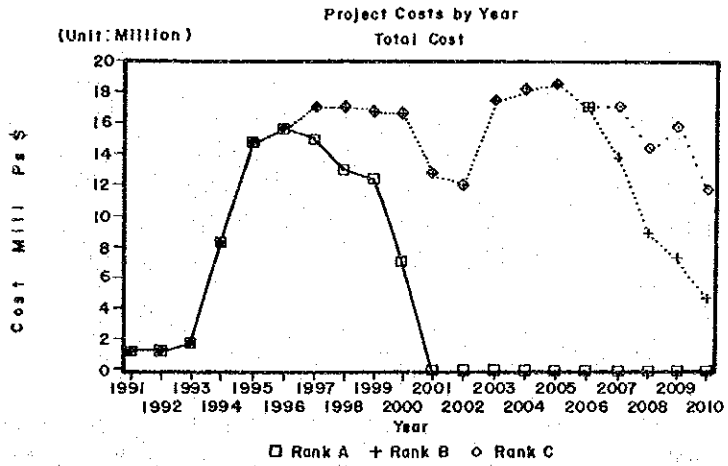


Figure 13.2-2 Annual Investment Amounts

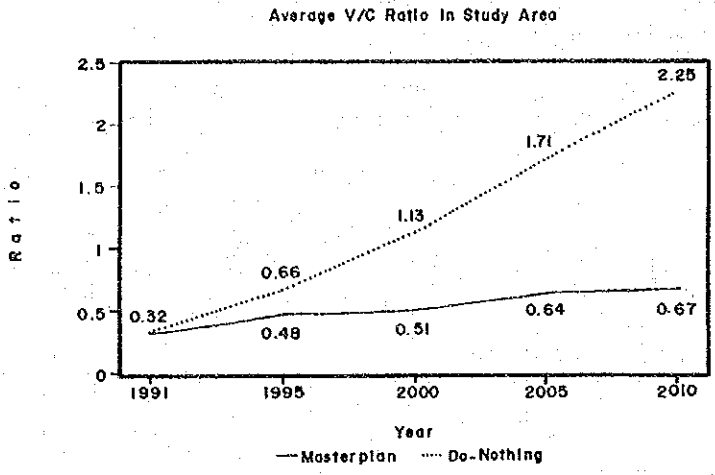


Figure 13.2-3 Average V/C Ratio in the Intermediate Years

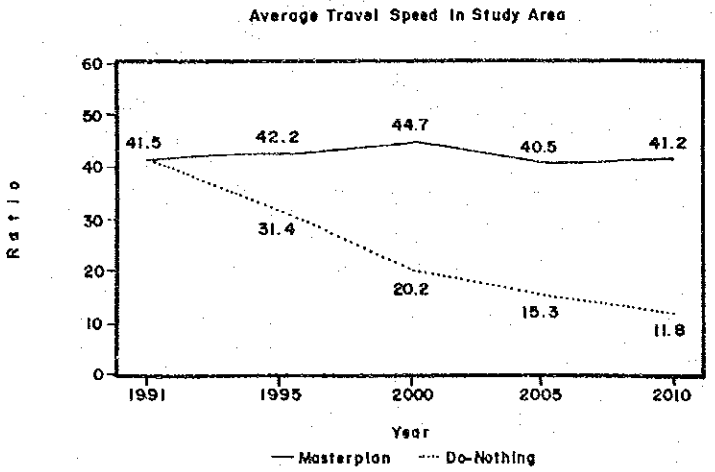


Figure 13.2-4 Average Travel Speed in the Intermediate Years

13.3 Public Bus Transportation Plan

(1) Identified Projects

891. Masterplan of the public transportation consists of the public bus operation system improvement (introduction of trunk-feeder bus system) and public bus facilities improvement (construction of bus stops, bus bays and bus terminals). The construction of 262 bus stops, 171 bus bays and 11 bus terminals is identified in this Masterplan.

(2) Implementation Schedule

892. Implementation schedule of public bus transportation plan is shown in Figure 13.3-1. Total cost of public bus transport will be 34,653.5 million pesos, equivalent to 53.31 million US$.

893. Facilities construction shall be proceeded. Especially bus stops and bus bays are required to improve the bus operation circumstances at first. Introduction of trunk-feeder system requires the enough period for the coordination and adjustment between the organizations concerned.

Project	Cost (million $)	'92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10
Passenger Terminals	34,406.6	
India Catalina	4,906.6	==========
Nueva Bosque	5,546.0	==========
Inter. Terminal	1,314.8	======
Mercado Bazurto	8,892.3	======
Bomba Amparo	10,125.9	======
Mamonal	2,291.0	======
Parque Centenario	197.1	======
Daniel Lemaitre	425.1	======
Manga	497.3	======
Bocagrande	157.6	======
Airport	52.9	======
Bus Bays/Bus Stops	246.9	
Bus Stop	31.0	==========
Bus Bay	215.9	==========
Trunk-Feeder System		
Primary Introduction (partial)		----------++++++++++
Secondary Introduction (partial)		----------++++++++++
Tertiary Introduction (partial)		----------++++++
Total System Adjustment		------
Total System Operation		++++++

note: ======: construction, ------: preparation, ++++++: operation

Figure 13.3-1 Public Bus Transport Implementation Schedule

13.4 Public Water Transport Plan

(1) Identified Projects

894. Circumstances for public water transport is very hard to introduce the system into Cartagena at present from socioeconomic viewpoint. However, in order to initiate the water transport from 1995 by three (3) routes as described in Chapter 11, the construction of 9 passenger terminals, 11 wharves, fuel supply station and maintenance yard, and channel preparation are required. For the future extension of its operation including Mamonal route, the construction of 7 additional passenger terminals and 7 wharves are necessary.

(2) Implementation Schedule

895. Implementation schedule of water transport plan is indicated in Figure 13.4-1. Total cost of water transport plan will be 3,788.1 million pesos, equivalent to 5.83 million US$.

Project	Cost (million $)	'92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10
Passenger Terminals	2,252.5	========== ======
Wharves	347.0	========== ===
Fuel Supply		===
Maintenance Yard	1,188.7	===
Channel Equipments	-	====== ===

Figure 13.4-1 Water Transport Implementation Schedule

13.5 Traffic Management Plan

(1) Identified Projects

896. Traffic management plan involves such projects as existing traffic signal improvement, traffic flow change, curb parking control improvement, future traffic signal improvement and pedestrian facility improvement.

(2) Implementation Schedule

897. Implementation schedule is shown in Figure 13.5-1. Total cost of the traffic management plan will be about 1,292.9 million pesos, equivalent to 1.99 million US$.

Project	Cost (million $)	'92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10
Existing signal	-	======
Traffic flow	-	===
Curb parking	-	======
Future signal	352.8	==========
Pedestrian facility	940.1	==========

Figure 13.5-1 Traffic Management Implementation Schedule

13.6 Budgetary Consideration

13.6.1 Available Financial Resources

898. In order to carry out the proposed Masterplan, it is important to assess the possible governmental financial resources to determine the financial capability for the projects.

899. As possible financial resources, following are considered due to lack of available funds from the general budget of Municipality of Cartagena for the projects of Masterplan;

a. Special tax on gasoline, diesel oil and natural gas,
b. "Valorizacion",
c. Toll road charge,
d. Licence fee, parking charge, fines, etc., and
e. Subsidies from Central government.

(1) Special Tax on Gasoline

900. From beginning of 1992, this taxation was introduced in Cartagena. 6% of the fuel price is levied on this tax item. The amount of revenue is estimated at about 1 billion pesos in 1992. Taking into account the growth of vehicle ownership as forecasted in section 6.3, Chapter 6, this tax revenue is estimated to be about 50 million US$ over the next two decades.

901. The major purpose of this special tax is to improve the condition of public transportation. This resource will be addressed under the public bus transport improvement as well as under the water transport introduction in Cartagena. Therefore, the construction of bus terminals, bus bays, bus stops, water transport passenger terminals, wharves, etc. will be financed from this resource.

(2) "Valorizacion"

902. "Valorizacion" is a common tool for road improvement in Colombia. The improvement projects of collector roads is suitable for this taxation, because of easier identification of beneficiaries from the project.

(3) Toll Road Charge

903. Toll road system, including repayment of its construction cost, is not yet employed in Colombia. For only maintenance purpose, road users' charge system is employed on the national road between Cartagena and Santa Marta.

904. For the bridge construction this toll system seems to be a useful resource for the project budget. Assuming the traffic volume of 20 thousand vehicles per day and one thousand pesos per vehicle, the annual toll revenue is estimated about 6 billion pesos, equivalent about 9 million US$.

(4) License Fees, Parking Charge, Fines, Etc.

905. This is to be directed for the revenue of DATT. Therefore, this budget will be used for traffic signal improvement or pedestrian facility construction. Assuming the curb parking charge in Centro as follows, about 50 million pesos per annum is expected as a revenue for the Masterplan project.

* 4,000 vehicle*times of curb parking per day
* 100 pesos per vehicle (50 pesos of net revenue per vehicle)
* 250 days per annum for charge

(5) Subsidies from Central Government

906. This resource is not so much expected because of the policy change of the Central Government for the decentralization. However, some principal roads forming the national road network or the roads of the same function are possibly constructed by the national fund or by subsidy from Central Government.

CHAPTER 14 ECONOMIC EVALUATION

14.1 Methodology

907. Evaluation of the Masterplan/Project will be done in the two stages of the planning process. One is planning of investment schedule, and prioritize the projects selected through demand analysis, and the other is to evaluate economic viability of the Masterplan. In both cases, methodology of cost-benefit analysis is applied. Figure 14.1-1 shows the flow of evaluation work.

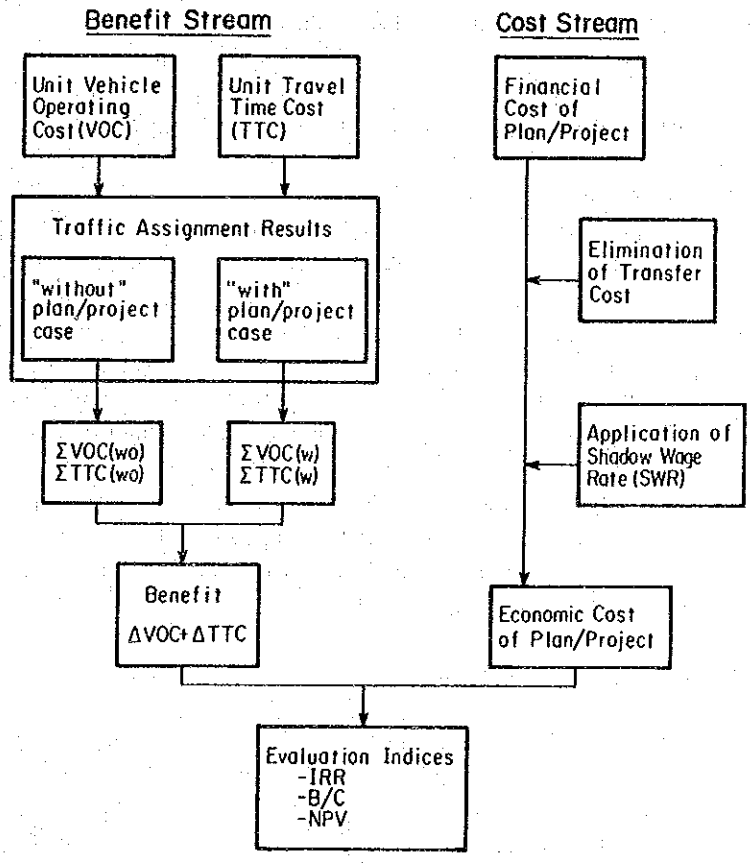


Figure 14.1-1 Work-Flow of Plan/Project Evaluation

908. The cost and benefit accruing from a project are measured at economic price. Comparison is made between the benefit which will contribute to the national or regional economy and the cost which is the monetary expression of real consumption of goods and service to implement the project. For this purpose, all the transfer cost (tax and subsidy) will be deducted from the cost and benefit. In addition, the shadow wage rate will be applied to estimate economic cost of unskilled labor force.

14.1.1 Benefit Estimation

909. Implementation of a transportation project can be expected to bring about a broad variety of benefits, such as improvement of safety and comfort and acceleration of urban development in the long run, as well as mitigation of traffic congestion. To define and quantify the benefit in this Study, however, a conservative approach will be taken, limiting the benefit to two items which are definitely known to exist and are comparatively easy to quantify, that is, savings in vehicle operating cost (VOC) and in passengers' travel time cost (TTC).

910. Benefit of a project is measured through so-called "with" and "without" comparison. Using the results of traffic assignment to a network with the project in question and also to the same network without the project, total VOC and TTC of each case are calculated. And then, the benefit of the project is obtained as the difference between "with" and "without".

911. In order to calculate the total transport cost (VOC plus TTC) in a network, unit VOC (vehicle operating cost per unit distance or per unit time by type of vehicle) and unit TTC (time cost per unit time of a passenger) must be analyzed (see 14.2). These unit costs are not estimated at market price but at economic price, and as they are expressed as a function of running speed, total transport cost is obtained as the sum of VOCs and TTCs of each link, where the running speed is determined, with reference to the assigned traffic on the link.

14.1.2 Economic Cost of Project

912. Project cost is estimated, at first, at market price in ordinary way. This cost represents the amount actually needed at implementation, and is called financial cost of the project. In order to convert this financial cost to economic cost which is used in the economic evaluation, three procedures must be taken, one is elimination of transfer cost, the second is adjustment of land acquisition cost and the third is application of shadow wage rate.

913. From the view point of national or regional economy, tax is not economic cost as it is not actual consumption of goods and services but only a monetary transfer. Therefore, taxes such as import duty, value added tax and consumption tax are to be deducted as far as possible from the financial cost of construction materials and equipment. On the other hand, in case that the financial cost is lowered by a subsidy, the amount of the subsidy must be added to the financial cost.

914. In the same way, when a public-owned land is used in the project land, financial cost estimation usually disregards acquisition cost for this land. In economic evaluation of a project, however, the land should be properly valued at market price and the acquisition cost should be added to the total cost.

915. In a society with surplus labor force and suffering from high unemployment rate, labor cost in the project cost does not duly reflect labor wage in the free market in most cases. Economic value of unskilled workers (shadow wage rate:SWR) may be lower than the wage rate in the market in such a case. According to the Haveman's formula, the shadow wage rate under a 12% unemployment rate is estimated empirically as follows:

SWR = (wage rate in market) x (1.25 - unemployment rate / 0.2)

916. As the Colombian Government reports that current unemployment rate is 8.7%, the SWR of Colombia is estimated at 0.815, applying above formula. This conversion rate will be multiplied to the unskilled labor cost included in the project cost.

14.1.3 Evaluation Indices

917. Comparison of cost and benefit will be done through a discount cash flow analysis. The discount rate used in the analysis is 12% which is widely used in Colombia as a economic interest rate (or rate of capital opportunity). As evaluation indices, internal rate of return (IRR), ratio of B/C and net present value are to be calculated.

918. To evaluate the Masterplan, annual benefit and cost are estimated based on the investment schedule and they are compared in a discounted cash flow. On the other hand, to prioritize the proposed road projects stated in Chapter 9 (Road Plan), the cost and benefit ratios are calculated, adopting the following simplified method only to compare the relative economic importance among the projects.

a. The annual cost and benefit generated in the single year of 2010 are compared.

b. Annual Cost C = P(1/n+i/2)
   where, P : Project cost
   n : Project life (30 years)
   i : Interest rate (12 %)

c. For simplification, financial cost of a project is used instead of economic cost.

14.2 Vehicle Operating Cost(VOC)

919. As basic information to estimate savings in vehicle operating cost which is a main source of economic benefit of a transport project, unit costs of vehicle operation are prepared. These unit costs are estimated by type of vehicle (passenger car, taxi, buseta, bus, small truck and medium-size truck) and are finally expressed in the form of a function of running speed. VOC is composed of the following cost items:

a. Fuel cost
b. Oil cost
c. Tire cost
d. Maintenance cost
e. Depreciation cost
f. Capital opportunity cost (interest)
g. Crew and overhead cost

920. Unit costs of each item are estimated at market price and then are converted into economic cost.VOC varies by road surface conditions. However, unit VOCs are investigated only for paved road because road networks examined in this Study are mostly in the urban area in Cartagena and consist of paved roads.

14.2.1 Selection and Characteristics of Representative Vehicles

921. Although there are many makes and models of vehicles running in the study area, and unit VOCs vary by make and model and also by vehicle age, the most typical models are selected by vehicle type as representative models, for the convenience of analysis, and their VOC costs are studied in detail. Road maintenance division of MOPT selected the following models as representative vehicle in 1990.

a. Passenger car	MAZDA /323NX
b. Taxi	CHEVROLET /CHEVETTE
c. Buseta	CHEVROLET /B60
d. Bus	CHEVROLET /CHR-58
e. Small Truck	CHEVROLET /C-30
f. Truck	BRIGADIER /229DDA

922. As Figure 14.2-1 shows make and model distribution of

passenger cars registered in Cartagena in the year of 1990, Chevrolet occupies the largest share of 41%, followed by Mazda with 35% and Renault with 19%. But as a single model, Mazda 323NX is the most prevalent car and is designated as representative car. However, the same model can not represent taxis, which vary in models and age and are mostly very old. For taxi, the Chevette of Chevrolet is selected, following the MOPT's selection.

923. Buses registered in DATT are classified by make as shown in Table 14.2-1. As for small buses with seat capacity less than 35 passengers, Chevrolet make is the most popular and Dodge make stands for as much as 60% of regular-size buses. Representative models are selected from each of them.

924. Out of 2,334 registered trucks, 57% are small trucks with loading capacity of 3 to 5 tons and 33% are medium size trucks of 6 to 10 tons. Mazda T-45 (2.5 tons) for small truck and Chevrolet C70-189 (8.5 tons) are identified respectively as the representative trucks.

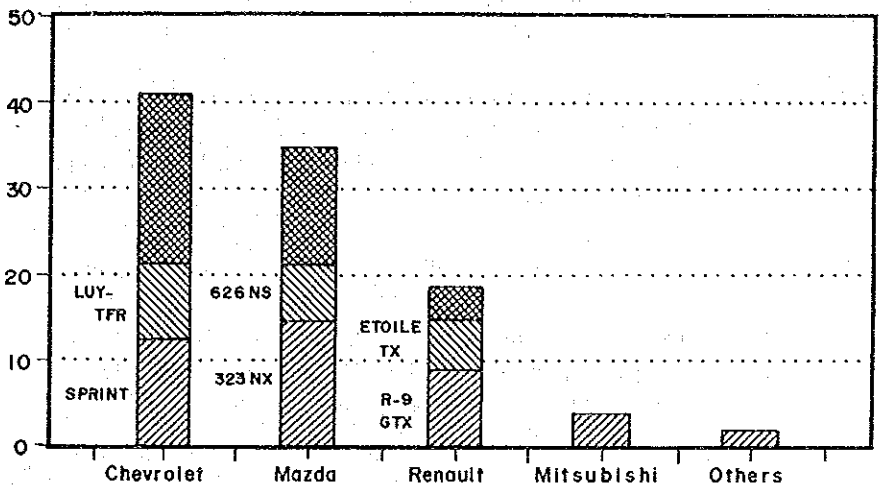


Figure 14.2-1 Vehicle Distribution by Make and Model in Cartagena,1991

Table 14.2-1 Classification of Buses in Cartagena by Make and Capacity (Year 1991)

Capacity / Fabrication	1 -20	2 21-25	3 26-30	4 31-35	5 36-40	6 41-45	7 46-50	8 51-55	9 56-	10 Total
1 Ford	3	3	1	10	39	44	33	16	0	149
2 Dodge	4	49	88	22	36	241	28	166	2	636
3 Austin	0	0	0	1	2	1	4	0	4	12
4 Chevrolet	0	18	277	9	69	120	8	7	3	511
5 International	1	0	0	1	2	3	5	25	0	37
6 Mercury	0	1	0	0	0	0	6	1	0	8
7 Fargo	0	0	0	1	5	3	10	0	0	19
8 Pegaso	0	0	0	1	2	0	0	1	4	8
9 Others	1	1	0	0	1	2	3	0	0	8
Total	9	72	366	45	156	414	97	216	13	1,388

925. Table 14.2-2 shows characteristics of each representative vehicle, such as price, number of tires and fuel type. Prices of vehicles are as of January, 1992. Economic cost is financial cost (market price) less taxes. Although the Government of Colombia is now reviewing and revising all the tax system, main taxes in February of 1990 are value added tax (IVA: 12%), tax by Law 75 (Ley 75: 8%) and contribution to the Industrial Development Institute (IFI: 3%). Total tax amount corresponds to about 20% of the financial price.

Table 14.2-2 Characteristics of Representative Vehicles as of January, 1992

	Car	Taxi	Buseta	Bus	L. Truck	M. Truck
1. Representative Model	MAZDA 323NX	CHEVROLET CHEVETTE	CHEVROLET B60	DODGE D-600	MAZDA T-45	CHEVROLET C70-189
2. Cost(1000$)						
(1) Financial	10,458	7,340	24,700	37,400	15,500	74,069
(2) Economic	8,394	5,891	19,825	30,019	12,441	59,451
3. No. of Tires	4	4	6	6	6	6
4. Fuel Type	Gasoline	Gasoline	Gasoline	Gasoline LNG	Gasoline Diesel	Gasoline Diesel

926. Passenger car and taxi have four tires while others have six. All the representative vehicles use gasoline, but some buses of other models mount engine using liquid natural gas and some of trucks use diesel.

14.2.2 Fuel Cost

927. Colombia produces and refines crude oil, but production of gasoline is not enough to meet the domestic demand and 20 to 25 % of total consumption depends on import. According to the announcement of the Ministry of Mines and Energy, cost composition of petro-products is as shown in Table 14.2-3. Retail price of regular gasoline is $121.9 /liter, of which 35% corresponds to taxes such as value added tax, sales tax, consumption tax and local development tax. Deducting this tax amount from the financial price, economic price of regular gasoline is estimated to be $78.8 /liter. In the same way, Economic price of super gasoline is $107.3, diesel oil $84.6 and LNG $68.6, respectively.

Table 14.2-3 Financial and Economic Cost of Fuel in Cartagena as of February, 1992

($/litter)

	Cost Item	Regular Gasoline	Super Gasoline	Diesel	Natural Gas
Petro-products refined in Colombia	Refinery Cost	22.4	26.2	27.4	22.3
	Transportation Cost				
	Primary Transp.	50.1	73.0	50.4	40.8
	Secondary Transp.	0.5	0.7	0.7	0.6
	Distributor's Margine	5.7	7.4	6.1	5.0
	Tax	43.1	43.7	36.2	29.4
	Financial Cost(Total)	121.9	151.0	120.8	98.0
	Economic Cost (excl. Tax)	78.8	107.3	84.6	68.6
Imported Petro-products	Import Price(CIF)	163.8	221.1	-	-
	Distribution Cost	6.2	8.1	-	-
	Tax-Subsidy	-48.2	-78.3	-	-
	Financial Cost(Total)	121.9	151.0	-	-
	Economic Cost (excl. Tax)	170.0	229.3	-	-
Weighted Average of Economic Cost	Market Share(%) Locally Produced	75.0	70.0	100.0	100.0
	Imported	25.0	30.0	-	-
	Economic Cost	101.6	143.9	84.6	68.6

928. On the other hand, economic cost of imported gasoline is estimated to be $170.0 /liter for regular gasoline and $229.3 /liter for super gasoline, adding transport cost and distribution cost to their border prices (CIF). As domestic gasoline and imported gasoline are sold at the same retail price, imported gasoline is regarded to be subsidized by the Government, tax amount plus $48 to $78 /liter. Consequently, weighted average of economic costs, using consumption share of domestic and imported gasoline are $101.6 /liter in case of regular gasoline and $143.9 /liter of super gasoline.

929. Table 14.2-4 shows composition of fuel consumption by type of vehicles, which was estimated based on DATT's data and interviewing survey of major gas station in Cartagena. Making averages of fuel prices weighted by these consumption rates, fuel costs of passenger car and taxi are estimated at $120.6, buseta at $109.2, bus at $94.7, small truck at $100.7 and medium size truck at $93.1.

Table 14.2-4 Composition of Fuel Consumption and Average Fuel Cost by Vehicle Type in Cartagena

(%, $/litter)

Fuel Type	Pass. Car & Taxi	Buseta	Bus	Light Truck	Medium Truck
Regular Gasoline	55	82	79	95	50
Super-Gasoline	45	18	-	-	-
Diesel	-	-	-	5	50
Natural Gas	-	-	21	-	-
Total	100	100	100	100	100
Average Economic Cost ($/litter)	120.6	109.2	94.7	100.7	93.1

930. Fuel consumption rate of a vehicle varies by its running speed. The most economical speed is 45 to 50 Km/hr for passenger car and 50 to 60 Km/hr for medium and large vehicles. Based on MOPT's data concerning the fuel consumption rate by running speed, fuel costs /Km are tabulated by type of vehicle, as shown in Table 14.2-5.

Table 14.2-5 Fuel Consumption Rate and Cost by Type of Vehicle

Speed (Km/Hour)	Pass. Car & Taxi	Buseta	Bus	Light Truck	Medium Truck
Fuel Consumption Rate(litter/1,000Km)					
5	216.6	337.2	672.7	605.2	1210.4
10	138.6	215.8	430.4	387.3	774.5
20	100.2	156.0	311.2	280.0	560.0
30	87.0	122.2	284.2	235.0	412.0
40	80.2	107.9	264.5	225.0	342.0
50	78.4	101.4	284.2	220.0	314.0
60	81.0	97.5	326.1	225.0	303.0
70	85.7	98.2	380.9	230.0	314.0
80	92.7	102.0	438.1	250.0	340.0
90	102.4	112.7	483.9	276.2	375.6
Fuel Cost($/Km)					
5	26.1	36.8	63.7	61.0	112.7
10	16.7	23.6	40.7	39.0	72.1
20	12.1	17.0	29.5	28.2	52.1
30	10.5	13.3	26.9	23.7	38.4
40	9.7	11.8	25.0	22.7	31.8
50	9.5	11.1	26.9	22.2	29.2
60	9.8	10.6	30.9	22.7	28.2
70	10.3	10.7	36.1	23.2	29.2
80	11.2	11.1	41.5	25.2	31.7
90	12.4	12.3	45.8	27.8	35.0

14.2.3 Oil Cost

931. Retail price of lubricant oil is $1,376 /liter and after deducting tax, economic cost is $1,073.3 /liter. According to MOPT's data, the relations between oil consumption and running speed are as shown in Table 14.2-6. From this information, economic oil cost can be calculated by running speed.

Table 14.2-6 Oil Consumption Rate and Cost by Type of Vehicle

Speed (Km/Hour)	Pass. Car & Taxi	Buseta	Bus	Light Truck	Medium Truck
Oil Consumption Rate (litter/1,000Km)					
5	3.48	4.10	8.01	6.86	8.01
10	2.24	2.63	5.14	4.40	5.14
20	1.54	1.81	3.54	3.03	3.54
30	1.27	1.49	2.92	2.50	2.92
40	1.13	1.33	2.68	2.22	2.68
50	1.10	1.29	2.58	2.08	2.58
60	1.09	1.28	2.36	1.80	2.36
70	1.07	1.26	2.14	1.68	2.14
80	1.00	1.18	1.87	1.52	1.87
90	0.90	1.06	1.68	1.37	1.68
Oil Cost ($/Km)					
5	3.7	4.4	8.6	7.4	8.6
10	2.4	2.8	5.5	4.7	5.5
20	1.7	1.9	3.8	3.3	3.8
30	1.4	1.6	3.1	2.7	3.1
40	1.2	1.4	2.9	2.4	2.9
50	1.2	1.4	2.8	2.2	2.8
60	1.2	1.4	2.5	1.9	2.5
70	1.1	1.4	2.3	1.8	2.3
80	1.1	1.3	2.0	1.6	2.0
90	1.0	1.1	1.8	1.5	1.8

14.2.4 Tire Cost

932. Table 14.2-7 presents type of tire, market price and economic price by type of vehicle. Under the condition of average speed of 35 mile/hr (56Km/hr) on paved roads, average tire life can be assumed to be 45,000 Km for passenger car and 50,000 Km for heavy vehicle. Thus, tire consumption rates per 1,000 Km are 8.9% and 12.0%, respectively. On the other hand, it is empirically known that this consumption rate becomes larger when average running speed rises. An IBRD report ("Quantification of road user savings", IBRD Occasional Paper No.2, 1966) shows the relationship as in Table 14.2-8. Based on this information, economic tire cost per Km can be obtained as shown in the same table.

933. Although some vehicles use re-treaded tire, they are neglected for the reasons that the market share is not significant and that the life of re-treaded tire is shorter than brand new tire even if its price is lower, so that there is no big difference in economic price per kilometer between the two.

Table 14.2-7 Financial and Economic Cost of Tires

	Passenger Car	Taxi	Buseta	Bus	Light Truck	Medium Truck
No. of Tires	4	4	6	6	6	6
Type of Tire	175-7013 Radial	175-7013	750-16	900-20 1000-20	750-16	900-20
Market Price/unit	32,500	21,242	56,367	120,917	56,367	120,917
Tax	8,426	5,507	14,614	31,349	14,614	31,349
Economic Cost/Set	96,296	62,939	250,519	537,407	250,519	537,407

Table 14.2-8 Tire Consumption Rate and Cost by Type of Vehicle

Speed (Km/Hour)	Passenger Car	Taxi	Buseta	Bus	Light Truck	Medium Truck
Tire Life(Kilometers)	45,000	45,000	45,000	50,000	45,000	50,000
Tire Consumption Rate(% per 1,000 Km)	8.9	8.9	13.3	12.0	13.3	12.0
Tire Consumption Indices(56Km/hr=100)						
5	53	53	53	53	53	53
10	56	56	56	56	56	56
20	60	60	60	60	60	60
30	67	67	67	67	67	67
40	78	78	78	78	78	78
50	92	92	92	92	92	92
56	100	100	100	100	100	100
60	107	107	107	107	107	107
70	125	125	125	125	125	125
80	151	151	151	151	151	151
90	180	180	180	180	180	180
Tire Cost($/Km)						
5	1.1	0.7	3.0	5.7	3.0	5.7
10	1.2	0.8	3.1	6.0	3.1	6.0
20	1.3	0.8	3.3	6.4	3.3	6.4
30	1.4	0.9	3.7	7.2	3.7	7.2
40	1.7	1.1	4.3	8.4	4.3	8.4
50	2.0	1.3	5.1	9.9	5.1	9.9
60	2.1	1.4	5.6	10.7	5.6	10.7
70	2.3	1.5	6.0	11.5	6.0	11.5
80	2.7	1.7	7.0	13.4	7.0	13.4
90	3.2	2.1	8.4	16.2	8.4	16.2

14.2.5 Maintenance Cost

934. Calculating annual maintenance cost based on MOPT's VOC data, the rate of annual maintenance cost to the vehicle price (excluding tire cost) is estimated to be 4% for passenger car, and small truck and 8% for other commercial vehicles with large annual running distance. By assuming annual running distance, maintenance cost per kilometer can be calculated as shown in Table 14.2-9.

935. According to the same IBRD report referred to in the tire cost estimation, the relationship between maintenance cost and running speed shows that maintenance cost becomes lowest at around 50 Km/hr of speed. Using these conversion rates, maintenance cost can be obtained at different speed.

Table 14.2-9 Maintenance Cost by Type of Vehicle and Speed

	Passenger Car	Taxi	Buseta	Bus	Light Truck	Medium Truck
Economic Cost (1,000$) of:						
Vehicle	8,394	5,891	19,825	30,019	12,441	59,451
A Set of Tires	96	63	251	537	251	537
Vehicle w/o Tire	8,298	5,828	19,575	29,481	12,190	58,913
Annual Maintenance Cost						
% of Vehicle Cost	4.0	8.0	8.0	8.0	4.0	8.0
Maintenance Cost /year	332	466	1,566	2,359	488	4,713
Annual Kilometerage	23,000	60,000	52,000	52,000	38,000	75,000
Average Speed(Km/hr)	35	35	20	20	35	40
Maintenance Cost at						
Av. Speed ($/Km)	14.4	7.8	30.1	45.4	16.3	62.8
Maintenance Cost Indices(Av. Speed=100)						
5	141	141	119	128	138	191
10	133	133	112	118	130	176
20	118	118	100	100	116	149
30	105	105	89	80	103	120
40	95	95	84	67	97	100
50	94	94	83	65	96	97
60	100	100	89	71	103	105
70	108	108	95	79	110	117
80	115	115	101	90	117	134
90	122	122	107	101	124	150
Maintenance Cost($/Km)						
5	20.4	11.0	35.9	58.2	22.5	120.0
10	19.2	10.3	33.9	53.6	21.2	110.4
20	17.1	9.2	30.1	45.4	18.9	93.5
30	15.1	8.1	26.7	36.4	16.7	75.1
40	13.7	7.4	25.2	30.5	15.8	62.8
50	13.6	7.3	25.0	29.6	15.6	60.9
60	14.5	7.8	26.8	32.1	16.8	66.2
70	15.7	8.4	28.6	35.8	17.9	73.8
80	16.6	8.9	30.4	40.8	19.0	84.0
90	17.6	9.5	32.2	45.8	20.2	94.5

14.2.6 Depreciation Cost

936. Depreciable amount is defined as the vehicle economic cost (without tire cost) less salvage cost after usage during vehicle life. In Colombia, where market of secondhand vehicles and spare parts is well developed, salvage value rate should be assumed at rather high rate, namely, 25% for passenger car, 20% for small truck and 15% for others (Table 14.2-10).

937. Vehicles are devaluated through their use in proportion to running kilometers, while their value will decrease as they become old, even without usage. Particularly, passenger car loses its value rapidly as time passes. Therefore, the proportion of depreciation subject to use and depreciation subject to time may be assumed as follows: 50:50 for passenger car and 70:30 for others.

938. Depreciation subject to use is furthermore subdivided into two parts. It is assumed that one third of this cost depends on the number of driven km and two thirds are affected by running speed, in the same way as maintenance cost. Both costs of use-related depreciation and time-related depreciation are shown in Table 14.2-10.

Table 14.2-10 Depreciation Cost by Type of Vehicle

	Passenger Car	Taxi	Buseta	Bus	Light Truck	Medium Truck
Economic Cost(1,000$) of:						
Vehicle	8,394	5,891	19,825	30,019	12,441	59,451
A Set of Tires	96	63	251	537	251	537
Vehicle w/o Tire	8,298	5,828	19,575	29,481	12,190	58,913
Salvage Value(%)	25	15	15	15	20	15
Annual Kilometerage(Km)	23,000	60,000	52,000	52,000	30,000	75,000
Average Speed(Km/hr)	35	35	20	20	35	40
Vehicle Life(Year)	12	12	10	12	12	12
Depreciable Amount(1,000$)						
Dep. subject to use	3,112	3,468	11,647	17,541	6,827	35,053
Dep. subject to time	3,112	1,486	4,992	7,518	2,926	15,023
Total	6,223	4,954	16,638	25,059	9,752	50,076
Indices for Depreciation Cost subject to Use(Av. speed:100)						
5	131	131	114	121	129	168
10	125	125	109	114	123	157
20	114	114	100	100	112	137
30	104	104	92	85	102	115
40	96	96	88	75	98	100
50	96	96	87	74	97	98
60	100	100	92	78	102	104
70	106	106	96	84	108	113
80	111	111	101	92	113	125
90	116	116	105	101	118	138
Depreciation Cost subject to Use($/Km)						
5	14.8	6.3	25.6	34.1	24.4	65.5
10	14.1	6.0	24.5	31.9	23.3	61.1
20	12.8	5.5	22.4	28.1	21.2	53.2
30	11.7	5.0	20.5	24.0	19.4	44.7
40	10.9	4.6	19.7	21.2	18.5	38.9
50	10.8	4.6	19.5	20.8	18.4	38.1
60	11.3	4.8	20.5	22.0	19.4	40.5
70	12.0	5.1	21.5	23.7	20.4	44.1
80	12.5	5.4	22.6	26.0	21.4	48.8
90	13.1	5.6	23.6	28.3	22.4	53.6
Depreciation Cost subject to Time($/day)	710	339	1,368	1,716	668	3,430

939. Time related depreciation in the table presents daily depreciation cost which is depreciable amount divided by number of days during life period. This cost is independent from driven distance and from running speed. Therefore, this cost shall be calculated separately based on the number of vehicles in the region and added to the other cost which is affected by running speed. The same thing can be said to the capital opportunity cost, crew cost and overhead cost.

14.2.7 Capital Opportunity Cost (Interest)

940. This cost is not affected by use but accrues only as time passes and is determined by vehicle price, life period, salvage value rate and interest rate, using the following formula.

$$C = P (1 - r) F - P / n + i r P$$
$$F = i (1 + i)^n / ((1 + i)^n - 1)$$

where, C : Capital opportunity cost
P : Economic cost of vehicle

F : Capital recovery factor
r : Salvage value rate
i : Interest rate
n : Durability (Vehicle life)

941. Interest rate is 12% which is the same rate as the discount rate used when calculating evaluation indices. Table 14.2-11 presents daily capital opportunity cost. Total capital opportunity cost in the study area is the product of this daily cost and total number of vehicles existing in the area. Therefore, in a with and without comparison for project evaluation, this cost will be canceled if in both cases have the number of vehicles is the same.

Table 14.2-11 Capital Opportunity Cost by Type of Vehicle

	Passenger Car	Taxi	Buseta	Bus	Light Truck	Medium Truck
Capital Cost(1,000$) (Economic Cost of Veh.)	8,394	5,891	19,825	30,019	12,441	59,451
Salvage Value(%)	25	15	15	15	20	15
Vehicle Life(Year)	12	12	10	12	12	12
Capital Recovery Factor at 12% of Interest Rate	0.1614	0.1614	0.1770	0.1614	0.1614	0.1614
Capital Opportunity Cost ($/Day)	1,558	1,160	3,717	5,912	2,380	11,709

14.2.8 Crew Cost and Overhead Cost

942. Also, this cost is not affected by driven kilometer but is proportional to time. According to hearing to vehicle owners, average annual wage of a bus driver is about $3,000,000 while that of a taxi driver is lower than this amount approximately by 15%. Average wage of a truck driver is in the same level as taxi driver's. Adding wages of assistants, annual crew cost per one truck is estimated to be $3,750,000 (refer to Table 14.2-12).

Table 14.2-12 Crew Cost and Overhead Cost by Type of Vehicle

Cost Item	Passenger Car	Taxi	Buseta	Bus	Light Truck	Heavy Truck
Annual Crew and Overhead Cost($/year)						
Crew Cost	-	2,500,000	3,000,000	3,000,000	-	3,750,000
Overhead Cost	-	0	150,000	150,000	-	2,250,000
Total	-	2,500,000	3,150,000	3,150,000	-	6,000,000
Daily Crew and Overhead Cost($/day)						
Crew Cost	-	6,849	8,219	8,219	-	10,274
Overhead Cost	-	0	411	411	-	6,164
Total	-	6,849	8,630	8,630	-	16,438

943. Most of buses are owned by individual persons in Cartagena, not by enterprise. One owner possesses one or few bus fleet and rents them to his driver. Under these circumstances, therefore, much overhead cost is not needed. Bus owner's profit is not regarded as economic cost, and overhead cost of truck

transport business is about 60% of crew cost.

14.2.9 Aggregate VOC

944. Aggregate unit VOCs are summarized as shown in Table 14.2-13. To calculate total VOC in a network, firstly, running speed of each link must be obtained from the traffic assignment result, secondly, total distance-related cost is calculated by summing up the cost in each link and finally, time-related cost calculated separately using total number of vehicles is added to the distance-related cost.

Table 14.2-13 Aggregate Vehicle Operating Cost by Type of Vehicle

(1) VOC subject to Use ($/Km)

Running Speed(Km/h)	Passenger Car	Taxi	Buseta	Bus	Light Truck	Medium Truck
5	66.1	47.9	105.7	170.3	118.2	312.5
10	53.6	36.3	87.9	137.8	91.4	255.2
20	44.9	29.2	74.8	113.2	74.9	209.1
30	40.1	25.9	65.9	97.7	66.2	188.5
40	37.2	24.0	62.4	88.0	63.7	144.9
50	37.0	23.8	62.1	89.9	63.6	140.9
60	38.9	25.0	64.9	98.3	66.4	148.3
70	41.4	26.5	68.2	109.3	69.3	160.9
80	44.0	28.3	72.3	123.7	74.2	179.9
90	47.3	30.5	77.6	138.0	80.3	201.1

(2) VOC subject to Time ($/day)

Cost Item	Passenger Car	Taxi	Buseta	Bus	Light Truck	Medium Truck
Depreciation	710	339	1,368	1,716	668	3,430
Capital Oppo.	1,558	1,160	3,717	5,912	2,380	11,709
Crew, Overhead	-	6,849	8,630	8,630	-	16,438
Total	2,268	8,348	13,715	16,258	3,048	31,577

14.3 Travel Time Cost

14.3.1 Time Value

945. Generally, Traveler's time value is defined based on his productivity. In this Study, the time value of inhabitants in Cartagena will be estimated using household income data, considering that their productivity may be related to their earnings.

946. According to a survey involving random interview to 400 sampled households, implemented by the Study Team in August of 1991, a significant difference was observed in the family income level between car-owning household and non car-owning households, namely the average income of the former was $425,000/month, while that of the latter was $130,000/month. On the other hand, Average number of income earners in a car-owning household was 2.35 persons against 1.58 persons in a non car-owning household. Conse-

quently, hourly income per earner is estimated to be $1,083 pesos for car-owning group and $493 pesos for non car-owning group, respectively. These figures will be the basis of time value estimation(refer to Table 14.3-1).

Table 14.3-1 Hourly Income by Car Ownership

Car Ownership	Family Income ($/Month)	No. of Earners (Person)	Work Hours (Hours)	Hourly Income ($/Hr/Person)
Car Owning	425,000	2.35	167	1083
Non-car Owning	130,000	1.58	167	493
Average	159,500	1.66	167	576

947. It is generally accepted that a person's time value during working hours (business time) is differnt from that during all other hours (non-business time). Time in working hours will have higher value than time in non-working hours, because it will be spent for a productive activity. Relating them to trip purposes, the time spent for business trip is regarded as time in working hours and time for all other trip purposes (to work, to school, shopping, leisure and so on) as time in non-working hours.

948. Time of business trip is valuated at the said rate of hourly income per earner, that is, $1,083 for passenger car users and $493 for public transport users. (Here, it is assumed that a worker belonging to the car-owning group would always use a car for business trip and a worker belonging to the non-car owning group would use public transportation for that purpose.) The equity time value of trips with other than business purposes is assumed to be 20% of the business trip time value. However, time value of school trips is zero.

949. Although there is a controversy that, among trips other than business trips, work trip could have higher value than others, this idea is not adopted, considering that the saved time of work trip would probably be spent for some non-productive activities.

950. Table 14.3-2 shows average time value, weighted by the share of trip with each trip purpose. Hourly time value of passenger car users is estimated to be $397 and that of public transport passengers to be $78. Converting these to time values per vehicle, $694 is obtained for a passenger car of which average occupancy is 1.75 persons and $1,931 for buses with average of 24.62 passengers.

Table 14.3-2 Estimate of Travel Time Value

(in 1991)

Item	Car User	Public Transp. Passenger	Average
1. Per Person			
1) Income/working hour	1,083	493	576
2) Time Value($/hr)			
(1) Business Trip	1,083	402	470
(2) School Trip	0	0	0
(3) Other Trip	217	80	94
3) Trip Composition(%)			
(1) Business Trip	21.9	4.2	7.0
(2) School Trip	4.4	19.2	16.8
(3) Other Trip	73.7	76.6	76.1
(4) Total	100.0	100.0	100.0
4) Weighted Average of Travel Time Value	397	78	105
2. Per Vehicle			
(1) Av. Occupancy(Person)	1.75	24.62	-
(2) Time Value($/hr/veh.)	694	1,931	-

951. Those time values are as of the year 1991. As shown in the previous Chapter for the projection of socioeconomic framework, the regional economy of the study area is envisaged to grow at an annual rate of 4.0 - 4.5 %. This means that GRP per capita of this region will grow by 1.585 times during 20 years from 1990 to 2010, in other words, at 2.32% per annum. The time values of passengers will also rise at the same rate and will be $615 for passenger car users and $121 for public transport passengers in the year 2010 as shown in Table 14.3-3.

Table 14.3-3 Future Travel Time Value

($/hour)

Item	1991	1992	2000	2010
1. Per Person				
1) Car & Taxi User	397	406	488	615
2) Public Transp. User	78	80	96	121
2. Per Vehicle				
1) Car & Taxi	694	710	854	1,075
2) Public Transportation	1,931	1,976	2,376	2,991

14.3.2 Estimation of Time Saving Benefit

952. Using the results of traffic assignment for both cases of "with" and "without" project to be evaluated, time saving benefit is calculated as the product of total saved time and time value. Total travel time of a network is obtained by summing up, for all the links, the time necessary for passing a link multiplied by the number of passengers of the link. For public transport passengers, time for access/egress, transfer time and terminal time are to be added to the net time of bus riding.

953. The time value may be affected by length of time, in addition to labor productivity and time spending purpose. It is generally agreed that a time of a certain length has higher values than fractional time as one can decide how to spend more freely. Improved urban transportation usually results in a time saving of fractional length, and in this context, have little useful time. Consequently, it is doubtful to regard the product of saved time and unit time value directly as economic benefit.

954. Figure 14.3-1 shows the accumulated histogram of trips in the year 2010 by saved time brought about by the Masterplan network. The curves of all mode shows that 26% of trips saves less than 15 minutes and 34% saves less than 20 minutes. Here, in this Study, saved time less than 20 minutes will be neglected, when estimating the benefits, assuming that at least 20 minutes would be necessary for productive activity.

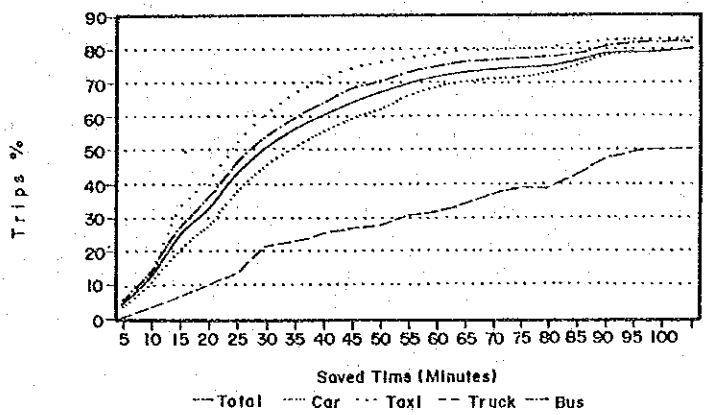


Figure 14.3-1 Accumulative Distribution of Trips by Saved Time

14.4 Economic Cost of Proposed Project

955. Investment amount of each transport project composing the Masterplan is shown in Chapter 13. They are so-called financial cost expressed at market price. In this section, those financial costs are converted to economic costs, taking the method states in 14.1. More concretely, the following procedure is taken:

a. Construction cost is broken down into three cost items; material cost, equipment cost and labor cost.
b. Out of material and equipment cost, import duties and value added tax are deducted. The rates of these taxes are in the range of 10 - 22%, the average is about 15%.
c. Assuming a half of labor cost is paid to unskilled laborers, the shadow wage rate of 0.815 is multiplied to the amount.

d. Public-owned land of which cost is not added up is valued referring the prices of neighboring land and added to the project cost.
e. 50% of contingency is regarded as price contingency preparing for the future inflation and is deducted from the cost.

956. Economic cost are estimated as shown in Table 14.4-1 for road and bridge projects, Table 14.4-2 for public transport projects and Table 14.4-3 for traffic management projects, respectively. Economic cost of water transport projects is shown in Section 11.9.2, separately. In most cases, economic cost corresponds to 80 to 90 % of the financial cost. In this study, these rates of road projects are rather high as some of projects use public-owned land. The average rate of new road projects is 96% and of road improvement projects is 90%, followed by 88% of public transport projects and 84 % of bridge projects and of traffic management projects.

Table 14.4-2 Economic Cost of Public Transport Project

(Million Pesos)

Project	Financial Cost				Economic Cost			
	Material, Equipment	Labour Cost	Land & Compen.	Total Cost	Material, Equipment	Labour Cost	Land & Compen.	Total Cost
Bus Terminals								
Catalina	3,429	1,478	0	4,907	2,867	1,341	966	5,174
Bazurto	6,225	2,668	0	8,892	5,204	2,421	2123	9,748
Terminal	881	434	0	1,315	737	394	126	1,256
Mamonal	1,347	664	280	2,291	1,127	602	280	2,009
Centenario	132	65	0	197	110	59	500	669
Bosque	2,608	1,203	1,535	5,546	2,347	1,092	1,535	4,975
Ampao	5,266	2,257	2,602	10,126	4,403	2,048	2,602	9,054
Boca grande	106	52	0	158	88	47	365	500
Aeropuerto	35	18	0	53	30	16	0	45
Lemaitre	152	75	198	425	127	68	198	393
Manga	166	82	250	497	139	74	250	463
Sub-total	20,547	8,994	4,865	34,406	17,180	8,162	8,945	34,287
Bus Stop	20	11	0	31	16	10	0	27
Bus Bay	128	88	0	216	107	79	0	187
Total	20,695	9,093	4,865	34,653	17,303	8,252	8,945	34,501

Table 14.4-3 Economic Cost of Traffic Management Project

Project	Financial Cost			Economic Cost		
	Material, Equipment	Labour Cost	Total Cost	Material, Equipment	Labour Cost	Total Cost
Traffic Signal Improvement						
Installation	129	14	143	107	13	120
Group Control	122	14	135	102	12	114
Centralization	15	60	75	13	54	67
Sub-total	265	88	353	222	80	301
Pedestrian Bridge	799	141	940	668	128	796
Total	1,064	229	1,293	890	208	1,097

Table 14.4-1 Economic Cost of Road and Bridge Project

(Million Pesos)

Project	Financial Cost				Economic Cost			
	Material, Equipment	Labour Cost	Land & Compen.	Total Cost	Material, Equipment	Labour Cost	Land & Compen.	Total Cost
New Road Construction Project								
C-1	22,121	2,787	2,715	27,623	17,128	2,529	2,715	22,372
C-2	15,096	1,884	2,616	19,595	11,908	1,709	2,616	16,233
C-3	10,110	1,271	4,972	16,354	8,183	1,154	4,972	14,308
C-4	6,535	1,032	1,669	9,236	5,414	937	1,669	8,019
C-7	854	152	0	1,006	728	138	8,250	9,116
C-8	1,533	296	4,114	5,943	1,300	269	4,114	5,683
C-9	3,065	562	3,030	6,657	2,585	510	3,030	6,125
C-10	1,504	285	4,381	6,170	1,276	258	4,381	5,916
C-11	1,206	176	876	2,258	1,010	159	876	2,045
C-12	573	82	159	814	476	74	159	710
C-13	840	105	239	1,184	699	96	239	1,033
C-14	190	29	461	679	164	26	461	651
C-15	202	30	461	692	173	27	461	661
C-16	325	48	882	1,255	279	44	882	1,204
C-18	463	69	506	1,038	396	63	506	965
C-19	1,135	204	3,713	5,052	954	185	3,713	4,852
C-20	1,817	329	3,406	5,552	1,531	298	4,878	6,708
Sub-total	67,569	9,341	34,200	111,109	54,201	8,477	43,922	106,600
Road Improvement Project								
I-1	1,701	272	1,167	3,141	1,398	247	1,167	2,812
I-2	15,128	2,283	1,749	19,160	11,760	2,072	1,749	15,581
I-3	903	168	0	1,071	767	152	0	920
I-4	762	167	0	929	643	151	0	794
I-5	940	178	1,705	2,822	797	161	1,705	2,664
I-6	835	167	0	1,002	707	151	0	859
I-7	679	124	1,282	2,085	577	113	1,282	1,972
I-8	990	182	1,830	3,002	841	165	1,830	2,836
I-9	141	25	4,001	4,167	120	23	4,001	4,144
I-10	202	36	373	611	171	33	373	577
I-11	929	159	5,133	6,221	792	144	5,133	6,069
I-12	1,490	270	0	1,759	1,263	245	0	1,508
I-13	773	140	0	913	655	127	0	783
I-14	8,558	1,603	1,297	11,458	7,262	1,455	1,297	10,014
I-15	897	164	3,503	4,564	763	149	3,503	4,415
I-16	1,753	308	2,311	4,372	1,493	279	2,311	4,084
I-17	1,058	182	4,766	6,005	902	165	4,766	5,833
I-18	271	48	598	916	231	43	598	872
I-19	282	48	762	1,092	241	43	762	1,046
I-20	745	129	1,235	2,109	635	117	1,235	1,988
I-21	780	136	1,761	2,677	665	124	1,761	2,549
I-22	168	29	338	535	143	27	338	508
I-23	628	108	346	1,082	536	98	346	980
I-24	503	87	339	929	429	79	339	847
I-25	983	169	2,205	3,357	838	154	2,205	3,197
Sub-total	42,097	7,183	36,701	85,981	34,631	6,518	36,701	77,851
Bridge Construction Project								
Br-1	1,986	268	0	2,254	1,661	243	0	1,904
Br-2	622	78	0	700	520	71	0	591
Br-3	50,534	6,310	0	56,844	42,253	5,726	0	47,979
Br-4	3,203	613	0	3,816	2,678	556	0	3,234
Br-8	9,229	1,383	0	10,612	7,717	1,255	0	8,972
Br-9	1,090	102	0	1,192	911	93	0	1,004
Br-10	1,111	208	0	1,319	929	189	0	1,118
Br-11	1,111	208	0	1,319	929	189	0	1,118
Br-12	1,111	208	0	1,319	929	189	0	1,118
Br-13	622	78	0	700	520	71	0	591
Sub-total	70,619	9,456	0	80,075	59,046	8,582	0	67,628
Total	180,285	25,979	70,901	277,166	147,879	23,576	80,623	252,078

14.5 Evaluation Results

14.5.1 Evaluation of Entire Masterplan

957. A sum of 272.0 billion pesos will be needed to accomplish all the projects in the Masterplan in economic terms at 1992 price. Out of this, 86.8 % is allotted to road and bridge sector, 12,7% to public transport sector and 0.5% to traffic management sector. If all these investment is attained, total travel cost (VOC plus TTC) would amount to 222.4 billion pesos (at 1992 price) in the year of 2010. On the other hand, that would be 508.6 billion pesos if the present network remains as it is. Hence, the economic benefits in 2010 expect to derive by the Masterplan is estimated to be 286.2 billion pesos. Of this, 22% is attributed to the VOC savings and 78% to TTC savings.

958. Annual profit estimated for each years is compared with investment cost in the form of cash flow in Table 14.5-1. As the percentage of TTC savings are extremely high, another case where only VOC saving is regarded as benefit is shown as the reference. Under the discount rate of 12%, the cost benefit ratio (B/C) is 5.9 and the net present value (NPV)is 370.9 billion pesos, which assures the high economic returns by Masterplan. The Internal rate of return (IRR) is also high at 56%.

Table 14.5-1 Cost-Benefit Analysis of Masterplan as a Whole

(Million Peso)

Year	Road & Bridge	Public Transp.	Traffic Management	Total Cost		Benefit		Cash Flow	
				Total	Land	VOC only	VOC+TTC	VOC only	VOC+TTC
1991	983	0	0	983	0	0	0	-983	-983
1992	983	0	0	983	0	0	0	-983	-983
1993	1,708	27	0	1,735	1,358	0	0	-1,735	-1,735
1994	7,871	27	72	7,969	5,071	0	0	-7,969	-7,969
1995	14,569	1,419	72	16,059	8,524	271	1,166	-15,789	-14,893
1996	13,170	1,533	72	14,775	1,930	2,276	9,799	-12,499	-4,976
1997	15,375	5,197	72	20,644	9,696	5,036	21,681	-15,608	1,037
1998	16,822	4,726	72	21,620	8,002	5,432	23,386	-16,188	1,766
1999	16,137	3,980	72	20,189	5,292	16,005	68,906	-4,185	48,717
2000	13,810	605	82	14,497	1,133	24,889	107,157	10,392	92,660
2001	10,734	3,435	82	14,251	3,441	30,429	131,892	16,178	117,641
2002	10,273	6,565	82	16,920	4,870	30,720	133,193	13,801	116,273
2003	14,997	6,673	82	21,752	3,282	34,958	152,115	13,206	130,363
2004	16,346	313	82	16,741	7,635	35,168	153,052	18,427	136,311
2005	16,590	0	93	16,683	6,318	36,166	157,508	19,483	140,824
2006	14,602	0	93	14,695	1,103	39,494	172,364	24,799	157,669
2007	15,011	0	93	15,104	3,227	44,663	195,442	29,558	180,338
2008	12,784	0	93	12,877	3,777	48,415	212,197	35,538	199,320
2009	13,445	0	93	13,538	1,121	49,382	216,516	35,844	202,978
2010	9,909	0	93	10,002	0	64,990	286,201	54,988	276,199
2011			Residual	-186,981	-75,780			262,761	262,761
Total	236,119	34,501	1,399	272,018	75,780	468,293	2,042,574	459,036	2,033,317
							IRR	18.0	55.9
							B/C	1.36	5.31
							NTV	34,374	370,983

959. In other words, traffic congestion would be so horrible that the diseconomies by congestion will become so serious, if the effort for improving transport facilities be neglected. The economic returns is so significant that the VOC savings alone can cover the cost, deriving IRR at 18% and B/C at 1.36.

14.5.2 Road and Bridge

(1) Entire Plan

960. Although the most part of the investment is occupied by the road and bridge sector, benefits by the Masterplan are generated from the same sector. In fact, more than 96% of the benefit in 2000 is attributed to the sector (refer to Table 14.5-2).

Table 14.5-2 Cost-Benefit Analysis of Road Projects as a Whole

(Million Peso)

Year	Total Cost		Benefit		Cash Flow	
	Total	Land	VOC only	VOC+TTC	VOC only	VOC+TTC
1991	983	0	0	0	-983	-983
1992	983	0	0	0	-983	-983
1993	1708	1358	0	0	-1,708	-1,708
1994	7871	5071	0	0	-7,871	-7,871
1995	14569	7558	3,440	14,436	-11,129	-133
1996	13170	1804	5,398	23,323	-7,772	10,153
1997	15375	7573	8,093	35,555	-7,282	20,180
1998	16822	8002	8,093	35,555	-8,729	18,733
1999	16137	4792	16,824	75,185	687	59,048
2000	13810	853	22,498	100,940	8,688	87,130
2001	10734	1906	34,575	150,755	23,841	140,021
2002	10273	2070	34,917	152,167	24,644	141,894
2003	14997	2667	43,278	186,650	28,281	171,653
2004	16346	7635	43,735	188,537	27,389	172,191
2005	16590	6318	43,735	188,537	27,145	171,947
2006	14602	1103	44,689	193,189	30,087	178,587
2007	15011	3227	48,086	209,755	33,075	194,744
2008	12784	3777	50,539	221,716	37,755	208,932
2009	13445	1121	51,187	224,878	37,742	211,433
2010	9909	0	61,648	275,891	51,739	265,982
2011	-164,287	-66,835	(Residual)		231,122	231,122
Total	236,119	66,835	520,734	2,277,068	515,737	2,272,071
				IRR	24.9	79.6
				B/C	1.86	8.11
				NTV	53,653	445,628

961. Assuming that no bus project and all the road and bridge project are implemented, the evaluation indicators are estimated to be 80% of the IRR and 8.1 of B/C, which are higher than the entire Masterplan case.

(2) Project Group by Implementation Period

962. Classifying all the projects proposed in the Masterplan by their opening year, each group is evaluated as shown in Table 14.5-3. It reveals that the earlier the operation year, the higher their economic return, which shows that the investment schedule was planned reasonably from the economic point of view.

Table 14.5-3 Evaluation of Road Projects by Period

Item	Period	1992-1995	1996-2000	2001-2005	2006-2010
Economic Cost(Mill. Peso)					
Total Cost		7,220	83,160	28,040	117,700
of which Land Cost		3,713	29,844	8,406	24,873
Evaluation					
(VOC+TTC)	IRR (%)	83.5	62.1	24.6	13.5
	B/C	22.10	13.92	4.22	1.23
	NTV (Mill. P.)	129,491	752,099	47,853	10,355

(3) New Construction Project and Improvement Project

963. All road and bridge projects are classified into two groups: one is construction of new facilities and the other is improvement of existing facilities.

964. The results of evaluation are presented in Table 14.5-4. The improvement project group is superior to the other. As the new construction group includes such a gigantic and costly bridge project, total economic cost is more than double of the other but its evaluation indicators are lower than half of the other group. In this respect, it would be also accepted that such large-scale projects are scheduled in the later phase of the planning period.

Table 14.5-4 Evaluation of New Road Projects and Road Improvement Projects

		New Road Project	Improvement Project
Economic Cost(Mill. Peso)			
Total Cost		163,612	72,507
of which Land Cost		35,674	31,161
Evaluation			
VOC Saving only	IRR (%)	16.3	33.7
	B/C	1.28	2.87
	NTV (Mill. P.)	12,521	33,404
VOC+TTC	IRR (%)	41.7	82.6
	B/C	4.38	11.78
	NTV (Mill. P.)	151,575	192,944

14.5.3 Public Transport Plan

965. Rationalization of bus route by trunk and feeder system will raise the seat occupancy, repressing bus traffic increase and this will ,more or less, hinder traffic conditions from becoming worse. Cars and taxis will enjoy this benefits.

966. Table 14.5-5 shows the benefits by the bus improving project, estimated by "with and without" comparison, assuming that all the road and bridge projects are implemented as scheduled in both cases.

Table 14.5-5 Economic Benefit of Bus Improving Project in 2010

(Million Pesos)

Item	Without Project	With Project	Economic Benefit
Vehicle Operating Cost			
Car	42,400	41,984	416
Taxi	14,019	13,879	140
Truck	38,511	38,138	373
Bus	25,765	24,063	1,702
Total	120,695	118,064	2,631
Travel Time Cost			
Car	50,470	49,064	1,406
Taxi	24,009	23,432	577
Truck	0	0	0
Bus	38,840	36,996	1,844
Total	113,319	109,492	3,827
VOC+TTC			
Car	92,870	91,048	1,822
Taxi	38,028	37,311	717
Truck	38,511	38,138	373
Bus	64,605	61,059	3,546
Total	234,014	227,556	6,458

967. The benefit in 2010 would be 6,458 million pesos, 40% of which derives from VOC savings and 60% from TTC savings. The distribution among mode is 55% of the total for buses, 28% for cars and the rest is for taxis and trucks. Accumulated total from the year of 2001 to 2010 is estimated to be 65.2 billion pesos.

968. It could be generally accepted public investment to improve bus passengers convenience and safty, up to the said amount. Although the bus operation system improving project does not necessarily need the facilities such as bus terminals and bus bays, the benefit is compared with the investment for such infrastructure as shown in Table 14.5-6. The B/C ratio is 1.16 and the IRR is 13.9%, Thus, the benefits exceeds the cost.

Table 14.5-6 Cost-Benefit Analysis of Public Transportation Plan

(Million Pesos)

Year	Cost					Benefit	Cash Flow
	Terminal		Bus Stop	Bus Bay	Total		
	Const.	Land					
1993	0	0		27	27		-27
1994	0	0		27	27		-27
1995	421	966	5	27	1,419		-1,419
1996	1,375	126	5	27	1,533		-1,533
1997	3,042	2,123	5	27	5,197		-5,197
1998	4,694	0	5	27	4,726		-4,726
1999	3,448	500	5	27	3,980		-3,980
2000	325	280			605		-605
2001	1,900	1,535			3,435	2,059	-1,376
2002	3,765	2,800			6,565	3,900	-2,665
2003	6,058	615			6,673	5,523	-1,151
2004	313	0			313	5,195	4,881
2005	0	0			0	9,734	9,734
2006	0	0			0	9,079	9,079
2007	0	0			0	8,423	8,423
2008	0	0			0	7,768	7,768
2009	0	0			0	7,113	7,113
2010	0	0			0	6,458	6,458
Residual	0				-25,840		25,840
Total	25,342	8,945	27	187	34,501	65,251	30,750
					IRR	13.9 %	
					B/C	1.16	
					NPV	1,920 Mill. Peso	

14.6 Social Impact

969. Savings in VOC and TTC are the most direct benefits which are easy to calculate. Beside these, however, development of transportation project will result in socio-economic benefits in various aspects. Some of them are explained.

(1) Creation of Job Opportunity

970. Currently in Cartagena, the economic ally active population is 236,000, of which 23,000 are unemployed persons. Unemployment rate is almost 10%. Under such situation, job creation by implementing the masterplan projects is significant.

971. Direct employment in the construction works is estimated, based on the investment amount shown in the previous section (13.4), to be 50,000 to 60,000 man-months.

972. Considering the multiplier effect, total employment would be 3 to 4 times of this. Public investment of sizable amount could trigger the vitalization of urban economy.

(2) Energy Conservation Effect

973. Demand for Petro-products is more than the domestic production in Colombia, and the shortage is covered by importation. More than two third of the consumption is for transport use.

974. It is estimated that approximately 40% of saved VOC by the masterplan is saving in fuel. Based on the results of traffic assignment, savings in fuel would be 24 billion pesos (equivalent to 62 million gallons of regular gasoline) in the year 2010, if the masterplan is realized as scheduled.

975. Totaling the annual saving from 1992 to 2010, the savings would amount to 172.8 billion pesos (446 million gallons). The masterplan implies such effect of earnings in foreign currency.

CHAPTER 15 CONCLUSION AND RECOMMENDATIONS

15.1 Conclusion

976. The Masterplan Study of the Urban Transport in Cartagena has been carried out during the period June 1991 and August 1992, which included a number of surveys of current socioeconomic, traffic and transport conditions in the Study Area. Based on those survey results obtained, a series of analyses and forecasting works were made and the Transport Masterplan for coming two decades is proposed.

977. Due to the relative low vehicle ownership in the Study Area at present, the traffic flow on current road network is not serious condition now. However, in order to meet the future growing traffic demand, the road network is required to expand its service area as well as to improve its service level.

978. 123 km of new road construction, 81 km of existing road improvement and 6,420 m of new bridge construction are proposed to be implemented until the year of 2010. Total project cost for the masterplan of road network is estimated at 266,031 million pesos, equivalent to 409.28 million US$.

979. Regarding the public bus transport, it is recognized that several points are necessary for improving its transport condition as for the operation system as well as the facilities. The facilities of bus stops and bus terminals are required to be prepared in order to provide the customers better services and also to make smoother traffic flow by regulated operation of bus vehicles.

980. Through the DATT's functions (guidances and licensings), the improvement of public bus transport is possible. The renewal of old bus vehicles and readjustment of bus routes are the typical examples of this matter. Not only to facility construction, the effort shall be paid also to this operational improvement.

981. Current operation system is to be changed to trunk-feeder operation system to meet the future public passenger demand increase. This operation system change is not easily realized be cause of the necessity of global consensus among the many organizations and personels concerned. However, it is concluded that the installation of this system in Cartagena will bring enough socioeconomic benefits not only for the public bus operators but also for the bus passengers.

982. The possibility of water transport introduction in

Cartagena was investigated based on the comprehensive transport demand analysis and socioeconomic/financial analysis of its operation. The result showed that from socioeconomic point of view, the introduction of water transport would bring a little benefit to the Study Area. Financial analysis also indicated that under the current public bus fare level, the revenue would be very difficult to recover the expense of the operation. However, the water transport project has already started and it is on its implementation stage. Therefore, it is necessary to establish a much favorite circumstance of less ship cost, less interest rate and higher fare level than the assumed in order to make water transport financially feasible.

983. The demand for water transport depend on the public bus transport service level. Improvement of public bus transport service will decrease the demand for water transport, especially, of the passengers possibly transferring from bus to boat. Therefore, in order to establish the multi-modal system of public transport in Cartagena, public transport planning policy for introduction of water transport should be confirmed as for the modal share of water transport, amount of subsidy from municipal government, etc.

984. Regarding traffic management, following projects are proposed as masterplan component;

a. improvement of curb parking system,
b. improvement of existing traffic signal phasing system,
c. improvement of signal system by signal installation, synchronization and centralization, and
d. construction of pedestrian overcrossing bridges.

985. Restriction of vehicle entrance into Central area shall be made as soon as possible for the conservation of this historical area. To this end, preparation of curb parking spaces and also strict control of illegal curb parking shall be carried out.

986. Improvement of traffic signal system is required according to the increase of traffic demand on the traffic corridors. Major concern shall be paid on the traffic flow efficiency improvement and traffic safety of vehicles as well as pedestrians.

15.2 Recommendations

987. To actualize the Masterplan, the following actions are recommended;

(1) Strengthening of Planning Sections

988. It is necessary to review the masterplan repeatedly because the socioeconomic conditions of the study area will change from those it assumes. Masterplan includes many aspects of municipal activities. Therefore, such reviewing works shall be coordinated by right municipal organization of planning sections.

989. Departamento de Planeacion shall be in charge for this coordinating tasks. It also shall be in charge of reviewing the land use and the socioeconomic framework. For these tasks, its power is not enough at present and shall be strengthened.

990. Departamento de Valorizacion and Secretaria de Oblas Publicas shall be in charge of road network planning and implementation. EPM and EDURBE are also in charge of the road planning and construction in the scope of their activities. The coordination of their activities will become very important for the development of the road network improvement.

991. Departamento Administrativo de Transito y Transporte (DATT Distrital) is in charge of public transport and traffic management improvement. Its capacity seems to be very poor for its duties, especially for the planning activities. Improvement of public bus transport system is a long term plan and requires the huge amount of investigations as well as coordination between the organizations concerned. Such tasks shall be carried out continuously by a permanent section.

992. Water transport is now being implemented by Empresa de Desarrollo Urbano de Bolivar S.A.(EDURBE). In order to actuate the introduction of water transport in Cartagena, it is required to have the planning section capable to investigate the further detail analysis on its operational conditions which will bring more favorite circumstances for water transport.

(2) Financial Resources

993. In order to realize the masterplan, it is essential to establish a solid self-sustained fund as well as to utilize the vitality of the private sector. In these respects, the followings are suggested;

a. To apply, more strongly, the benefit principle: The primary beneficiaries of the road and bus facility development are car

owners as well as inhabitants along the road. Consequently car owners and inhabitants should shoulder the costs.

b. To introduce the toll road system: Toll roads shall be developed where the alternative road exists. The utilization of private sector funds shall be considered together with the funds from public sector.
c. To establish public enterprises: New enterprises should be set up to undertake such public-type business as urban bus terminal. Their profits should be reinvested in public works. If the water transport will be introduced, the cost shall be subsidized from this revenue.

(3) Feasibility Study

994. As the major large-scale projects, the following are identified through the masterplan study.

a. Road network development,
b. Public bus system improvement, and
c. Water transport system introduction.

995. As for the projects with high priority, it is recommended to undertake a feasibility study at an early stage. Among the above, the projects indicated below are to be the candidates for the feasibility study;

a. road network improvement around the Bay of Animas,
b. trunk-feeder public bus system introduction, and
c. water transport system introduction

996. The financial condition of water transport is indicated to be very difficult from the preliminary analysis in this masterplan. To implement the project without further detailed investigation is not desirable and will lead into the severe situation of its operation. Much detailed investigation to find out the more favorable condition for the water transport shall be undertaken.

(4) Environmental Consideration

997. There is considered to be few influence on the environment of the Study Area by the masterplan implementation. Projects planned in the masterplan are located almost in the already urbanized area and the water area inside this urban area.

998. However, some road constructions in rural area such as the Bayunca Road and Trans-Baru Road are considered to give a reverse influences on their environments of water quality and vegetational condition. The detailed assessment for these aspects is recommended to be undertaken before their implementation.