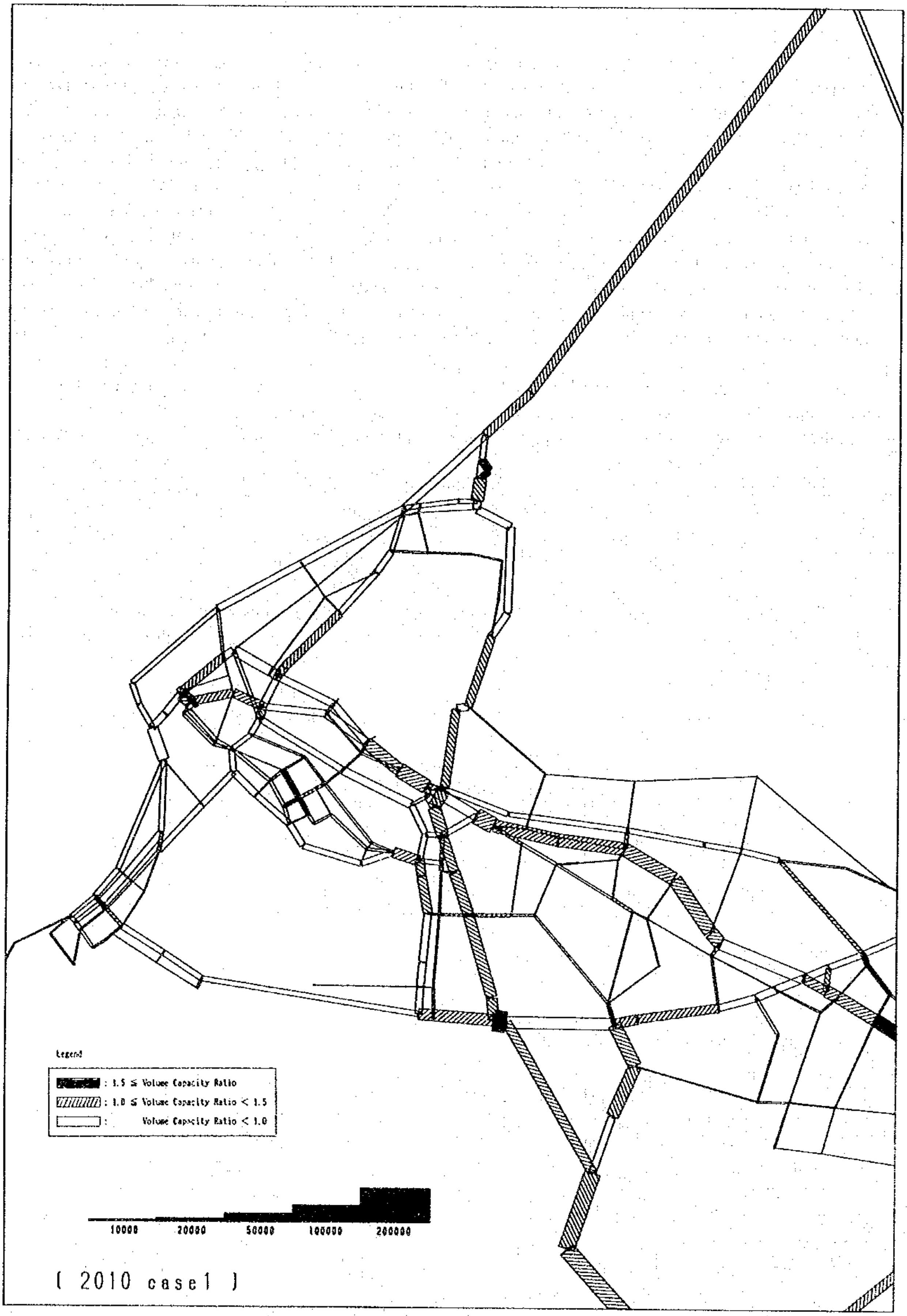


Figure 9.4-2 Assigned Traffic Volume in The Road Masterplan in 2010 (Case-1)

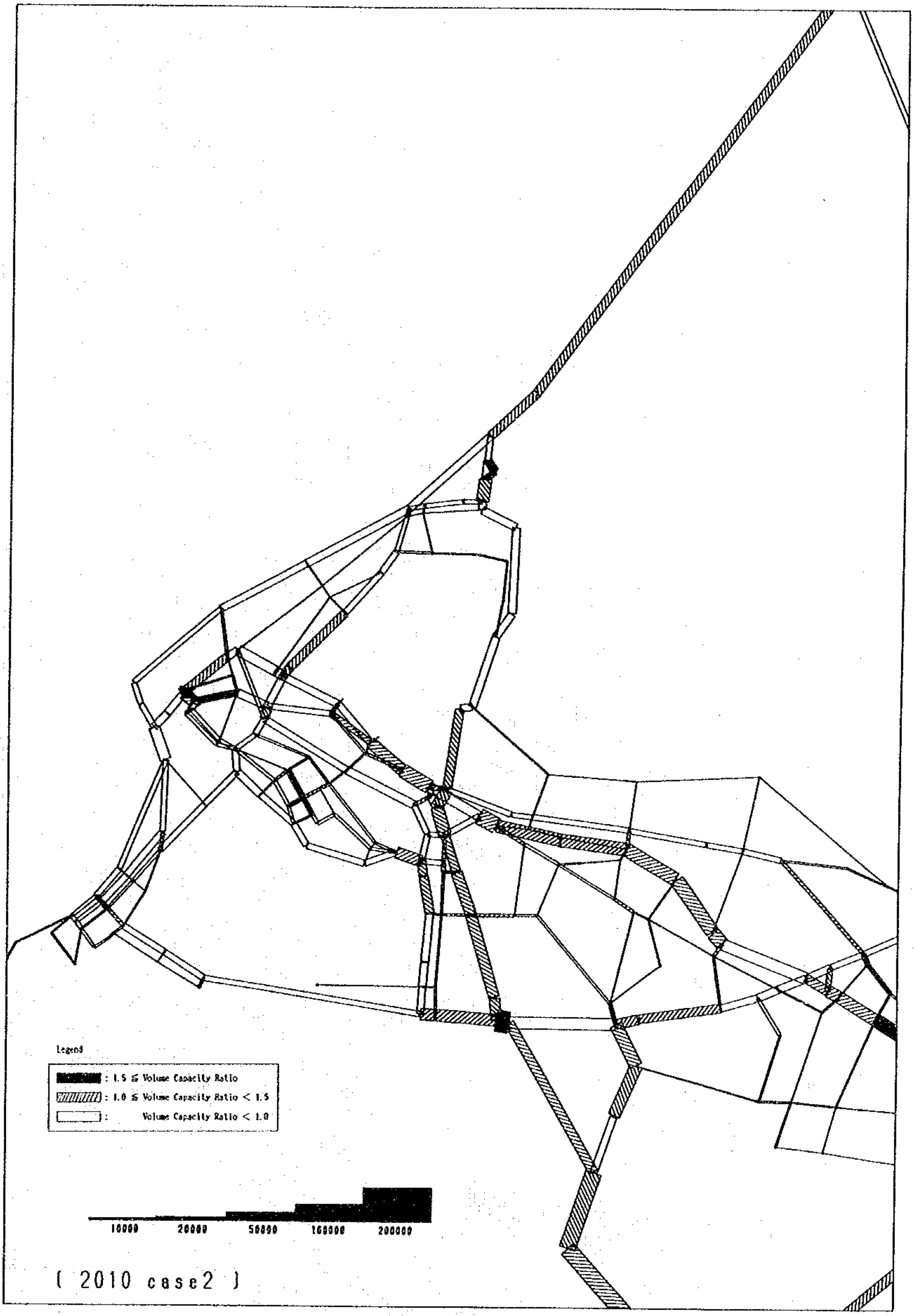


Figure 9.4-3 Assigned Traffic Volume in The Road Masterplan in 2010 (Case-2)

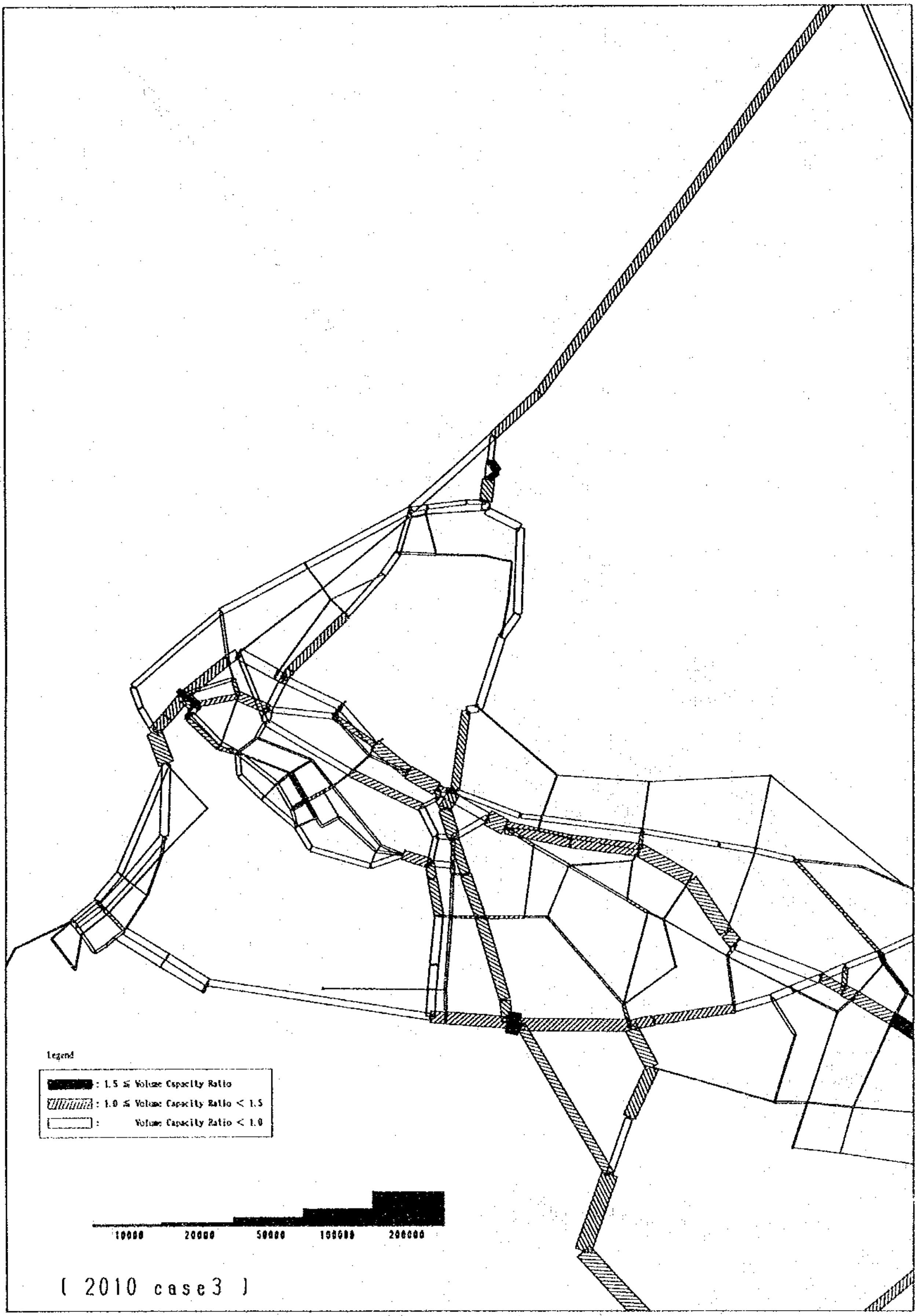


Figure 9.4-4 Assigned Traffic Volume in The Road Masterplan in 2010 (Case-3)

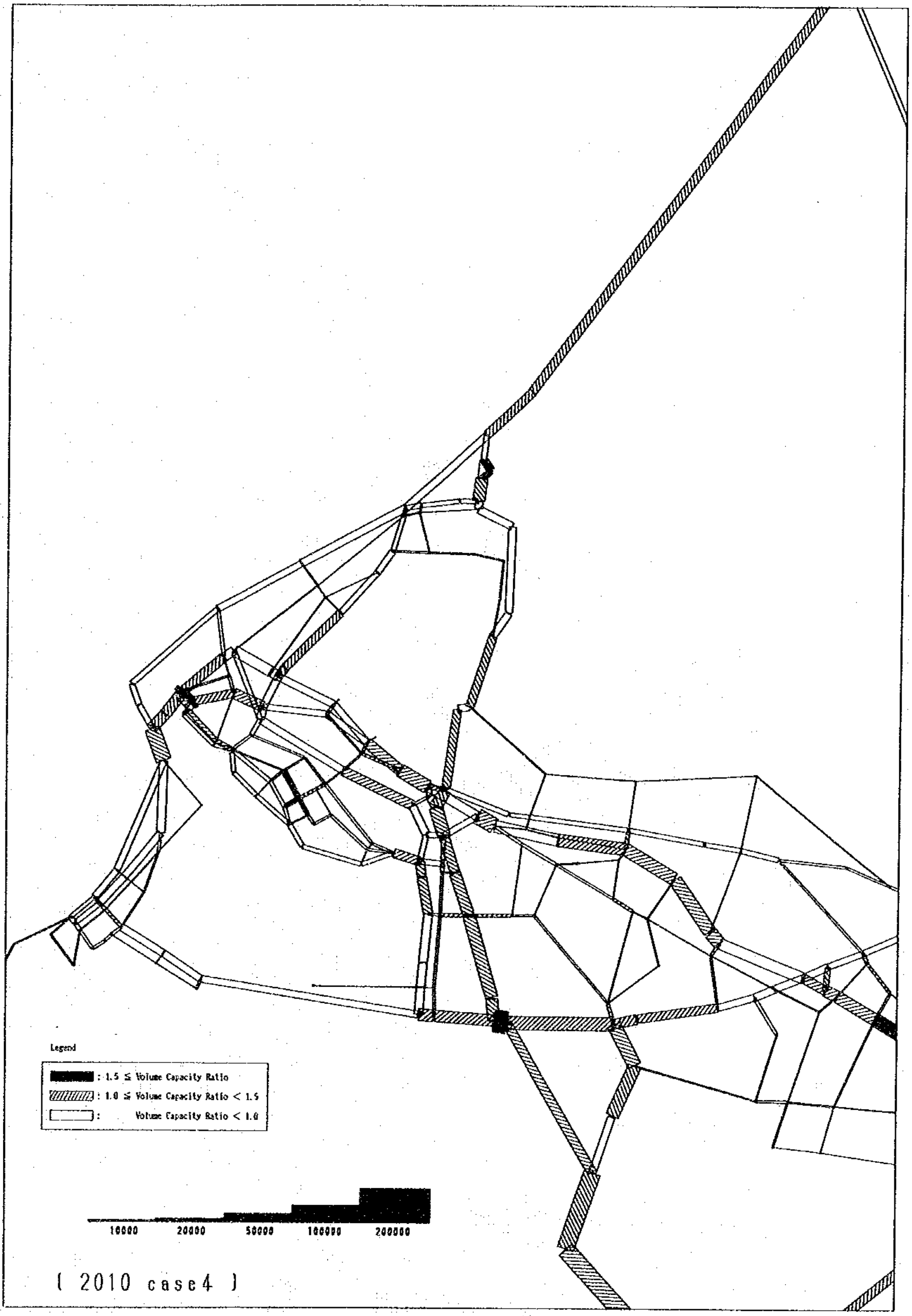


Figure 9.4-5 Assigned Traffic Volume in The Road Masterplan in 2010 (Case-4)

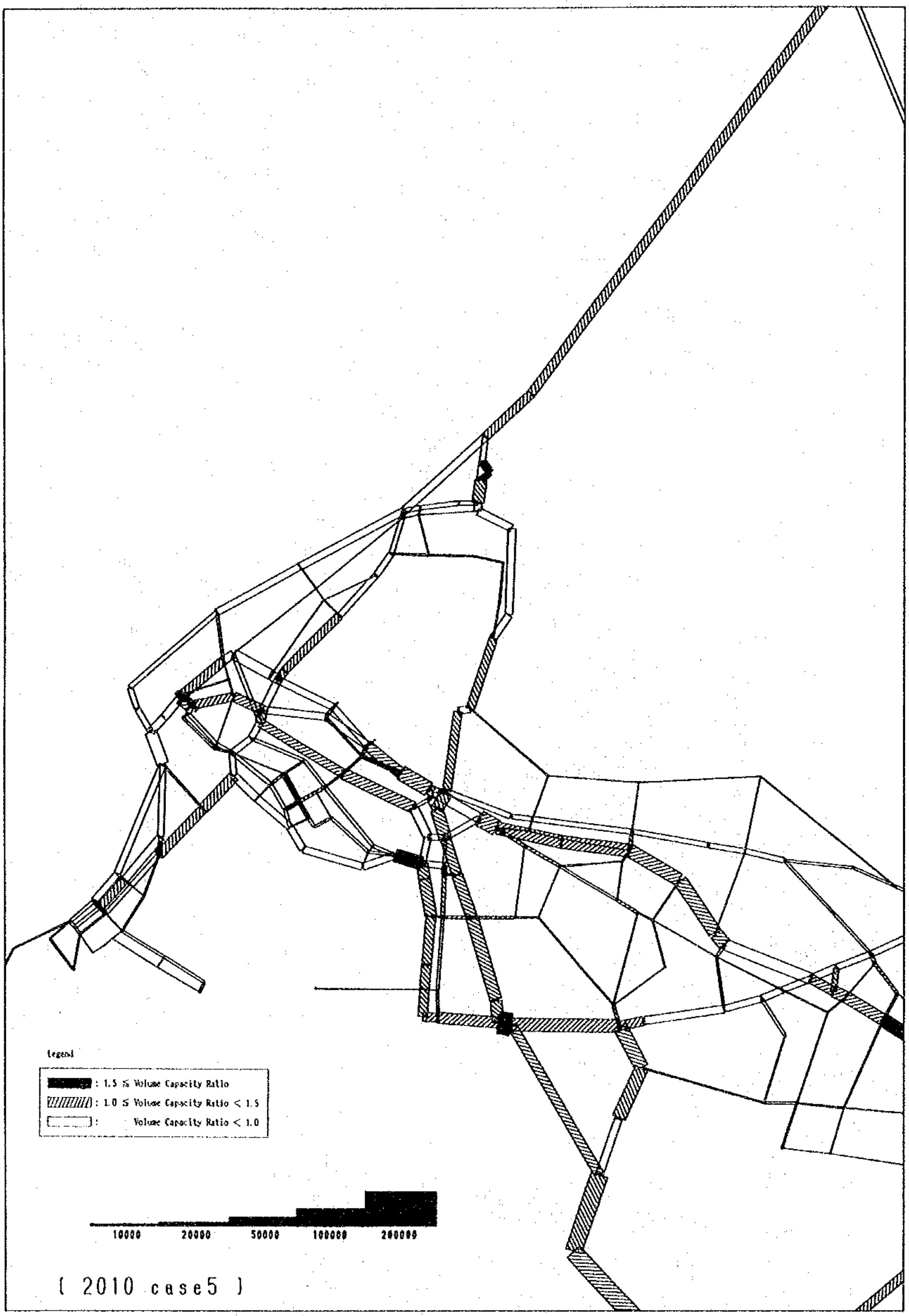
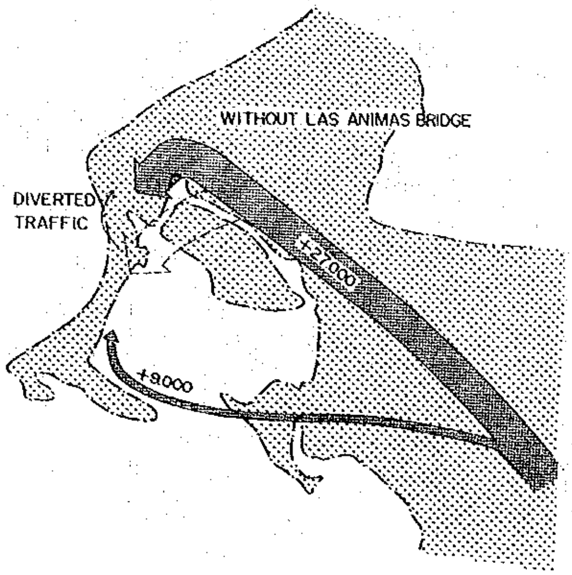
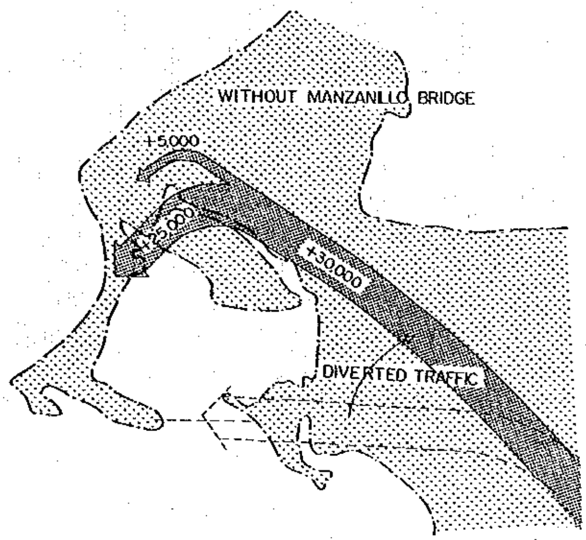


Figure 9.4-6 Assigned Traffic Volume in The Road Masterplan in 2010 (Case-5)

Without Las Animas Bridge Project



Without Manzanillo Bridge Project



Without Improvement of Calle 30

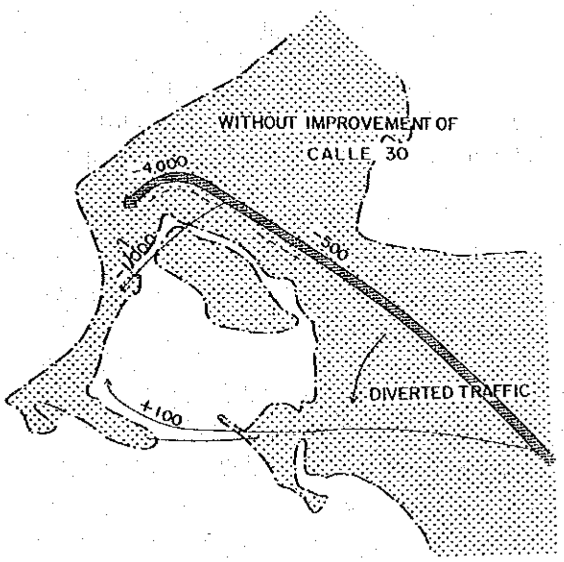


Figure 9.4-7 Schematic Traffic Movements (Difference of Traffic Volume from The Masterplan)

net present value were calculated on assumption of 12% discount rate. The detailed method refers to Chapter 12, Economic Analysis.

612. Table 9.4-8 shows the estimate of cost-benefit by the alternatives. The B/C ratio and B-C of each alternative are found at almost same level. Of these, Case-5 without Br-3 project has higher benefit value because the Br-3 project cost is higher.

Table 9.4-8 Estimate of Cost Benefit by Alternatives

Items	Case-1	Case-2	Case-3	Case-4	Case-5
(1)Benefit (Mill Ps$/Year)					
1)VOC	62,867	62,667	62,262	62,105	61,425
2)TTC	218,777	218,131	217,117	216,717	214,802
3)VOC+TTC	281,644	280,798	279,379	278,822	276,226
(2)Cost (Mill Ps$)	270,806	266,031	255,428	260,204	213,962
(3) B/C	11.14	11.31	11.72	11.48	13.83
(4) B-C (Mill Ps$)	293,786	294,891	298,047	294,793	315,644

613. As for the evaluation of alternatives from the traffic point of view, traffic on the major corridor of Pedro de Heredia influenced by the widening on Calle 30 (I-9 and 10 projects) is very small. Land acquisition and compensation along these roads to obtain road area for widening will be very difficult because those roads pass through historical spots and commercial area in Cartagena and the widening will demolish parts of historical monuments. Therefore, those projects are eliminated from the 2010 masterplan.

614. The Br-3 project, Manzanillo Bridge, is of great importance for alleviating the traffic congestion in future by diverting traffic into the bridge. This project is indispensable in 2010 masterplan.

615. The Br-8 project, Las Animas Bridge, will also have an important role in lightening the traffic congestion near Centro. This project is also needed in 2010 masterplan.

616. From the economic point of view, the B/C ratio and B-C value by each alternative are almost equivalent with the exception of Case-5 where the B/C and B-C are somewhat higher.

617. It appears that it is difficult for Case-5 to be chosen as the 2010 masterplan alternatives from the traffic point of view. According to the above discussion, Case-2 will be recommended as the proposed alternative in the masterplan for 2010.

618. The traffic and economic conditions in terms of average volume capacity ratio, average travel speed and travel cost by four traffic/network cases; 1991 condition, Do-nothing, Long Term Planning and 2010 Masterplan cases, are shown in Table 9.4-9. In this table, these figures except those for the masterplan case are already shown in Table 9.2-4. Although the average volume capacity ratio and average travel speed on the masterplan are somewhat higher and more slow than those of the long term plan, respectively, those conditions will be maintained at the same level as those of the long term plan.

Table 9.4-9 Traffic Conditions by Network Plans

Items	1) 1991	2) Do-Nothing in 2010	3) Long Term in 2010	4) Masterplan in 2010	Increase Ratio 2)/1)	3)/1)	4)/1)
Average Volume-Capacity Ratio							
1) Study Area	0.32	2.25	0.60	0.67	7.06	1.89	2.11
2) Urban Area	0.46	2.24	0.61	0.69	4.89	1.34	1.51
Average Travel Speed							
1) Study Area	41.5	11.8	43.8	41.2	0.29	1.06	0.99
2) Urban Area	39.4	11.5	37.6	37.0	0.29	0.95	0.94
Travel Cost (Mill.Ps$/Year)					Benefit 2)/1)	2)-3)	2)-4)
1) VOC	21,478	178,192	114,778	116,544	8.30	63,414	61,648
2) TTC	11,007	320,051	96,377	105,808	29.08	223,674	214,243
3) VOC+TTC	32,485	498,243	211,155	222,352	15.34	287,088	275,891

(Influence of Br-9 Project across Channel for Water Transport)

619. In the masterplan case, the influence of traffic movement around Centro by "without" case of Br-9 Project (Las Palmas Bridge, which crosses water channel network for the planned water transport) was studied. At present this bridge does not provide sufficient clearance for passage of through vessels. For the planned water transport to pass through under the bridge, it is necessary to reconstruct a new bridge for passing vessels. In case the bridge is removed to obtain the transport channel, the influence of traffic is measured and the necessity of the bridge is discussed.

620. In order to measure the influence of traffic congestion in the area which is around that bridge, two case traffic volumes forecasted by the traffic assignment were compared. Those cases are for "with" and "without" of Br-9 project under the masterplan network forecasted by the traffic assignment. The schematic figure is shown in Figure 9.4-8, in which the difference of two assigned traffic volumes are shown.

621. As can be seen in Figure 9.4-8, when the bridge is removed, the influence area for traffic is within Manga, Centro, Bocagrande and surrounding area with Castillo San Felipe de

Barjas and Mercado. Those are the most traffic congested areas in Cartagena at the present and in future.

622. The two changes of major traffic flows are found in those areas. One is for traffic which flows from near Mercado to Centro or Bocagrande. This traffic movement is changed from using Br-9 and Br-8 to using Pedro de Heredia and/or Roman Bridge. The other is for traffic movement from Manga to Centro. The traffic flow in Manga to Centro will change to way of Jimenez Bridge, or Roman Bridge and San Lorenzo Bridge (Br-1), from the route of Br-9 bridge.

623. Therefore, traffic volume near Centro considerably rises in comparison with that of the masterplan network. The figures to be increased are approximately 7,000-10,000 pcu/day. The volume capacity ratio on Calle 30 exceeds 1.0, in contrast to 0.95 for the "with" case. The above discussion indicates that Br-9 project is indispensable for alleviating traffic congestion in CBD in Cartagena.

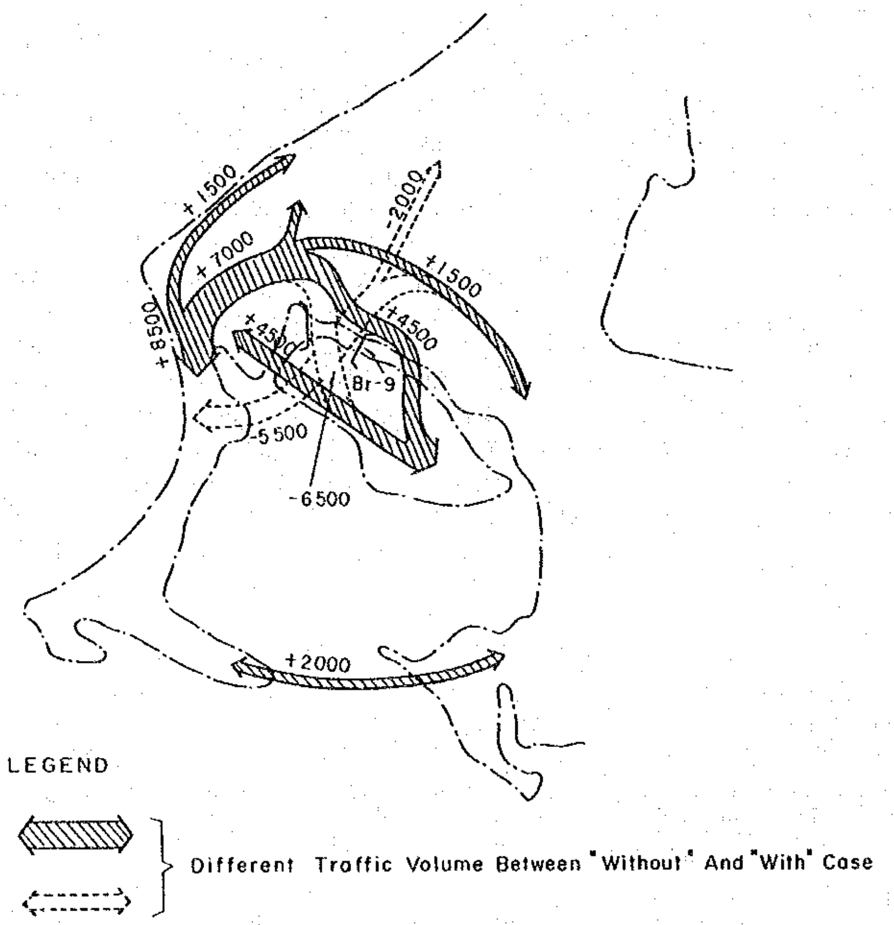


Figure 9.4-8 Change of Traffic Movement by Br-9 Project

9.5 Consideration for Project Implementation

624. In this section, priority ranks of road projects were determined for implementing these projects from the road master-plan. The schedule for those project implementation was formulated based on the project priority rank. The bar chart for implementation schedule is explained in Section 13.2 in Chapter 13.

9.5.1 Priority of Road Projects

625. There are many elements for determining the project priority. Of these, major elements chosen in many studies are following.

a. Economic viability
b. Traffic aspect
c. Network configuration
d. Urban development
e. Project consensus
f. Ease of implementation

Some of these elements such as items a. and b. of above list are possible to replace tangible and the others are difficult. It is necessary to take into consideration intangible elements for comprehensively evaluating the project priority.

626. The elements chosen in the Study were classified into 3 categories:

1) Economic viability: B/C ratio,
2) Traffic aspect: Traffic volume, trip length, etc., and
3) Social conditions: Progress of planning, project consensus, etc.

The elements 1) and 2) are composed of tangible measures such as B/C ratio, traffic volume and trip length and 3) is for intangible.

627. Priority ranks for planned projects were determined by totaling above three (3) elements of which each measure by element is divided into 3 ranks: high, medium and low priorities, corresponding to criteria of ranking.

628. The project priority was conducted by group which is composed of area: urban or sub-urban area, and road function: arterial/collector or minor collector. It is because the projects on arterial road in urban area will only be chosen as high priority project if the criteria of ranks is not shifted correspond-

ing to group. Therefore, in the Study four (4) groups were made as shown in Table 9.5-1. In this table, the bridge construction projects take one group because of the above reason.

Table 9.5-1 Grouping for Project Priority

Area	Road Function		Bridge Const.
	Traffic	Access	
Urban	Group-1	Group-2	Group-4
Sub-Urban	Group-3	-	Group-4

629. The projects which have good benefit scale, high traffic effectiveness and high social consensus by each group will finally be selected as a high priority project.

(1) Economic Viability

630. The benefit of a road project was counted for savings in vehicle operating cost (VOC) and in passengers' travel time cost (TTC). The benefit is measured through so-called "with" and "without" comparison. Those savings are calculated as the difference between the total VOC and TTC in the Masterplan network and those in case where a designated project will not be executed in Masterplan network. The benefit for one year in the year 2010 of each project is calculated. Ratio of B/C is chosen as a measure to evaluate the economic viability. The B/C ratio was calculated on assumption of 12% discount rate.

631. The priority ranking for economic aspect is shown in Table 9.5-2 in which the priorities for B/C ratio are determined by ranks shown in Table 9.5-3. As seen in Table 9.5-2, the B/C ratios are considerably fluctuated by each project and are higher on the arterial/collector roads than those on others. Therefore, the priority ranks were set depending on each group as shown in Table 9.5-3.

(2) Traffic Aspect

632. Traffic effectiveness by road construction or improvement has two aspects: one is direct effectiveness that the planned road itself is used by many vehicles. The other is for indirect that by that reason traffic volumes or congestion on other roads near the planned road are reduced or alleviated.

Table 9.5-2 Priority Rank for Economic Viability

Traffic and Cost Indices by Project

Projec	Distance (km)	Project Cost (Mill. Ps$)	Benefit (M. Ps$/Y)	B/C Ratio	B/C Ratio
1) Arterial/Collectors					
C-7	1.50	1,007	1,419	15.1	C
C-8	2.68	5,942	3,170	5.7	C
C-9	5.92	6,659	222	0.4	C
C-10	2.67	3,001	1,223	4.4	C
I-3	2.64	1,067	453	4.5	C
I-4	2.13	928	3,553	41.0	A
I-5	2.05	2,819	222	0.8	C
I-6	2.88	1,001	2,867	30.7	B
I-7	1.80	2,082	2,622	13.5	C
I-8	2.29	2,998	8,570	30.6	B
I-11	4.26	6,218	4,335	7.5	C
I-12	3.66	1,758	10,055	61.3	A
I-13	1.90	913	1,608	18.9	C
I-14	13.42	11,456	40,589	38.0	B
I-15	3.27	4,562	1,348	3.2	C
2) Minor Collectors					
C-11	2.19	2,258	998	4.7	A
C-14	0.53	678	8	0.1	C
C-15	0.58	691	10	0.2	C
C-16	0.89	1,254	82	0.7	C
C-18	1.55	1,039	7	0.1	C
C-19	2.25	5,053	134	0.3	C
C-20	3.50	5,550	1,078	2.1	B
I-16	4.21	4,370	1,900	4.7	A
I-17	3.85	6,005	547	1.0	C
I-18	0.65	915	5	0.1	C
I-19	1.25	1,090	257	2.5	B
I-20	2.32	2,109	265	1.3	C
I-21	2.13	2,676	980	3.9	A
I-22	0.62	535	0	0.0	C
I-23	2.16	1,080	476	4.7	A
I-24	1.69	928	163	1.9	B
I-25	3.38	3,355	908	2.9	B
3) Sub-Urban Roads					
C-1	22.32	27,621	144,809	56.2	A
C-2	23.78	19,596	23,321	12.8	C
C-3	21.34	16,354	42,169	27.6	B
C-4	25.10	9,237	3,592	4.2	C
C-12	2.39	814	166	2.2	C
C-13	3.60	1,184	334	3.0	C
I-2	18.26	19,160	33,755	18.9	B
4) Bridge Construction					
Br-1	0.42	2,254	559	2.7	B
Br-2	0.32	700	1,663	25.4	A
Br-3	2.70	56,844	6,986	1.3	C
Br-4	1.05	3,816	708	2.0	C
Br-8	0.60	10,602	1,419	1.4	C
Br-9	0.21	1,192	223	2.0	B
Br-10	0.32	1,319	0	0.0	C
Br-11	0.10	1,319	212	1.7	C
Br-12	0.10	1,319	21	0.2	C
Br-13	0.60	700	74	1.1	C

633. The traffic related measures as direct effectiveness are composed of traffic volume, trip length, volume-capacity ratio and number of OD-pairs. These measures are represented that the heaver, longer, and larger these measures are, the higher the priority ranks are. In group-2 (access function and urban area), trip length is excluded from measure item. The access function should be evaluated, regardless as to whether the trip length is long or not.

634. The priority ranking for direct effectiveness is shown in Table 9.5-4 in which the priorities by each measure are determined by ranks shown in Table 9.5-3. Totaled evaluation for direct effectiveness was made by summed up each measure's rank which is converted from A, B and C to 3, 2 and 1, respectively.

Table 9.5-3 Priority Ranks

Priority Rank Table

Items	Ranks	Group-1 Arterial	Group-2 Minor Col.	Group-3 Sub-Urban	Group-4 Bridge
1) Economic Viability					
(1) B/C Ratio	C	0 - 19	0.0 - 0.5	0 - 14	0 - 1
	B	20 - 39	1.5 - 2.0	15 - 29	2 - 3
	A	40 -	3.0 -	30 -	4 -
2) Traffic Aspect					
- Direct Effectiveness					
(1) Traffic Volume	C	0 - 29,999	0 - 9,999	0 - 19,999	0 - 19,999
	B	30,000 - 49,999	10,000 - 29,999	20,000 - 39,999	20,000 - 39,999
	A	50,000 -	30,000 -	40,000 -	40,000 -
(2) Trip Length (km)	C	0 - 9	-	0 - 29	0 - 9
	B	10 - 19	-	30 - 39	10 - 19
	A	20 -	-	40 -	20 -
(3) V/C Ratio	C	0.0 - 0.7	0.0 - 0.7	0.0 - 0.7	0.0 - 0.7
	B	0.8 - 0.9	0.8 - 0.9	0.8 - 0.9	0.8 - 0.9
	A	1.0 -	1.0 -	1.0 -	1.0 -
(4) OD-Pairs	C	0 - 99	0 - 39	0 - 79	0 - 99
	B	100 - 159	40 - 99	80 - 139	100 - 159
	A	160 -	100 -	140 -	160 -
- Indirect Effectiveness					
(1) V/C Ratio	C	0.000 - 0.009	0.000 - 0.004	0.000 - 0.009	0.000 - 0.001
	B	0.010 - 0.024	0.005 - 0.009	0.010 - 0.029	0.002 - 0.004
	A	0.025 -	0.010 -	0.030 -	0.005 -
(2) Travel Speed (km/h)	C	0.000 - 0.029	0.000 - 0.009	0.000 - 0.049	0.000 - 0.009
	B	0.030 - 0.049	0.010 - 0.019	0.050 - 0.099	0.010 - 0.019
	A	0.050 -	0.020 -	0.100 -	0.020 -
(3) Length by V/C Ratio (<1.0)	C	0.000 - 0.029	0.000 - 0.009	0.000 - 0.099	0.000 - 0.009
	B	0.030 - 0.049	0.010 - 0.019	0.100 - 0.199	0.010 - 0.019
	A	0.050 -	0.020 -	0.200 -	0.020 -

Table 9.5-4 Priority Ranks for Direct Traffic Effectiveness

		Traffic Related Indices				Priority Ranks				
Projec	Distance (km)	Volume (pcu/day)	Trip leng. (km)	V/C Ratio	OD-Pair (Number)	Volume (pcu/day)	Trip leng. (km)	V/C Ratio	OD-Pair (Number)	Estimate For Traffic
1) Arterial/Collectors										
C-7	1.50	36,149	8.01	0.75	140	B	C	C	B	B
C-8	2.68	40,337	17.63	0.85	161	B	B	B	A	B
C-9	5.92	3,702	16.86	0.23	46	C	B	C	C	C
C-10	2.67	23,676	10.66	0.49	117	C	B	C	B	B
I-3	2.64	34,361	10.41	0.65	78	B	B	C	C	B
I-4	2.13	20,882	11.44	0.44	121	C	B	C	B	B
I-5	2.05	47,001	17.01	0.98	191	B	B	B	A	B
I-6	2.88	39,116	11.18	0.82	99	B	B	B	C	B
I-7	1.80	44,328	10.37	0.93	165	B	B	B	A	B
I-8	2.29	74,024	14.02	1.21	164	A	B	A	A	A
I-11	4.26	73,631	15.33	1.02	182	A	B	A	A	A
I-12	3.66	53,489	22.74	1.11	209	A	A	A	A	A
I-13	1.90	37,916	25.87	0.79	147	B	A	C	B	B
I-14	13.42	79,388	18.41	1.12	205	A	B	A	A	A
I-15	3.27	40,595	14.57	0.85	162	B	B	B	A	B
2) Minor Collectors										
C-11	2.19	53,288	16.37	1.11	74	A	-	A	B	A
C-14	0.53	401	7.88	0.03	12	C	-	C	C	C
C-15	0.58	1,392	12.27	0.11	15	C	-	C	C	C
C-16	0.89	4,034	19.66	0.32	44	C	-	C	B	C
C-18	1.55	487	8.41	0.04	12	C	-	C	C	C
C-19	2.25	31,390	12.15	0.66	89	A	-	C	B	B
C-20	3.50	8,658	18.31	0.24	14	C	-	C	C	C
I-16	4.21	27,584	14.08	0.60	152	B	-	C	A	B
I-17	3.85	8,398	7.17	0.56	76	C	-	C	B	C
I-18	0.65	36,955	13.65	0.96	141	A	-	B	A	A
I-19	1.25	12,788	9.32	1.00	112	B	-	B	A	B
I-20	2.32	7,992	8.48	0.62	78	C	-	C	B	C
I-21	2.13	5,962	7.34	0.46	68	C	-	C	B	C
I-22	0.62	11,175	17.48	0.29	27	B	-	C	C	C
I-23	2.16	11,111	27.60	0.87	45	B	-	B	B	B
I-24	1.69	5,372	17.16	0.42	139	C	-	C	A	B
I-25	3.38	6,041	9.78	0.47	81	C	-	C	B	C
3) Sub-Urban Roads										
C-1	22.32	65,167	34.44	1.19	205	A	B	A	A	A
C-2	23.78	16,679	47.65	1.04	131	C	A	A	B	B
C-3	21.34	35,323	37.76	0.74	90	B	B	C	B	B
C-4	25.10	2,129	42.43	0.13	163	C	A	C	A	B
C-12	2.39	7,257	32.18	0.45	15	C	B	C	C	C
C-13	3.60	13,382	27.54	0.84	62	C	C	B	C	C
I-2	18.26	48,146	37.11	1.00	188	A	B	B	A	A
4) Bridge Construction										
Br-1	0.42	25,064	8.99	1.19	100	B	C	A	C	B
Br-2	0.32	68,754	11.93	1.43	191	A	B	A	A	A
Br-3	2.70	30,833	13.51	0.64	179	B	B	C	A	B
Br-4	1.05	11,892	23.67	0.25	235	C	A	C	A	B
Br-8	0.60	36,149	8.01	0.75	140	B	C	C	B	B
Br-9	0.21	34,589	12.25	0.72	98	B	B	C	C	B
Br-10	0.32	2,432	26.35	0.19	10	C	A	C	C	B
Br-11	0.10	23,516	22.44	1.47	54	B	A	A	C	B
Br-12	0.10	44,547	18.54	0.93	177	A	B	B	A	A
Br-13	0.60	38,233	10.72	0.80	129	B	B	B	B	B

635. As for indirect effectiveness, the embodied measures are average volume-capacity, average travel speed and total road length on volume-capacity less than 1.0 in urban area or the Study area. The alleviate ratios of these measures by a project to the total alleviation when all masterplan projects are implemented are calculated and these values are used for ranking those measures.

636. The priority ranking for indirect effectiveness is shown in Table 9.5-5 in which the priorities by each measure are determined by ranks shown in Table 9.5-3. Totaled evaluation for indirect effectiveness was made by the same manner as that for the direct effectiveness.

637. The evaluation included both direct and indirect effectiveness as traffic aspect was made by totaling both the effectiveness. The evaluation of traffic aspect is shown in the column of "Traffic Factor" in Table 9.5-6.

Table 9.5-5 Priority Ranks for Indirect Traffic Effectiveness

Participation Ratio to Traffic by Projects

Proj	Participation Ratio			Priority Ranks			
	V/C Ratio	Speed (km/h)	V/C Ratio <1.0	V/C Ratio	Speed	V/C Ratio <1.0	Estimate
1) Arterial/Collectors							
C-7	0.009	0.028	0.023	C	C	C	C
C-8	0.021	0.043	0.063	B	B	A	B
C-9	0.012	0.016	0.031	B	C	B	B
C-10	0.013	0.055	0.029	B	A	C	B
I-3	0.005	0.028	0.012	C	C	C	C
I-4	0.008	0.038	0.037	C	B	B	B
I-5	0.010	0.023	0.027	C	C	C	C
I-6	0.005	0.035	0.002	C	B	C	C
I-7	0.007	0.023	0.022	C	C	C	C
I-8	0.020	0.027	0.022	B	C	C	C
I-11	0.009	0.028	0.015	C	C	C	C
I-12	0.030	0.048	0.053	A	B	A	A
I-13	0.010	0.025	0.016	C	C	C	C
I-14	0.083	0.101	0.276	A	A	A	A
I-15	0.021	0.034	0.037	B	B	B	B
2) Minor Collectors							
C-11	0.020	0.031	0.030	A	A	A	A
C-14	0.001	0.001	0.004	C	C	C	C
C-15	0.001	0.000	0.002	C	C	C	C
C-16	0.000	0.001	0.006	C	C	C	C
C-18	0.004	0.002	0.007	C	C	C	C
C-19	0.003	0.014	0.001	C	B	C	C
C-20	0.010	0.018	0.024	A	B	A	A
I-16	0.009	0.026	0.014	B	A	B	B
I-17	0.004	0.003	0.012	C	C	B	C
I-18	0.003	0.008	0.005	C	C	C	C
I-19	0.000	0.001	0.001	C	C	C	C
I-20	0.001	0.004	0.002	C	C	C	C
I-21	0.001	0.012	0.002	C	B	C	C
I-22	0.002	0.002	0.000	C	C	C	C
I-23	0.000	0.005	0.004	C	C	C	C
I-24	0.001	0.006	0.005	C	C	C	C
I-25	0.001	0.012	0.000	C	B	C	C
3) Sub-Urban Roads							
C-1	0.037	0.083	0.284	A	B	A	A
C-2	0.003	0.009	0.165	C	C	B	C
C-3	0.062	0.128	0.225	A	A	A	A
C-4	0.000	0.000	0.014	C	C	C	C
C-12	0.001	0.001	0.017	C	C	C	C
C-13	0.000	0.000	0.029	C	C	C	C
I-2	0.006	0.021	0.074	C	C	C	C
4) Bridge Construction							
Br-1	0.002	0.003	0.009	B	C	C	C
Br-2	0.004	0.003	0.000	B	C	C	C
Br-3	0.010	0.058	0.055	A	A	A	A
Br-4	0.000	0.000	0.005	C	C	C	C
Br-8	0.006	0.023	0.019	A	A	B	A
Br-9	0.002	0.002	0.001	C	C	C	C
Br-10	0.000	0.000	0.000	C	C	C	C
Br-11	0.001	0.003	0.004	C	C	C	C
Br-12	0.006	0.010	0.015	A	C	B	B
Br-13	0.001	0.002	0.000	C	C	C	C

(3) Social Conditions

638. Progress of planning, difficulty of consensus and network interaction are embodied as evaluation measures for social condition. In Cartagena, there are many existing road plans which have been already studied or are now under study or in the design stage by concerned agencies. The road masterplan in the Study was made by incorporating existing road plans. These existing road plans should be taken high priority rank than others. Therefore, a project with existing plan by related agencies is given rank "A".

639. In commercial area and historical spots, difficulties of land acquisition and house compensation along road area will be accompanied. This difficulty of consensus is evaluated according to information from the related agencies. Therefore, a project along the location where land acquisition and house compensation are difficult, is given rank "C".

640. In case that priority ranks on adjacent projects are different, it is necessary to adjust the project rank. This network interaction is evaluated after total evaluation of projects is completed. The ranks are adjusted corresponding to the priority ranks on adjacent projects.

641. The evaluation of the social conditions is shown in the column of "Social Factor" in Table 9.5-6.

9.5.2 Evaluation of Projects

642. Total priority ranks for planned projects were finally determined by totaling three elements: Economic Viability, Traffic Aspect and Social Conditions, explained in the preceding section. The procedure for totaling three elements was conducted by two (2) steps: at first step the evaluation for both Economic Viability and Traffic Aspect was made by summed up each element rank which is converted from A, B and C to 3, 2 and 1, respectively. In the second step, the priority ranks were finally determined taking into consideration Social Conditions.

643. Table 9.5-6 shows the final priority rank of projects. The projects with Rank A on the arterial/collector roads (Group-1) are included C-9: Cienaga de la Virgen Road, C-10: Av.Miramar Road, I-6: Av. Jacobo del Valle, I-12: Amplicacion Troncal Sta.Lucia-Temera and I-14: Diagonal 30. Of these, the rank "A" projects evaluated from the Economic and Traffic elements are I-4, I-12 and I-14. The I-4 project is finally determined in rank "B" because of the ranks of adjacent projects: Rank "B" for Br-3

and "C" for Br-8. The C-7 project is evaluated in rank "C" because the planned road passes through the Navy base on which it will be difficult to remove by the year 2000, though being evaluated in rank "B" in the first step.

644. As for the minor collectors (Group-2), C-14: Boston Road, C-15: Carrera 51, C-19: 5th Av.Manga and C-20: Chambacu Road are determined in rank "A" because the "Progress of Planning" measure participates in high rank due to the fact that these projects are now under study.

645. The C-1: Anillo Vial Road project priority in sub-urban road (Group-3) has high rank "A" in every element. This project is now under construction with 2 lanes. In this Study, however, 4 lane road but some section on 6 lanes is planned corresponding with assigned traffic volume.

646. As for priority rank for bridge construction projects (Group-4), Br-1: San Lorenzo Bridge and Br-2: Bazurto Bridge are in rank "A". Although Br-1 itself is in rank "B", this project is shifted to rank "A" corresponding with ranks of adjacent projects. Br-3: Manzanillo Bridge which is the most biggest project in the Study is evaluated in rank "B", of which the element for Traffic Aspect is in rank "A", and Economic Viability is in rank "C" due to the fact that project cost is big.

Table 9.5-6 Priority Rank of Projects

Priority Rank of Projects

Projec	Distance (km)	Project Cost (Mill. Ps$)	1) Econimic Factor	2) Traffic Factor: Traffic on Project	2) Traffic Factor: Traffic on Area	2) Traffic Factor: Estimate	3) Priority Rank 1)+2)	4) Social Factor: Progress of Planning	4) Social Factor: Difficulty of Consensus	4) Social Factor: Network Interaction	5) Final Rank	Project
1) Arterial/Collectors												1) Arterial/Collectors
C-7	1.50	1,007	C	B	C	B	B		C		C	C-7
C-8	2.68	5,942	C	B	B	B	B				B	C-8
C-9	5.92	6,659	C	C	B	B	B	A			A	C-9
C-10	2.67	3,001	C	B	B	B	B	A			A	C-10
I-3	2.64	1,067	C	B	C	B	B				B	I-3
I-4	2.13	928	A	B	B	B	A			B	B	I-4
I-5	2.05	2,819	C	B	C	B	B				B	I-5
I-6	2.88	1,001	B	B	C	B	B	A			A	I-6
I-7	1.80	2,082	C	B	C	B	B				B	I-7
I-8	2.29	2,998	B	A	C	B	B				B	I-8
I-11	4.26	6,218	C	A	C	B	B				B	I-11
I-12	3.66	1,758	A	A	A	A	A				A	I-12
I-13	1.90	913	C	B	C	B	B				B	I-13
I-14	13.42	11,456	B	A	A	A	A				A	I-14
I-15	3.27	4,562	C	B	B	B	B				B	I-15
2) Minor Collectors												2) Minor Collectors
C-11	2.19	2,258	A	A	A	A	A				A	C-11
C-14	0.53	678	C	C	C	C	C	A			A	C-14
C-15	0.58	691	C	C	C	C	C	A			A	C-15
C-16	0.89	1,254	C	C	C	C	C				C	C-16
C-18	1.55	1,039	C	C	C	C	C				C	C-18
C-19	2.25	5,053	C	B	C	B	B	A			A	C-19
C-20	3.50	5,550	B	C	A	B	B	A			A	C-20
I-16	4.21	4,370	A	B	B	B	A				A	I-16
I-17	3.85	6,005	C	C	C	C	C				C	I-17
I-18	0.65	915	C	A	C	B	B				B	I-18
I-19	1.25	1,090	B	B	C	B	B				B	I-19
I-20	2.32	2,109	C	C	C	C	C				C	I-20
I-21	2.13	2,676	A	C	C	C	B				B	I-21
I-22	0.62	535	C	C	C	C	C				C	I-22
I-23	2.16	1,080	A	B	C	B	A				A	I-23
I-24	1.69	928	B	B	C	B	B				B	I-24
I-25	3.38	3,355	B	C	C	C	B				B	I-25
3) Sub-Urban Roads												3) Sub-Urban Roads
C-1	22.32	27,621	A	A	A	A	A	A			A	C-1
C-2	23.78	19,596	C	B	C	B	B				B	C-2
C-3	21.34	16,354	B	B	A	A	A				A	C-3
C-4	25.10	9,237	C	B	C	B	B				B	C-4
C-12	2.39	814	C	C	C	C	C				C	C-12
C-13	3.60	1,184	C	C	C	C	C				C	C-13
I-2	18.26	19,160	B	A	C	B	B				B	I-2
4) Bridge Construction												4) Bridge Construction
Br-1	0.42	2,254	B	B	C	B	B			A	A	Br-1
Br-2	0.32	700	A	A	C	B	A				A	Br-2
Br-3	2.70	56,844	C	B	A	A	B				B	Br-3
Br-4	1.05	3,816	C	B	C	B	B				B	Br-4
Br-8	0.60	10,602	C	B	A	A	B		C		C	Br-8
Br-9	0.21	1,192	B	B	C	B	B				B	Br-9
Br-10	0.32	1,319	C	B	C	B	B				B	Br-10
Br-11	0.10	1,319	C	B	C	B	B				B	Br-11
Br-12	0.10	1,319	C	A	B	A	B				B	Br-12
Br-13	0.60	700	C	B	C	B	B				B	Br-13

CHAPTER 10 PUBLIC BUS TRANSPORTATION PLAN

10.1 General

10.1.1 Basic Policy for Improvement

(1) Medium/Long Term Plan

647. As explained in Chapter 7, future trip demand of public bus passenger is forecasted to be 1.79 million in 2010 from 1.03 million in 1991. This trip demand distributes in a current urban area in the same pattern as at present and also in the areas of the current urban fringes and the suburbs due to the expansion of urban activities of the Study Area (refer to Figure 7.4-7).

648. Due to the continuity of urban activities concentrated in existing Central Area, the trip demand distribution shows same tendency as before. The trip flow of east-west direction is still through the main traffic corridor.

649. For this future public passenger trip demand, current transport system shows following problems if the same operation continues (refer to Table 10.1-1);

a. Vehicle operation kilometer will increase about 2.0 times according to the increase in the number of passengers to 2.0 times in current urban area.
b. Number of peak hour bus operation on the road section between Mercado Bazurto and India Catalina of Av. Pedro de Heredia becomes about 900 in one direction. Number of bus operation at bus stop is maximum about 500 per hour, if 3 bus berths and 20 seconds stop time are assumed. This will become the cause of operational delay.
c. Additionally 1.4 thousand bus vehicles shall be procured for the future public bus operation. Including the number of replacement of old vehicles, more than 100 vehicles shall be purchased every year. It will bring on a cost increase for public bus operation.
d. For the peak hour, more than 60 buses shall be dispatched from local terminal. Due to the long route length the operation control seems to become very difficult because of increased uncertainty of round trip time case.
e. Number of transfer passengers will increase due to the limited bus routes assumption. If additional bus routes are operated financial condition will become worse because of vehicle operation kilometer increase.

650. Current operation system thus is forecasted to become difficult in operational condition as well as in financial condi-

tion in future, which in turn will bring to the passengers a lower service level than ever.

Table 10.1-1 Operational Data of Public Bus Transport by Current Public Bus Operation System

	1991	2010
Public Bus Passenger Demand	1,016,248	1,774,263
Passenger Number Transported	1,190,810	2,354,550
Transfer Passenger Number	174,562	580,287
Bus Operation Kilometer/Day	297,575	610,311
Number of Bus Operation/Day	12,658	24,367
Number of Bus Vehicle	1,339	2,684
Bus operation No. at Mercado Bazurto at Peak Hour	440-470	880-940

note: only in urban area operation
source: Study Team

651. The problems of the current bus operation system are;

a. Every bus operation has feeder/collector and trunk operation functions,
b. Route length tend to become longer, and
c. Vehicle capacity is little due to the road condition.

652. In order to improve these problems, the following measures are considered (details refer to Appendix 10.1-1);

a. division of the operational functions: trunk service and feeder service,
b. setting the short route length, and
c. selection of capacity suitable for operation area.

653. Excluding small transport capacity means because some 40 thousand passengers demand per hour per one direction is forecasted, the majority of the urban mass transportation system in the world are;

a. bus, including trunk-feeder system,
b. subway, and
c. heavy railway.

654. As before mentioned, the amount of investment is too large to justify the financial evaluation for the establishment of subway or railway network system in medium size city of 1 million population like Cartagena. To construct the trunk line on major traffic corridor by railway or subway system is not competitive with trunk-feeder bus system on cost aspect.

(2) Short Term Plan

655. Improvement concentrates in bus facilities plan and operation management plan, as explained in Chapter 8.

656. Regarding to the bus facilities plan, the construction of bus stops and bus terminals is the first step for the improvement of current bus operation problems. Renewal of bus vehicles of old age is also required through the DATT's guidance.

657. In regard to the bus operation management plan, tariff decision system and time control system shall be discussed.

10.1.2 Trunk-Feeder Bus System

658. For the examination of the introduction of trunk-feeder bus system, the operational conditions of current bus operation system and proposed trunk-feeder bus operation system are simulated by using computer model with the 1991 public passenger OD.

(1) Concept of Bus System

659. The present major problems of public bus transportation are;

a. Many bus routes concentrate on specified road section,
b. Almost all the bus routes have one end in Centro area, and
c. All the routes are competing with each other due to same radial pattern of routes.

660. The new bus network plan aims to improve this wasteful competition of these bus routes on the same road section. The major point of improvement is a division of route function. The routes are classified into a trunk route and a feeder route where at present, each bus route has both of those functions.

661. The trunk bus routes are assigned on the trunk bus passenger corridors connecting with the major bus terminals. Between these major terminals the large capacity buses are operated frequently. In future the capacity of bus is to be about 80 passengers. The major terminals are expected to be facilitated at, for example, Centro (India Catalina), Mercado Bazurto, Intermunicipal bus terminal and Mamonal.

662. The feeder bus routes are assigned on the secondary roads (collector roads) which serve in residential area. These feeder buses collect passengers in the residential area and transfer the passengers to the trunk buses.

663. The major points of this improvement are as follows;

a. For operational side:
- The cost of operation will decrease.
- The occupancy rate will increase.

b. For bus passenger side:
- The fare level is expected to be lower.
- The travel time will be decreased.
- The service level will be improved.

(2) Simulation Method

664. In order to examine the effect of improvement, the following two networks are compared by the assignment of the present OD table.

Network A: Present bus network
Network B: Improved network on present road network

665. Network A is the structure of the current bus network. Network B is the structure of trunk-feeder network. The methodology of assignment is used, and following assumptions are applied.

Tariff: Uniform system inside the urban area is proposed. Net A is the same tariff system at present. Net B allows to transfer to the other bus by paying a fare once on the first ride. Outside of urban area, other type of fare system should be applied. However, the assumption is the same as a uniform tariff system.

Terminal: Net B has two kinds of terminals such as the major terminals and the major local terminals. The major terminals are Centro (India Catalina), Mercado Bazurto, Terminal of inter-municipal bus and Mamonal. The major local terminals are Centro (Parque Centenario), Bocagrande, Airport, Daniel Lemaitre, Nuevo Bosque and Cruse el Amparo. These terminals are permitted to transfer to another bus route free of charge.

Bus-stop: At the bus stops on the trunk routes it is possible to transfer to/from other trunk/feeder bus routes, however this transfer requires a tariff charge once again.

The trips between the outside area and the urban area are charged upon the transfer to other bus route.

666. Trip assignment has been done by the OD table by pas-

senger unit. It is necessary to calculate by bus vehicle unit. The number of bus vehicle has been calculated to divide the maximum numbers of the assigned passengers on each route by the average occupancy of passengers for one bus vehicle.

667. For the purpose of estimating peak hour operation, the following assumptions are made;

Average occupancy rate:
BUS ; 58.5 passengers for trunk routes
BUS ; 45.0 passengers for major feeder routes
BUSETA; 32.5 passengers for ordinary feeder routes
Peak hour rate: 8 %

The number of bus fleets necessary for daily operation is calculated based on the operation frequency per day and trip time required. Average operating velocity is assumed as follows;

Trunk route ; 25 km/h
Feeder route; 20 km/h

(3) Network

668. Both networks are shown in Figures 10.1-1 and 10.1-2.

(4) Result of Examination

669. The present total number of trip demand is 1,016 thousand. The total number of bus passengers for Net-A is 1,292 thousand and Net-B is 1,666 thousand. This difference is induced by transferring to another bus. Trunk/feeder bus system requires transfer from feeder to trunk bus.

670. In trunk/feeder bus route system, the passenger*km is slightly increased (3%), including outside area. However, bus vehicles*km and passengers*hour decrease 25% and 8% respectively. Therefore, the efficiency of bus operation, calculated by passengers*km / bus vehicles*km, is improved from 18.5 to 25.4 passengers/vehicle (refer to Table 10.1-2). The reduction of vehicles*km is very effective in operation cost savings which would be shared by public bus operators and bus passengers.

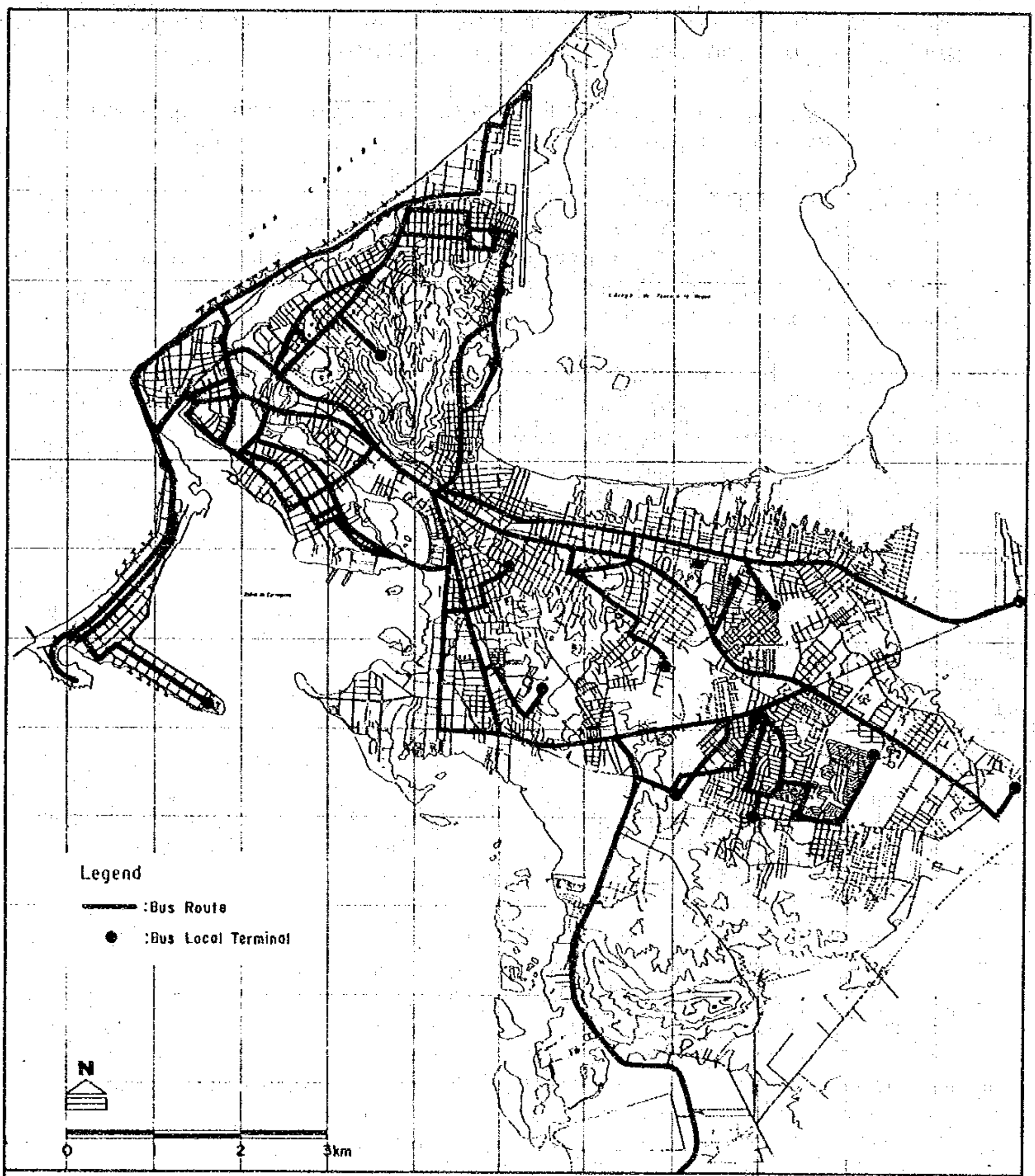


Figure 10.1-1 Present Public Bus Network

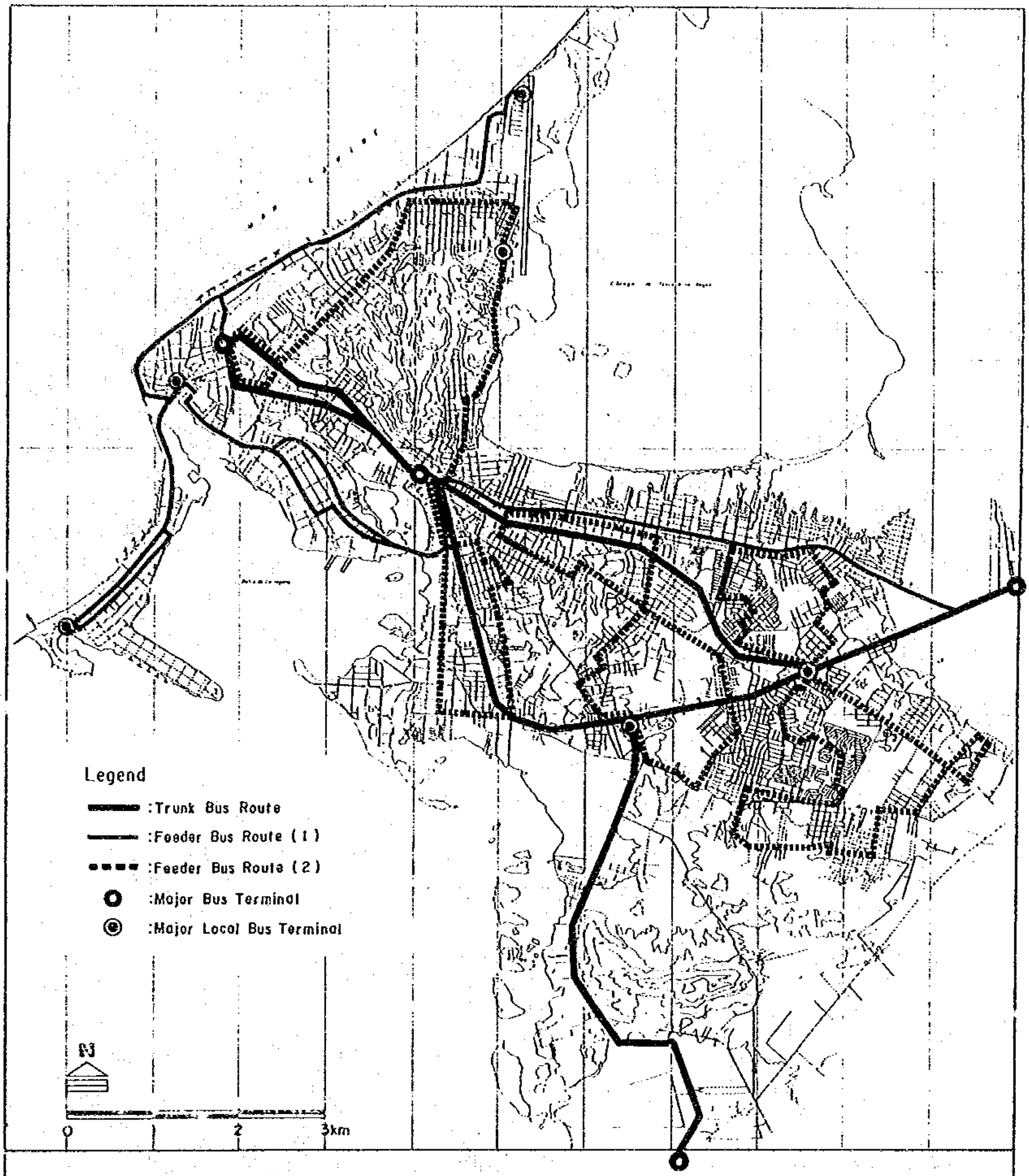


Figure 10.1-2 Public Bus Network Plan (Trunk-Feeder System)

Table 10.1-2 Comparison of Operation Data (Study Area)

	Network A	Network B	B/A
1) Total Passenger*km	7,198,541	7,382,167	1.03
2) Total Passenger*hour	791,365	729,528	0.92
3) Total Vehicles*km	389,953	290,524	0.75
4) Total Transfer Number	276,128	650,113	2.35
5) Efficiency: 1)/3)	18.5	25.4	1.37
6) Passenger No. to Pay	1,292,376	1,110,467	0.86
7) Number of Operation	12,704	17,010	1.34

Source: Study Team

671. Table 10.1-3 shows the comparison of bus operation in urban area excluding the passengers and buses from outside area.

672. The number of bus operation frequency in the peak hour is 1,534 trips at Network B which represent an increase of 1.53 times than Network A. However, the necessary number of total bus vehicles to be operated per day is 1,196 buses at Network B which is a decrease by 11% from the current network. The proportion of Bus and Buseta is almost same percentage in both cases. Another more important result is the number of bus*km reduction by 21 % from present system. This is directly related to a reduction of operation cost. Following points are indicated as the favorable aspects by trunk-feeder bus system;

a. Bus vehicles * km reduction .... 21 %
b. Total bus vehicles reduction .... 11 %
c. Passengers * time reduction .... 8 %
d. Bus operation frequency increase ... 54 %

Table 10.1-3 Comparison of Urban Bus Operation Data

	Network A	Network B	B/A
Total Passenger OD	1,016,248	1,016,248	1.00
No. of Passenger	1,190,810	1,567,535	1.32
Total Passenger*km	5,979,623	5,731,349	0.96
Number of Transfer	174,375	551,287	3.16
Peak Hour Operation	994	1,534	1.54
Operation per Day	12,658	19,181	1.52
Average Passenger per Bus	94.1	81.7	0.87
Bus Vehicle*km	297,575	234,586	0.79
No. of Vehicles	1,339	1,196	0.89
No. of BUS	887	750	0.85
No. of BUSETA	452	449	0.99
BUS Vehicle*km	184,235	166,885	0.91
BUSETA Vehicle*km	113,340	67,701	0.60
Average Occupancy	19.6	24.4	1.24

673. Figure 10.1-3 and 10.1-4 show the bus operation density by road network at case of bus operation Network A and B, respectively. The number of operation on trunk bus route of Av. Pedro de Heredia in case of B decreases remarkably. It comes from the improvement of occupancy rate by eliminating the duplication of bus operation in case of A.

10.2 Alternative Plan

10.2.1 Bus Operation Alternatives in 2010

(1) Alternatives in Future Bus Operation

674. Bus operation alternatives in future is as follows;

a. Operation by current operation system with current network,
b. Trunk-feeder operation system with network shown in Figure 10.2-1/10.2-3,
c. Trunk-feeder operation system with network shown in Figure 10.2-2/10.2-3, and
d. Operation by current operation system with future road network shown in Figure 10.2-4/10.2-5.

Alternative C intend to make the shorter feeder route network. Alternatives B and C expect the completion of road network proposed in the road masterplan in 2010. Therefore, at intermediate time period, bus operation on some feeder routes shall be changed by available route operation.

675. For the outside of the urban area same network structure is assumed in alternatives B and C as shown in Figure 10.2-3.

(2) Comparison of Alternatives

676. Simulation results on urban area bus operation are shown in Tables 10.2-1, 10.2-2 and Figure 10.2-6.

677. Alternatives A and D show same result except on number of bus operation and number of vehicle. Number of bus operation of Alternative D is less than Alternative A because of the improvement of operation network. Alternative C shows better result on service level than Alternative D except the number of transfer.

678. Comparing Alternatives B with C, Alternative C shows better results, which is due to the feeder network characteristics.

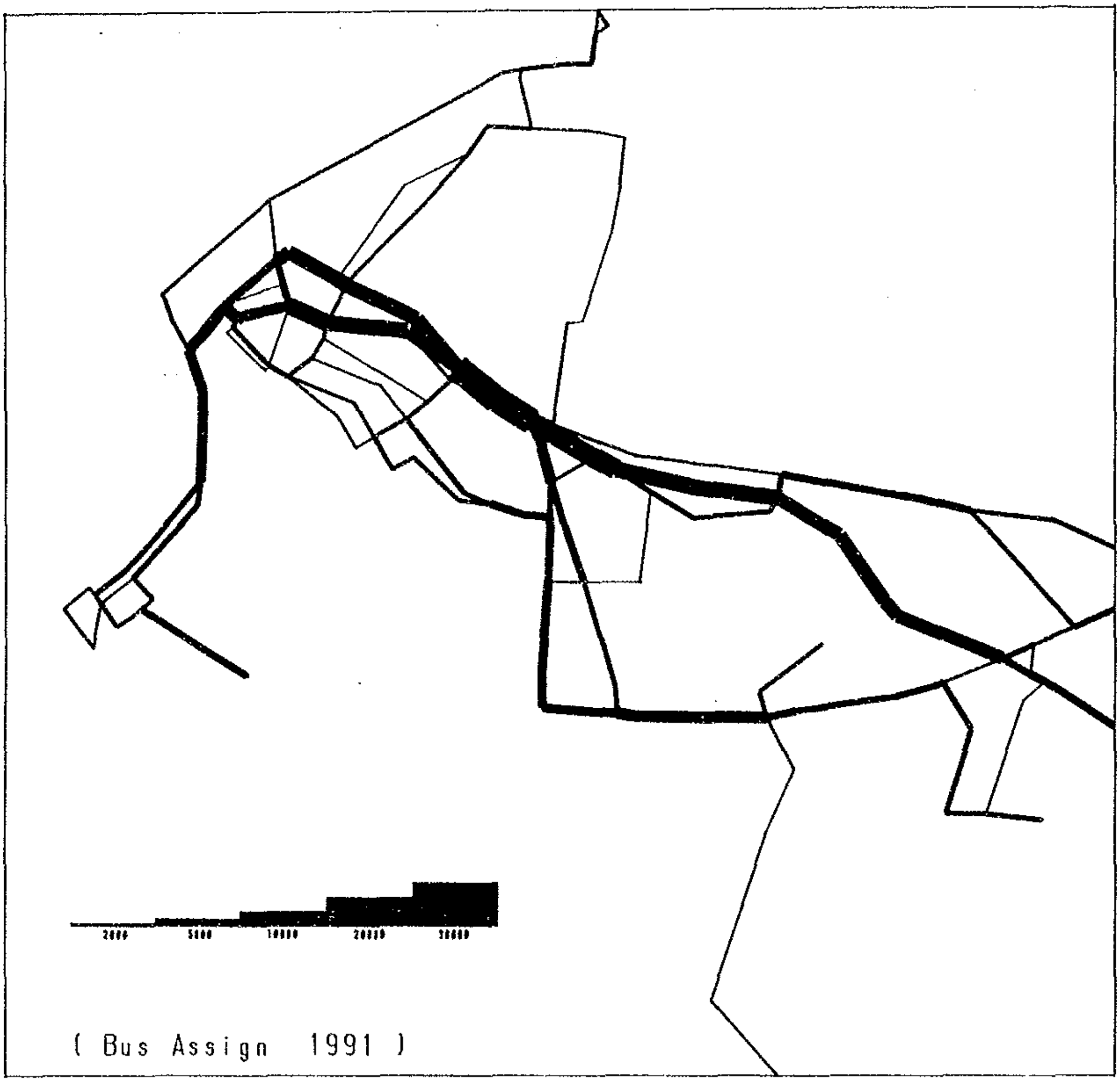


Figure 10.1-3 Public Bus Vehicle Assignment (Existing System)

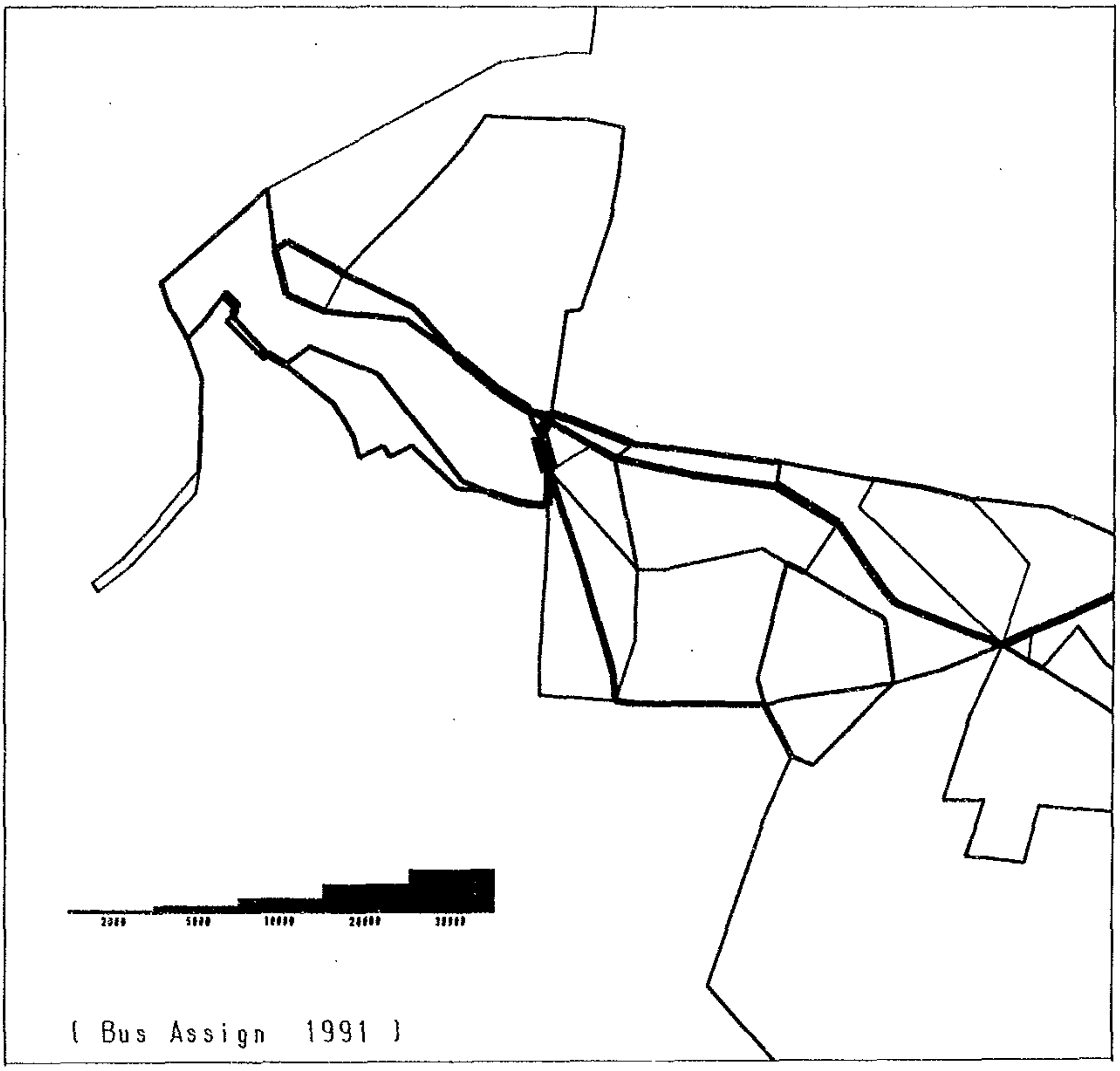


Figure 10.1-4 Public Bus Vehicle Assignment (Trunk-Feeder System)

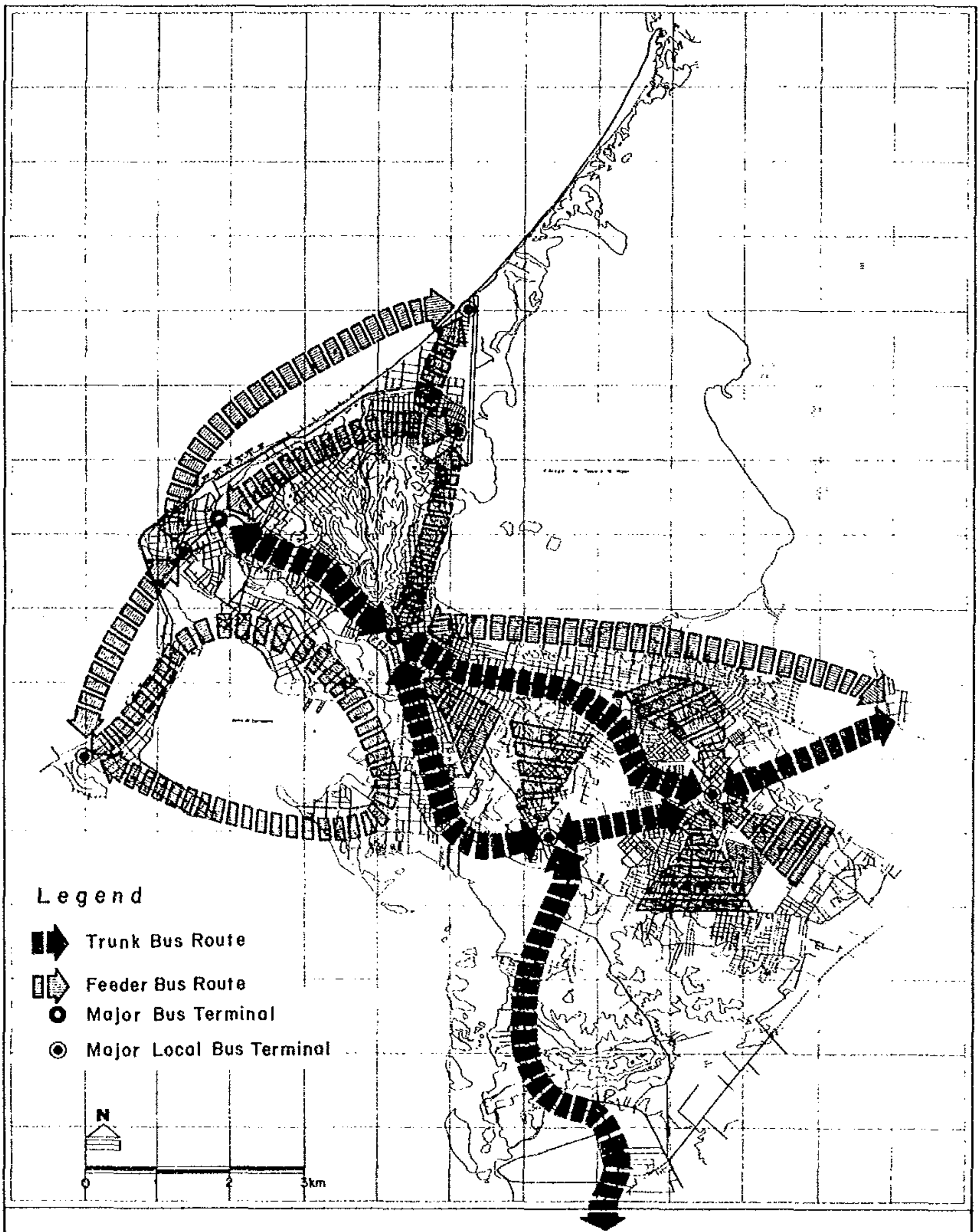


Figure 10.2-1 Bus Network Alternative B

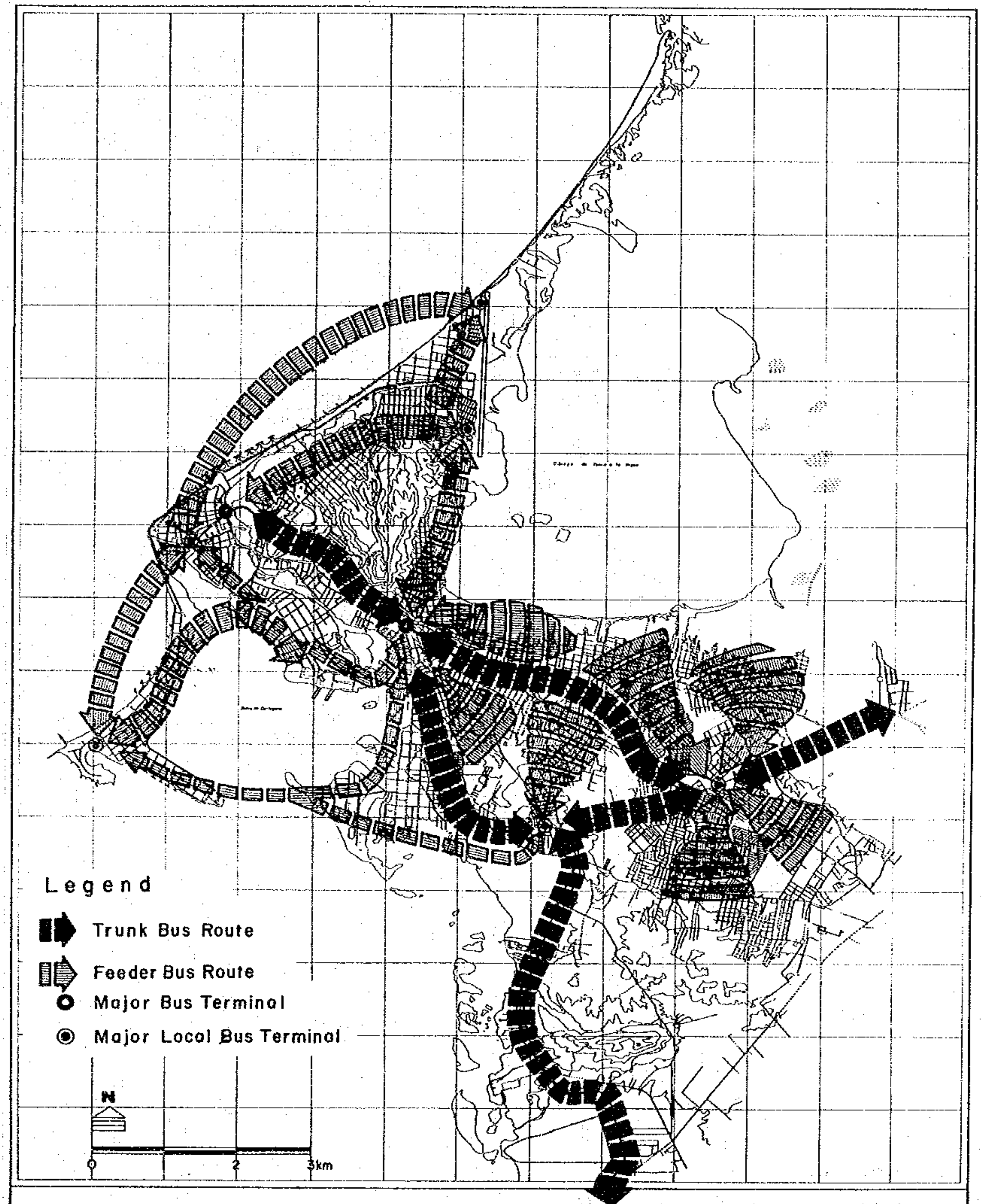


Figure 10.2-2 Bus Network Alternative C

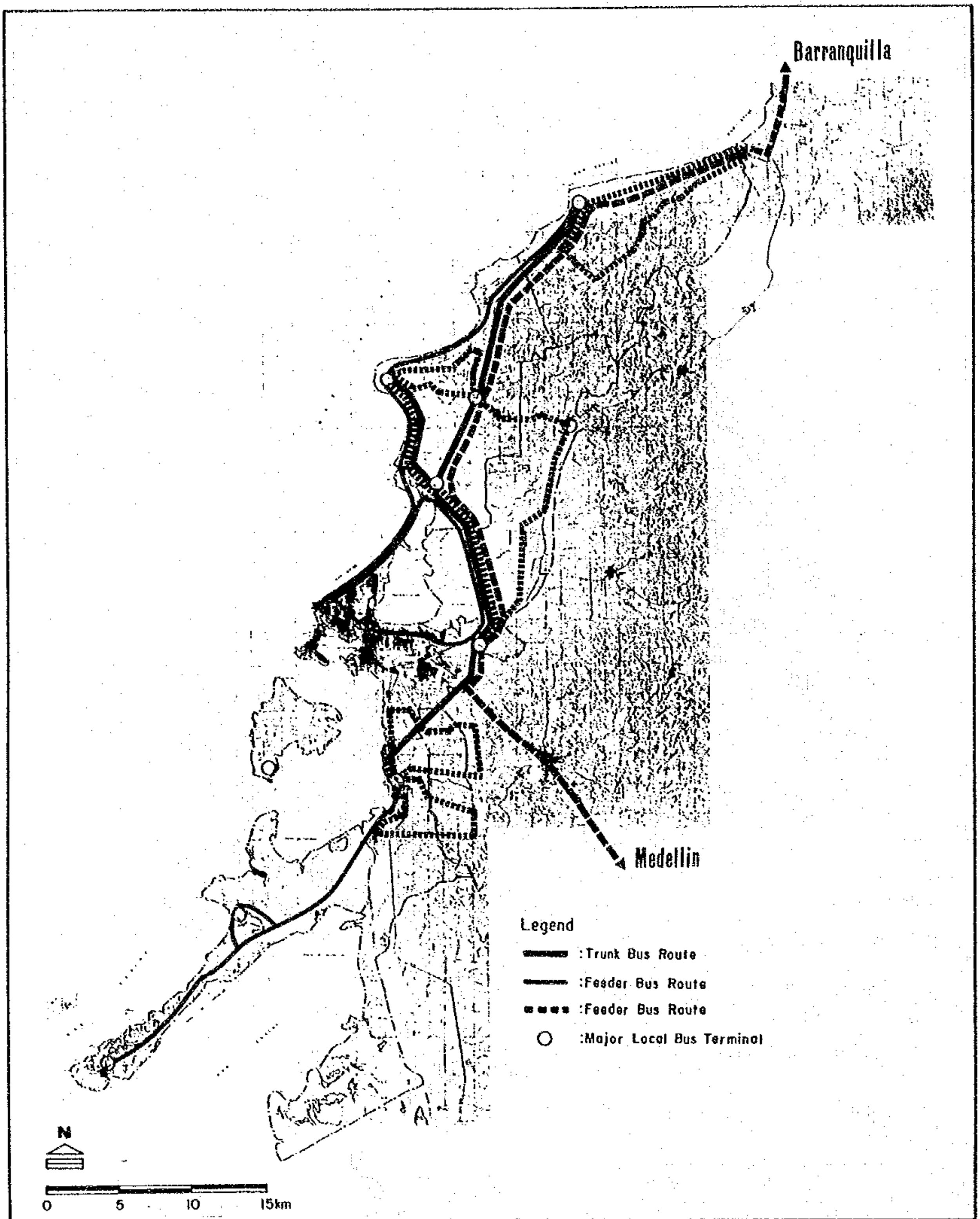


Figure 10.2-3 Bus Network outside the Urban Area

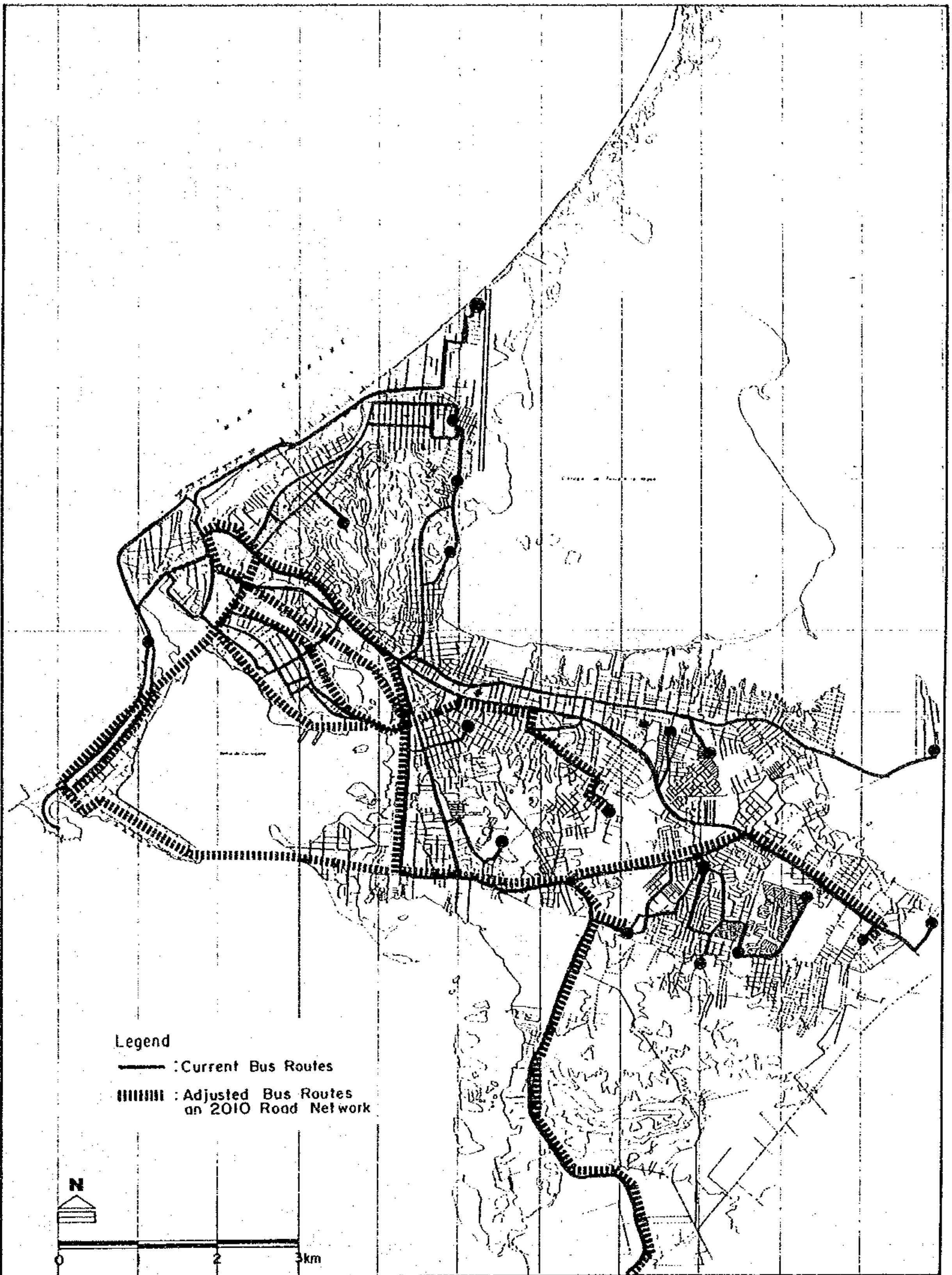


Figure 10.2-4 Bus Network Alternative D (Inside of Urban Area)

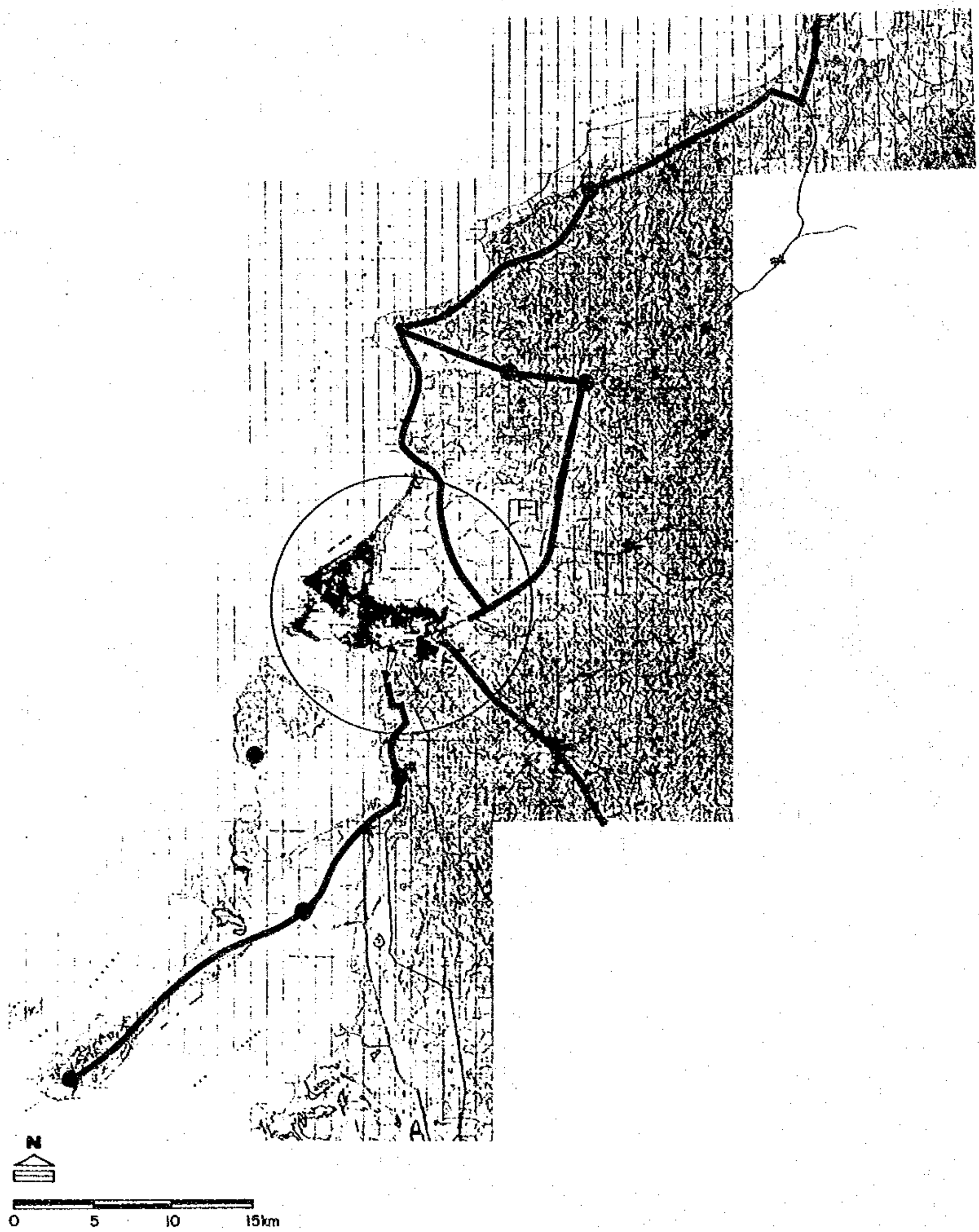


Figure 10.2-5 Bus Network Alternative D (Outside of Urban Area)

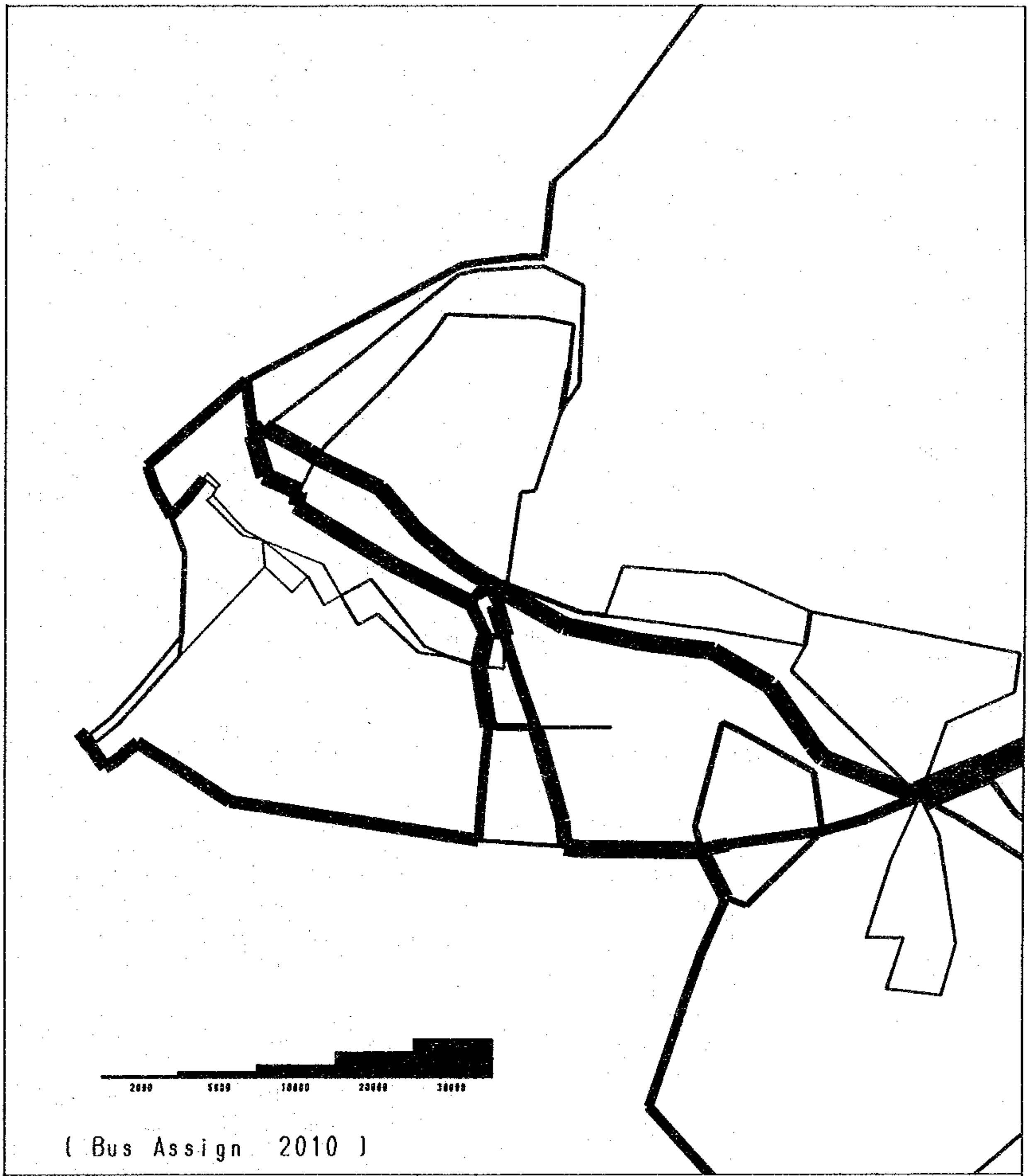


Figure 10.2-6 Public Bus Vehicle Assignment (Alternative C)

Table 10.2-1 Comparison of Alternatives (Urban Area)

	Alt.-A	Alt.-B	Alt.-C	Alt.-D
Passenger OD Trip	1,774,263	1,774,263	1,774,263	1,774,263
Total Route Length (km)	721.0	336.0	297.0	794.0
Total Passenger Trip	2,124,800	3,245,968	3,036,578	2,112,569
Payable Passenger No.	2,124,800	1,774,263	1,774,263	2,112,569
Transfer Passenger No.	350,537	1,471.705	1,262,315	338,306
Total Passenger*km	13,308,606	14,515,774	14,841,824	13,193,805
Bus (person*km)	10,862,676	12,980,366	12,310,818	11,191,817
Buseta	2,485,930	1,535,408	2,531,015	2,001,988
Peak Hour Operation Frequency	1,815	2,856	2,765	1,546
Daily Operation Freq.	22,688	35,695	34,557	19,326
Bus vehicle*km	566,458	474,020	447,609	569,004
Bus (vehicle*km)	383,198	358,258	322,177	420,715
Buseta	183,260	115,762	125,432	148,289
No. of Bus	2,503	2,315	2,196	2,265
Bus	1,535	1,522	1,397	1,645
Buseta	968	793	799	620
Average Passenger per Bus	94	91	88	109
Bus	108	142	139	123
Buseta	63	44	46	62
Average Occupancy	23.5	30.6	33.2	23.2

source: Study Team

Table 10.2-2 Future Bus Operation Analysis (Urban Area)

ALT-C

Route No.	Route Length	No. Psn. Transp.	Psn.*km	Max. Psn. Section	Peak hour bus trip	Bus opr. trip/hr	Bus opr. trip/day	Average Psn. No.	Bus*km per day	Bus No.	Psn.*km/Bus*km
1	26.0	467618	3115753	220906	222	222	2774	168.6	72119	286	43.2
2	29.1	268329	1660087	174294	175	175	2191	122.5	63763	248	26.0
3	37.9	333402	2935344	143739	145	145	1809	184.3	68570	256	42.8
4	36.3	233409	1691185	99278	100	100	1253	186.2	45526	171	37.1
21	12.1	90893	303966	44122	61	61	767	118.5	9285	45	32.7
22	10.8	77854	188386	55787	77	77	966	80.6	10453	56	18.0
23	6.2	77712	138182	38865	54	54	577	114.3	4197	29	32.9
24	5.0	95342	227449	48383	120	120	1501	63.5	7506	58	30.3
25	8.3	186149	589495	91036	125	125	1569	118.7	13036	79	45.2
26	8.7	67997	167282	39672	99	99	1233	55.1	10667	64	15.7
27	5.5	129548	206498	97672	241	241	3018	42.9	16477	120	12.5
28	5.8	55712	103938	32156	80	80	1002	55.6	5831	42	17.8
29	6.3	96259	154191	92806	229	229	2868	33.6	18155	123	8.5
31	14.0	135968	838335	62609	64	64	795	171.0	11100	52	57.5
32	14.9	8257	34743	4708	7	7	93	88.8	1382	7	25.1
33	8.6	70369	138583	38040	53	53	663	106.2	5700	35	24.3
34	4.3	30099	65368	15584	39	39	492	61.2	2135	18	30.6
35	5.7	38335	983006	17340	44	44	546	70.2	3085	23	318.6
71	14.5	156480	724351	72389	100	100	1250	125.2	18149	83	39.9
72	10.4	63847	152398	49511	69	69	859	74.3	8898	50	17.1
76	8.7	65141	158838	37516	93	93	1167	55.8	10093	60	15.7
77	5.5	139995	217141	101081	250	250	3123	44.8	17050	124	12.7
78	5.8	50561	92012	32570	81	81	1015	49.8	5905	42	15.6
79	6.3	97302	155292	94715	234	234	2927	33.2	18527	125	8.4
Total	297	3036578	14841824	1704779	2765	2765	34557	87.9	447609	2196	33.2
Bus	229	2170287	12310810	1095284	1253	1253	15666	138.5	332177	1397	37.1
Buseta	68	866291	2531015	609495	1511	1511	18891	45.9	115432	799	21.9

10.2.2 Public Bus Operation

(1) Trunk-Feeder Bus Operation System

679. The trunk route should be operated by a large capacity bus, such as about 80 passengers or more. This capacity will be introduced by standing passenger type bus or the articulated bus. These large type buses will serve at high frequency on this trunk bus routes.

680. Trunk bus routes are formed by connecting the major bus terminals. The operational variation will be necessary. That is, one is express type directly connecting between the terminals, and another one is local type stopping at each bus stop on trunk route.

681. Feeder bus is to collect the passengers in the residential area and transfer those passengers to trunk routes at the major terminals. Thus feeder bus is operated by smaller buses such as BUSETA in its short bus route. Due to this short length of feeder bus route, the frequency can be kept high and bus vehicle*km does not increase appreciably.

(2) Bus Stop

682. The bus operation in future should fundamentally be based on the bus stop system. At present, passengers can ride on/off the bus anywhere along the road. This seems to be a convenient system for passengers, but it gives reverse effect for the smooth traffic flow and traffic safety. Therefore, from an overall point of view, passengers do not receive much benefit from this free ride system.

683. The orderly and systematic operation would be kept by stopping at the fixed bus stop. In future, much more buses shall be operated. If a bus will stop at any place along the road section, the major road will not function anymore. Especially, a bus tends to stop at the corner of crossing, then this will cut the traffic flow and induce a traffic congestion.

(3) Bus Priority Lane and Bus Exclusive Lane

684. Bus exclusive lane is so much effective for the bus operation with high frequency. It can be introduced in case the road has enough capacity for the traffic volume. From view point of the trunk bus route operation, it is better to have a bus exclusive lane system. This possibility depends upon the improvement of arterial road network in future. The proposed road sections of the bus exclusive lane are as follows;

a. Av. Pedro Heredia; India Catalina- Bomba del Amparo
b. Via de la Cordialidad Transversal 54; Bomba del Amparo - Inter departmental bus terminal
c. New road along the Caño de Bazurto; Pie del Cerro - Pie de la Popa - Mercado Bazurto

685. Bus priority lane is more desirable to be introduced for the other sections of trunk bus routes in the major roads.

(4) Fare System

686. Trunk/Feeder Bus System is based on the free transfer at the terminal. Therefore, the fare system is better if kept uniform same as the present fare system. Ticket system will provide easier operation for these functions.

(5) Time Table

687. Every bus stop and every bus should be equipped with a time table of the bus operation. Passenger can know easily and the bus drivers can keep their schedule easily on it.

688. The major concerning is how the operation can be performed. It will be necessary at the bus terminal to orderly perform the bus operation and it should be controlled by the bus operation center in those terminals.

(6) Bus Fleet

689. For the trunk route large size bus vehicles are used to improve the efficiency of operation. Articulated bus is a alternative for this type of vehicle. For the feeder route current vehicle types of bus and buseta are available depending on the road condition.

(7) The Organization for Trunk-Feeder Bus System

690. In order to provide the operation and tariff system in trunk-feeder bus system, a new organization should be established. From the operational view point, the trunk bus route operation will be composed of several bus companies. It will be difficult to control the bus operation by each bus company independently at the trunk bus terminal. From view point of tariff system, the different systems of tariff collection including transfer by each company will be difficult to control correctly.

691. Therefore, those controls should be done by a new organization. For example, the checking of collected bus tariffs,

calculation of the amount of tariff on each day by company and calculation of the share of the total tariff to each bus company, are functions which are very difficult to be handled by individual company. The new organization shall be organized by DATT, ADESTRA-COSTA and bus companies etc.

10.2.3 Public Bus Facilities

(1) Major Bus Terminal

1) Necessity

692. The bus terminal can handle a large number of bus operation in orderly fashion. There is no such facility in Cartagena at present. "Terminal" as is being referred to comprises those of "Gran Parada" or "Parking Space". India Catalina or Parque Centenario or Mercado Bazurto can be said to be such "gran parada /large bus stop".

693. In trunk-feeder bus system, a large number of bus trips will concentrate in the main connecting points. There is no space or function at the present main connecting points to operate such volume of bus trips of more than 1000 buses per hour.

694. Trunk/Feeder bus system should have the function of transfer at the major terminals. Especially, when there is no charge of tariff for the transfer it would be easy to operate in such facilities. It can be expected that by these combined functions of bus operation and tariff system, trunk-feeder bus system will be able to perform an orderly bus operation and passengers control.

695. The improvement of bus terminals has an impact for the commercial activities of surrounding area of bus terminals. If the condition of the bus terminal will be kept well, the commercial activities will grow steadily and more progressively due to the consumption by a large number of bus passengers. Especially, the major local terminal will give better effects for the formation of urban sub-center in suburban areas.

2) The Major Terminals

696. The major terminals of the trunk bus routes are planned at the end of the routes. These are as follows;

a. India Catalina in Centro area
b. Mercado Bazurto
c. Inter-Departamental Bus Terminal
d. Mamonal area

i) India Catalina

697. India Catalina in Centro area is the most important bus terminal. The main pattern of bus passengers up to the year 2010 is still the movement toward the Centro area. Thus it will be involved in a large number of bus trips and their passengers. However, Centro area does not have any more space for operation of such number of buses on the road, because Centro area is the historical/touristic zone and also preserved area. Therefore, up to the year 2010, this Centro area should be relieved from vehicle traffic as much as possible. From this point of view, if the major bus terminal would be at India Catalina, buses can terminate their operation there and there would be no need to pass through inside Centro area.

698. At India Catalina, there is no space on the road to operate a larger number of buses than at present (989 buses in a peak hour in 2010). It is necessary to improve the present condition for the major bus terminal. Proposed location is shown in Figure 10.2-7.

ii) Mercado Bazurto

699. As for the road traffic at Mercado Bazurto, the road section is fully occupied by buses and also the roadside by passengers at the peak hour. Here is so called "gran parada". It is very difficult to manage larger number of buses/passengers than at present on the same space of present road section and road side (892 buses in a peak hour in 2010). Proposed location is shown in Figure 10.2-8.

iii) Inter-Departamental Bus Terminal

700. At present, Inter-departamental bus terminal is still under construction. However, this terminal has not been well planned to connect with the urban bus and Inter departamental buses. In this Inter departamental bus terminal almost all inter municipal /departamental buses concentrate. Many passengers should transfer to/from urban buses. Therefore, transfer is one of the important functions of this terminal. In order to make this transfer smooth, this terminal should have more space and facilities for urban bus operation (585 buses in a peak hour in 2010). Proposed location is in Figure 10.2-9.

iv) Mamonal area

701. Mamonal area is planned as industrial area and steady future development is expected. A large number of people will come to work here by bus (333 buses in a peak hour in 2010). Consider-

ing this condition, there should be a plan to prepare the site and facilities. The construction of the major bus terminal will initiate the development of the bus transportation system in Mamonal area (refer to Figure 10.2-10).

3) The Major Local Terminal

702. The scale of major local bus terminal is not as big as the major bus terminal. However the function is important for the trunk /feeder bus system. These are connecting points of trunk bus routes or main feeder bus route. These bus terminals support the function of the trunk /feeder bus system. These major local bus terminals are proposed as shown below;

a. Parque Centenario in Centro area (Figure 10.2-11)
b. Nueva Bosque (Figure 10.2-12)
c. Bomba del Amparo (at Santa Lucia) (Figure 10.2-13)
d. Bocagrande
e. Air Port
f. Daniel Lemaitre
g. Manga (at Terminal Maritimo) (Figure 10.2-14)

703. Parque Centenario is the bus terminal for the routes of Bocagrande and Manga. In order not to pass through the Centro, the bus terminal facility should be located in the place opposite of India Catalina. The passengers who want to use the bus service at India Catarina are requested to walk to there for transfer. This terminal does not need a big facility because of small number of the bus routes it serves (200 buses in a peak hour in 2010). Proposed location is shown in Figure 10.2-11.

704. Nueva Bosque and Bomba del Amparo are important nodes of trunk-feeder bus operation. In 2010, 1071 and 1401 buses in a peak hour will gather in these terminals of Nueva Bosque and Bomba del Amparo, respectively. Proposed locations are shown in Figures 10.2-12 and 10.2-13.

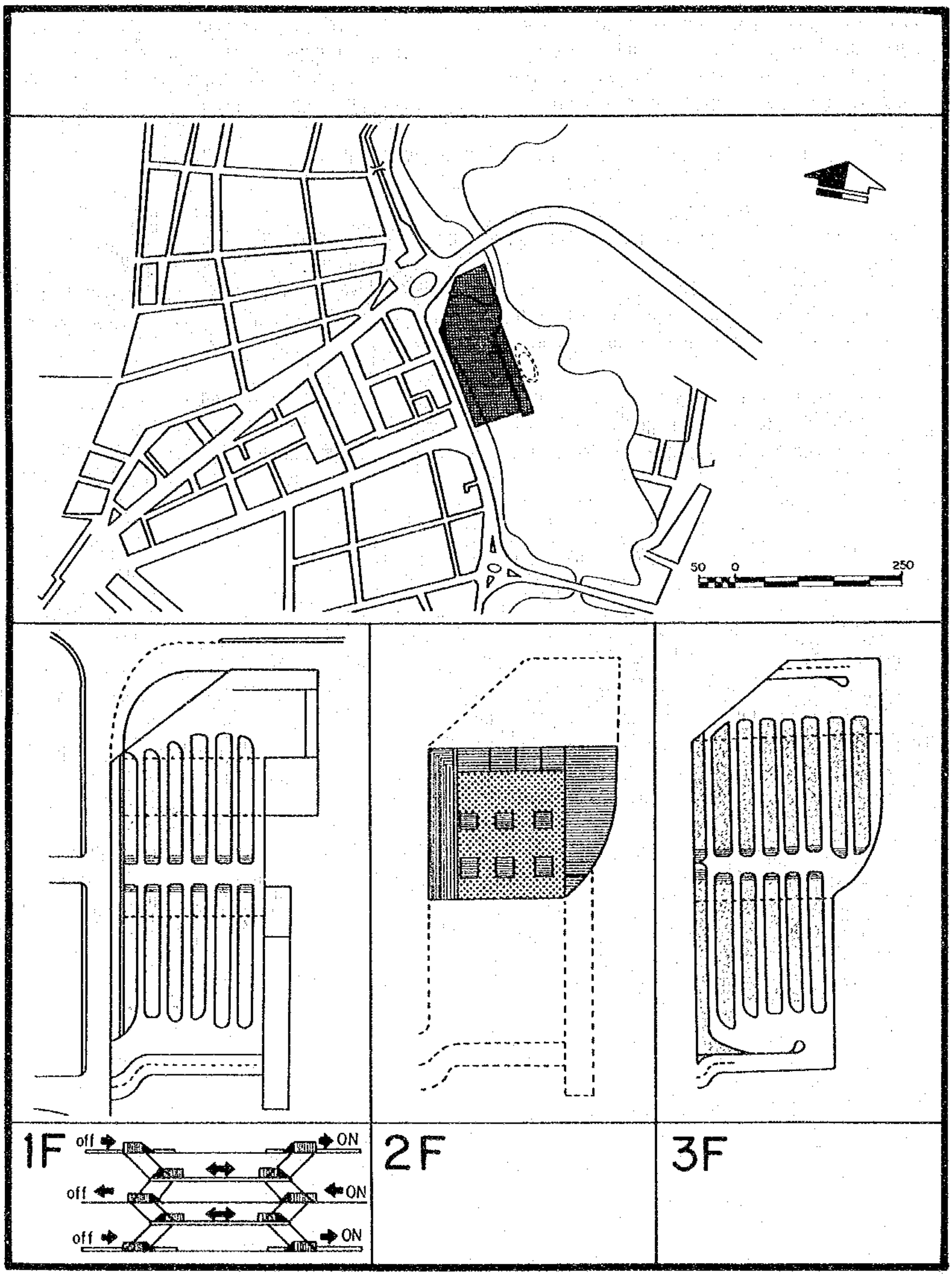


Figure 10.2-7 Bus Terminal Plan in India Catalina

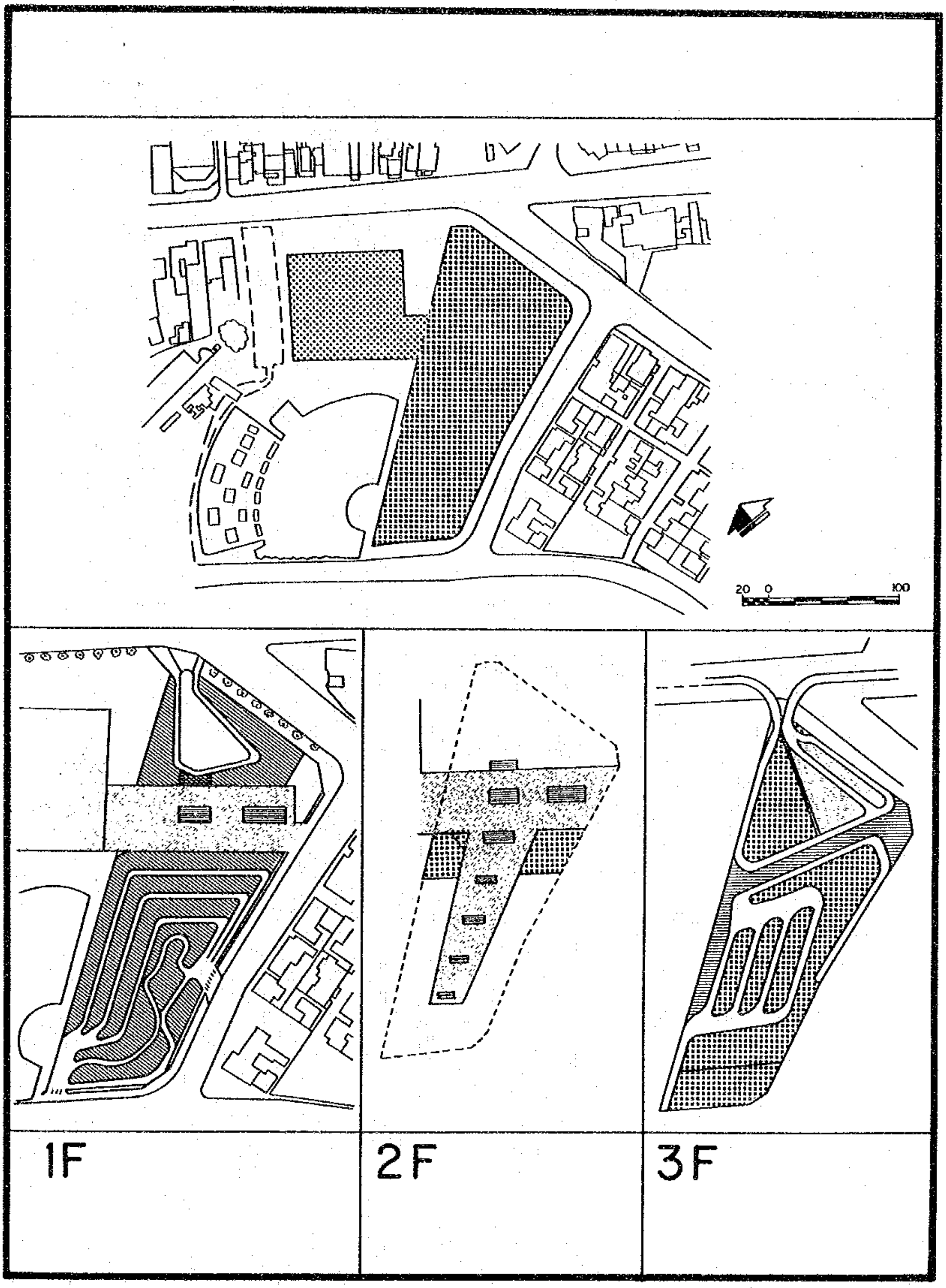


Figure 10.2-8 Bus Terminal Plan in Mercado Bazurto

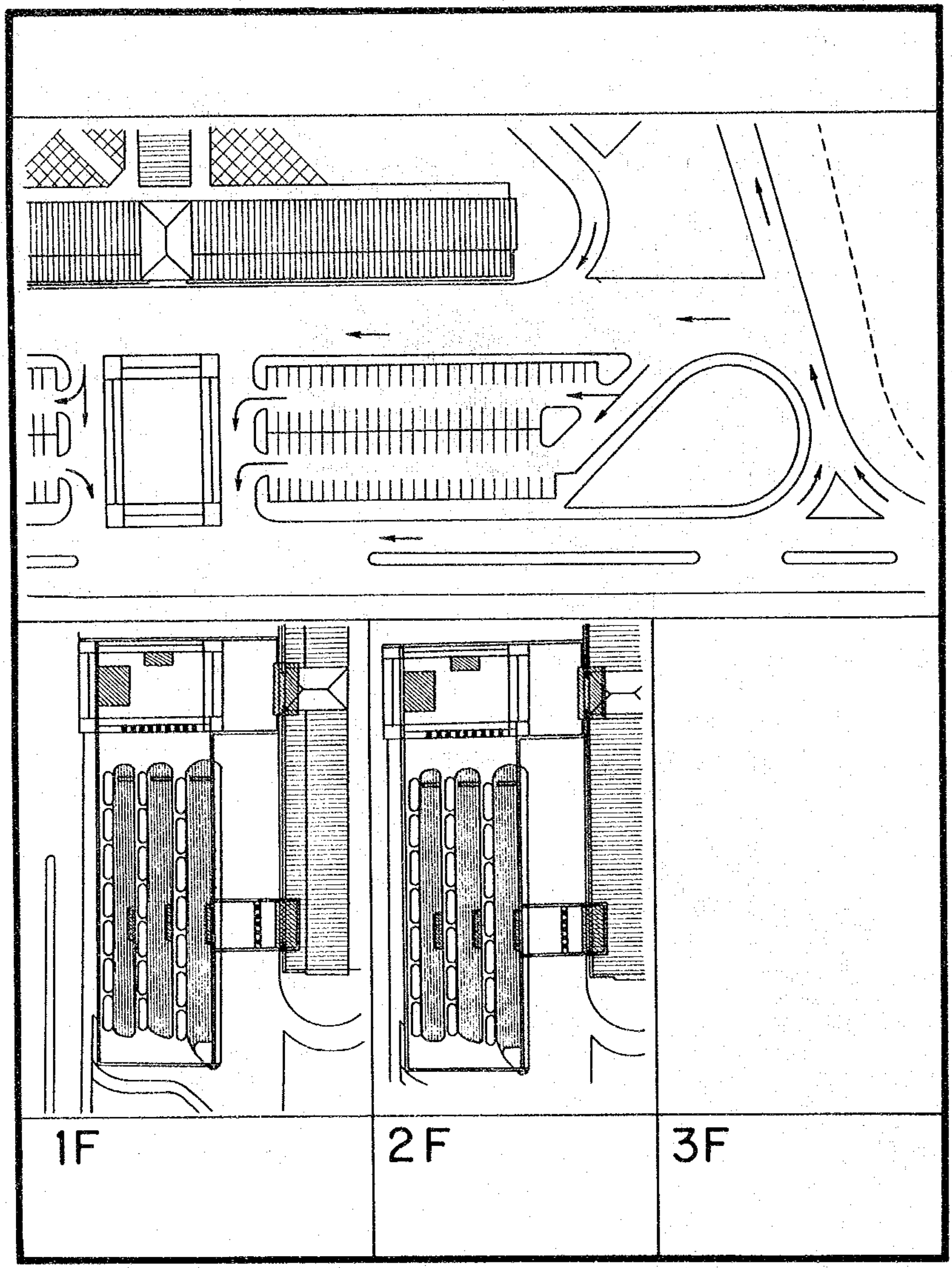


Figure 10.2-9 Bus Terminal Plan
in Inter-Departamental Bus Terminal

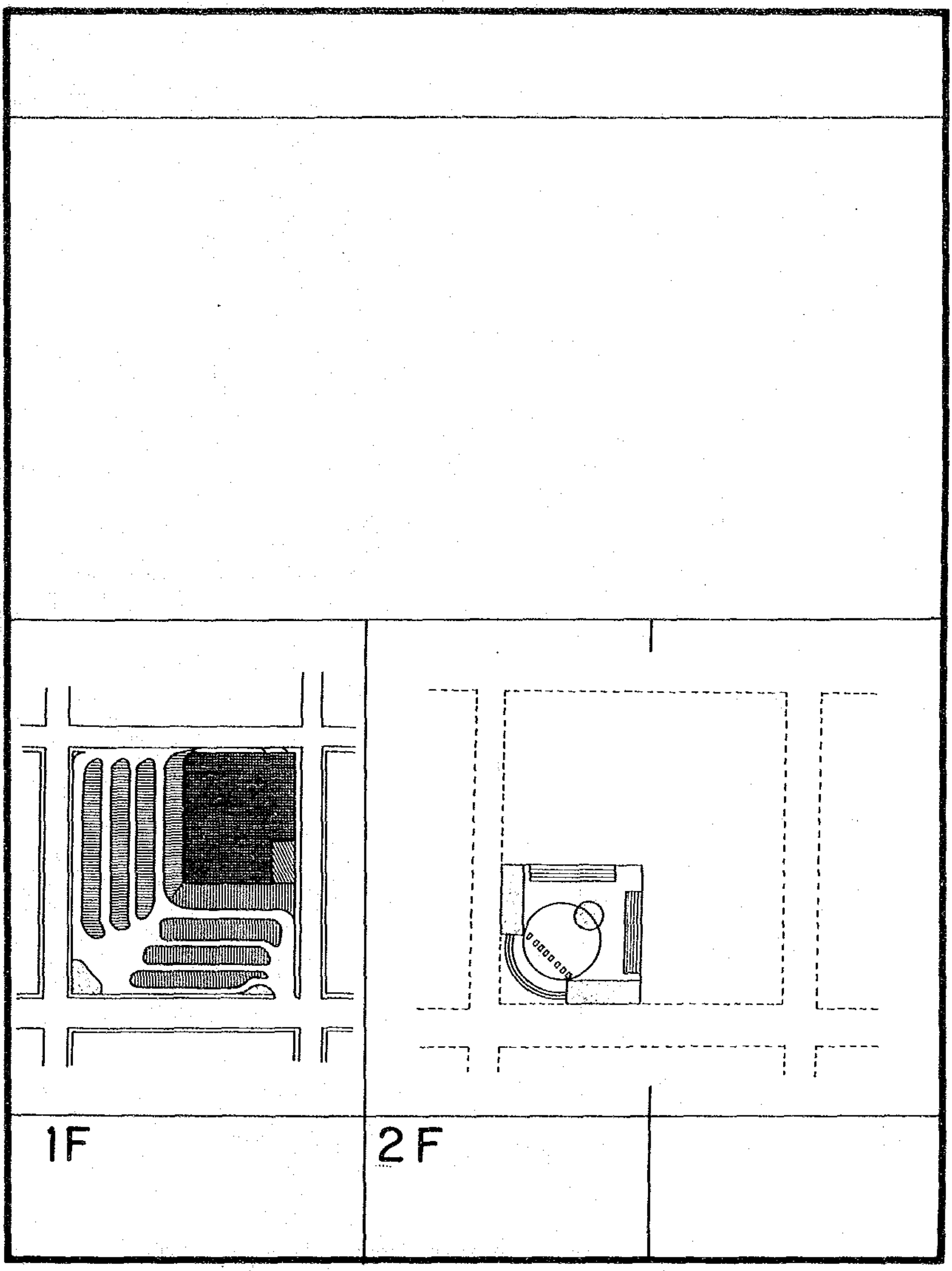


Figure 10.2-10 Bus Terminal Plan in Mamonal Area

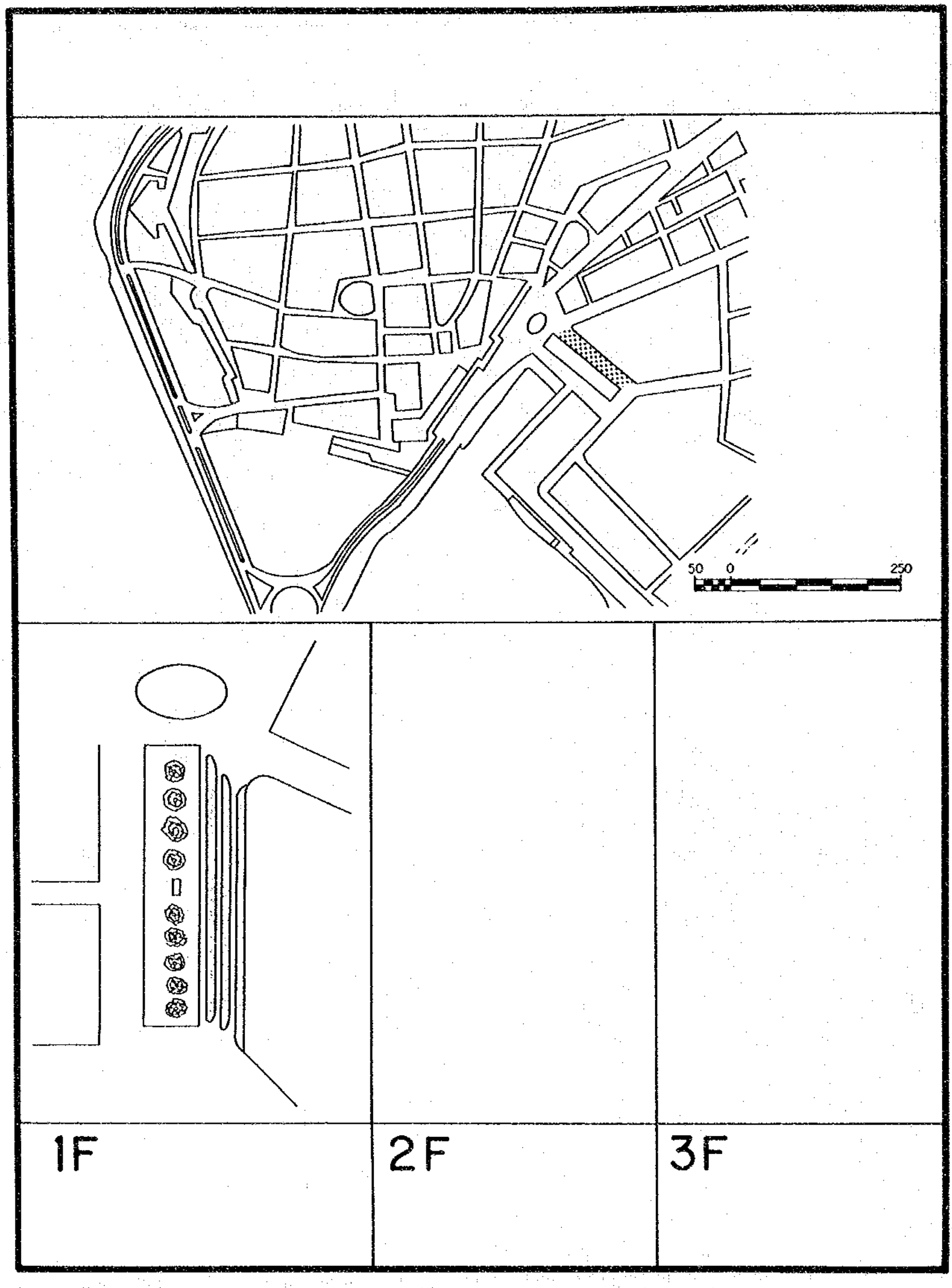


Figure 10.2-11 Bus Terminal Plan in Parque Centenario

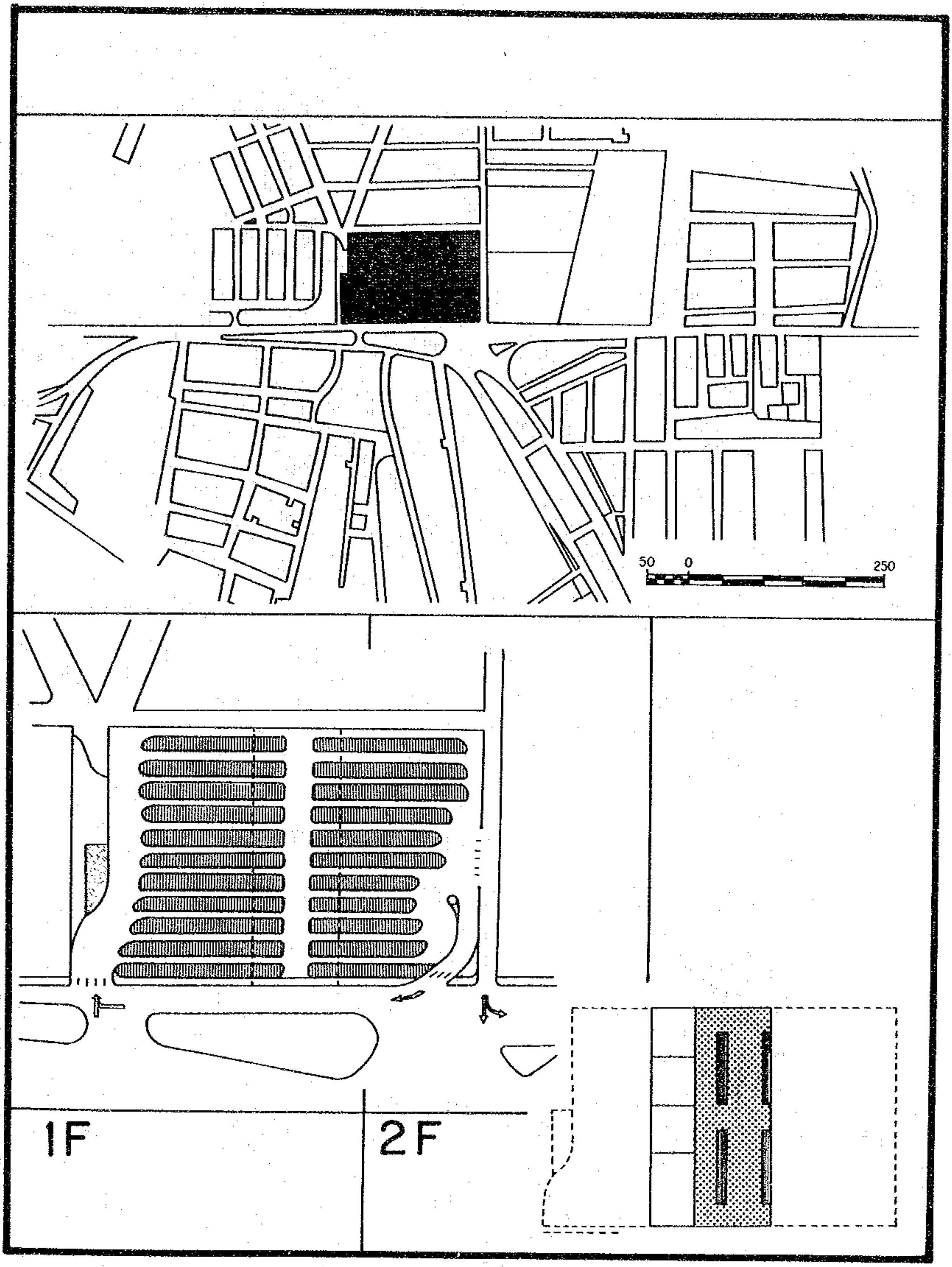


Figure 10.2-12 Bus Terminal Plan in Nueva Bosque

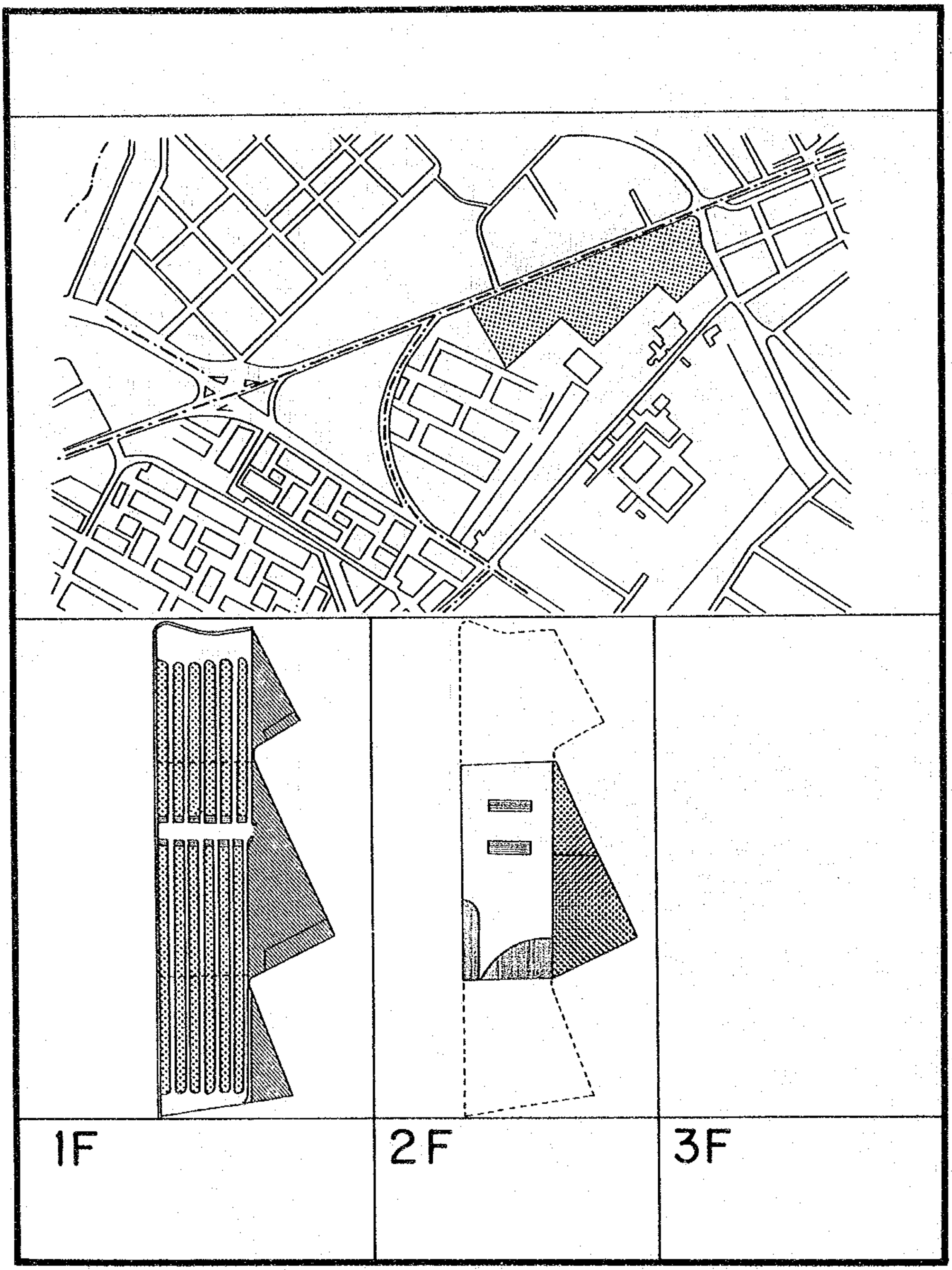


Figure 10.2-13 Bus Terminal Plan in Bomba del Amparo

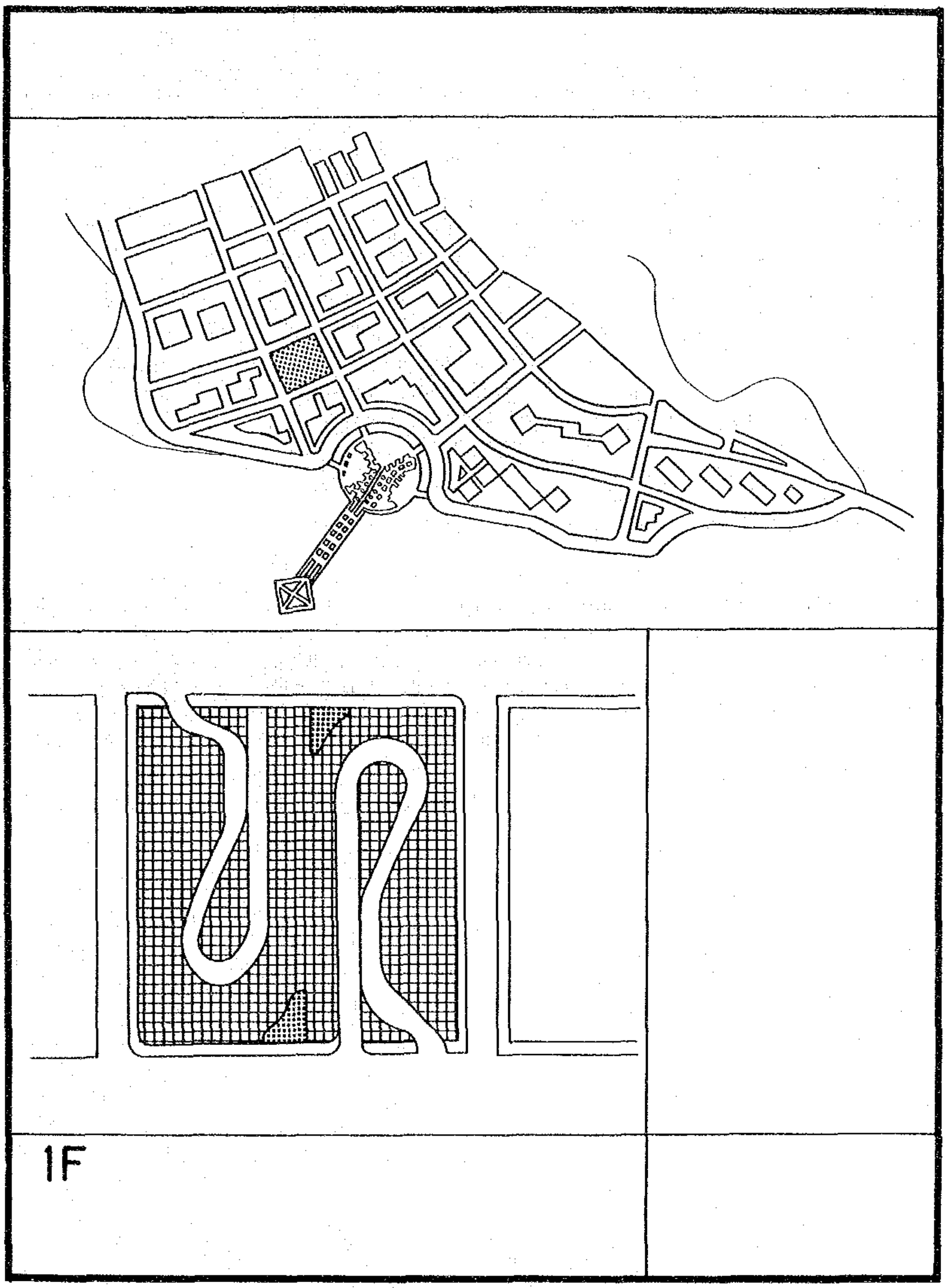


Figure 10.2-14 Bus Terminal Plan in Manga

10.2.4 Financial Condition of Trunk-Feeder Bus Operation

705. Using the result of trunk-feeder bus operation system, the financial condition of the operation in 2010 is analyzed taking into consideration the following assumptions;

a. bus operation cost
   bus in trunk route : 373.2 peso/km
   bus in feeder route: 278.8 peso/km
   buseta in feeder route: 198.1 peso/km

b. passenger fare
   bus in trunk route : 97 peso for 1 ride
   express; 160 peso, local; 70 peso
   30 % component of express
   bus in feeder route: 88 peso for 1 ride
   20 % component of express
   buseta in feeder route: 70 peso for 1 ride

c. at bus terminal free one transfer

706. Table 10.2-3 shows the result of the analysis. Total system indicates the enough managerial index, however, some of the routes especially in trunk routes show low managerial index less than 1.0 due to the free transfer system. This represents the necessity to establish the organization for the trunk-feeder bus operation system as to the coordination on operational aspects as well as financial one.

Table 10.2-3 Managerial Index of Trunk-Feeder Bus System

financial condition of alternative c

Route No.	Route Length	Type of Bus	No of Round Trip	Bus km per Day	Oper. Cost 1000 peso	No of Psn Transport	No of Psn to pay	Total Rev. 1000 peso	Managerial Index
1	26.0	bus-a	2774	72124.0	26916.7	467618	289747	28105.5	1.044
2	29.1	bus-a	2191	63758.1	23794.5	268329	82423	7995.0	0.336
3	37.9	bus-a	1809	68561.1	25587.0	333402	237669	23053.9	0.901
4	36.3	bus-a	1253	45483.9	16974.6	233409	108497	10524.2	0.620
21	12.1	bus	767	9280.7	2587.5	90893	50644	4456.7	1.722
22	10.8	bus	966	10432.8	2908.7	77854	48000	4224.0	1.452
23	6.2	bus	677	4197.4	1170.2	77712	50507	4444.6	3.798
24	5.0	buseta	1501	7505.0	1486.7	95342	56223	3935.6	2.647
25	8.3	bus	1569	13022.7	3630.7	186149	119212	10490.7	2.889
26	8.7	buseta	1233	10727.1	2125.0	67997	28496	1994.7	0.939
27	5.5	buseta	3018	16599.0	3288.3	129548	102020	7141.4	2.172
28	5.8	buseta	1002	5811.6	1151.3	55712	25013	1750.9	1.521
29	6.3	buseta	2868	18068.4	3579.4	96259	3453	241.7	0.068
31	14.0	bus-a	795	11130.0	4153.7	135968	46908	4550.1	1.095
32	14.9	bus	93	1385.7	386.3	8257	3995	351.6	0.910
33	8.6	bus	663	5701.8	1589.7	70369	39981	3518.3	2.213
34	4.3	buseta	492	2115.6	419.1	30099	22449	1571.4	3.750
35	5.7	buseta	546	3112.2	616.5	102258	56833	3978.3	6.453
71	14.5	bus	1250	18125.0	5053.3	156480	96959	8532.4	1.688
72	10.4	bus	859	8933.6	2490.7	63847	57058	5021.1	2.016
76	8.7	buseta	1167	10152.9	2011.3	65141	44521	3116.5	1.549
77	5.5	buseta	3123	17176.5	3402.7	139995	40364	2825.5	0.830
78	5.8	buseta	1015	5887.0	1166.2	50561	34585	2421.0	2.076
79	6.3	buseta	2927	18440.1	3653.0	97302	97302	6811.1	1.865
Total	297.0		34557	447732.2	140143.0	3100501	1742859	151056	1.078

10.3 Short Term Improvement Plan

10.3.1 Facility Plan

(1) Bus Stop

707. Bus stop will be introduced on collector class roads or feeder bus routes by equipping the sign of bus stop. The number of location is estimated about 262.

(2) Bus Bay

708. Bus bay will be introduced on arterial class roads or trunk bus routes and major feeder routes. Two (2) meters width by fifteen (15) meters length is considered as a standard space for bus bay (two berths, 20 seconds stop, 360 buses per hour of maximum capacity). It will equip the passenger shelf and bus bay sign. Total number of bus bay construction is estimated about 171.

(3) Bus Terminal

709. As stated in section 10.1, some of bus terminals shall be constructed for the bus operation improvement at early stage of this Masterplan. These are the terminals at India Catalina, Nueva Bosque and Intermunicipal Terminal. Other terminals are considered to be built in medium/long term plan.

710. For designing the bus terminals, following basic criteria are prepared;

a. Maximum use of public owned space, such as road or park,
b. Loading and unloading berths are separated,
c. Different berth areas for different routes, and
d. 2 and 3 minutes period at berth for unloading and loading of passengers, respectively.

Number of berths is estimated depend on the maximum bus operation frequency at peak hour of each route.

711. The land acquisition for the terminal areas is decided based on the site reconnaissance. For the terminals of India Catarina, Mercado Bazurto, Airport, Intermunicipal bus terminal, Bocagrande and Parque Centenario, public spaces are available. Other terminals require the private land acquisition.

712. Major dimensions of the terminals are shown in Table 10.3-1 (Details are indicated in Appendix 10.3-1).

Table 10.3-1 Details of Bus Terminals

Location	Area (m^2)	No. of Berth	No. of Peak Bus Operation	Area of Building (m^2)
*India Catalina	9,660	12,14	989	27,280
*Nueva Bosque	19,190	11,11	1,071	22,300
*Intr. Terminal	4,200	3, 3	585	7,310
Mdo. Bazurto	21,230	11, 8	892	49,440
Bomba Amparo	32,530	6, 6	1,401	25,110
Mamonal	14,000	4, 4	333	4,500
P. Centenario	2,000	3, 3	200	25
D. Lemaitre	2,470	3, 3	200	100
Manga	2,500	2, 2	136	40
Bocagrande	1,460	2, 2	205	50
Airport	500	1, 1	100	-

note: *; to be constructed in short term plan
No. of berth indicates the number for loading and unloading, respectively.

10.3.2 Operational/Institutional Improvement Plan

(1) Determination System of Public Bus Fare

713. DATT has a standard calculation formula for fare level estimation. This is the same formula as described in Chapter 4, section 4.2.6. If the data used in this formula are correct, the fare level estimated is considered to be the reasonable one for the basis to negotiate and determine the public bus tariff system in Cartagena. In order to get the leading position to determine the public bus tariff system, DATT has to publish her firm attitude for this matter and to investigate the latest and correct data for the estimation of the tariff system.

(2) Aged Vehicle Control

714. There are many aged public bus vehicles in use. Based on the INTRA data, some 40 per cent of BUS is older than 20 years and some 20 per cent of BUSETA older than 15 years. It is not generally recommendable to use such aged vehicle for public transportation because of the lower operational efficiency, worse exhaust quality and lesser passenger accommodation.

715. However, it is very difficult to stop these vehicle use immediately from now on. DATT shall make a legal guideline for this matter taking into consideration the passenger service quality as well as the tariff determination system. Through yearly vehicle inspection and licensing system, DATT will able to improve the vehicle condition of public bus transport.

10.4 Cost Estimation of the Improvement Plan

10.4.1 Bus Stop and Bus Bay

716. Tables 10.4-1 and 10.4-2 indicate the unit construction costs of bus stop and bus bay, respectively.

Table 10.4-1 Unit Construction Cost of Bus Stop (pesos)

Constr. Item	Constr. Cost
Sign/Pole	50,200
Paint, etc.	25,000
Installation	8,200
Sub Total	83,400
Indirect Cost	34,760
Total	118,160

717. Land acquisition is not considered at cost estimation because of the space preparation for bus bay available inside the right of way of the arterial road.

Table 10.4-2 Unit Construction Cost of Bus Bay (pesos)

Constr. Item	Constr. Cost
Pavement	358,200
Pedestrian Walk	167,340
Sign/Pole	55,267
Passenger Roof	309,681
Sub Total	890,500
Indirect Cost	371,340
Total	1,261,840

718. Total construction cost of bus stop and bus bay is shown in Table 10.4-3.

Table 10.4-3 Construction Cost of Bus Stop and Bus Bay

Item	No. of Location	Unit Cost (pesos)	Constr. Cost (million pesos)
Bus Stop	262	118,160	31.0
Bus Bay	171	1,261,840	215.9
Total			246.9

10.4.2 Bus Terminal

719. Bus terminal cost is estimated referring the unit construction cost data of Barranquilla Transport Terminal construction. Table 10.4-4 shows the cost estimation result of each terminal.

Table 10.4-4 Construction Cost of Terminals

Terminal Name	Terminal Area (m^2)	Total Floor Area (m^2)	Berth with Roof (m^2)	Parking Area (m^2)	Unit Cost (pesos) Floor	Berth	Parking	Total Cost (million)	Land Acquist. Cost(million)	G.Total (million)
I. Catalina	9,660	27,280	-	-	126,930	-	-	4,906.6	-	4,906.6
Nva Bosque	19,190	22,300	-	-	126,930	-	-	4,010.8	1,535.2	5,546.0
Terminal	4,200	7,310	-	-	126,930	-	-	1,314.8	-	1,314.8
Bazurto	21,230	49,440	-	-	126,930	-	-	8,892.3	-	8,892.3
Amparo	32,530	25,110	16,720	-	126,930	126,930	-	7,523.5	2,602.4	10,125.9
Mamonal	14,000	4,500	6,300	4,050	126,930	126,930	11,940	2,011.0	280.0	2,291.0
Centenario	2,000	25	1,800	-	76,200	76,200	-	197.1	-	197.1
Lemaitre	2,470	100	1,900	670	76,200	76,200	11,940	227.3	197.8	425.1
Manga	2,500	40	2,250	-	76,200	76,200	-	247.3	250.0	497.3
Bocagrande	1,460	50	1,410	-	76,200	76,200	-	157.6	-	157.6
Airport	500	-	490	-	76,200	76,200	-	52.9	-	52.9
Total	109,740	136,155						29,541.2	4,865.4	34,406.6

note: Total cost include the indirect cost, equivalent to 41.7% of direct cost.
The number includes construction cost of the functions not only for bus terminal but also for small commercial activities inside the terminal such as kiosk.

720. Due to the land space limitation, large scale terminals are designed as multi-stories terminal. Inside the terminal building, bus parking spaces and loading/unloading berths are arranged with administrative office, passenger waiting room, bus company office, maintenance yard, kiosk, etc. For the small scale bus terminals, only administrative office building is constructed together with loading/unloading berths with sun roofs.

CHAPTER 11 WATER TRANSPORT

11.1 General

721. The western part of the urban area of Cartagena is the current urban core of the socioeconomic activities of the Municipality and, therefore, the traffic concentrates into this area. However, the physical condition, surrounded by the sea, bays, lagoons, lake and canals make it difficult to construct an effective and sufficient road network in this area.

722. Major roads, such as Av. Santander from north-east and south, and Av. Pedro de Heredia from south-west, concentrate into the central area without any road connecting between them. As a result people, who have a destination other than the central area, are forced to travel through the central area wasting time and money.

723. The idea of water transport was proposed as the supplemental traffic route for the public transportation by using canals, lagoons and bay at the time when the improvement project was planned for solving the problem of water pollution.

724. In 1983, a preliminary study on water transportation was carried out to investigate the possibility of its operation. Based on the OD survey result and preliminary assumptions of the trip transfer from by land to by water transport, it was concluded that there is enough demand for water transport and that further study should be carried out.

725. In the study made in 1983 by HIDROTEC, trip OD by 23 zones in the urban area was obtained based on the sample OD survey made in the Area (sample rate 3.6%). Because the survey area didn't cover a whole urban area, some 75% of the trips of the city population were investigated. The OD tables were made for trips by public transport, and those by passenger car and taxi.

726. Using the trip OD by public transport, and considering the influence area of the service and the travel time difference between by land and by water transport, trip demand for the water transport in 1983 was proposed. The tariff for water transport was assumed to be the same as or less than current tariff by public bus transport. The estimation of trip transfer from by land to by water was not carried out by using any kind of computer simulation model, as a result the travel time, transfer time, tariff amount, connection with public bus network, etc were not taken into account.

727. Following operations of the water transport were

planned on the routes;

a. for the north-west route: Canal Juan de Angola - Lagoon of Cabrero - Lagoon of Chambacu - Lagoon of San Lazaro
b. for the south route: Bay of Las Animas - Bay of Cartagena
c. for the south-west route: Canal Bazurto - Canal Manzanillo - Canal Zona Dragada

728. In 1989, Dr. Hernando Sara C. carried out a pre-feasibility study on the water transportation in the Cartagena Bay on request by EDURBE. This study analyzed the water transport demand based on the OD characteristics obtained in 1983 and the operation data in 1989 given by the public bus company association in Cartagena (ADESTRACOSTA).

729. The estimation of transfer trips from by land to by water transport was not investigated in detail.

730. Operation around the Cartagena bay was proposed. Based on the financial analysis, the capacity of boat to be used should be larger than 75 passengers.

731. As for the operator for this service, interviews to several tourist companies and individuals, that had the possibilities to join in the services, were carried out. However, their facilities such as boats, wharves, car parking spaces, etc. showed insufficient enough capacities for the public transport demand.

732. As mentioned in the previous paragraphs, the problems for the implementation of water transport are summarized as follows;

a. the connection with current pubic bus network,
b. the operators and their capabilities for public transport,
c. tariff system combined with the public bus transport, and
d. cooperation from current bus company union when the services are operated by other than bus companies.

733. The connection with current bus network is very important for the water transport as a public transport system because its influence area will be limited if there are no linkage to the bus network and the demand for the system will be small. As shown in previous section, the major bus routes run along in-land side roads from the canals and bays where the terminals or wharves for water transport will be situated. From the viewpoint of public bus company, public water transport is a competitive service, and without any benefit for the company, it is very difficult to expect additional bus network operation to support the water transport.

734. To operate water transport as a public transport, the frequency of operation shall be a minimum of two or three (2-3) times per hour. To compete with current public bus operation the service level should be more frequent. Such operation requires a large investment in equipment and facilities such as 4 or 5 boats of more than 100 passenger capacity, several new passenger wharves and a dockyard for the maintenance. Existing tourism boat service companies do not have such kind of equipment and facilities. Therefore, if it is expected that water transport service be operated by the private sector, sufficient short term return for the investment shall be confirmed through financial analysis based on the detailed demand forecast in case of no governmental subsidies.

735. A large part of the passengers using the water transport will also use the public bus transport in course of their trips between their origin and destination. In case the passenger should pay a fare every time he changes transport mode, the total amount of the fare will become more and more, and the demand for the water transport will decrease in spite of the time reduction offered by the water transport. Therefore, the wharves for water transport shall be located near the public bus network nodal points and also a competitive tariff system combined with public bus fare shall be taken into consideration.

736. As explained before, the cooperation from public bus operators is very important for the realization of water transport service. To expect their cooperation for the water transport operation such as bus network connection, combining fare system, etc., the socioeconomic and also financial benefits, resulting from the water transport operation, shall be shared with the public bus operators.

11.2 Network and Service Area

737. Based on the previous study results, three routes of Bay Area route, Centro-Mamonal route and Canal route are proposed. Considering the accessibility to public bus route and commercial/residential/industrial/tourist zones, several boat terminal points are selected.

738. However, from 1991 public bus passenger OD table, it can be found that the demand for Centro-Mamonal Route is very small at present and the operation of Mamonal route should be postponed until the development of south Mamonal area.

739. On the other hand, as the demand between Centro and Mercado Bazurto is quite large, the operation on this route is also examined. Figure 11.2-1 shows the operation routes for water

transport investigated in preliminary stage from 1995 for example.

740. As for the Bay Area Route, round trip type operation around Bocagrande-Castillogrande-Bosque-Mercado Bazurto-Manga was envisioned at first. However, considering the canal improvement completion within several years, when water transport will be open for public, piston type operation between India Catalina-Bocagrande-Castillogrande-Bosque-Mercado Bazurto is investigated.

Table 11.2-1 Routes and Terminals

No.	Route: Bay Area Route	Centro Route	Canal Route	Mamonal Route
1	India Catalina	Los Pegasos	Olaya Herrera	Los Pegasos
2	Bocagrande	El Bosque	Boston	Albornoz
3	Castillogrande	Mercado Bazurto	La Maria	Planta di Soda
4	El Bosque		Santa Maria	Pasacaballo
5	Mercado Bazurto		San Pedro	
6			Marbella	
7			India Catarina	
8			Barrio Chino	
9			Mercado Bazurto	

note: Underlined ones are terminals in preliminary stage.

1) Route No.101, Bay Area Route

741. This is the local type route dropping in the spots of tourism, business, commercial and administrative centers of Cartagena. Starting from India Catarlna, it goes by Bocagrande, Castillogrande and El Bosque, and terminates at Mercado Bazurto. It re turns on the same route.

2) Route No.102, Centro Route

742. This is the express type route of only one stop at El Bosque starting from Centro (Los Pegasos) until Mercado Bazurto. It aims to gather the passengers between Centro and Mercado Bazurto including transfer from public bus services by less travel time.

3) Route No.103, Canal Route

743. This is the local type route serving for the residents living along the canal and Cienaga de La Virgen, which links the Centro and Cienaga de La Virgen. It starts from Olaya Herrera, east end of Cienaga de La Virgen, stops at seven terminals on the way and arrives at Mercado Bazurto. It returns on the same route. In preliminary stage, the operation is scheduled between Mercado Bazurto and Santa Maria.

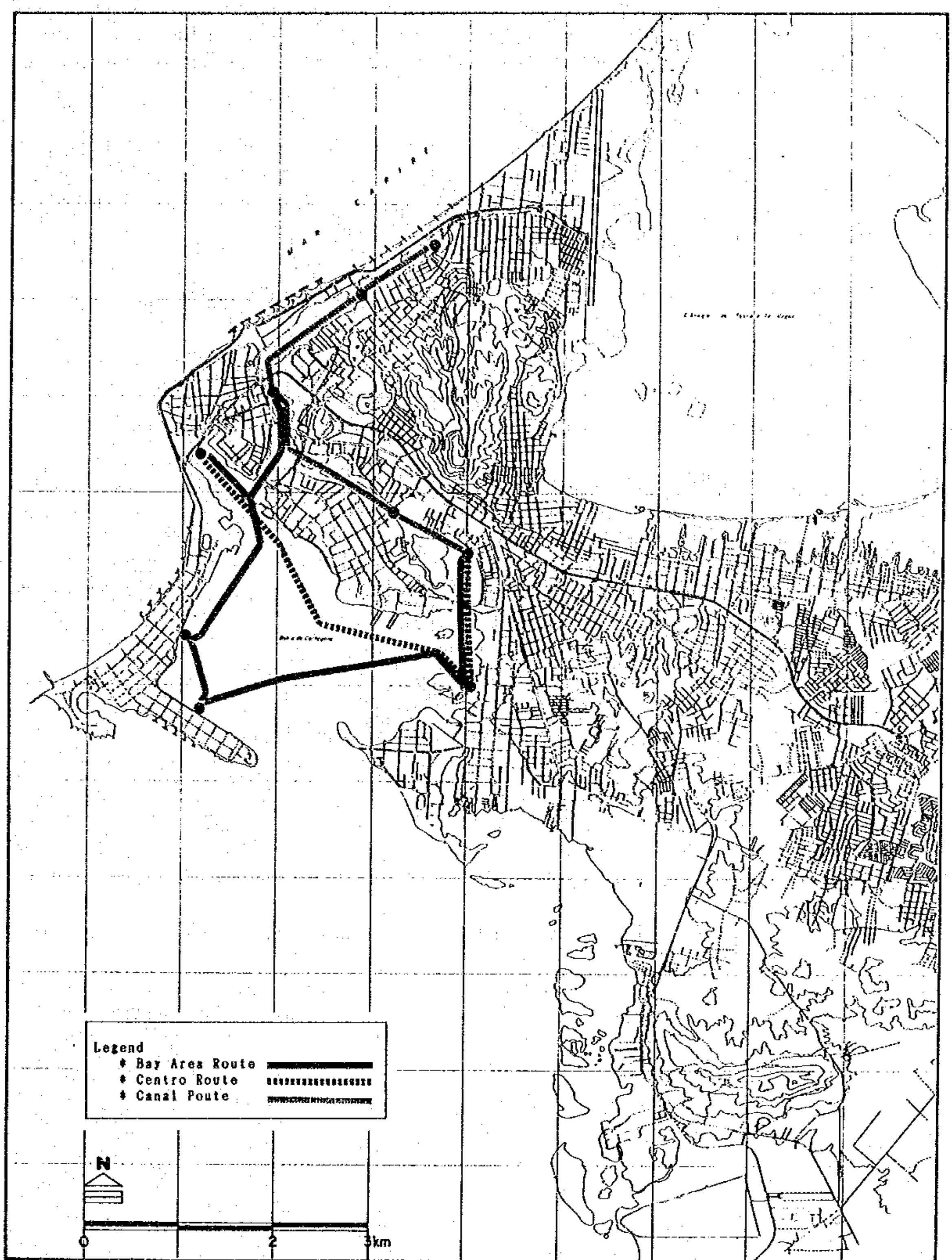


Figure 11.2-1 Route Network of Water Transport
(Preliminary Stage)

744. There are many obstacles on the navigation course of operation routes considered such as reefs, piles, shallow areas near the shore, etc. The setting of navigation course requires careful investigation.

745. Figure 11.2-2 shows the service network at 2010, which includes the introduction of Mamonal route and the extension of Canal route from San Pedro to Olaya Herrera into the preliminary network of water transport.

11.3 Demand Forecast

11.3.1 Methodology

746. For the estimation of passenger demand for water transport, the following method is employed;

a. Public bus passenger OD in 1991 and in 2010 is used,
b. Passengers within 500 meters radius around the terminal, which means walking distance, are considered to have priority to use water transport if its network is available for their OD,
c. Combining above two passenger ODs, the passenger OD for water transport demand estimation is created,
d. Network systems combined water transport network with current public bus network and improved public bus network (trunk-feeder system) are made for the computer simulation,
e. Using the above passenger OD and public transport network, computer simulation is carried out taking into consideration bus fare level ($120 per one ride), water transport fare level ($120 per one ride) and time value ($78 per hour),
f. Diversion rate variable by travel time difference, is used for the final estimation of number of passengers using water transport.
g. Travel speed of public bus operation is assumed 25 km per hour.
h. Travel speed of boat is assumed 14 knots per hour for Bay Area Route and Centro Route, and 7 knots per hour for Canal Route, respectively.

747. Flow chart of the demand forecast to water transport is shown in Figure 11.3-1.

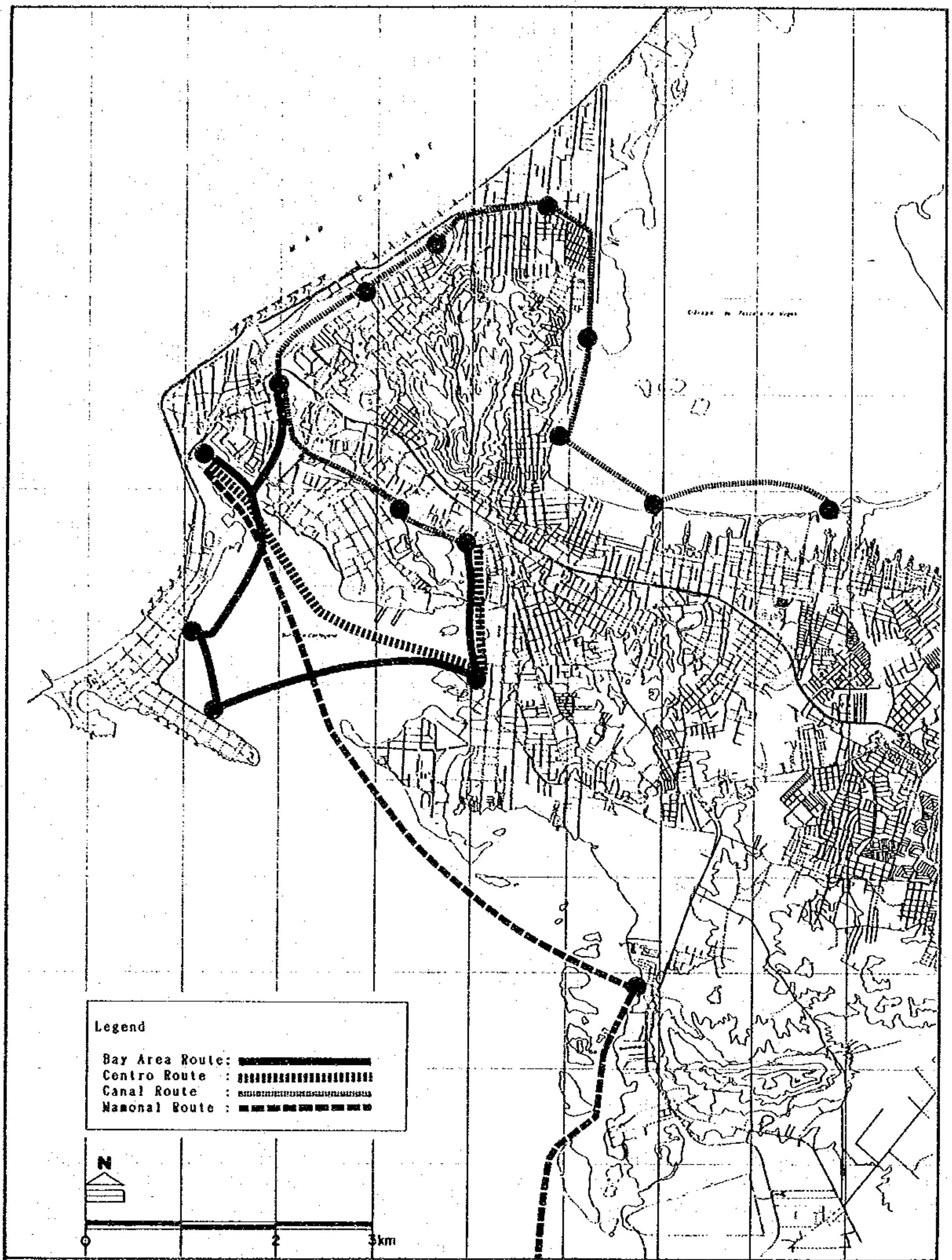


Figure 11.2-2 Service Network in 2010

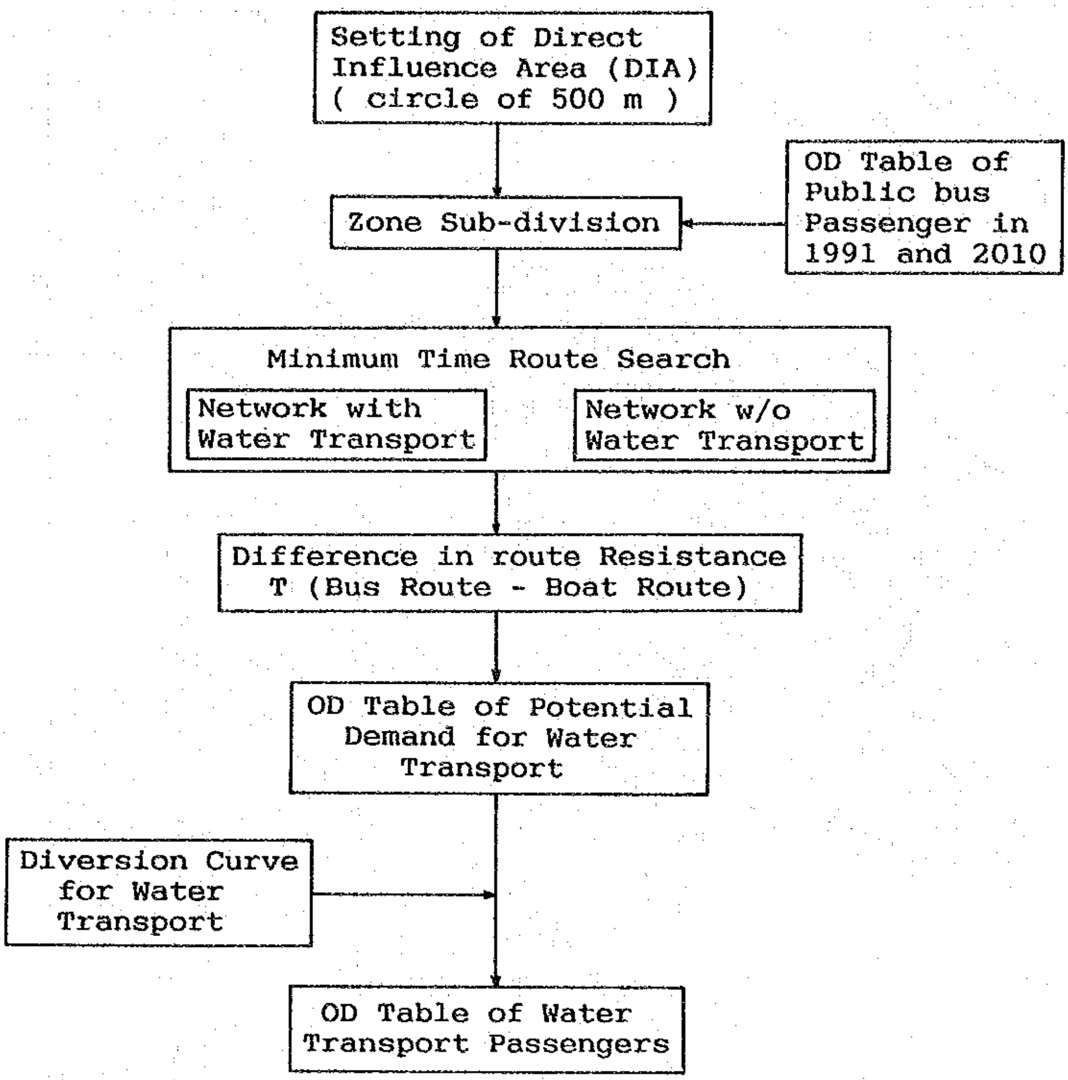
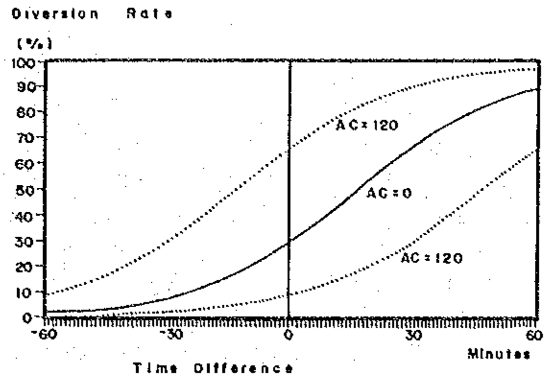


Figure 11.3-1 Demand Forecast Flowchart for Water Transport

748. As for the Diversion Rate, following assumptions are prepared (refer to Figure 11.3-2);

a. if $T < 0$ then $R = 0$
b. if $T >= 0$ then $R = 1.0/(1+\exp(-0.05\ T + 0.873))$
where; T: travel time difference in minutes

When the time difference is 30 minutes, the diversion rate is assumed 65 % and 90 % for 60 minutes. Fare level difference is converted to time using the time value of \$78 per hour.



δC: Tariff difference

Figure 11.3-2 Diversion Rate Curve

11.3.2 Simulation Result

(1) Service Network without Bus Service Improvement

749. Tables 11.3-1 and 11.3-2 show the result of computer simulation for the water transport traffic demand in 1991 and 2010. Public bus network in 2010 is assumed as those by current operation system with additional introduction of several new routes on the roads implemented and the operation of Mamonal route and Canal route extension is assumed.

Table 11.3-1 Water Transport Traffic Demand

	1991	2010	2010/1991
Passenger Od Volume between DIA only	33,076	60,128	1.82
Potential Demand (under condition of T >= 0)			
Boat only	28,499	124,637	4.37
Boat + Bus	14,313	47,237	3.30
Total	42,812	171,874	4.01
Demand diverted to Boat			
Boat only	15,815	58,132	3.68
Boat + Bus	4,822	19,239	3.99
Total	20,637	77,371	3.75

Table 11.3-2 Route Assignment of Passenger

Route No.	Total Pns No. 1991	Total Pns No. 2010	Peak Section Pns No. 1991	Peak Section Pns No. 2010
101	9,319	40,856	3,580	17,199
102	5,517	6,651	2,478	3,343
103	8,939	47,950	4,185	23,047
104	-	21,365	-	10,988
Total	23,775	116,822	-	-

note: Peak passenger number for one direction

(2) Service Network with Bus Operation System Improvement

750. Using the 1991 and 2010 public passenger ODs and water transport network with Mamonal route and Canal route extension in 2010, water transport demand was analyzed. In this case, public bus network in 2010 was supposed as those of trunk-feeder system. The result is shown in Tables 11.3-3 and 11.3-4.

Table 11.3-3 Water Transport Traffic Demand

	1991	2010	2010/1991
Passenger Od Volume between DIA only	33,076	60,128	1.82
Potential Demand (under condition of T >= 0)			
Boat only	28,499	83,618	2.93
Boat + Bus	14,313	1,684	0.11
Total	42,812	85,302	1.95
Demand diverted to Boat			
Boat only	15,815	38,419	2.43
Boat + Bus	4,822	688	0.14
Total	20,637	39,107	1.87

Table 11.3-4 Route Assignment Of Passenger

Route No.	Total Pns No. 1991	Total Pns No. 2010	Peak Section Pns No. 1991	Peak Section Pns No. 2010
101	9,319	26,813	3,580	11,814
102	5,517	3,086	2,478	1,598
103	8,939	18,892	4,185	5,736
104	-	5,284	-	3,951
Total	23,775	54,075	-	-

note: Peak passenger number for one direction

751. The comparison between the results of Table 11.3-1 and Table 11.3-3 indicates;

a. Demand for water transport is depend on the progress of the improvement of road network and public bus operation.
b. Water transport demand will increase from 39 thousand to 77 thousand when no improvement of bus operation system.
c. If without any improvement on road network and bus operation, computer simulation indicates the demand for water transport will be about 134 thousand trips per day.

11.4 Selection of Boat Dimension

11.4.1 General

752. For the determination of the boat type and boat size to be used for public water transport, there are many aspects to be examined not only from the technical view point but also from passenger safety as well as financial view points.

11.4.2 Design Criteria

753. Following design criteria for boat size determination are considered;

1) passenger capacity
   In order to analyze the cost-capacity relationship, five (5) classes of capacity are examined: 50, 75, 100, 200 and 300 psns.

2) operation maximum speed
   10, 20, 30 and 40 knots are examined.

3) engineering conditions
   a. boat structural material; fiberglass reinforced plastics
   b. shape of boat; monohull and catamaran types
   c. principal dimension ratio;
      overall length/maximum breadth <= 7
      maximum breadth/depth <= 4
   d. stability;
      metacenter at full load condition >= 1 meter
      freeboard at full load condition >= 0.7 meter
      freeboard at full load on one side >= 0.2 meter
      inclined angle at full capacity on one side <= 10 degrees
   e. main engine type;
      diesel engine type, considering the reliability, durability, and fuel cost
   f. passenger space;
      all chair type seats, 0.5 meter width and 1.1 length,
      the width of an aisle 0.7 meter
   g. entrance/exit;
      2 places for passenger capacity of less than 100 psns
      3 places for passenger capacity of more than 200 psns
   h. fuel tank capacity;
      120 % of the amount necessary for the operation for 11 hours, unit by 200 liters
   i. equipments and fittings
      anchor, ropes, safety equipments and tools, lights, navigation equipments, information systems, etc. total weight 0.25 tons

11.4.3 Design Procedure of Boat Principal Dimensions

754. Figure 11.4-1 shows the design flowchart. In this chart, the values of passenger capacity, length of fore/afterdeck and cockpit and bulwark height are set at constant, and the values of maximum continuous operation hours, transverse seat number, depth and engine power are examined to fulfill the design conditions.

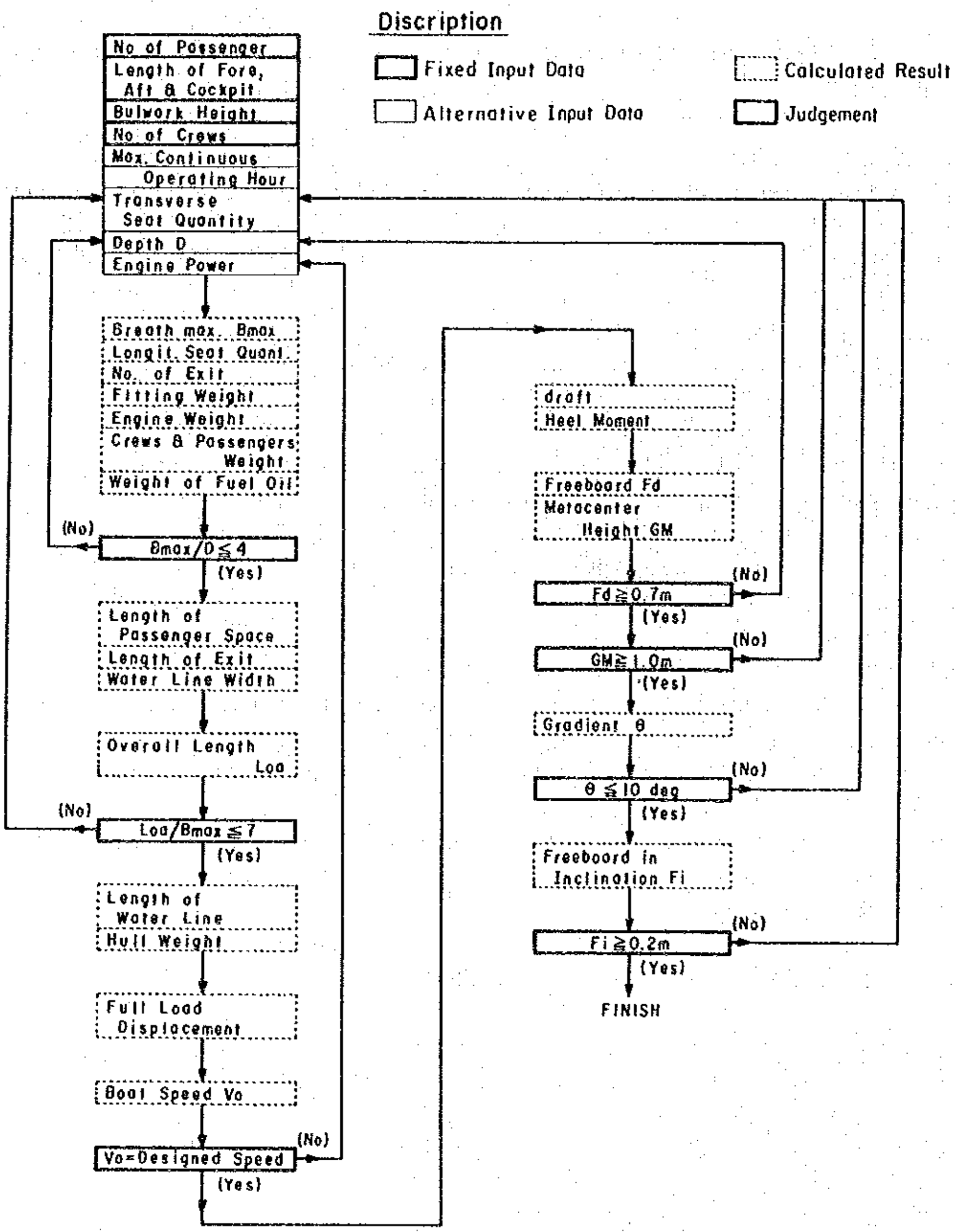
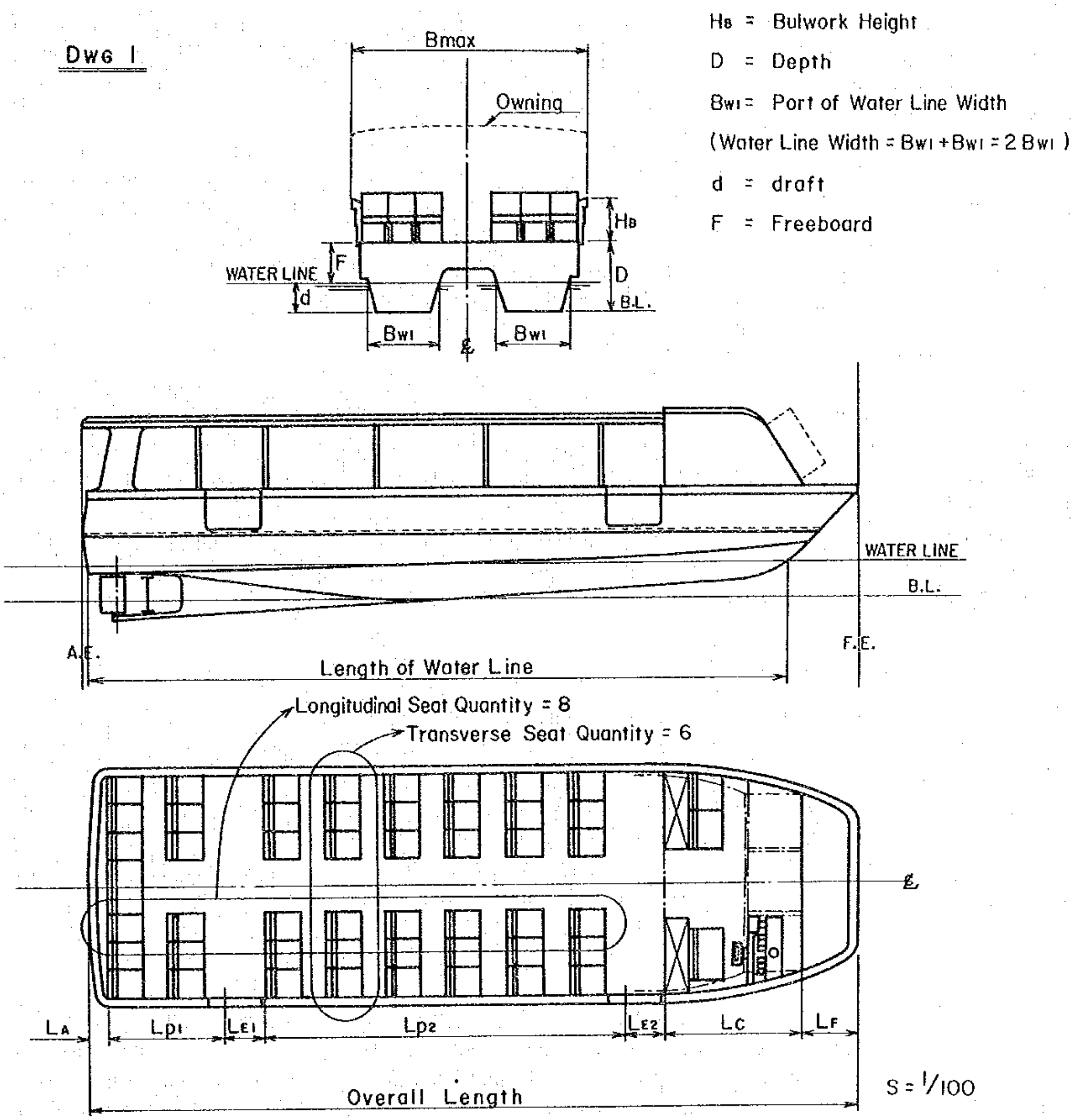


Figure 11.4-1(1) Design Flow Chart for Boat Dimension



L_A = Length of Aft

L_{P1} = Part of Length of Passenger Space

L_{P2} = 〃

(Length of Passenger Space = $L_{P1} + L_{P2}$)

L_{E1} = Part of Length of Exit

L_{E2} =

(Length of Exit = $L_{E1} + L_{E2}$)

L_C = Length of Cockpit

L_F = Length of Fare

Figure 11.4-1(2) Illustration of Boat Dimension

11.4.4 Result of Design

755. Tables 11.4-1 and 11.4-2 show the results of design works of the boat principal dimensions for monohull and catamaran types, respectively. They also include the preliminary boat construction cost.

756. Tables 11.4-3 and 11.4-4 show the boat cost per each passenger capacity and boat operation cost for monohull type and catamaran type per each passenger nautical mile, respectively. Based on these Tables, both boat cost and operation cost decrease according to the increase of passenger capacity.

11.4.5 Selection of Boat Size

757. As shown in Tables 11.4-3 and 11.4-4, bigger boat size and lower operation speed is better for operation from financial view point. However, actual operation has the restriction of physical and operational conditions of the route such as amount of demand, service frequency, navigation channel condition and route length. Therefore, the actual boat size shall be decided considering such conditions.

(1) Boat for Canal Route

758. The canal width is planned to be improved by 30 meters. Therefore, the boat overall length able to turn is to be less than 20 meters. And also the operation speed is limited so as not to induce the collapse of canal bank caused by high waves. Assuming the waterline length of boat 20 meters, the operating speed flude number is less than 0.326, which means low wave range by boat navigation, is 8.9 nautical mile per hour.

V = 0.326 x sqr(20 x 9.8) x 1.944 = 8.9 kt

759. Under this condition, the passenger capacity shall be less than 100 passengers. From economic view point, the monohull type boat is better, however, its superiority is not so much and stability is less than catamaran type. Therefore, for further investigation, following two types of boat shown in Table 11.4-5 are used;

Catamaran type, Capacity: 75 and 100 passengers

Table 11.4-1 Results of Boat Design (Monohull Type)

(MONOHULL-1)

No	No. of Passenger / Boat Speed(KT)	50 PASSENGERS					75 PASSENGERS					100 PASSENGERS				
		10	20	30	40	40	10	20	30	40	40	10	20	30	40	40
1	Length overall Loa (m)	14.70	14.70	12.50	12.50	12.50	19.10	15.80	15.80	15.80	15.80	19.10	19.10	19.10	19.10	19.10
2	Breadth maximum Bmax (m)	4.10	4.10	5.80	5.80	5.80	4.10	5.80	5.80	5.80	5.80	5.80	5.80	5.80	5.80	5.80
3	Depth D (m)	1.34	1.49	1.78	6.02	2.27	1.38	1.45	1.65	2.59	1.87	1.45	1.45	1.56	2.03	1.69
4	draft d (m)	0.64	0.79	1.08	5.32	1.57	0.68	0.72	0.95	1.89	1.17	0.62	0.71	0.86	1.33	0.99
5	Full load displacement ΔFull (t)	12.80	15.79	26.33	130.05	38.34	18.18	22.67	29.96	59.67	36.92	24.14	27.48	33.38	51.48	38.28
6	Engine horsepower SHP (ps)	85	495	1906	15510	4573	74	662	1772	5700	3527	98	671	1635	4024	2992
7	Loading fuel oil (t)	0.33	1.33	4.65	36.85	3.98	0.33	1.66	4.32	13.61	3.15	0.33	1.66	3.98	9.63	2.66
8	Fuel oil capacity (l)	400	1600	5600	44400	4800	400	2000	5200	16400	3800	400	2000	4800	11600	3200
9	Number of seats(transverse)	6	6	8	8	8	6	8	8	8	8	8	8	8	8	8
10	Continuous boat operating time (h)	11	11	11	11	4	11	11	11	11	4	11	11	11	11	4
11	Hull weight Wh (t)	6.70	7.20	9.80	26.90	11.80	9.60	10.70	11.80	16.50	12.90	13.00	13.00	13.60	16.50	14.40
12	Outfitting weight Wo (t)	1.75	1.75	1.75	1.75	1.75	2.50	2.50	2.50	2.50	2.50	3.25	3.25	3.25	3.25	3.25
13	Cost estimation Weight Wh+Wo (t)	8.45	8.95	11.55	28.65	13.55	12.10	13.20	14.30	19.00	15.40	16.25	16.25	16.85	19.75	17.65
14	Metacenter height GM (m)	2.03	1.50	3.26	1.10	2.14	1.78	5.15	3.75	1.68	2.94	5.91	5.18	4.17	2.50	3.56
15	Freeboard Fd (m)	0.70	0.70	0.70	0.70	0.70	0.70	0.73	0.70	0.70	0.70	0.83	0.74	0.70	0.70	0.70
16	Inclination θ (deg)	8.4	9.3	3.6	2.2	3.8	10.0	3.9	4.0	4.5	4.2	4.2	4.2	4.3	4.7	4.4
17	Freeboard in inclining (m)	0.40	0.37	0.52	0.59	0.51	0.34	0.53	0.49	0.47	0.49	0.62	0.53	0.48	0.46	0.48
	Hull Cost(Million Pesos) (Wh+Wo)*8	67.6	71.6	92.4	229.2	108.4	96.8	105.6	114.4	152.0	123.2	130.0	130.0	134.8	158.0	141.2
	Engine Cost(Million Pesos) SHP*0.151	12.8	74.7	287.8	2342.0	690.5	11.2	100.0	267.6	860.7	532.6	14.8	101.3	246.9	607.6	451.8
	Boat Cost(Million Pesos) Hull+Engine	80.4	146.3	380.2	2571.2	798.9	108.0	205.6	382.0	1012.7	655.8	144.8	231.3	381.7	765.6	593.0
	Boat Cost for One Passenger(Mill. Pesos) Boat Cost÷Number of Passenger	1.61	2.93	7.60	51.42	15.98	1.44	2.74	5.09	13.50	8.74	1.45	2.31	3.82	7.66	5.93
	F.O. Cost for 1P*1Nautical Mile(Pesos) C*SHP/(No. of Passenger*Speed)	3.64	10.59	27.20	165.99	48.94	2.11	9.45	16.86	40.67	25.16	2.10	7.18	11.66	21.53	16.01

(MONOHULL-2)

No	No. of Passenger / Boat Speed(KT)	200 PASSENGERS					300 PASSENGERS				
		10	20	30	40	40	10	20	30	40	40
1	Length overall Loa (m)	33.00	33.00	33.00	33.00	33.00	38.50	38.50	38.50	38.50	38.50
2	Breadth maximum Bmax (m)	5.80	5.80	5.80	5.80	5.80	6.80	6.80	6.80	6.80	6.80
3	Depth D (m)	1.46	1.53	1.63	1.81	1.69	1.70	1.70	1.70	1.83	1.73
4	draft d (m)	0.76	0.83	0.93	1.11	0.99	0.83	0.88	0.97	1.13	1.03
5	Full load displacement ΔFull (t)	52.79	57.07	64.06	76.48	68.43	79.77	84.22	9.74	108.33	98.91
6	Engine horsepower SHP (ps)	65	792	1914	3740	3346	70	951	2451	4638	4234
7	Loading fuel oil (t)	0.17	1.99	4.65	8.96	2.99	0.33	2.32	5.98	11.12	3.82
8	Fuel oil capacity (l)	200	2400	5600	10800	3600	400	2800	7200	13400	4600
9	Number of seats(transverse)	8	8	8	8	8	10	10	10	10	10
10	Continuous boat operating time (h)	11	11	11	11	4	11	11	11	11	4
11	Hull weight Wh (t)	31.90	32.10	32.50	33.30	32.80	48.70	48.70	48.70	49.40	48.90
12	Outfitting weight Wo (t)	6.25	6.25	6.25	6.25	6.25	9.25	9.25	9.25	9.25	9.25
13	Cost estimation Weight Wh+Wo (t)	38.15	38.35	38.75	39.55	39.05	57.95	57.95	57.95	58.65	58.15
14	Metacenter height GM (m)	4.62	4.21	3.67	2.97	3.40	6.18	5.86	5.28	4.50	4.99
15	Freeboard Fd (m)	0.70	0.70	0.70	0.70	0.70	0.87	0.82	0.73	0.70	0.70
16	Inclination θ (deg)	4.8	4.9	5.0	5.2	5.1	4.2	4.2	4.2	4.2	4.2
17	Freeboard in inclining (m)	0.45	0.45	0.45	0.44	0.44	0.62	0.57	0.48	0.45	0.45
	Hull Cost(Million Pesos) (Wh+Wo)*8	305.2	306.8	310.0	316.4	312.4	463.6	463.6	463.6	469.2	465.2
	Engine Cost(Million Pesos) SHP*0.151	9.8	119.6	289.0	564.7	505.2	10.6	143.6	370.1	700.3	639.3
	Boat Cost(Million Pesos) Hull+Engine	315.0	426.4	599.0	881.1	817.6	474.2	607.2	833.7	1169.5	1104.5
	Boat Cost for One Passenger(Mill. Pesos) Boat Cost÷Number of Passenger	1.58	2.13	3.00	4.41	4.09	1.58	2.02	2.78	3.90	3.68
	F.O. Cost for 1P*1Nautical Mile(Pesos) C*SHP/(No. of Passenger*Speed)	0.70	4.24	6.83	10.01	8.95	0.50	3.39	5.83	8.27	7.55

Note: The operation speed and passenger capacity considered in analysis were set taking into consideration the possible range of boat operation. Actual selection of these issues were made based on the local conditions of the navigation channels.

Table 11.4-2 Results of Boat Design (Catamaran Type)

[CATAMARAN-1]

No	No. of Passenger / Boat Speed(KT)			50 PASSENGERS					75 PASSENGERS					100 PASSENGERS				
				10	20	30	40	40	10	20	30	40	40	10	20	30	40	40
1	Length overall	Loa	(m)	12.50	12.50	12.50	12.50	12.50	15.80	15.80	15.80	15.80	15.80	19.10	19.10	19.10	19.10	19.10
2	Breadth maximum	Bmax	(m)	5.80	5.80	5.80	5.80	5.80	5.80	5.80	5.80	5.80	5.80	5.80	5.80	5.80	5.80	5.80
3	Depth	D	(m)	1.45	1.55	1.85	4.02	2.26	1.46	1.61	1.87	2.76	2.10	1.54	1.66	1.87	2.43	2.03
4	draft	d	(m)	0.69	0.85	1.15	3.32	1.56	0.76	0.91	1.17	2.06	1.40	0.84	0.96	1.17	1.73	1.33
5	Full load displacement	ΔFull	(t)	13.08	16.21	21.93	63.08	29.67	18.77	22.36	28.70	50.78	34.39	25.25	29.10	35.45	52.16	40.27
6	Engine horsepower	SHP	(ps)	114	595	1588	7523	3540	111	653	1697	4851	3285	102	711	1736	4076	3147
7	Loading fuel oil		(t)	0.33	1.49	3.82	17.93	3.15	0.33	1.66	4.15	11.62	2.99	0.33	1.83	4.15	9.79	2.82
8	Fuel oil capacity		(l)	400	1800	4600	21600	3800	400	2090	5000	14000	3600	400	2200	5000	11800	3400
9	Number of seats(transverse)			8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
10	Continuous boat operating time		(h)	11	11	11	11	4	11	11	11	11	4	11	11	11	11	4
11	Hull weight	Wh	(t)	6.90	7.00	7.50	10.80	8.10	10.10	10.40	11.00	13.00	11.50	14.10	14.40	15.10	16.80	15.60
12	Outfitting weight	Wo	(t)	1.75	1.75	1.75	1.75	1.75	2.50	2.50	2.50	2.50	2.50	3.25	3.25	3.25	3.25	3.25
13	Cost estimation Weight	Wh+Wo	(t)	8.65	8.75	9.25	12.55	9.85	12.60	12.90	13.50	15.50	14.00	17.35	17.65	18.35	20.05	18.85
14	Metacenter height	GM	(m)	8.00	6.37	4.56	1.76	3.32	7.09	5.83	4.40	2.38	3.62	6.31	5.38	4.29	2.77	3.72
15	Freeboard	Fd	(m)	0.76	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
16	Inclination	θ	(deg)	2.9	3.0	3.1	2.8	3.1	3.4	3.5	3.6	3.8	3.6	3.8	3.8	3.9	4.1	4.0
17	Freeboard in inclining		(m)	0.61	0.55	0.54	0.56	0.54	0.53	0.52	0.52	0.51	0.52	0.51	0.51	0.50	0.49	0.50
	Hull Cost(Million Pesos) (Wh+Wo)*8			69.2	70.0	74.0	100.4	78.8	100.8	103.2	108.0	124.0	112.0	138.8	141.2	146.8	160.4	150.8
	Engine Cost(Milllion Pesos) SHP*0.151			17.2	89.8	239.8	1136.0	534.5	16.8	98.6	256.2	732.5	496.0	15.4	107.4	262.1	615.5	475.2
	Boat Cost(Million Pesos) Hull+Engine			86.4	159.8	313.8	1236.4	613.3	117.6	201.8	364.2	856.5	608.0	154.2	248.6	408.9	775.9	626.0
	Boat Cost for One Passenger(Mill.Pesos) Boat Cost÷Number of Passenger			1.73	3.20	6.28	24.73	12.27	1.57	2.69	4.86	11.42	8.11	1.54	2.49	4.09	7.76	6.26
	F.O.Cost for 1P*1Nautical Mile(Pesos) C*SHP/(No.of Passenger*Speed)			4.88	12.74	22.66	80.51	37.88	3.17	9.32	16.14	34.61	23.44	2.18	7.61	12.39	21.81	16.84

[CATAMARAN-2]

No	No. of Passenger / Boat Speed(KT)			200 PASSENGERS					300 PASSENGERS				
				10	20	30	40	40	10	20	30	40	40
1	Length overall	Loa	(m)	33.00	33.00	33.00	33.00	33.00	38.50	38.50	38.50	38.50	38.50
2	Breadth maximum	Bmax	(m)	5.80	5.80	5.80	5.80	5.80	6.80	6.80	6.80	6.80	6.80
3	Depth	D	(m)	1.81	1.90	2.08	2.39	2.18	2.14	2.24	2.46	2.79	2.57
4	draft	d	(m)	1.11	1.20	1.38	1.69	1.48	1.44	1.54	1.76	2.09	1.87
5	Full load displacement	ΔFull	(t)	59.57	64.48	74.13	90.73	79.87	90.79	97.10	110.93	132.01	118.29
6	Engine horsepower	SHP	(ps)	73	895	2215	4436	3905	80	1096	2900	5650	5063
7	Loading fuel oil		(t)	0.33	2.16	5.31	10.62	3.49	0.33	2.66	6.97	13.45	4.48
8	Fuel oil capacity		(l)	400	2600	6400	12800	4200	400	3200	8400	16200	5400
9	Number of seats(transverse)			8	8	8	8	8	10	10	10	10	10
10	Continuous boat operating time		(h)	11	11	11	11	4	11	11	11	11	4
11	Hull weight	Wh	(t)	38.50	39.20	40.70	43.10	41.50	59.70	60.80	63.10	66.70	64.30
12	Outfitting weight	Wo	(t)	6.25	6.25	6.25	6.25	6.25	9.25	9.25	9.25	9.25	9.25
13	Cost estimation Weight	Wh+Wo	(t)	44.75	45.45	46.95	49.35	47.75	68.95	70.05	72.35	75.95	73.55
14	Metacenter height	GM	(m)	4.32	3.92	3.30	2.57	3.03	5.63	5.20	4.43	3.60	4.13
15	Freeboard	Fd	(m)	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
16	Inclination	θ	(deg)	4.6	4.7	4.8	5.1	4.9	4.0	4.1	4.2	4.3	4.2
17	Freeboard in inclining		(m)	0.47	0.46	0.45	0.44	0.45	0.46	0.46	0.45	0.44	0.45
	Hull Cost(Million Pesos) (Wh+Wo)*8			358.0	363.6	375.6	394.8	382.0	551.6	560.4	578.8	607.6	588.4
	Engine Cost(Milllion Pesos) SHP*0.151			11.0	135.1	334.5	669.8	589.7	12.1	165.5	437.9	853.2	764.5
	Boat Cost(Million Pesos) Hull+Engine			369.0	498.7	710.1	1064.6	971.7	563.7	725.9	1016.7	1460.8	1352.9
	Boat Cost for One Passenger(Mill.Pesos) Boat Cost÷Number of Passenger			1.85	2.49	3.55	5.32	4.86	1.88	2.42	3.39	4.87	4.51
	F.O.Cost for 1P*1Nautical Mile(Pesos) C*SHP/(No.of Passenger*Speed)			0.78	4.79	7.90	11.87	10.45	0.57	3.91	6.90	10.08	9.03

Table 11.4-3 Boat Construction Cost and Operation Cost (Monohull Type)

MONOHULL: Boat Cost for One Passenger(Million Pesos)

No of Passengers	50	75	100	200	300
10 KT	1.61	1.44	1.45	1.58	1.58
20 KT	2.93	2.74	2.31	2.13	2.02
30 KT	7.60	5.09	3.82	3.00	2.78
40 KT(1)	51.42	13.50	7.66	4.41	3.90
40 KT(2)	15.98	8.74	5.93	4.09	3.68

MONOHULL: Fuel oil Cost for One Passenger*One Nautical Mile(Pesos)

No of Passengers	50	75	100	200	300
10 KT	3.64	2.11	2.10	0.70	0.50
20 KT	10.59	9.45	7.18	4.24	3.39
30 KT	27.20	16.86	11.66	6.83	5.83
40 KT(1)	165.99	40.67	21.53	10.01	8.27
40 KT(2)	48.94	25.16	16.01	8.95	7.55

40KT(1):Continuous operating time is as same as another(11 Hours)
40KT(2):Continuous operating time is Different from another(4 Hours)

Table 11.4-4 Boat Construction Cost and Operation Cost (Catamaran Type)

CATAMARAN: Boat Cost for One Passenger(Million Pesos)

No of Passengers	50	75	100	200	300
10 KT	1.73	1.57	1.54	1.85	1.88
20 KT	3.20	2.69	2.49	2.49	2.42
30 KT	6.28	4.86	4.09	3.55	3.39
40 KT(1)	24.73	11.42	7.76	5.32	4.87
40 KT(2)	12.27	8.11	6.26	4.86	4.51

CATAMARAN: Fuel oil Cost for One Passenger*One Nautical Mile(Pesos)

No of Passengers	50	75	100	200	300
10 KT	4.88	3.17	2.18	0.78	0.57
20 KT	12.74	9.32	7.61	4.79	3.91
30 KT	22.66	16.14	12.39	7.90	6.90
40 KT(1)	80.51	34.61	21.81	11.87	10.08
40 KT(2)	37.88	23.44	16.84	10.45	9.03

40KT(1):Continuous operating time is as same as another(11 Hours)
40KT(2):Continuous operating time is Different from another(4 Hours)

Table 11.4-5 Boat Size for Canal Route Operation

Boat Type	Catamaran	Catamaran
Passenger Capacity	75	100
Overall Length	15.8 m	19.1 m
Breath Maximum	5.8 m	5.8 m
Depth	1.46m	1.54m
Waterline Length	14.5 m	17.8 m
Operation Speed	7.6 kt	8.4 kt
Engine Power	111 ps	102 ps
Boat Cost(million $)	117.6	154.2

source: Study Team

(2) Boat for Bay Area Route and Centro Route

760. In these routes the operation condition of lower speed and bigger passenger capacity seems to be adopted. However, the low operation speed brings the low service frequency and less competing service with public bus operation. Taking into consideration the competitive operation speed with public bus between Centro and Mercado Bazurto, the maximum operation speed of boat should be more than 20 kt.

761. Overall length of 38.5 meters for the boat of 300 passenger capacity is too long from view point of handling. Therefore, following boats shown in Table 11.4-6 are selected for further investigation;

Table 11.4-6 Boat Size for Bay Area Route and Centro Route

Boat Type	Catamaran	Catamaran
Passenger Capacity	100	200
Overall Length	19.1	33.0 m
Breath Maximum	5.8 m	5.8 m
Operation Speed	20 kt	20 kt
Engine Power	711 ps	895 ps
Boat Cost (Million $)	248.6	498.7

11.5 Operation System

11.5.1 Service Frequency

762. The operation period of water transport is 15 hours, from 6 a.m. to 9 p.m. same as public bus operation period. On the Bay Area Route and Centro Route, after sunset it will be necessary to decrease its operation speed (10 kt) for navigation safety.

763. From the demand analysis, the daily maximum passenger number of each route section is given. Assuming peak hour ratio of 8 %, the operation frequency and necessary boat number is estimated as shown in Table 11.5-1 (Demand in 1991 is employed).

764. In addition to this analysis, the number of operation shall be determined considering the service level compared with current public bus service. For the passengers, long operation interval results in smaller chance to use. Therefore, a minimum two (2) operations per hour system is considered.

Table 11.5-1 Operation Frequency and Boat Number Required

Route No.	101		102		103	
Max. Psn Demand	3,580		2,478		4,185	
Peak Psn Demand	286		198		335	
Boat Capacity	200	100	200	100	100	75
Frequency/hour	1.4	2.9	1.0	2.0	3.3	4.5
Max. Transfer Time (minute)	43	21	60	30	19	14
Round Trip Length (k.mile)	11.17		8.40		13.49	
Average Operation Speed (kt)	14	14	14	14	7	7
Round Trip Time (minute)	48		36		116	
Operation						
Frequency/hour	2	3	1	2	4	5
Revised frequency	2	3	2	2	4	5
Frequency/day	30	38	30	30	50	62
Boat Number	2	3	2	2	7	9

source: Study Team
note: Based on the demand forecast in 1991.

11.5.2 Administrative and Operation Organization

765. The organization composed of following sections is proposed;

Administrative section:
Function: operation control, financial control, administrative

Operation section:
Function: operation, communication

Customer Service section:
Function: ticketing, guide, sales, house keeping

Fuel, Maintenance section:
Function: maintenance, procurement, fuel stock

766. The organization size varies according to the boat size, boat number and terminal number.

11.5.3 Ticketing and Embarkation/Disembarkation System

767. As for the boarding system, following issues are considered;

a. boarding passenger list,
b. ticketing, and
c. fare collection.

(1) Boarding Passenger List

768. Passenger list is very useful in case of accidents and for the analysis of operation record. However, it is not an indispensable system (refer to the system of water transport in London). For the sake of cost saving and simple boarding system, passenger list is not employed.

(2) Ticketing

769. To issue the ticket at class C terminal is not recommendable because of the high cost necessary for those operations. However, it is useful to prevent the mistakes and errors in fare collection. Therefore, at class A and B terminals, ticketing system is to be introduced.

(3) Fare Collection

770. There are three systems to collect the fare;

a. before embarkation,
b. after disembarkation, and
c. on boat.

The first two systems require closed type terminal. On the other hand, fare collection on boat is very difficult to execute for large number of passengers.

771. Following fare collection system is proposed;

Class A and B Terminal:	Closed type terminal, ticketing at terminal and collection before boarding
Class C Terminal :	Open type terminal, ticketing on board and collection before off-boarding

11.6 Facility Plan

772. For the water transport operation, many sorts of facilities shall be invested on land as well as in the bay/canal. In the bay and canal, the beacon shall be introduced for night time navigation (about 11 locations).

773. On land, the following facilities are required;

a. boat terminal,
b. pontoon or wharf,
c. fuel supply and storage, and
d. maintenance yard.

(1) Boat Terminal

774. In order to determine the terminal size, it is necessary to plan its capacity for long term period. For this reason, passenger number passing through the terminal in 2010 is estimated. Table 11.6-1 shows the passenger number for each terminal.

Table 11.6-1 Passenger Number of the Terminal in 2010

Terminal No.	Name	No. of Passenger
1	Castillogrande	2,100
2	Bocagrande	5,100
3	Centro	14,300
4	India Catalina	8,400
5	Marbella	2,900
6	San Pedro	2,400
7	Barrio Chino	2,800
8	Mercado Bazurto	6,900
9	El Bosque	1,500
10	Santa Maria	4,200
11	Boston	500
12	Olaya Herrera	1,000

source: Study Team

775. For the purpose of planning the terminals, three levels of capacity are considered;

a. Class A: Centro, India Catalina and Mercado Bazurto
b. Class B: Bocagrande, Marbella, Barrio Chino and Santa Maria