3.2 Traffic Crossing Over the Biobio River

3.2.1 Past Trends of River Crossing Traffic

Past trends of traffic volume crossing over the Biobio River are shown in Table 3-2 and in Fig.3-5 from 1980 to 1993. Average annual growth rates of traffic through the past 13 years are summarized below:

- Cars,Wagons,Pickups : 12.6 % p.a.
- Buses : 9.5 % p.a.
- Trucks : 5.6 % p.a.
- Total : 11.3 % p.a.

Although stagnation and a downward shift appeared in 1984 and in 1988, the total traffic volume at the end of 1993 reached 42,400 vehicles a day. It is about 4(four) times the 1980 daily traffic.

3.2.2 Traffic Characteristics

(1) Traffic Volume on Each Bridge

According to the results of traffic survey conducted by the Study Team in December 1993, 24-hour traffic volume on each bridge is summarized below and detailed traffic data are presented in Table 3-3 to Table 3-8.

Table 3-1 Present Traffic Volume, Crossing the River,1993

(Vehículos/día)

Tipo de Vehículo	Puente Biobío Antiguo	Puente Juan Pablo II
Auto, familiar	14.729	8.746
Taxibuses	3.199	2.346
Camionetas	5.016	4.512
Buses	-	307
Camión (2 ejes)	-	1.718
Camión (3 ejes)	-	504
Camión con acoplado	-	1.329
TOTAL (doble sentido)	22.944	19.462

Source: Traffic census conducted by JICA Team and Road Department on December, 1993.

Although the vehicles passing through the present Biobio Bridge are limited to a maximum of 8 ton weight and the Bridge has only 2 lanes, more traffic volume is handled than that on the Juan Pablo II Bridge. A reason for this may partly depend upon the location of both bridges which affect the access to the CBD in Concepcion city.

Table 3-2 Past Trends of River Crossing Traffic

(Vehicle/Day)

Año	Auto,Wagon,Pickup	Bus	Camión	Total
1980	7.018	1.804	1.739	10.561
1982	17.049	3.832	1.083	21.964
1984	17.097	3.797	1.574	22.468
1988	16.047	3.366	1.733	21.146
1989	22.157	3.902	2.792	* 28.851
1992	-	-	-	** 40.521
1993	33.003	5.852	3.551	*** 42.406
Tasa Anual de Crecimiento				
(%)	12,6	9,5	5,6	11,3

Source: * Encuesta Origen-Destino de Vigas del Gran Concepción. 1990 DICTUC
** Estudio Censo Flujos de Trafico 1992-DICTUC
*** Equipo de Estudio de JICA, Dic.15.1993 y Otros años son de MOP

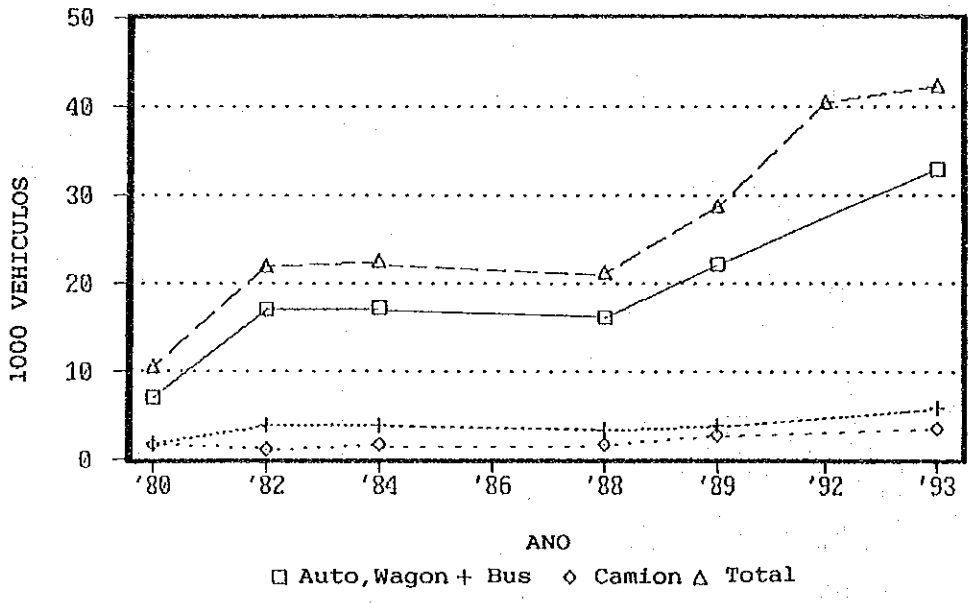


Fig. 3-5 Past Trends of River Crossing Traffic (1980-1993)

Table 3-3 River Crossing Traffic (BioBio Antiguo Bridge) [San Pedro to Concepcion: 1993]

Hora	AUTO WAGON	TAXIBUS	PICKUP	BUS	CAMION 2 EJES	CAMION >3EJES	ACOPLADOS	TOTAL
07-08	352	115	108	0	0	0	0	575
08-09	612	93	191	0	0	0	0	896
09-10	590	125	237	0	0	0	0	952
10-11	435	107	164	0	0	0	0	706
11-12	345	107	162	0	0	0	0	614
12-13	364	102	191	0	0	0	0	657
13-14	330	99	137	0	0	0	0	566
14-15	414	62	94	0	0	0	0	570
15-16	655	110	233	0	0	0	0	998
16-17	560	97	220	0	0	0	0	877
17-18	445	103	166	0	0	0	0	714
18-19	549	106	173	0	0	0	0	828
19-20	573	94	182	0	0	0	0	849
20-21	398	101	135	0	0	0	0	635
21-22	431	80	118	0	0	0	0	629
22-23	240	60	96	0	0	0	0	396
23-24	157	23	47	0	0	0	0	227
24-01	116	8	48	0	0	0	0	172
01-02	81	3	20	0	0	0	0	104
02-03	46	2	16	0	0	0	0	64
03-04	20	1	10	0	0	0	0	31
04-05	11	0	3	0	0	0	0	14
05-06	24	1	2	0	0	0	0	27
06-07	26	39	17	0	0	0	0	82
Total	7775	1638	2770	0	0	0	0	12183
12Horas Total	5651	1226	2076	0	0	0	0	8953
Tasa de Diaria/Diurna	1.38	1.34	1.33					1.36
Tasa de Horas Puntas	(%) 8.60	7.63	8.56					8.15

Table 3-4 River Crossing Traffic (BioBio Antiguo Bridge) [Concepcion to San Pedro: 1993]

time	AUTOS WAGONS	TAXIBUS	PICKUP	BUS	TRUCK 2 AXLES	TRUCK >3AXLES	TRAILERS	TOTAL
07-08	39	29	24	0	0	0	0	92
08-09	204	91	89	0	0	0	0	384
09-10	261	107	133	0	0	0	0	501
10-11	251	109	141	0	0	0	0	501
11-12	301	106	143	0	0	0	0	550
12-13	429	99	168	0	0	0	0	696
13-14	587	100	166	0	0	0	0	853
14-15	459	86	161	0	0	0	0	706
15-16	361	118	159	0	0	0	0	638
16-17	331	101	133	0	0	0	0	565
17-18	339	106	120	0	0	0	0	565
18-19	460	82	121	0	0	0	0	663
19-20	623	98	174	0	0	0	0	895
20-21	616	89	127	0	0	0	0	832
21-22	587	98	149	0	0	0	0	834
22-23	470	69	93	0	0	0	0	632
23-24	224	40	54	0	0	0	0	318
24-01	162	17	42	0	0	0	0	221
01-02	81	4	14	0	0	0	0	99
02-03	32	0	16	0	0	0	0	48
03-04	26	0	10	0	0	0	0	36
04-05	16	0	3	0	0	0	0	19
05-06	10	3	2	0	0	0	0	15
06-07	23	9	4	0	0	0	0	36
TOTAL	6892	1561	2246	0	0	0	0	10699
12HourTotal	4022	1134	1558	0	0	0	0	6714
Daily/Daytime Ratio	1.71	1.38	1.44					1.59
Peak Hour Ratio	(%) 9.04	7.56	7.75					8.37

Table 3-5 River Crossing Traffic (BioBio Antiguo Bridge) [Both-ways: 1993]

Hora	AUTO WAGON	TAXIBUS	PICKUP	BUS	CAMION 2 EJES	CAMION >3EJES	ACOPLADOS	TOTAL
07-08	391	144	132	0	0	0	0	667
08-09	816	184	280	0	0	0	0	1280
09-10	851	232	370	0	0	0	0	1453
10-11	686	216	305	0	0	0	0	1207
11-12	646	213	305	0	0	0	0	1164
12-13	793	201	359	0	0	0	0	1353
13-14	917	199	303	0	0	0	0	1419
14-15	873	148	255	0	0	0	0	1276
15-16	1016	228	392	0	0	0	0	1636
16-17	801	198	353	0	0	0	0	1442
17-18	784	209	286	0	0	0	0	1279
18-19	1009	188	294	0	0	0	0	1491
19-20	1196	192	356	0	0	0	0	1744
20-21	1015	190	262	0	0	0	0	1467
21-22	1018	178	267	0	0	0	0	1463
22-23	710	129	189	0	0	0	0	1028
23-24	381	63	101	0	0	0	0	545
24-01	278	25	90	0	0	0	0	393
01-02	162	7	34	0	0	0	0	203
02-03	78	2	32	0	0	0	0	112
03-04	46	1	20	0	0	0	0	67
04-05	27	0	6	0	0	0	0	33
05-06	34	4	4	0	0	0	0	42
06-07	49	48	21	0	0	0	0	118
Total	14667	3199	5016	0	0	0	0	22882
12Horas Total	9673	2360	3634	0	0	0	0	15667
Tasa de Diaria/Diurna	1.52	1.36	1.38					1.46
Tasa de Horas Puntas	(%) 8.15	7.25	7.81					7.60

Table 3-6 River Crossing Traffic (Juan Pablo II Bridge) [San Pedro to Concepcion: 1993]

Hora	AUTO WAGON	TAXIBUS	PICKUP	BUS	CAMION 2 EJES	CAMION >3EJES	ACOPLADOS	TOTAL
07-08	355	105	111	4	30	7	26	638
08-09	390	88	220	1	50	8	21	778
09-10	208	87	136	6	60	18	48	563
10-11	192	55	103	4	40	13	40	447
11-12	159	64	95	9	66	12	33	438
12-13	132	56	90	2	61	21	34	396
13-14	158	54	106	4	50	16	40	428
14-15	173	51	75	5	49	15	33	401
15-16	237	76	126	10	51	14	56	570
16-17	214	71	114	9	59	16	42	525
17-18	207	80	136	10	60	15	52	560
18-19	226	70	121	15	53	17	33	535
19-20	191	76	103	7	41	12	41	471
20-21	186	62	66	9	37	11	41	412
21-22	233	39	100	6	22	8	26	434
22-23	200	35	90	14	22	9	21	390
23-24	177	9	42	15	10	4	16	273
24-01	94	8	22	4	3	3	14	148
01-02	48	2	16	2	4	2	6	80
02-03	31	2	12	0	3	2	5	55
03-04	22	0	9	0	3	1	5	40
04-05	20	0	6	0	7	2	8	43
05-06	24	1	24	1	7	3	7	67
06-07	54	42	28	15	21	5	21	186
Total	3931	1131	1951	152	809	233	669	8876
12Horas Total	2651	855	1433	78	629	172	458	6276
Tasa de Diaria/Diurna	1.48	1.32	1.36	1.94	1.29	1.35	1.46	1.41
Tasa de Horas Puntas	(%) 9.92	9.30	11.28	9.84	8.16	9.01	8.37	8.76

Table 3-7 River Crossing Traffic (Juan Pablo II Bridge)
[Concepcion to San Pedro: 1993]

Hora	AUTO WAGON	TAXIBUS	PICKUP	BUS	CAMION 2 EJES	CAMION >3EJES	ACOPLADOS	TOTAL
07-08	184	74	102	11	41	9	32	453
08-09	273	105	189	7	75	14	32	695
09-10	189	96	137	4	77	14	43	560
10-11	167	55	127	7	73	9	48	486
11-12	186	64	122	5	71	13	51	512
12-13	216	70	140	9	66	18	31	550
13-14	317	76	189	4	52	19	56	715
14-15	263	58	156	12	47	8	42	586
15-16	210	54	129	4	45	13	30	485
16-17	231	60	146	9	72	9	33	561
17-18	267	63	146	13	51	21	27	588
18-19	341	76	164	9	43	29	35	697
19-20	433	91	205	9	50	5	44	836
20-21	436	82	148	10	81	8	31	796
21-22	347	61	160	3	16	15	27	630
22-23	262	46	104	3	6	4	14	439
23-24	180	33	56	6	6	4	18	303
24-01	114	6	40	3	4	4	18	190
01-02	62	4	30	2	5	1	17	121
02-03	52	2	9	0	3	1	5	72
03-04	15	0	8	0	0	0	8	31
04-05	13	0	8	0	1	5	6	33
05-06	26	3	14	1	5	18	9	76
06-07	31	34	32	22	19	30	3	171
Total	4815	1215	2561	155	909	271	660	10586
12Horas Total	2844	854	1747	96	713	176	460	6889
Tasa de Diaria/Diurna	1.69	1.42	1.47	1.62	1.27	1.54	1.43	1.54
Tasa de Horas Puntas	(%) 9.06	8.66	8.00	14.44	8.91	11.07	8.48	7.90

Table 3-8 River Crossing Traffic (Juan Pablo II Bridge)
[Both-ways: 1993]

Hora	AUTO WAGON	TAXIBUS	PICKUP	BUS	CAMION 2 EJES	CAMION >3EJES	ACOPLADOS	TOTAL
07-08	539	179	213	15	71	16	58	1091
08-09	663	193	409	8	125	22	53	1473
09-10	397	183	273	11	137	32	91	1124
10-11	359	110	230	11	113	22	88	933
11-12	345	129	217	14	137	25	84	951
12-13	348	126	230	11	127	39	65	946
13-14	475	131	295	8	102	35	96	1142
14-15	436	109	231	17	96	23	75	987
15-16	447	130	255	14	96	27	86	1055
16-17	445	131	260	18	131	25	75	1085
17-18	474	143	282	23	111	36	79	1148
18-19	567	146	285	24	96	46	68	1232
19-20	624	167	308	16	91	17	85	1308
20-21	622	144	214	19	118	19	72	1208
21-22	580	100	260	10	38	23	53	1064
22-23	462	81	194	16	28	12	35	828
23-24	357	41	98	21	16	8	34	575
24-01	208	14	62	7	7	7	32	337
01-02	110	6	46	4	9	3	23	201
02-03	83	4	21	0	6	3	10	127
03-04	37	0	17	0	3	1	13	71
04-05	33	0	14	0	8	7	14	76
05-06	50	4	38	2	12	21	16	143
06-07	85	76	60	37	40	35	24	357
Total	8746	2347	4512	306	1718	504	1329	19462
12Horas Total	5495	1710	3180	174	1342	348	918	13167
Tasa de Diaria/Diurna	1.59	1.37	1.42	1.76	1.28	1.45	1.45	1.48
Tasa de Horas Puntas	(%) 7.58	8.22	9.06	12.16	7.97	9.13	7.22	7.57

(2) Vehicle Composition

Percentage composition rates of vehicle type on each bridge are illustrated in Fig.3-6. The most dominant vehicle types on both bridges are passenger cars,wagons and pickups. Cargo vehicles such as trucks and trailers are currently using only the Juan Pablo II Bridge.

(3) Daily/daytime Ratio

In general, (daily)/(daytime) traffic ratios reflect the activity patterns of the areas and are indicators of roles/functions of roads. The ratios for the Biobio Bridge and Juan Pablo Bridge are around 1.46 and 1.48 respectively. This means that many vehicles which amount to about 50 % of daytime traffic volume are still running even in night time (from 7:00 PM to 7:00 AM of next morning).

(4) Peak Hour Ratio

The peak hour ratios of both bridges are almost the same, (7.60 %).

(5) Time Fluctuations of Traffic

- Present Fluctuation patterns of Both Bridges

The hourly fluctuations in traffic by each bridge and by direction in 1993 are shown in Fig.3-7. Three (3) peaks are clearly observed i.e: morning peak (8:00 AM - 9:00 AM), afternoon peak (1:00 PM - 3:00 PM) and evening peak (7:00 PM - 9:00 PM). The afternoon peak for the direction of Concepcion to San Pedro appears shortly before the afternoon peak for the direction of San Pedro to Concepcion. This reflects a characteristic of urban structures of Concepcion and San Pedro.

- Past Trend of Time Fluctuations

Fig.3-8 indicates the comparison of hourly fluctuations in 1989, 1991 and 1993. Traffic volume on Juan Pablo II Bridge have been increasing in every time zone and shapes of peaks became more sharp. Hourly traffic on the Biobio Bridge in 1993 has increased from 1989 in every time except for the period 12:00 - 1:00 PM. On the other hand, comparison of fluctuations between 1991 and 1993 does not show clear difference because of only 2 years interval.

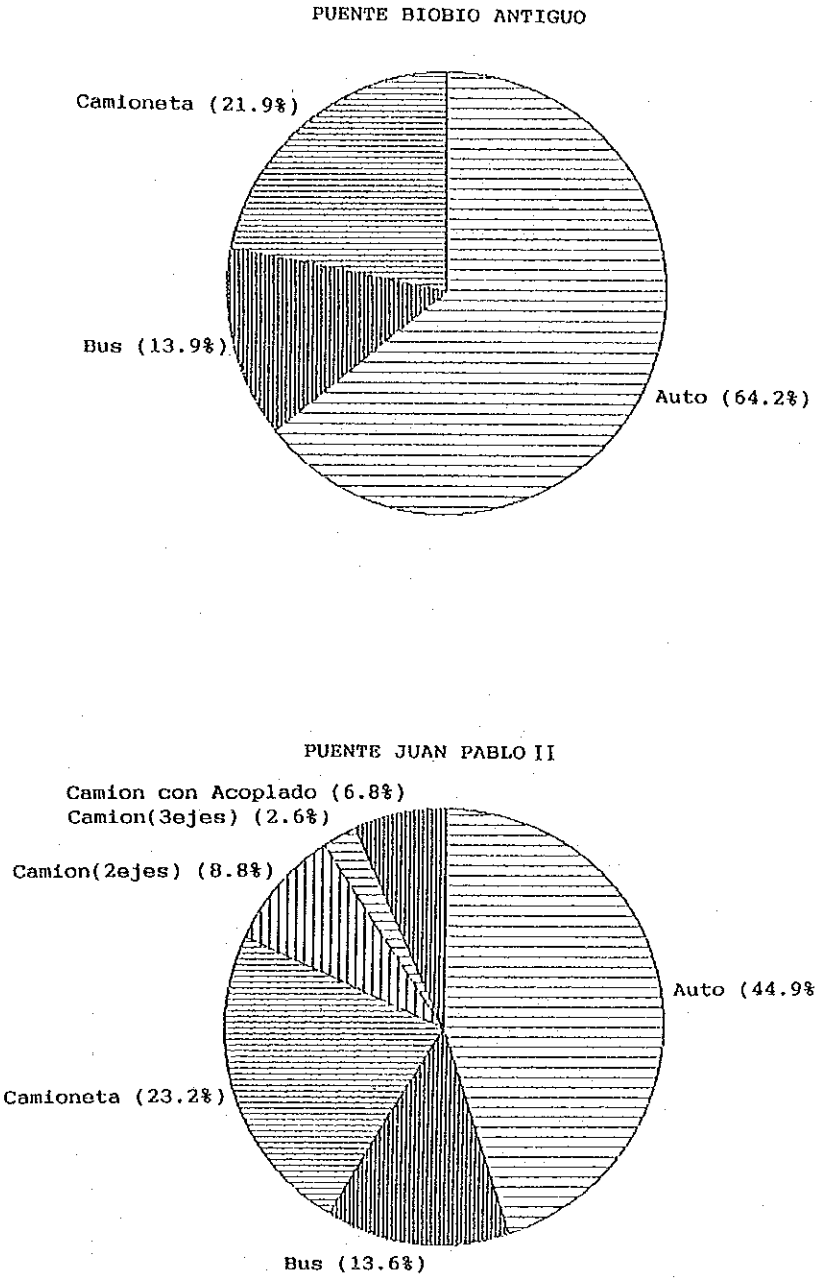
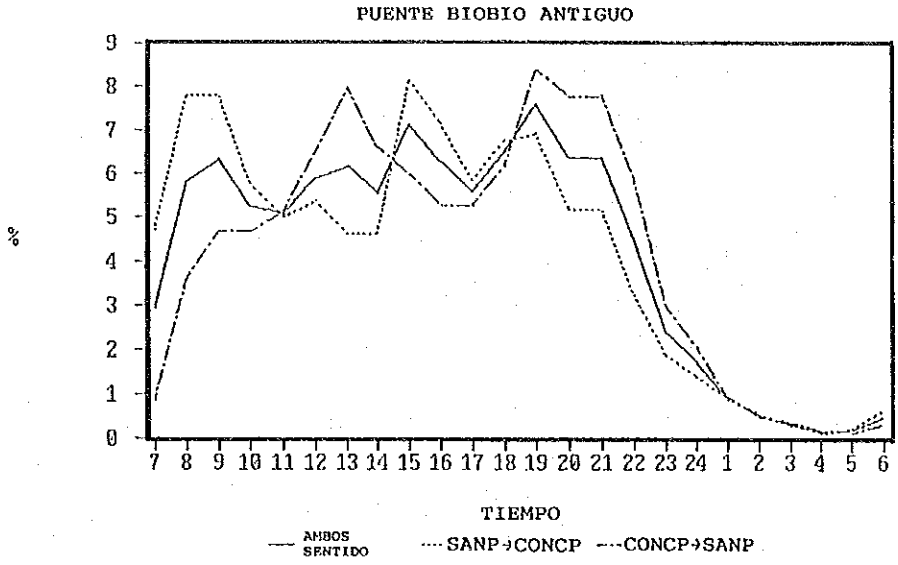


Fig. 3-6 Vehicle Composition



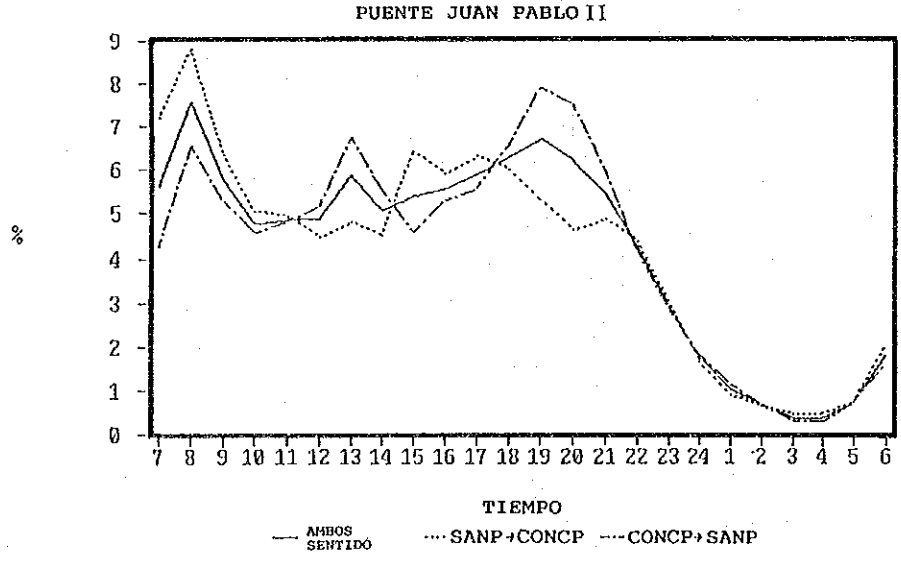
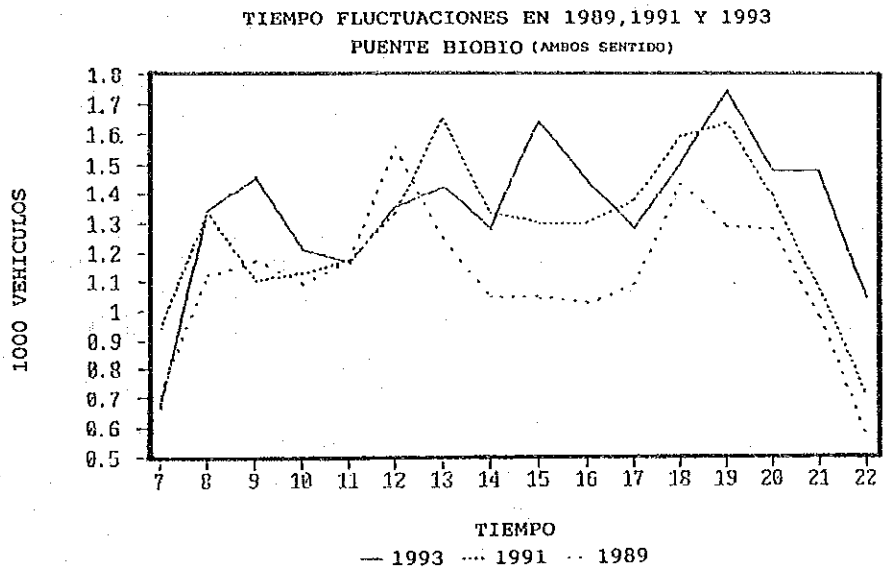


Fig. 3-7 Time Fluctuations of Traffic



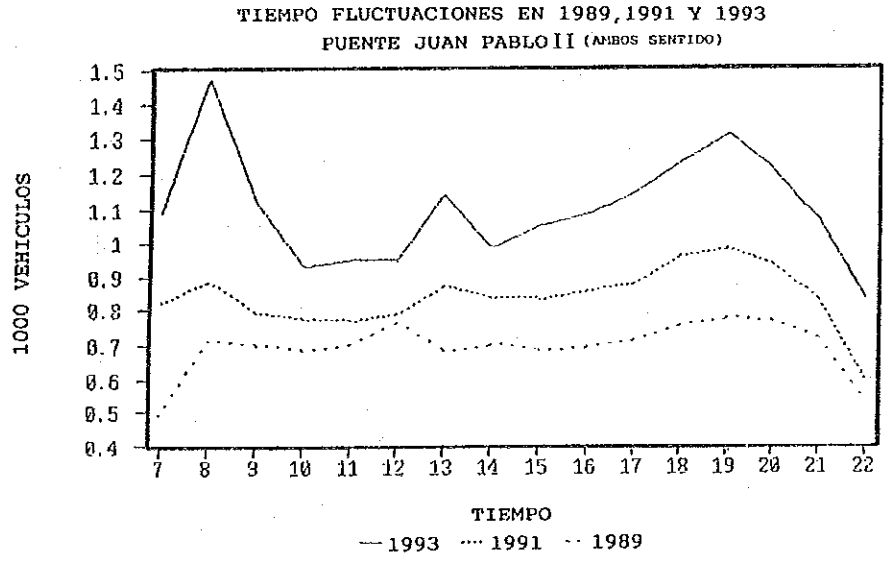


Fig. 3-8 Past Trend of Time Fluctuations

3.3 Traffic in the Town Area

A comprehensive traffic study was conducted by Departamento Ingenieria Civil De Transporte, Pontificia Universidad Catolica (DICTUC) "Encuesta Origen-Destino de Viajes Del Gran Concepcion" in 1989 which involved O-D survey and classified traffic counting survey in the town area of Concepcion. A total of 21 survey stations shown in Fig.3-9 were selected from the study mentioned above for the analysis. The summarized traffic data are presented in Table 3-9.

Among these survey stations, those located at the entrances to the central area (No.16,17,18,19,20,35) show comparatively high traffic volume more than 10,000 vehicles. The trunk roads forming North - South Axes such as A.Prat avenue (No.34) and Paicavi street(No.37) handled 18,000 vehicles and 17,000 vehicles respectively. The number of buses and its composition percentage at A.Prat avenue(No.34) indicate high figures because of the bus terminal located along the avenue.

The traffic volume of cargo vehicles are not so significant except for the entrance gates such as Juan Pablo Bridge (No.17), Autopista (No.20) and Rotonda Bonilla(No.36). See Table 3-10.

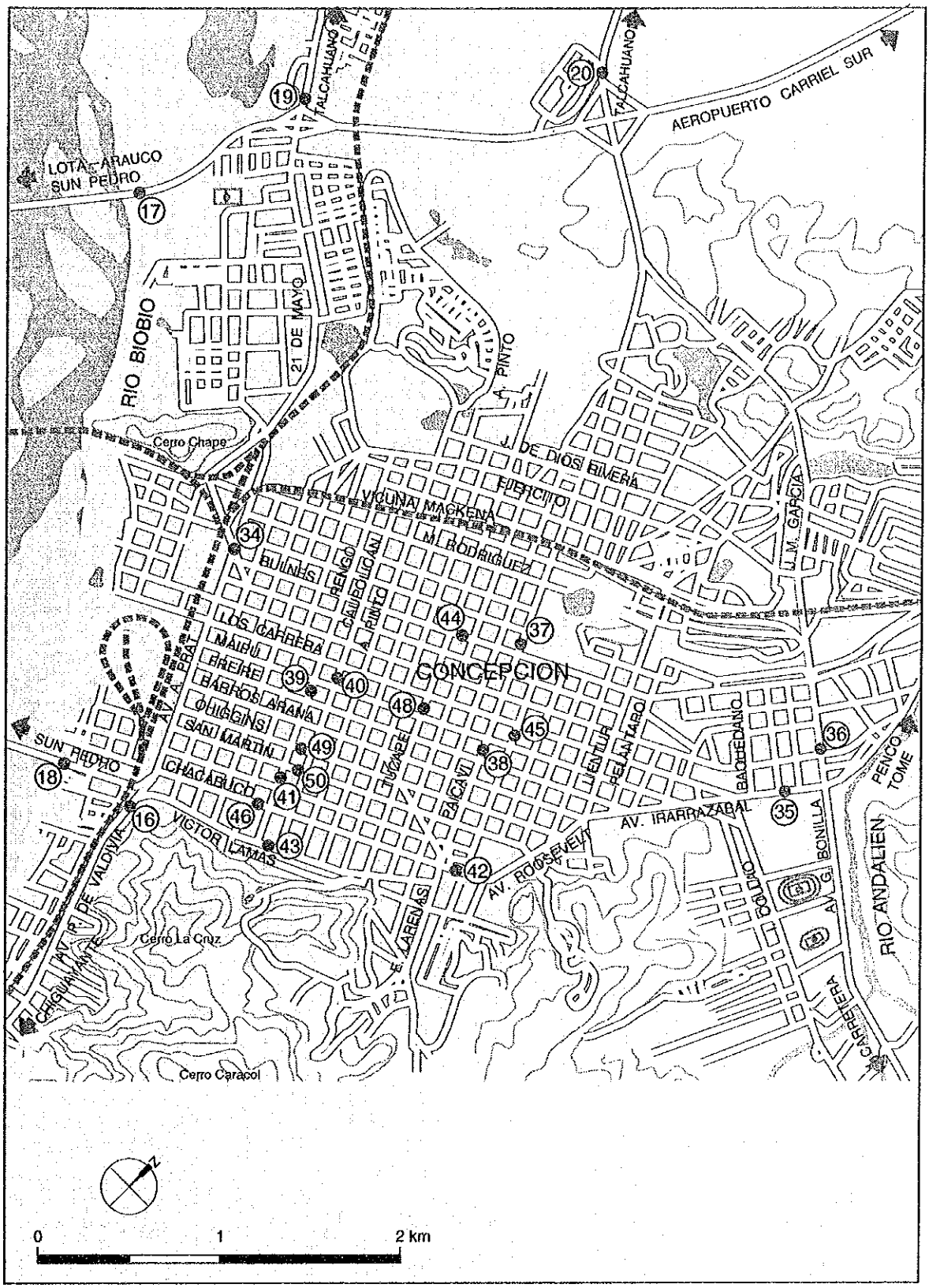


Fig. 3-9 Traffic Survey Stations by DICTUC (Central Area)

Table 3-9 Traffic Volume on Main Streets (1989)

(Vehiculos/16horas)

Codigo de Estacion	Auto, Taxi	Bus	Camion	Total	Un Sentido Dos Sentidos
16	12,879	2,538	1,133	16,550	2
17	7,142	1,492	2,451	11,085	2
18	15,015	2,410	341	17,766	2
19	10,977	6,212	823	18,012	2
20	16,992	2,718	3,209	22,919	2
34	9,100	7,821	1,322	18,243	2
35	8,237	2,591	638	11,466	2
36	6,006	682	3,107	9,795	2
37	12,833	2,853	961	16,647	2
38	6,921	2,377	117	9,415	1
39	7,744	678	179	8,601	1
40	7,611	447	105	8,163	1
41	5,546	629	41	6,216	1
42	10,704	1,108	166	11,978	2
43	9,950	96	201	10,247	1
44	5,212	192	567	5,971	1
45	3,293	1,284	92	4,669	1
46	8,955	448	151	9,554	2
48	5,122	803	105	6,030	1
49	9,289	3,684	102	13,075	1
50	6,751	2,397	109	9,257	1

Source: Encuesta Origen-Destino Viajes Del Gran Concepcion
Ministerio de Economia, Fomento y Reconstruccion
Enero-1990 Pontificia Universidad Catolica De Chile

Table 3-10 Vehicle Composition

(%)

Codigo de Estacion	Auto, Taxi	Bus	Camion	Total
16	77.82	15.34	6.85	100.00
17	64.43	13.46	22.11	100.00
18	84.52	13.57	1.92	100.00
19	60.94	34.49	4.57	100.00
20	74.14	11.86	14.00	100.00
34	49.88	42.87	7.25	100.00
35	71.84	22.60	5.56	100.00
36	61.32	6.96	31.72	100.00
37	77.09	17.14	5.77	100.00
38	73.51	25.25	1.24	100.00
39	90.04	7.88	2.08	100.00
40	93.24	5.48	1.29	100.00
41	89.22	10.12	0.66	100.00
42	89.36	9.25	1.39	100.00
43	97.10	0.94	1.96	100.00
44	87.29	3.22	9.50	100.00
45	70.53	27.50	1.97	100.00
46	93.73	4.69	1.58	100.00
48	84.94	13.32	1.74	100.00
49	71.04	28.18	0.78	100.00
50	72.93	25.89	1.18	100.00

Source: Encuesta Origen-Destino Viajes Del Gran Concepcion
Ministerio de Economia, Fomento y Reconstruccion
Enero-1990 Pontificia Universidad Catolica De Chile

CHAPTER 4. FUTURE SOCIO-ECONOMIC FRAME OF THE STUDY AREA

4.1 Basic Idea of Projection

The projection of socio-economic indicators is conducted as shown in Fig. 4-1 and Fig. 4-2.

For the development of traffic generation/attraction, the population data, number of employed persons on working place basis, and number and type of vehicles, are selected as the three basic indicators to be projected at the zone level. As basic indices, the Gross Domestic Product (GDP) and the Gross Regional Domestic Product (GRDP) are projected at the national and regional levels, respectively. Household income, which is regarded as an important indicator for the projection of the number of household-owned vehicles, is used only for the urban areas of the Concepcion Province due to lack of data.

The base year of projection is 1993 and the target year is 2010. Since the most recently available data are available only for 1992, our first task was to collect and arrange the official data for 1992, and make the basic projections for the year 2010. Projections for the years 2000 and 2020 were also conducted.

No data are published for the district or community level areas smaller than the municipality. Since there are several zones (15) within the Municipality of Concepcion, we had to develop a breakdown of the data by zones and obtain the information from various sources in order to get a comprehensive information about the Municipality of Concepcion. The following studies were, therefore, carried out for the Municipality of Concepcion.

1. To request the Instituto Nacional de Estadisticas (INE) for a special tabulation of 1991 Pre-census data at the level of Census District (population, number of households and number of establishments by economic activity).

2. To collect data on the numbers of private economic establishments and owners of vehicles according to our traffic zones using the municipal directories of registered establishments and vehicle owners, which were obtained by the Study Team through the courtesy of the Municipality of Concepcion.

3. To visit selected establishments from the various categories in order to collect data on the number of employed persons.

4. To make use of the data of a 1989 study carried out by Secretaria de Transporte (SECTRA) for the Urban Area of Metropolitan Concepcion. This study included data on number of households by monthly income rank, number of vehicles owned by household, number of employed persons and peak OD table, each at their traffic zone level, and almost corresponding to the Census Zone. In actuality, the Census Zone is smaller than the Census District.

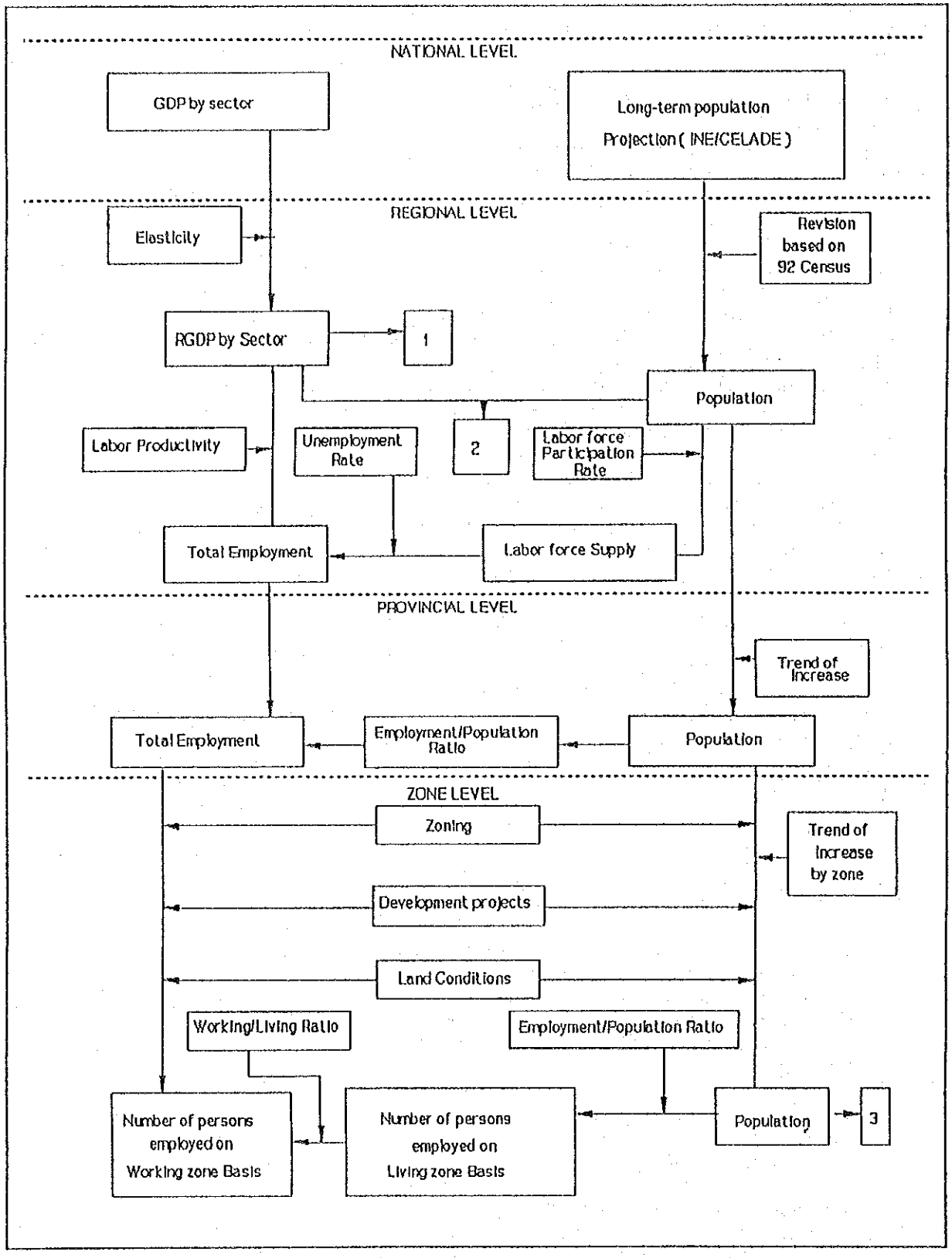


Fig. 4-1 Projection Flow of Population and Employment

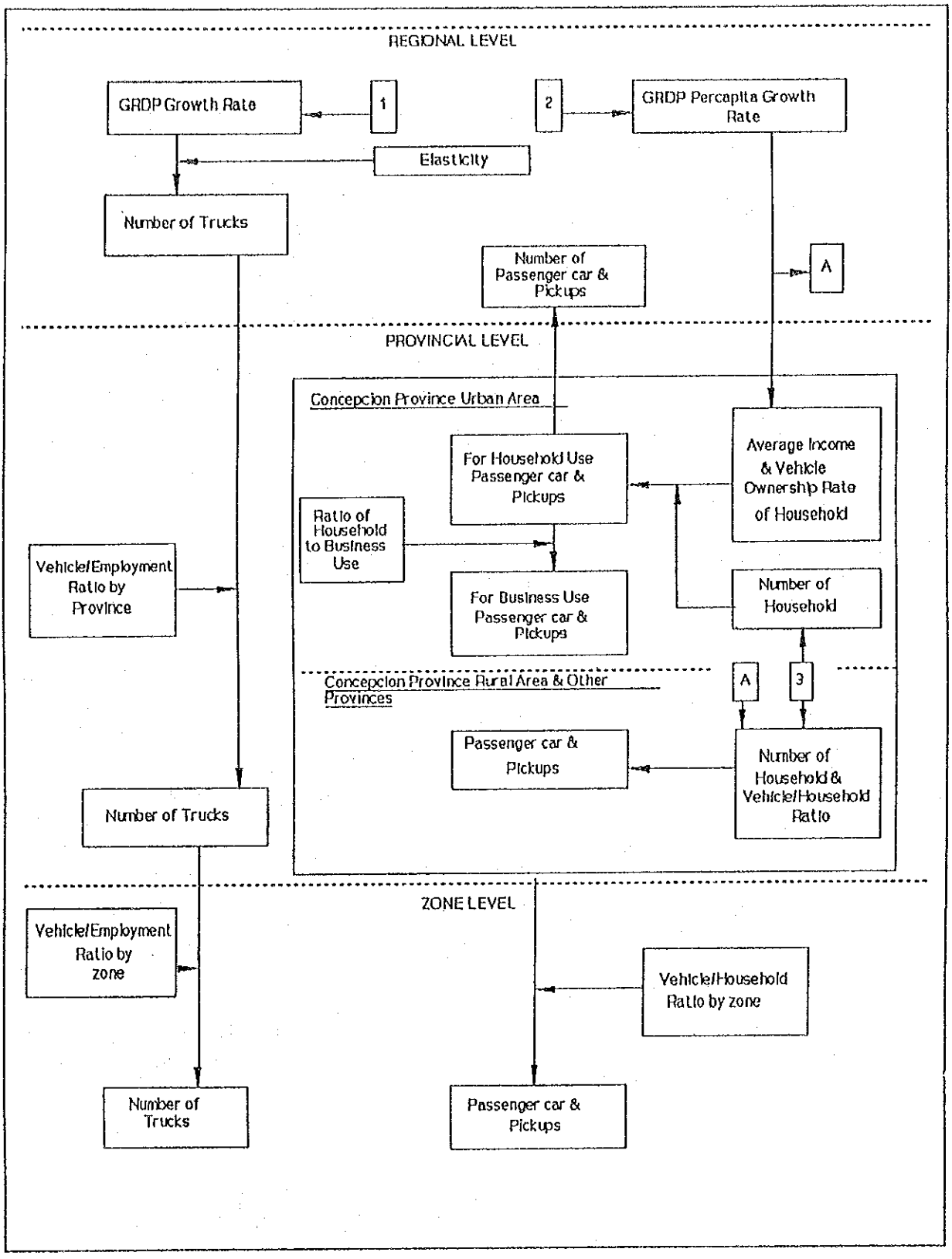


Fig. 4-2 Projection Flow of Number of Vehicles

The principal elements of the future projections are as follows:

1. The future sectoral growth of the economic conditions (primary, secondary and tertiary) of the Region VIII will change in parallel with the national economic growth.

2. In the long term the population of Chile will increase along the projections made by Instituto Nacional de Estadisticas/ Centro Latino Americano de Demografia-Naciones Unidos (INE/CELADE). Regional and provincial population distribution will follow a similar pattern after making the adjustments based on the 1992 Census.

3. Within the Concepcion Province, the population distribution will be affected by the present trends of increase by zone reflecting the physical and social land availability. It will also be affected by the zoning of Plan Regulador and other development projects carried out by the public and private sectors.

4. Employment will be determined as a balance in supply and demand of the labor force.

5. Commuting in and out at the provincial level will be balanced.

6. Within the Concepcion Province, employment distribution will continue along the existing pattern with some changes brought about by industrial/commercial development projects planned in the suburbs and inside the built-up area.

7. More than 80% of the registered cars and pickups are owned and used by household.It is therefore concluded that future ownership of vehicles of this type will be mainly determined by household income.

8. The average household income will rise parallel to the increase in the GRDP on condition that a constant portion of the value added in the economic activity will be distributed to personal income.

9. The distribution of passenger cars and pickups will be affected by the gaps in the household incomes of the specific zone.

10. The number of trucks will increase in accordance with the regional economic growth.

11. The distribution of trucks will reflect the existing relationship of the ratios of "number of trucks to employment" by zone.

4.2 Trend of Economic Growth in Chile and the Region VIII

4.2.1 National Economy

As a consequence of the international recession in the early eighties, the Chilean economy experienced a drastic fall of -14.1% in 1982, followed by -0.7% in 1983. Since 1984, however, the Chilean economy has been experiencing a continuous growth. See Table 4-1.

Ever since the debt crisis of 1982, the government took various steps which affected the economic policies, including the imposition of severe austerity measures, negotiating for debt rescheduling, capitalization of debt, promoting exports and restraining imports, and devaluation of the Chilean Peso. Success of these measures, supported by high prices of copper and low prices of crude oil on the world market, has brought about a long-term economic expansion.

According to a recent publication of the Central Bank of Chile "Cuentas Nacionales de Chile, 1985-1992", GDP per capita in 1992 was 1,098.6 thousand Pesos at current prices, equivalent to US $3,030, applying the annual average exchange rate of US $1.00 = Ch.$362.576.

Nearly half of Chile's total exports are mineral products, especially copper. Fluctuation of its international price, therefore, has a great influence on the Chilean economy. As for the countries of destination, Japan and the United States are competing for first place in recent years, with each accounting for 15% to 20% of the total value of the exports.

The above mentioned facts indicate vulnerability of Chile's economic structure due to fluctuations in the world copper price and recession in the industrialized countries, especially Japan and US which impacted adversely on the Chilean economy in 1993.

4.2.2 Economic Situation of the Region VIII

The Gross Regional Domestic Product (GRDP) is estimated and published by the Central Bank of Chile. At present the figures until 1986 are available. The 1987 to 1990 figures are being processed and are not yet available. The GRDP of the Region VIII for 1986 is shown in Table 4-2.

The total amount of GRDP was 36,394 million Pesos at 1977 prices, which amounted to 9.7% of the GDP in that year.

The sectoral composition of the Region VIII shows an excellent position with regard to the manufacturing industry. It produces one third of the Region's total value added and 15% of the national total of the manufacturing industry. The industrial activity of the Region is concentrated at the industrial complex organized in the Municipality of Talcahuano in Concepcion

Table 4-1 Economic Growth Trend of Chile

Año	PIB (Millones de pessos de 1977)	Tasa anual de crecimiento (%)
1980	363.446	---
1981	383.551	5,5
1982	329.523	-14,1
1983	327.180	-0,7
1984	347.926	6,3
1985	356.447	2,4
1986	376.627	5,7
1987	398.230	5,7
1988	427.530	7,4
1989	470.243	
1990	480.323	10,0
1991	509.153	2,1
1992	562.254	6,0
		10,4

Source : Central Bank of Chile

Table 4-2 GRDP by Sector of the Region VIII in 1986

Clase de Actividad Económica	PIBR (Millones de Pesos de 1977	Distribución Regional (%)	Contribución Nacional(%)
Agricultura y pesca	5.911	16,3	15,9
Minería	836	2,3	2,7
Industrias manufactureras	11.936	32,8	15,2
Construcción	1.585	4,4	7,6
Electricidad, gas y agua(1)	1.867	5,1	19,2
Transporte y comunicación(2)	2.127	5,8	9,9
Comercio(3)	4.392	12,1	7,0
Otros(4)	7.740	21,2	6,8
Sector primario	5.911	16,3	15,9
Sector secundario(5)	14.357	39,5	11,0
Sector terciario(6)	16.126	44,2	7,7
Total	36.394	100,0	9,7

Note: (1) Incluye servicios sanitarios
(2) Incluye almacenaje
(3) Incluye comercio al por mayor y al por menor
(4) Incluye sector financiero, propiedad de vivienda, educación, salud, otros servicios, administración publica e imputaciones bancarias
(5) Incluye mineria, industrias manufactureras y construcción
(6) Incluyeelectricidad, gas y agua,transporte y comunicación, comercio y otros

Source: Banco Central de Chil

Province, where an oil refinery, an ironworks establishment, a number of fish meal producing factories and other types of manufacturing industries are located.

In addition to the above-mentioned industrial zone, there are some large-scale factories in Concepcion Province, such as, a papermill in San Pedro, a footwear factory in Concepcion, a textile factory in Chiguayante, all in the Municipality of Concepcion. There is a textile factory in the Municipality of Tome. In the Municipality of Penco there are a glassworks factory and a pottery factory which went bankrupt recently.

By virtue of the presence of the industrial complex and other large-scale factories, Concepcion Province accounts for two thirds of the industrial activity of the Region. (See Table 4-3).

In 1991, there were 476 establishments (manufacturing industry) with 10 or more employees in the Region VIII. The number of employees was 47,104 and the amount of value added was 479,573 million Pesos. As shown in Table 4-4, "Foodstuffs", "Wood industry except furniture", "Paper & products", "petroleum refining" and "Basic iron and steel" are important industrial types from the viewpoint of employment or value added.

Data about number of employed persons by economic sector at the national and regional levels are published quarterly by the INE based on the "Enquesta Nacional del Empleo" (national employment survey). Table 4-5 shows the annual average number of employed persons by sector in 1986.

The total number of employed persons is 472,750. The sector "Others" has the largest share, 31.5 %, followed by "Agriculture & fishing". "Manufacturing" uses only 13.0 % of the total employment while it accounts for 32.8 % of GRDP.

The sectoral labor productivities, calculated by dividing GRDP by the number of employed persons, are shown in Table 4-6. This table shows that the labor productivity of Region VIII is approximately 80 % of the national average. Manufacturing industries, and electricity, gas and water of the Region have a higher productivity, while the other sectors have a considerably lower productivity than the national average except for agriculture.

Table 4-3 Industrial Activity by Province in the Region VIII, 1991

(Establecimientos con 10 o más personas contratadas)

Provincia	Número de Establecimientos	Ocupación Media Total	Valor Agregado (Millones de Pesos)
Concepción	301	31.196	311.727
Ñuble	76	5.456	30.964
Biobío	82	8.293	105.688
Arauco	17	2.159	31.194
Total	476	47.104	479.573

Source: INE

Table 4-4 Industrial Activity by Type of Industry in the Region VIII, 1991

(Establishments of 10 and more persons engaged)

Tipo de Industria	Número de Establecimientos	Ocupación Media Total	Valor Agregado (Millones de Pesos)
Alimenticios	176	14.060	88.629
Bebidas	6	786	13.091
Textiles	7	2.191	12.148
Prendas	10	337	591
Cuero	5	407	1.396
Calzado	21	1.757	5.067
Madera	106	10.199	57.686
Muebles	14	664	2.421
Papel	8	2.897	112.180
Imprentas	15	426	1.394
Ss.químicas	9	767	20.476
Os.químicos	3	219	1.062
Refinerías	1	645	63.106
Petro/carbón	3	103	255
Caucho	2	46	94
Plásticos	4	130	1.829
Loza	3	1.425	2.247
Vidrio	2	281	1.548
Os.no metal.	15	1.002	10.914
Hierro	2	3.867	55.192
Ps.metálicos	24	2.624	14.383
Maquinaria	23	1.486	9.779
M.transporte	14	727	3.980
Equipo prof.	1	12	30
	2	36	75
Total	476	47.104	479.573

Source: INE

Table 4-5 Employed Persons by Sector in the Region VIII in 1986 (Annual Average)

Clase de Actividad Económica	Número de Personas	Porcentaje
Agricultura y pesca	133.750	28,3
Minería	13.750	2,9
Industrias manufactureras	61.600	13,0
Construcción	17.750	3,8
Electricidad, gas y agua	2.350	0,5
Transporte y comunicación	25.300	5,4
Comercio	69.200	14,6
Otros	149.050	31,5
Sector primario	133.750	28,3
Sector secundario	93.100	19,7
Sector terciario	245.900	52,0
Total	472.750	100.0

Source: Calculacions del Equipo de Estudio como el promedio de los datos de trimestre octubre diciembre de 1985 y 1986 publicado por INE

Table 4-6 Labor Productivity by Sector in the Region VIII in Comparison with Chile Total, 1986

Clase de Actividad Económica	Región VIII (Pesos de 1977 por persona)	Chile (Pesos de 1977 por persona)	Razón Región por Chile
Agricultura y pesca	44.200	47.800	0,92
Minería	60.800	370.400	0,16
Industrias manufactureras	193.800	153.100	1,27
Construcción	89.300	126.500	0,71
Electricidad, gas y agua	794.500	386.700	2,05
Transporte y comunicación	84.100	97.000	0,87
Comercio	63.500	97.200	0,65
Otros	51.900	83.200	0,62
Sector primario	44.200	47.800	0,92
Sector secundario	154.200	171.600	0,90
Sector terciario	65.600	91.900	0,71
Total	77.000	98.900	0,78

The low productivity in mining highlights the difference between copper and coal minings. The national average includes the high productivity of the copper mining, whereas the mining of Region VIII involves the large coal mining zone from Coronel in Concepcion Province to Lebu in Arauco Province. The coal pits are about to be closed due to financial trouble brought about by low productivity.

The annual average number of employed persons in 1992 (Table 4-7) increased remarkably from that of 1986. The number of employed persons in "Industrias manufacturales", and "Construccion" in the secondary sector; and "Transporte y Comunicacion" and "Comercio" in the tertiary sector, grew considerably. In the same period, "mining" showed a reduction in the number of employed persons, and it is estimated that only about 7,000 persons remain in the mining activity in 1993.

Observing the data since 1980, these productivity differentials by sector continued almost at the same levels till 1986. Assuming that the differentials in 1986 continued with no change till 1992, the GRDP by sector (3 sectors) of Region VIII is estimated for 1992. See Table 4-8.

Economic development of the Region, between 1986 and 1992, grew at an annual rate of 7.0 %, which was slightly higher than the annual national growth rate of 6.9 %. The primary sector registered a very low annual growth rate of only 2.3 % and dropped its share in the GRDP from 16.3 % in 1986 to 12.4 % in 1992. The secondary sector expanded steadily, however, mining acted as a drag on its growth. The tertiary sector, however, achieved a significant evolution, and although its scale in the economic activity in 1986 was small, it increased more than 1.6 times from 1986 to 1992, and its share in the GRDP grew from 44.2 % to 48.6 % .

4.3 Future GDP and GRDP of the Region VIII

4.3.1 Future GDP

The Chilean economy enjoyed a "Decade of Growth" (1982-1992), with an annual growth during that period of 5.5 %.

According to the Central Bank of Chile, Chile's trade balance is estimated to sink to US$ 995 million deficit in 1993, partly due to the international economic recession in the industrialized countries, and affected by the fall in the international prices of the country's principal export products, such as copper which fell 16.3 %, cellulose which fell 25.4 % and fish meal which fell 21.1 %. Imports, on the other hand, increased by more than 10 %.

On the other hand, in 1993, investments, including US$ 2,683.8 million in foreign investments, registered a strong increase of about 16 %.

Table 4-7 Employed persons by Sector in the Region VIII in 1992 (Annual Average)

Clase de Actividad Económica	Número de Persona	Porcentaje
Agricultura y pesca	136.850	23,5
Mineria	12.750	2,2
Industrias manufactureras	99.350	17,1
Construcción	38.950	6,7
Electricidad, gas y agua	2.300	0,4
Transporte y comunicación	47.350	8,1
Comercio	92.250	15,9
Otros	151.400	26,1
Sector primario	136.850	23,5
Sector secundario	151.050	26,0
Sector terciario	293.300	50,5
Total	581.200	100,0

Source: Cálculo del Equipo de Estudio como el promedio de los datos de trimestre octubre-diciembre de 1991 y 1992 publicado por INE

Table 4-8 Estimated GRDP by Sector of the Region VIII in 1992

Sector de Actividad Económica	PIBR (Millones de Pesos de 1977)	Distribución Sectorial (%)	Tasa Anual de Crecimiento 1986-1992 (%)
Sector primario	6.758	12,4	2,3
Sector secundario	21.229	39,0	6,7
Sector terciario	26.483	48,6	8,6
Total	54.470	100,0	7,0

The increases in imports and investments stimulated the production sectors, and according to estimates made by business circles for 1993, the construction sector grew at about 12 % and the manufacturing sector grew at 4.7 %.

Based on the above facts, the INE estimated that Chile's economy grew at a rate of 5.7 % in 1993.

Some institutions have set a lower figure for the growth rate in 1994 than that for 1993. One technical institute states that the economic growth in 1994 will fall between 3 and 4 %, although it is possible to expect an average annual growth rate of 7 % during the rest of the 90s. Government organizations have put the target for the growth rate in 1994 at 4 to 5 %.

Trends of the international recession and international prices of Chile's principal products will affect the country's economic growth. The economic situation in the United States will show an improvement in 1994, Europe will follow in the recovery later in the same year. Japan's economy is still cloudy and it is difficult to predict when will its economy begin to recover. The economic growth in the Asian countries will give Chile an opportunity to export to them.

From 1993 onwards to 2010, it may be difficult for Chile to maintain an annual average economic growth of 5.5 % similar to what it experienced during the period 1982-1992. However, considering the macro-economic structure of Chile, and the recovery trends of the international economy, a 4.5 % annual average economic growth is assumed for the period of 1992-2010 and a 4.0 % for 2010-2020.

Regarding the sectoral growth, the elasticity of each sector's growth rate to the total GDP growth rate as obtained from the results of 1982-1992 is decided to be applied. The elasticities applied and the annual growth rate by sector are shown in Table 4-9.

Table 4-10 shows the calculation results based on the assumed future growth rates.

Based on the assumed growth rates by sector for the future, Chile's economy will expand by approximately 2.2 times from 1992 to 2010.The tertiary sector will be 2.3 times the current scale, while the primary sector's growth will be comparatively lower.

GDP per capita will be 1.75 times the 1992 level in 2010. At 1992 prices it is equivalent to Ch $ 1,922.6 thousand Pesos or US$ 5,300, applying the exchange rate of US$ 1.00 = Ch S 362.576 in that year.

4.3.2 Future GRDP of the Region VIII

The economic situation of the Region VIII is sluggish, especially due to the slack in exports and the problems in the mining sector. In order to improve the mining activity, the companies are making efforts to improve the productivity and proposing some measures to their employees, however, no agreements have been reached. The public sector plans several investment projects, including a new bridge on the Biobio River, inter and intra urban road projects and the improvement of the port of Coronel for revitalizing the Region's economy.

For the projections of future GRDP of the Region VIII, it is assumed that the Region's economic development will follow the national trend at a rate proportional to that determined for the period of 1986-1992.

The sectoral elasticities and assumed future growth rates are shown in Table 4-11.

Table 4-9 Elasticities and Future Growth Rates by Sector, Chile

Sector	1982-1992		1992-2010	2010-2010
	Tasa Anual de Crecimiento (%)	Elasti-cidad	Tasa Anual de Crecimiento (%)	Tasa Anual de Crecimiento (%)
Primario	4,1	0,75	3,4	3,0
Secundario	5,4	0,98	4,4	3,9
Terciario	5,7	1,04	4,7	4,1
Total	5,5	1,00	4,5	4,0

Table 4-10 Future GDP by Sector, Chile

Sector	PIB (Millones de pesos de 1977)				Aumento 1992-2010
	1992	2000	2010	2020	
Primario	46.106	60.245	84.164	113.110	1,83
Secundario	188.408	265.891	408.986	599.603	2,17
Terciario	327.740	473.263	749.152	1.119.636	2,29
Total	562.254	799.399	1.242.302	1.832.349	2,21

Tabla 4-11 Elasticities and Future Growth Rates by Sector, Region VIII

Sector	1986-1992		Elasticidad	1992-2010	2010-2020
	Tasa anual de crecimiento(%)			Tasa anual de crecimiento (%)	Tasa anual de crecimiento(%)
	Chile	VIII Rgn			
Primario	3,7	2,3	0,62	2,1	1,8
Secundario	6,3	6,7	1,06	4,7	4,2
Terciario	7,8	8,6	1,10	5,2	4,5
Total	6,9	7,0	1,01	4,7	4,2

Using the assumed growth rates, the future GRDP of the Region VIII is estimated as shown in Table 4-12. It is expected that the Region's economy will expand about 2.3 times from 1992-2010. The tertiary sector will grow to become about 2.5 times the present situation and will occupy more than half the total GRDP in 2010.

GRDP per capita will rise from 819.1 thousand Pesos in 1992 at 1992 prices (US$ 2,260 at the exchange rate of US$ 1.00 = Ch $ 362.576 in that year) to Ch $ 1548.6 thousand Pesos in 2010, which is equivalent to US $ 4,270.

4.4 Future Population and Employment

4.4.1 Future population of the Region VIII and the Concepcion Province

In mid 1993, the population of the Region VIII is estimated at 1,788,800. It is assumed that the future population of Region VIII will increase along the course projected by INE and will reach 2,133,800 in mid-2010.

In order to determine the future population by province, the estimated population at the Region level is distributed to each province based on the past tendency of increase. The results are shown in Table 4-13.

Reflecting the declining tendency of the birth rate, the rate of increase in the population of the Region will gradually slow down.

The population of Concepcion Province will grow at a little higher rate than the regional average, and will become 1.24 times its current figure in 2010, reaching more than 1 million at that time.

4.4.2 Future Employment in the Region VIII and the Concepcion Province

Table 4-14 shows the 1993 estimated annual average employment situation by sector and by province in the Region VIII, based on the recent employment survey results.

Future employment will be determined as a balance between the labor force supply and the labor force demand.

The supply will depend on the percentage of working age population (15 years of age and over) in the total population and on the labor force participation rate (ratio of persons who are employed or looking for a job to the population 15 years and over).

The percentage of working age population is estimated to have been increasing steadily in the early 80s and gradually slowing down from the end of the 80s to the 90s. According to the

Table 4-12 Future GRDP by Sector, Region VIII

Sector	PIBR(Millones de pesos de 1977)				Aumento 1992-2010
	1992	2000	2010	2020	
Primario	6.758	7.970	9.794	11.750	1,45
Secundario	21.229	30.736	48.814	73.634	2,30
Terciario	26.483	39.673	65.752	102.311	2,48
Total	54.470	78.379	124.361	187.696	2,28

Table 4-13 Future Population by Province in Region VIII

Provincia	Población (Miles de personas)				Tasa anual de crecimiento (%)		
	1993	2000	2010	2020	93/00	00/10	10/20
Concepción	870,1	960,1	1.076,9	1.187,2	1,4	1,2	1,0
Ñuble	430,6	454,3	482,9	507,4	0,8	0,6	0,5
Biobío	333,4	356,5	385,5	411,9	1,0	0,8	0,7
Arauco	154,6	169,4	188,5	206,5	1,3	1,1	0,9
VIII Rgn	1.788,8	1.940,3	2.133,8	2.313,0	1,2	1,1	0,8

Table 4-14 Number of Employed Persons by Sector and by Province of Region VIII, 1993 (Annual Average)

Provincia	Primario	Secundario	Terciario	Total
Concepción	20.250	98.800	168.450	287.500
Ñuble	60.850	22.600	63.550	147.000
Biobío	39.500	24.200	47.500	111.200
Arauco	16.750	12.600	19.100	48.450
Total	137.350	158.200	298.600	594.150

Source: Estimated by Istuday Team bases on the National Employmen Survey

1992 cencuc, this ratio is 70.6 % in Chile as a whole and 69.7 % in the Region VIII. It is anticipated that the above figures (70.6 % and 69.7 %) will be more or less the same in the year 2000.

On the other hand, the labor force participation rates are generally holding at around 52 % according to the recent employment survey, and it is difficult to find any tendency.

It is therefore decided to use the working age population rate as a constant 70 %, and the labor force participation rate also as a constant at 52 %.

Labor productivity is a key factor for the labor demand. Economic growth is achieved as a product of employment increase and labor productivity rise. Since the population increase (labor force increase) is not expected to be significant in the future, a considerable economic growth requires a rise in labor productivity. A high rise in labor productivity, however, will bring about a high unemployment rate.

The sectoral assumptions about future rise in labor productivity are as follows:

1. Labor productivity of the primary sector rose at an annual rate of 1.9 % during the period of 1986-1992, contributing to the sector's growth of 2.3 % during the same period. This sector's productivity will rise at an annual rate of 1.7 %, which rise will contribute to the estimated 2.1 % growth of the sector till 2010 in the same degree as for the period 1986-1992.

   After 2010, although the sector's annual growth rate will fall to 1.8 %, productivity rise is assumed to continue at the same level. At that time, the population increase rate will be too low and the economic growth will have to depend more on the productivity rise.

2. The rate of rise in the tertiary sector's productivity is derived in the same manner as for the primary sector.

3. The secondary sector registered a negative rise in productivity between 1986 and 1992. It is therefore assumed that the productivity will not change, but will keep at the same level of 1992 till 1995. After that, it will rise proportionally, same as the tertiary sector.

The results of future projections are shown in Table 4-15.

The employment distribution to the provinces is carried out only for the total employment, based on each province's actual differential in the "employment/population" ratio. Table 4-16 shows the results.

4.5 Future Vehicle Ownership

4.5.1 Passenger Cars and Pickups in Metropolitan Concepcion

Most passenger cars and pickups are owned by households and used for private purposes. Vehicle ownership by households depends highly on the household income.

In the urban areas of Metropolitan Concepcion, it is assumed that the average household income per capita will rise parallel to the increase in the per capita GRDP, on condition that a constant portion of the "Value added" in the economic activity will be distributed to personal income.

Utilizing the zone data about household income and vehicle ownership rate of SECTRA's OD survey in 1989, the relationship between the average monthly household income and the number of vehicles per household was obtained by formula as follows:

$$Y = \frac{1.5}{1+30.928*e^{-0.0242X}} + 0.083$$

where X = Average monthly household income (in units of Ch $1000 at 1989 prices)
Y = Number of vehicles per household

Coefficient of determination $R^2 = 0.72898$

Since the average monthly household income in 2010 is expected to be 1.83 times the 1993 level (from 52800 Pesos to 96600 Pesos at 1989 prices), the number of vehicles per household will rise from 0.239 in 1993 to 0.459 in 2010.

In 2010, the population of the urban areas of Metropolitan Concepcion is projected to be 1,020.4 thousands, and the number of households 231.9 thousands. Applying 0.459 units/household to the estimated number of households, 106,440 vehicles for household use will be obtained.

Passenger cars and pickups are also owned by establishments for business use. The ratio of business-use vehicles is assumed not to change from the current 17.5 %. Observing past trends and considering the promotional popularity for passenger vehicles, it is determined that the passenger vehicles constitute 75 % of the total grouping of passenger vehicles and pickups.

Based on the above-mentioned assumptions, the future number of passenger cars and pickups in the year 2010 in the urban areas of Metropolitan Concepcion is determined. See Table 4-17.

4.5.2 Passenger cars and Pickups in the Other Area of the VIIIth Region

The area other than Metropolitan Concepcion in the Region VIII consists of the rural areas of Concepcion Province and the Provinces of Nuble, Biobio and Arauco.

In 1993, there were 45,840 passenger cars and pickups owned by both households and business establishments in this area. Due to lack of data, it is difficult to determine the number of vehicles for household use and those for business use. Therefore, the projection is prorated on the basis of the ratio of "number

Table 4-15 Future Employment by Sector, Region VIII

Sector	Empleo (Miles de personas)				Aumento 1993-2010
	1993	2000	2010	2020	
Primario	137,35	141,00	146,40	148,40	1,07
Secundario	158,20	186,00	213,50	232,70	1,35
Terciario	298,60	338,80	405,90	456,50	1,36
Total	594,15	665,80	765,80	837,60	1,29

Tabla 4-16 Future Employment by Province in Region VIII

Provincia	Empleo (Miles de personas)				Aumento 1993-
	1993	2000	2010	2020	
Concepción	287,50	327,80	384,70	428,10	1,34
Ñuble	147,00	160,30	178,20	189,00	1,21
Biobío	111,20	122,80	139,00	149,90	1,25
Arauco	48,45	54,90	63,90	70,60	1,32
VIII Rgn	594,15	665,80	765,80	837,60	1,29

Table 4-17 Future Number of Passenger Cars and Pickups in the Metropolitan Concepcion

Tipo de vehículos	Número de vehículos		Aumento
	1993	2010	1993/2010
Automóvil	37.530	96.770	2,56
Camioneta	16.630	32.250	1,94
Total	54.160	129.020	2,38
Tasa de motorización (vcl/hgr)	0,239	0,459	1,92

of vehicles (household-owned and establishment-owned) to number of households. Applying the same multiple of the household car ownership rate in the urban area of Metropolitan Concepcion during 1993 and 2010, this ratio will rise from 0.209 in 1993 to 0.401 in 2010.

In 2010, the population of the Other Area of the Region VIII is projected to be 1,113.4 thousands, and the number of households 253.0 thousands. The percentage of passenger cars is assumed at 60 % according to the past trend. See Table 4-18.

4.5.3 Trucks in the Region VIII and Concepcion Province

The future number of trucks in the Region VIII is estimated by using an elasticity of the rate of increase of trucks to the growth of the regional economy. Since the number of trucks increased at an annual rate of 4.1 % from 1982 to 1992 and the GRDP expanded at an annual rate of 6.2 % during the same period, the elasticity was calculated to be 0.66. Applying the elasticity to the projected annual 4.7 % growth rate of the regional economy till 2010, a 3.1 % annual rate of increase for trucks is adopted. The estimated results are indicated in Table 4-19.

4.6 Zonewise Projections of Socio-economic Indicators

4.6.1 Population

For the population projection by zone, the following factors are considered;

1. Trends of population increase by zone
2. Use zoning of "Plan Regulador"
3. Development projects
4. Physical conditions of each zone

The main points are as follows;

1. The population will continue to decline in the "Centro" (Zones 1 and 2), and the character of the commercial center will continue to strengthen.
2. As a result, for the "Centro", by the year 2010, it is anticipated that the population will decrease by 7,000, while employment will increase by 13,000.
3. Zone 3 (Costanera), which is the core of the "Recuperacion de la Ribera Norte del Rio Biobio", is considered not to increase its population by much, although improvements of infrastructure will be carried out for existing people, however, large-scale redevelopment and densification is not planned at present.
4. Zones where population growth will be significant are Zone 18, Zone 7, Zone 9 and Zone 11 in Concepcion and Zone 14(Talcahuano).
   In particular, Zone 18 has a large surface area available for residential development.

4.6.2 Employment

For projecting the number of employed persons on working place basis, the following main factors are taken into consideration;

1. Use zoning of "Plan Regulador"
2. Development projects
3. Physical conditions of each zone

The first task is to calculate the number of employed persons on living place basis. This is done by using the future population by zone and present "Employed/Total Population" ratio by zone. After applying present "Working employed/Living employed persons" ratio by zone, the first step of the employment distribution is carried out. Considering the development projects mentioned below, the final distribution is determined.

The development projects considered and their impact are as follows;

1. About 8,000 persons will be added to Zone 3, on the basis of a planned governmental/commercial center which will be realized by the year 2010 and which will cover about 40 ha and have a employment density of 200 persons per hectare, the same density as the present Zone 1.

2. About 1,000 persons will be added to Zone 11, considering that the industrial zone of 20 ha will be occupied by the year 2010 and land requirement per persons engaged is assumed at around 200 m2.

4.6.3 Number of Vehicles by Type

For the distribution of vehicles by zone, the following two methods are adopted;

1. Distribution based on the "Number of vehicles/Household" ratio by zone for passenger cars and pickups.

2. Distribution based on the "Number of vehicles/Employment" ratio by zone for trucks.

The results show to some extent the existing characteristics of zones relating to household vehicle ownership and the establishment vehicle ownership.

The zonewise combined projection results for population, employment and number of vehicles are shown in Table 4-20.

Table 4-18 Future Number of Passenger Cars and Pickups in the Other Área of Region VIII

Tipo de vehículos	Número de vehículos		Aumento
	1993	2010	1993/2010
Automóvil	25.870	60.870	2,35
Camioneta	19.970	40.580	2,03
Total	45.840	101.450	2,19

Table 4-19 Future Number of Trucks by Province in Region VIII

Provincia	Ñumero de Vehículos		Aumento
	1993	2010	1992/2010
Concepcíon	5.400	9.250	1,71
Ñuble	3.100	5.000	1,61
Biobío	3.000	4.990	1,66
Arauco	1.200	2.100	1,75
Región VIII	12.700	21.340	1,68

Table 4-20 Socioeconomic Indices by Zone, 1993 and 2010

(1) Population and Employment

Número de Zona	Población			Empleo		
	1993	2010	2010/1993	1993	2010	2010/1993
1	20.000	16.100	0,81	37.400	43.560	1,16
2	29.500	26.300	0,89	25.840	32.740	1,27
3	12.500	15.000	1,20	3.040	11.000	3,62
4	7.800	10.200	1,31	1.000	1.370	1,37
5	21.100	23.300	1,10	2.690	3.120	1,16
6	30.200	34.000	1,13	9.650	11.390	1,18
7	41.400	54.300	1,31	8.840	12.160	1,38
8	1.600	2.000	1,25	2.080	2.730	1,31
9	25.000	34.000	1,36	14.910	21.260	1,43
10	58.000	65.600	1,13	9.740	11.550	1,19
11	14.000	20.000	1,43	3.510	6.500	1,85
12	4.700	10.000	2,13	1.180	2.630	2,23
13	3.200	5.000	1,56	1.170	1.920	1,64
14	258.000	328.900	1,27	87.640	121.080	1,38
15	92.300	105.700	1,15	19.080	22.910	1,20
16	10.400	10.000	0,96	3.550	3.570	1,01
17	16.600	18.200	1,10	4.900	5.640	1,15
18	71.400	120.000	1,68	13.250	23.350	1,76
19	2.300	4.400	1,91	150	300	2,00
20	137.800	160.600	1,17	33.690	41.170	1,22
21	12.300	13.300	1,08	4.190	4.750	1,13
22	430.600	482.900	1,12	147.000	178.200	1,21
23	333.500	385.500	1,16	111.200	139.000	1,25
24	154.600	188.500	1,22	48.450	63.900	1,32
Total	1788.800	2133.800	1,19	594.150	765.800	1,29

(2) Number of Vehicles

Número de Zona	Auto			Camioneta			Camión		
	1993	2010	2010/1993	1993	2010	2010/1993	1993	2010	2010/1993
1	4.750	5.030	1,06	2.180	2,310	1,06	615	950	1,54
2	3.190	5.300	1,66	1.700	2,70	1,45	430	720	1,67
3	490	1.330	2,71	320	640	2,00	25	120	4,80
4	240	710	2,96	70	150	2,14	30	55	1,83
5	970	2.430	2,51	600	1.100	1,83	115	180	1,57
6	1.710	4.370	2,56	570	1.250	1,87	90	140	1,56
7	1.960	5.840	2,98	900	1.960	2,18	165	300	1,82
8	320	500	1,56	120	180	1,50	75	130	1,73
9	2.590	5.400	2,08	700	1.550	2,21	70	130	1,86
10	2.830	7.270	2,57	970	1.820	1,88	240	380	1,58
11	550	1.780	3,24	380	900	2,37	50	120	2,40
12	50	230	4,60	70	270	3,86	5	15	3,00
13	40	140	3,50	20	60	3,00	10	20	2,00
14	9.100	26.340	2,89	3.870	8.200	2,12	1.180	2.170	1,84
15	1.780	4.630	2,60	1.030	1.960	1,90	460	730	1,59
16	220	470	2,14	250	440	1,76	270	360	1,33
17	2.100	2.800	1,33	1.000	1.340	1,34	330	510	1,55
18	4.540	17.320	3,81	1.710	4.770	2,79	280	660	2,36
19	480	1.180	2,46	130	320	2,46	10	30	3,00
20	2.030	5.370	2,65	1.200	2.480	1,94	870	1.410	1,62
21	260	620	2,38	230	450	1,96	80	120	1,50
22	11.300	27.920	2,47	9.400	19.100	2,03	3.100	5.000	1,61
23	9.300	23.680	2,55	6.700	14.030	2,09	3.000	4.990	1,66
24	2.600	6.980	2,68	2.300	5.080	2,21	1.200	2.100	1,75
Total	63.400	157.640	2,49	36.600	32.830	1,99	12.700	21.340	1,68

CHAPTER 5 FUTURE TRANSPORT NETWORK PLAN

5.1 General

In this chapter, all the on-going or planned projects in transportation sector of Concepcion Province are reviewed and their impact taken into consideration in the development of the future socio-economic framework (Chapter 4) and the formulation of the transportation demand forecast (Chapter 6).

There are no long-term comprehensive plans, either for the Region VIII or for Concepcion Province. MIDIPLAN however, publishes the annual investment guideline for each Region (La Accion Regional del Govierno).

5.2 On-going Road Projects in Concepcion

According to MOP, all the roads in Chile are classified into two categories; basic network (23,000 km), and municipality road network (57,000 km). The total length is 80,000 km. The roads are further classified or ranked. Thus, the basic road network is subdivided into three ranks, A, B and C, and the municipality road network into two ranks, D and E. National roads with route number are classified or ranked A and B, although some roads without number are also classified to the rank B.

Planning, construction and maintenance of the basic road network is under the jurisdiction of MOP, while for the municipality road network it is done by the respective responsible municipality office with financial and technical support from MOP, where necessary. MOP, however, is responsible for all the bridges in Chile. Some roads in urbanized areas or aiming at urban development are planned and constructed by MINVU.

Concepcion has implemented road programs with BID finance, the first program in 1987-1988 and the second program in 1992-1994. The third program is planned for the period of 1994-1998 with Government funding.

Table 5-1 shows road projects in Concepcion, currently under construction or planned for implementation in the near future. Their locations are illustrated in Fig.5-1. All the projects on the list are rather small-scale ones costing less than 10 million US$. Widening projects (2, 3, 5 and 10) will impact on the project under the Study, and will be taken into consideration.

In addition to the projects mentioned above, some road projects are planned for the short-term period also in Talcahuano and San Pedro. They are not reviewed, however, because they will not cause any impacts, apparently, on the traffic demand for the new Biobio bridge.

Table 5-1 On-going Road Project in Concepcion

PROYECTO	ESTADO ACTUAL	UNIDAD EJECTORA	FUENTE FINANCIAM.	INNVERSION MILL.US$
A) MEJORAMIENTOS				
1. PEDRO DE VALDIVIA	TERMINADO AGOSTO 93	MINVU	BID 559	4,4
2. EJE 21 DE MAYO (ARGOMEDO - P. DE ONA)	EN EJECUCION	MINVU	BID 559	1,3
3. EJE PRAT V. LAMAS-M.RODRIGUEZ	EN EJECUCION	MINVU	BID 559	1,9
4. NUDO NOBIS	EN EJECUCION	MINVU	BID 559	1,0
5. EJE A. PRAT - 21 DE MAYO (M.RODRIGUEZ - ARGOMEDO)	EST. INGENIERIA DE DETALLE TERMINADO	MINVU	3er PROG. INVERSIONES	3,7
8. AVDA. COLLAO Y GRAL. NOVOA	ESTUDIO PREFACTIBILIDAD TERMINADO	MINVU	BIRF 3028	5,0
9. EJE CHACABUCO	EN EJECUCION ESTUDIO DE ING. DE DETALLE	MINVU	3er PROG. INVERSIONES	1,7
10. EJE LOS CARRERA	ESPERA FONDOS PARA ESTUDIO ING. DE DETALLE	MINVU	3er PROG. INVERSIONES	9,4
12. AV. P. AGUIRRE CERDA PTE. VIEJO Y PTE. NUEVO	ESTUDIO PREFACTIBILIDAD EN EJECUCION 1993-1994	MOP	3er PROG. INVERSIONES	2,7
13. AV. ROOSEVELT Y AV. IRARRAZAVAL	ESTUDIO PREFACTIBILIDAD EN EJECUCION 1993-1994	MINVU	3er PROG. INVERSIONES	2,5
14. ACCESO SUR PTE. VIEJO	SIN INFORMACION	MOP	S/I	0,4
15. INTER. ALMTE. RIVERO A. PINTO	EN ESTUDIO	MUNICIP.	NO TIENE	5,7
16. PROYECTO EJE RENGO Y CAUPOLICAN	ESTUDIO TERMINADO	MUNICIP.	NO TIENE	1,0
17. MEJORAMIENTO EJE TUCAPEL	ESTUDIO TERMINADO	MUNICIP.	DIR. DE TTO.	0,1
18. SAN MARTIN DIAGONAL	ESTUDIO TERMINADO	MUNICIP. SECTRA	NO TIENE	7,2
19. BULNES - PAICAVI	EN ESTUDIO	MUNICIP.	NO TIENE	SIN INF.
XX. MAIPU - IRARRAZAVAL	EN ESTUDIO	MUNICIP.	NO TIENE	SIN I
XX. BULNES LIENTUR	ESTUDIO TERMINADO	MUNICIP.	NO TIENE	0,9
XX. INTERCONEXION CONCEPCION - CHIGUAYANTE	TERMINADO AGOSTO 93	MINVU MINVU	BID 559	4,4
XX. INTERCONEXION PAICAVI	ESPERA FONDOS PARA ESTUDIO INGENIERIA DE DETALLE	MINVU	3er PROG. INVERSIONE	4,8
XX. EJE O'HIGGINS EN CHIGUAYANTE	ESTUDIO PREFACTIBILIDAD EN EJECUCION 1993-1994	MINVU	3er PROG. INVERSIONES	2,0
XX. PAV. 30 DE OCTUBRE VALLE NONGUEN	POSTULANDO A INVERSION		POR VERSE	$ 80.000
XX. CONEXION BARRIO NORTE SANTA SABINA	NO HAY PROYECTO POSTULANDO A FINANCIAMIENTO	MINVU MUNICIP.	POR VERSE	$ 70.000
XX. MEJORAMIENTO DE INGRESO A LA CIUDAD	NO HAY PROYECTO ESTUDIO TERMINADO		NO TIENE	7,7
B) CONSTRUCCION	ESTUDIO			
11. AUTOPISTA GRAL. BONILLA CAMPUS SN. ANDRES	PREFACTIBILIDAD EN EJECUCION 1993-1994	MOP	3er PROG. INVERSIONES	2,6
C) SEMAFORIZACION				
6. MEJORAM. RED CENTRO SEMAFOROS	SE ESPERA LLAMAR A LICIT. PROXIMAMENTE	MINVU	BIRF 3028	1,7
7. MEJORAM. GESTION DE TRANSITO PAICAVI - CHACABUCO LIENTUR - IRARRAZABAL LIENTUR - BULNES SAN MARTIN - ROOSBVELT MAIPU - IRARRAZABAL	ESTUDIO INGENIERIA DETALLE SE ENCUENTRA TERMINADO A EJECUTARSE DESPUES DE LA LA RED DEL PROYECTO RED CENTRO.	MINVU	BIRF 3028	1,2
XX. INSTALAC. SEMAFORO PEATONAL BULNES(ESC. DIFERENCIAL)	TERMINADO LICITADO DURANTE 1993	MUNICIP.	PRESUPUESTO INVER. 1993	2,7
XX. INSTALACION DE CINCO SEMAFOROS PEATONALES		MUNICIP.	PRESUPUESTO INVER. 1993	13,5
D) OTROS				
20. ESTUDIO ESTACIONAMIENTO SECTOR CENTRICO	EN ESTUDIO EN EJECUCION	MUNICIP.	NO TIENE	SIN INF.
XX. CONCESION REFUGIOS PUBLICITARIO	TERMINADO EN PROCESO DE ADJUDICACION	MUNICIP.	AUDIOVIS. Y PUBLICIDAD	50 REFUGIOS
XX. PROVISION REFUGIOS PEATONALES	TERMINADO	MUNICIP.	PRESUPUESTO INVER. 1993	5,1
XX. ESTUDIO DE MEDICIONES DE TRANSITO		MUNICIP.	PRESUPUESTO INVER. 1993	2,5
XX. PROVISION DE SENALES DE TRANSITO		MUNICIP.	PRESUPUESTO INVER. 1993	4,3

FUENTE: MUNICIPALIDAD DE CONCEPCION, VIII REGION.
NOTA : XX : PROYECTO FUERA DEL AREA DE FIGURA O SIN IDENTIFICACION

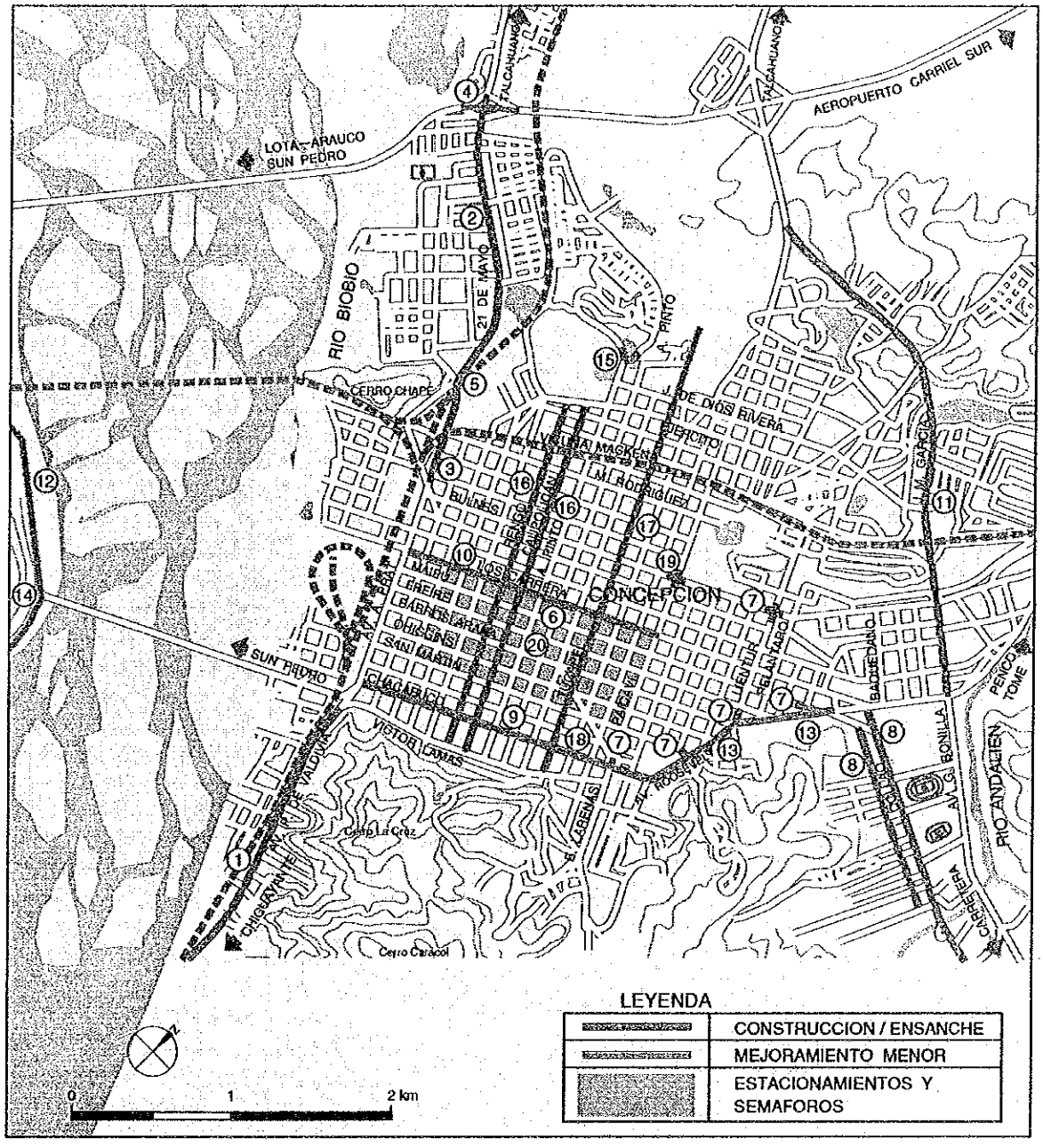


Fig. 5-1 On-going Road Project in Concepcion

5.3 Investment Plan of MOP up to 2010

Under the new Government following the Presidential election in December, 1993, MOP prepared the 17-year investment plan targeting for the year 2010. The total investment amount during the period is envisaged at 33,360 million US$.

Since the total investment budget for MOP is 713 million US$, it would take 47 years to accomplish the plan using annual investments equivalent to 1993 budget. To accomplish the plan during the 17 years would require an annual increase in the budget equivalent to 11.5 %.

The amount of 24,427 million US$, representing 73% of the total program, is allotted to the road sector, of which 7,370 million US$ is allocated to the urban road sector. Out of the last amount, the assignment to the South Central Region (Regions VII and VIII) is 1,251 million US$ (Table 5- 2).

The Government will officially publish the details of the plan in March of 1994. Information on the projects listed in Table 5-3 and shown in Fig.5-2 was released to the Study Team. All the projects are for inter-city roads and will not impact on the transportation demand for the New Biobio Bridge. Projects 1, 2, 8 and 10 are concession projects and explained in the next section.

Table 5-2 Investment Plan of MOP for 1994-2010

(Million US$ at 1993 price)

Sector	A. Region Central Sur (VII y VIII)	B. Total Nacional	(A/B)
Ruta interurbana	3.467	17.057	20,3
Camino urbano	1.251	7.370	17,0
Puerto y puerto pesquero	166	726	22,9
Aeropuerto	16	213	7,5
Sistemas de drenaje	535	1.361	39,3
Suministro deagua	112	1.042	10,7
Alcantarillado	172	2.217	7,8
Aguas lluvias	30	52	57,7
Control del río	28	107	26,2
Edificios públicos	350	1.381	25,3
Metros	-	1.232	0,0
Vías férreas	-	501	0,0
Total	6.126	33.260	18,4

Source: El Mercurio, 29 of January,1994

Table 5-3 Investment Projects of MOP for 1994-2010

Ruta Proyecto	Longitud km	Inverción (92-98) Mill.$	Saldo Mill.$	Observaciónes
A) Construcción				
1. Confluencia Agua A - Penco	59.7	0,1	16742,0	
2. Rafael - Agua Amarilla	-	1,1	3606,0	
B) Ampliación				
L-615 3. Ruta Q180 (Los Angeles - Coihue)	-	50,0	0,0	Estudio Termina en 1996
RUTA-5 4. Sector Cabrero - Mulchen	78.0	4200,0	12000,0	
RUTA-5 5. Sector Ccilian - Bulnes	24.0	2850,0	2000,0	
O-50 6. Copiulemu - A. La Gloria	13.8	2242,0	0,0	Proy. Termina en 1998
C) Pavimentación				
N-69 7. Bulnes - Cruce Ruta N-59 II	11.8	635,0	0,0	Proy. Termina en 1997
N-78-0 8. Quillon - Nueva Aldea	11.0	760,9	0,0	Proy. Termina en 1996
O-66-N 9. Rafael - Bif. Nipas	21.0	1269,0	0,0	Proy. Termina en 1998
O-70-Q 10. S. Juana - Nacim. - Coihue II	31.0	0,1	1576,0	
O-852 11. Coronel - Cruce Ruta De La Madera (Patagual)	22.0	1370,0	0,0	Proy. Termina en 1998
Q-34 12. Laja - Santa Fe	5.0	1855,0	0,0	Proy. Termina en 1998

Source: Dirección de Vialidad, MOP

5.4 Concession Road Project

To cope with the rapidly increasing traffic and demand for public works, the Chilean Government intends to privatize partly such infrastructures as roads and ports. This privatization is done based on the Law 15850 and the Ministerial Decree DS-MOP 164 promulgated in 1991. There are two road projects planned as concession projects, namely, Acceso Norte and Camino de la Madera.

5.4.1 Acceso Norte (North Access)

There are two routes connecting Concepcion and Route 5; National route 148 and O-50, both of which have poor alignment and surface conditions. The construction of the third route is planned to the north of Route 148, using funds from the private sector (Fig.5-3).

Acceso Norte starts from Penco, and continues east and reaches Route 5 at about 13 km south of Chillan. The total length is about 65 km. Two branch roads are also planned to be constructed to connect with Quillon and Rafael. These roads are designed as access-controlled expressways with four lanes. The toll system has not yet been determined.

The concessionaire who will be granted the concession for the project will be responsible to construct and maintain the road and to recover the investment from toll revenues. The concession period is 25 to 30 years. After the period, the road will be transferred to MOP.

5.4.2 Camino de la Madera (Timber Road)

This project, to be financed by the private sector, aims at improvement and maintenance of 113 km road between San Pedro - Caihue via Santa Juana and Nacimiento. As optional sections, two sections are proposed; Caihue - Mulchen (41 km) and Santa Juana - San Rosendo - La Laja. The latter includes construction

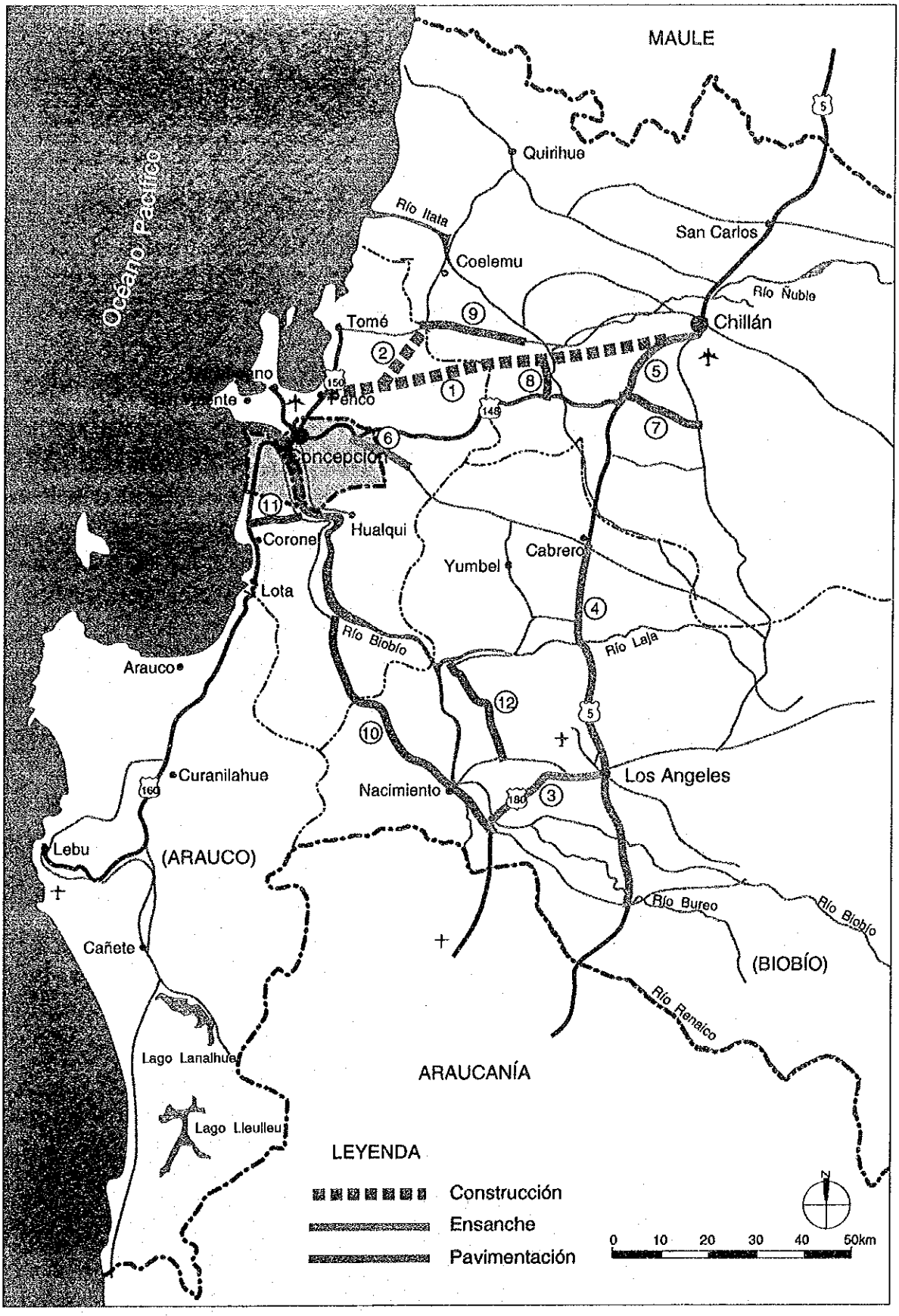


Fig. 5-2 Road Project for 1994-2010

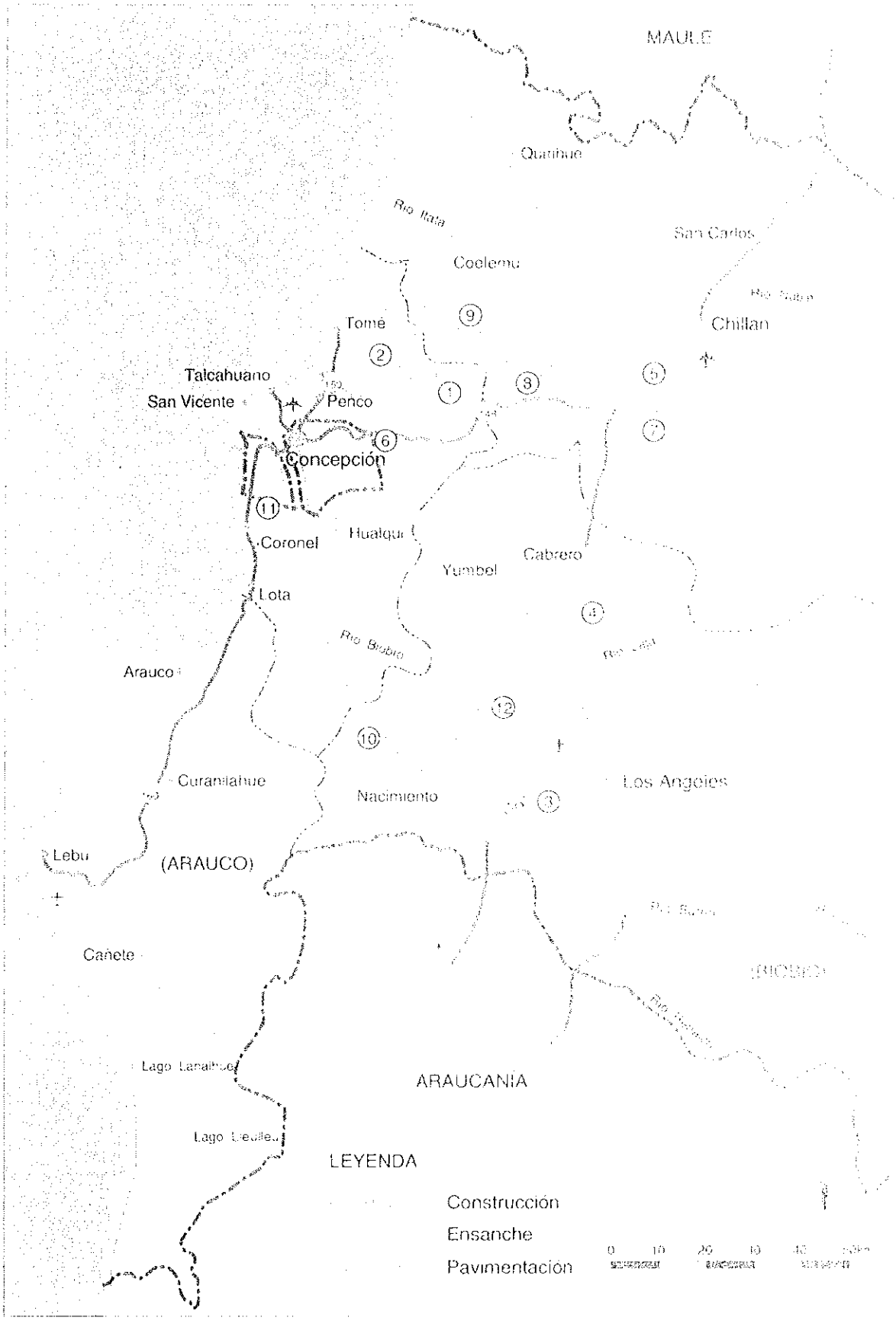


Fig. 5-2 Road Project for 1994-2011

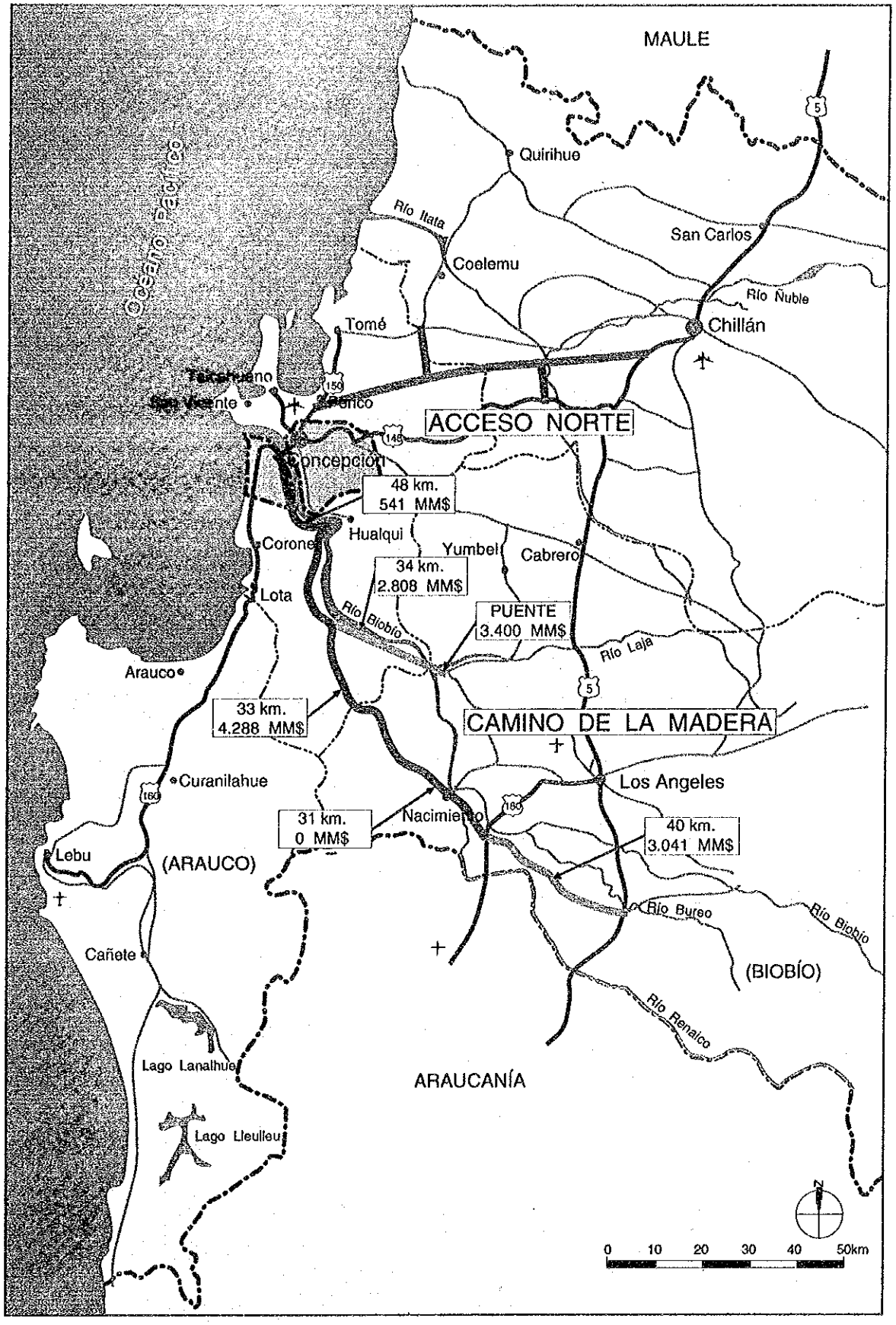


Fig. 5-3 Concession Road Project in the Study Area

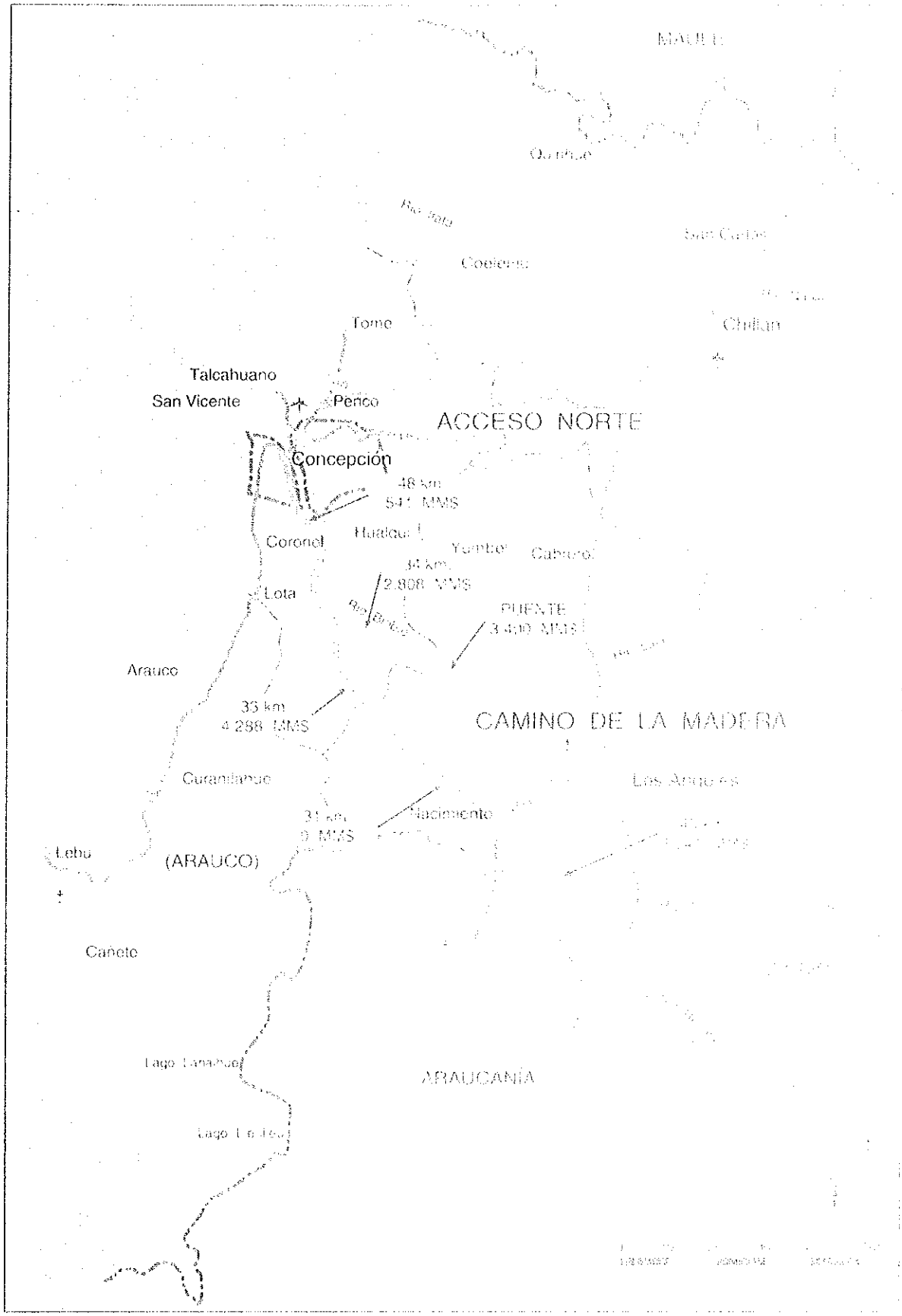


Fig. 5-3 Concession Road Project in the Study Area

river are transported mainly through this route to the ports of Talcahuano, San Vicente and Lirquen. Improvement works and costs are shown by section in Table 5-4. Total investment is estimated to be Ch.$ 14,328 million.

Bidding for the concession has been made already. The concession period is for a maximum of 25 years. Toll rates must not exceed Ch.$ 1,500 for a passenger car, Ch.$ 4,500 for a 2-axle truck and bus, and Ch.$ 7,500 for heavy truck at 1993 price, but can escalate every 6 or 12 months according to the consumer price index. The maximum rates are also reviewed and revised every three years.

For Section A of the road, the Government guarantees the minimum traffic depending on the concession period, which stands at 100,000 to 110,000 per annum in case of 25 year concession. If the annual traffic does not reach these levels, the Government will subsidize the deficit to the Concessionaire.

Table 5-4 Improvement Works and Investment of Camino de la Madera Project

Obra	Long. km	Estado Actual	Obras	Inversión Mill.Ch.$ Jun.92
A) Camino Coihue-San.Pedro				
A1. Tramo Coihue-Bif. Diuquin	32,0	en Repavimentación	Conservación	0
A2. Tramo Bif. Diuquin-Sta.Juana	33,0	Grava	Construc./ Conserv.	4,200
A3. Tramo Sta. Juana-San.Pedro	49,0	Pavimentado (Buen Estado)	Conservación	541
B) Camino Mulchen-Coihue				3,041
B1. Tramo Mulchen-Negrete	33,0	Granular (Mal Estado)	Construc./ Conserv.	--
B2. Tramo Negrete-Coihue	6,5	Pavimentado (Buen Estado)	Conservación	--
C) Pte. Sobre Biobío en Laja Mas	--	No Existe Puente	Construc.-Conserv.	3,400
Pavim. La Laja-Sta. Juana	34,0	Gramular y de Tierra	Construc.-Conserv.	2,808
D) Camino Laja-Sta.Juana	34,0	Granular y de Tierra	Ripiado y Conserv.	--

Source : Dirección de Vialidad, MOP

5.5 Costanera (River-side Road)

The Costanera project is a river-side road construction of 35 km, starting from Hualqui which is regarded as the southern limit of urbanization and extending to the mouth of the Biobio river (Fig.5-4). This is one of the main components of a large-scale urban development project named "the Biobio River North-Dike Area Recovery Project" which aims at land and urban development, economic activation, creation of urban amenity and relief of squatters in the river- side areas.

This urban development project was initiated in 1990 by the Government of Region VIII and a pre-feasibility study was made, using the FNDR's fund. Based on the results of the study, the Coordinating Committee for the project was composed, consisting of representatives of relevant Authorities.

The 35 km section is divided into six sub-sections (called "Program"). The Committee gave the top priority to Program 3 and 4, especially to the section between the railway bridge (Chepe hill) and the old Biobio bridge, where the development potential is undoubtedly highest. Between the railway and the river, there is an unused workshop yard of rolling stock which is being planned for conversion to commercial and residential purposes.

In this area, about 3,000 households are inhabited, of which about 1,000 households are illegally inhabited on public land, without water supply, sewage and sanitary facilities. The Committee decided to initiate in 1994, a human settlement project in this area, with German Cooperation through GTZ, including the following components:

- Topographic Survey and Cadastral Survey
- Preliminary Study on Land Readjustment
- Land Reclamation
- Rain Water Drainage
- Sewerage

The New Biobio bridge will cause significant positive impact on the urban development in this area and the plan of the bridge should be closely coordinated with Costanera Road Project.

5.6 Railway

There are four railway lines from Concepcion; the San Rosendo - Concepcion, the Concepcion - Talcahuano line(these two constitute a branch of the Santiago - Puerto Montt), the Concepcion - Rucapequin line and the Concepcion - Curanilahue line. Of these, only the San Rosendo - Concepcion section operates passenger trains (Fig.5-5). The length of each section is as follows:

Concepcion - San Rosendo:	70.0 km
Concepcion - Talcahuano :	13.3
Concepcion - Rucapequin :	130.0
Concepcion - Curanilahue:	90.6

Railway cargoes, mainly timbers and wooden chips have been recently increasing due do the favorable economic growth in Chile, while railway passenger ridership has been on a declining trend, due to competition from bus transport (Table 5-5).

The total number of railway passengers leaving and arriving at Concepcion Station in each direction is 320,000 annually. This averages about 1,000 passengers per day in each direction . Since there are three arrivals and three departures daily, the average number of passengers of each train is then 330 passengers. (Table 5-6).

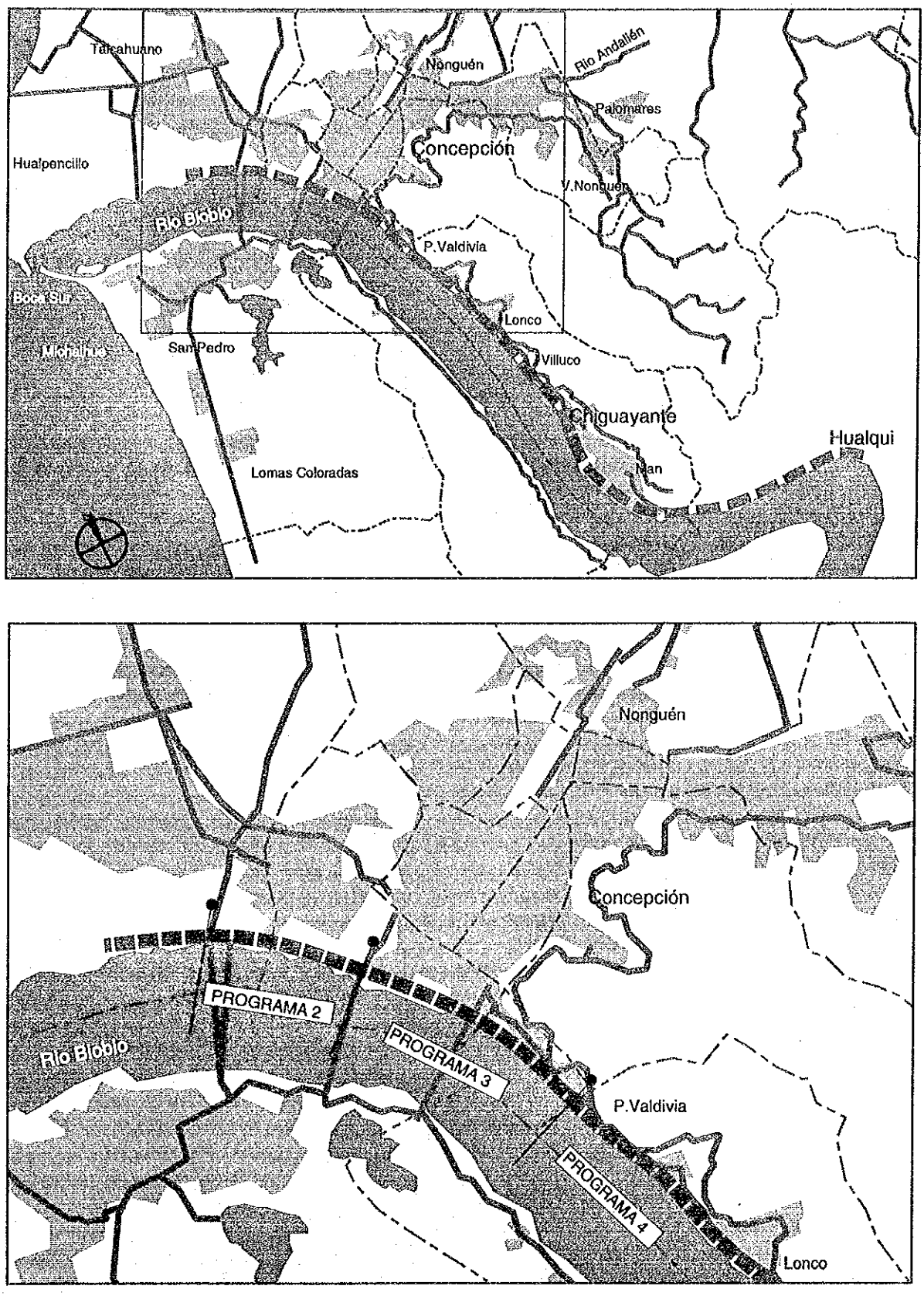


Fig. 5-4 Costanera Project

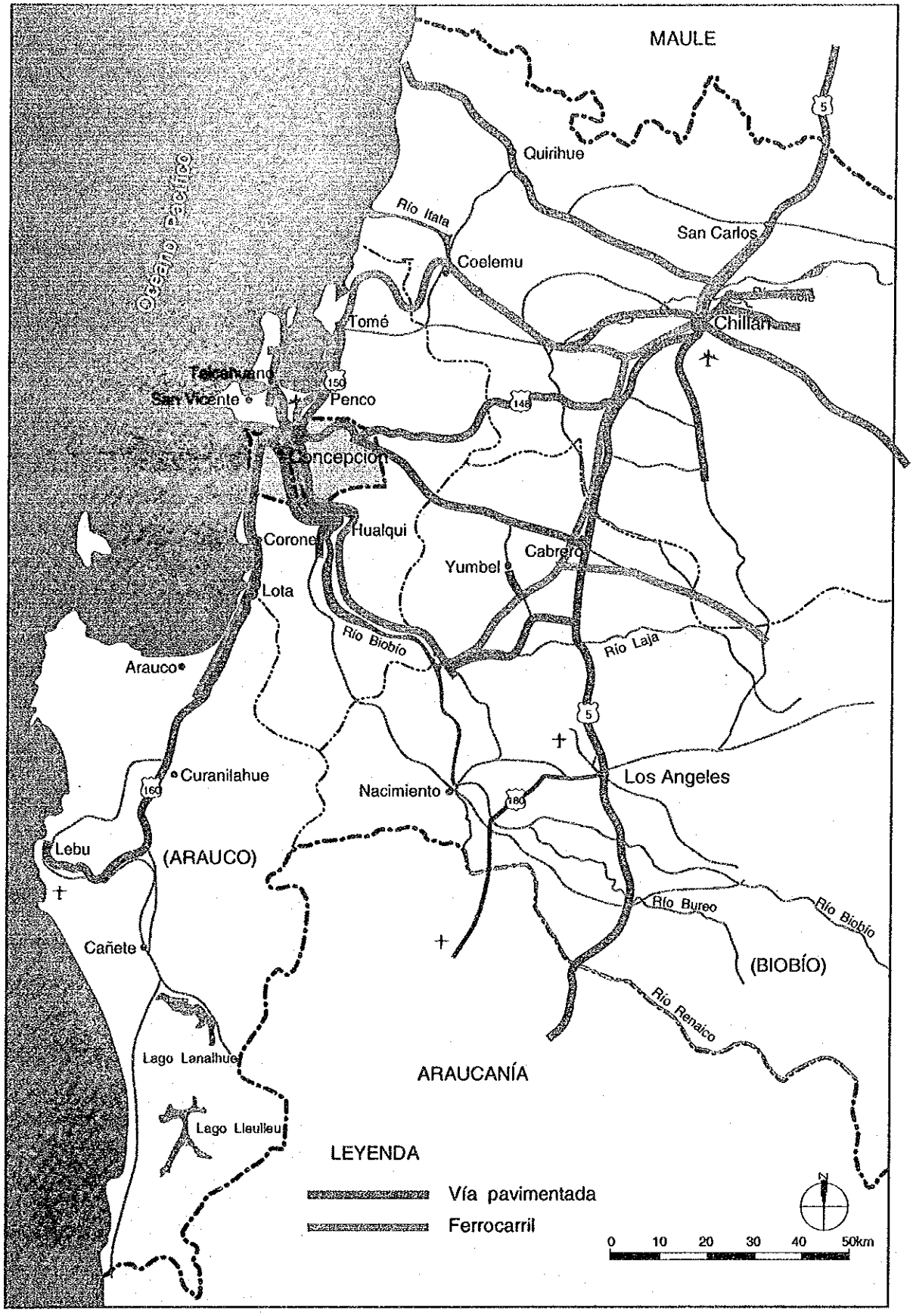


Fig. 5-5 Railway Network in the Study Area

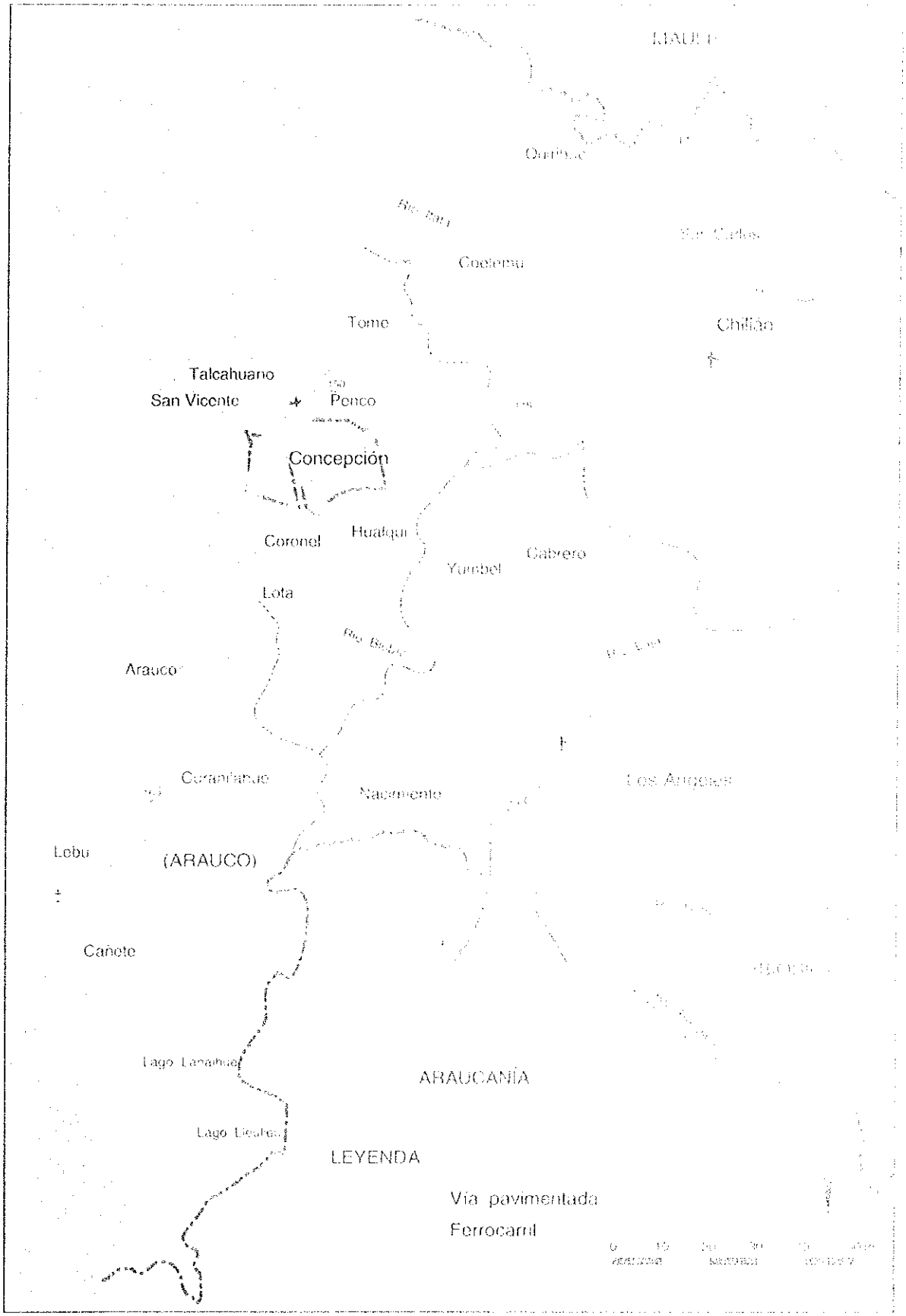


Fig. 5-5 Railway Network in the Study Area

Table 5-5 Railway Traffic in Concepcion Lines

(in million gross ton-km)

De/a Concerción	Carga		Pasajeros	
	1991	1992	1991	1992
San Rosendo	265,3	299,4	318,6	109,6
Talcahuano	10,3	43,3	-	-
Curanilahue	113,8	181,6	-	-
Recapequín	16,8	38,8	-	-

Source: FFEE, Gerencia de Planificación

Table 5-6 Railway Passengers and Cargoes at selected Stations in Concepcion Province, 1992

Estación	Carga (ton/año)		Pasajeros (pas/año)	
	Salida	Llegada	Salida	Llegada
Concepción	21.561	22.603	313.796	322.283
Chiguayante	-	-	11.129	8.404
San Rosendo	9.109	3.377	18.932	31.364
Biobío	20.154	18.037	-	-
Km56/Concepción	368.486	258.215	-	-
	278.605	24.380	-	-
	8.820	24.096	-	-

Source: FFEE, Gerencia de Planificación

The National Railway plans to carry out a nation-wide rehabilitation project of old-aged rail tracks, communication facilities and rolling stock. It was due to start in 1991 but has been delayed because of financing difficulties. The total cost is estimated at 60 million US$, of which 46 Million US$ is a foreign portion. The Chilean Government is negotiating with OECF of Japan for a loan to fund this project.

There is a 12 hectare workshop area, which has not been in use for a long time. The National Railway has decided to urbanize this area as a component project of "The Biobio North-Riverbank Development Program (Recuperacion de la Ribera Norte del Biobio)" which is explained in Chapter 4. The National Railway has already started negotiations with a private sector company to sell the land at a price of 10 UF (about US$ 260) per square-meter. The new bridge over the Biobio, together with the Costanera (River-side road) Project, will contribute significantly to the development of this area.

5.7 Port

Public ports are operated by EMPPORCHI, a semi-governmental and semi-private organization, although they are planned and constructed by MINTRATEL. There are two public ports in

Concepcion Province; Talcahuano port and San Vicente port. In addition to these, there are three private ports, one at at Lirquen for timber and chip export and the other two at Lota and Coronel for coal export (Fig 5-6).

The past trends of throughput of the public ports are shown in Table 5-7, and their layout in Fig 5-7. Talcahuano port has two berths, 155 meter and 205 meter long, respectively. Recently, the main roles of cargo handling has shifted from Talcahuano to San Vicente, because of the shallow water depth (8.8 and 6.7 meter deep) and old-aged equipment in Talcahuano port.

San Vicente port has three berths; two old berths with 220 meter length and a 150 meter berth newly constructed in 1992. All of them are 12 meter in depth and can accommodate up to 40,000 ton DWT ships. To cope with increasing demand, EMPORCHI has a plan to expand the San Vicente port further by constructing two additional berths in the south-west part of the existing berths.

Lirquen port has one pier with four berths and another pier under construction, together with 22,000 square meter open shed, which will accommodate two berths by the end of 1994 and finally four berths by 1997. Also, there is a plan to develop a new port at Coronel for timber exportation by private sector.

Table 5-7 Throughput of Talcahuano and San Vicente Port
(ton/year)

Años	Puerto Talcahuano	Puerto San Vicente
1980	601.742	1.302.417
1981	312.641	1.302.417
1982	337.766	1.425.587
1983	338.365	1.483.174
1984	258.649	1.599.829
1985	371.990	1.707.754
1986	411.123	1.704.364
1987	575.056	2.317.140
1988	773.542	2.390.427
1989	748.261	2.820.965
1990	532.462	2.687.582
1991	545.332	2.927.071
1992	562.811	3.181.740

Source: EMPORCHI

5.8 Airport

The airport of Concepcion named "Carriel Sur" is located 2.3 km north of the central part of Concepcion at the boundary with Talcahuano city (Fig. 5-8). The runway is 2,300 meter long and can accommodate an aircraft of B767 class, although only B727 are currently operated.

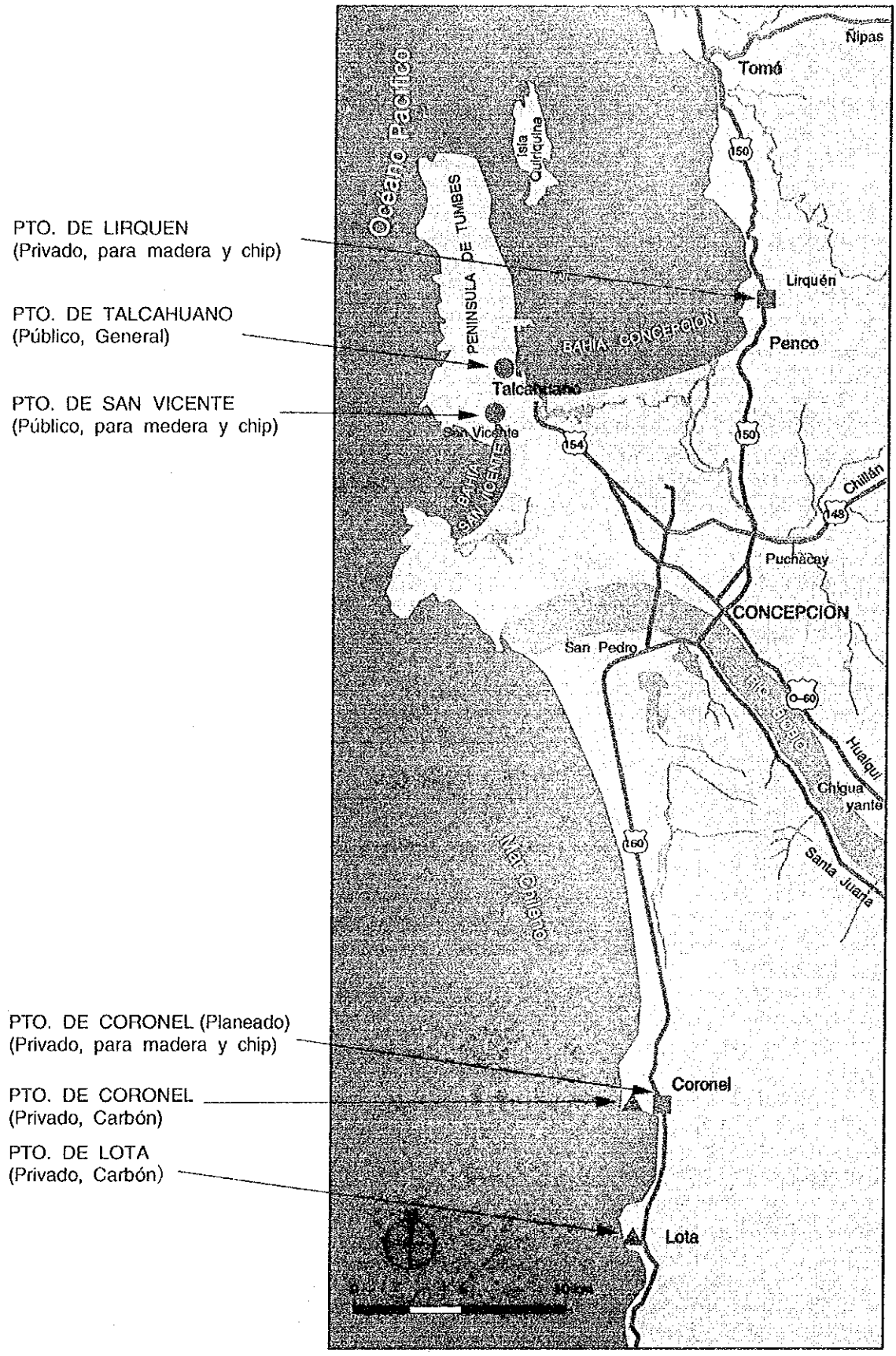


Fig. 5-6 Port in the Study Area

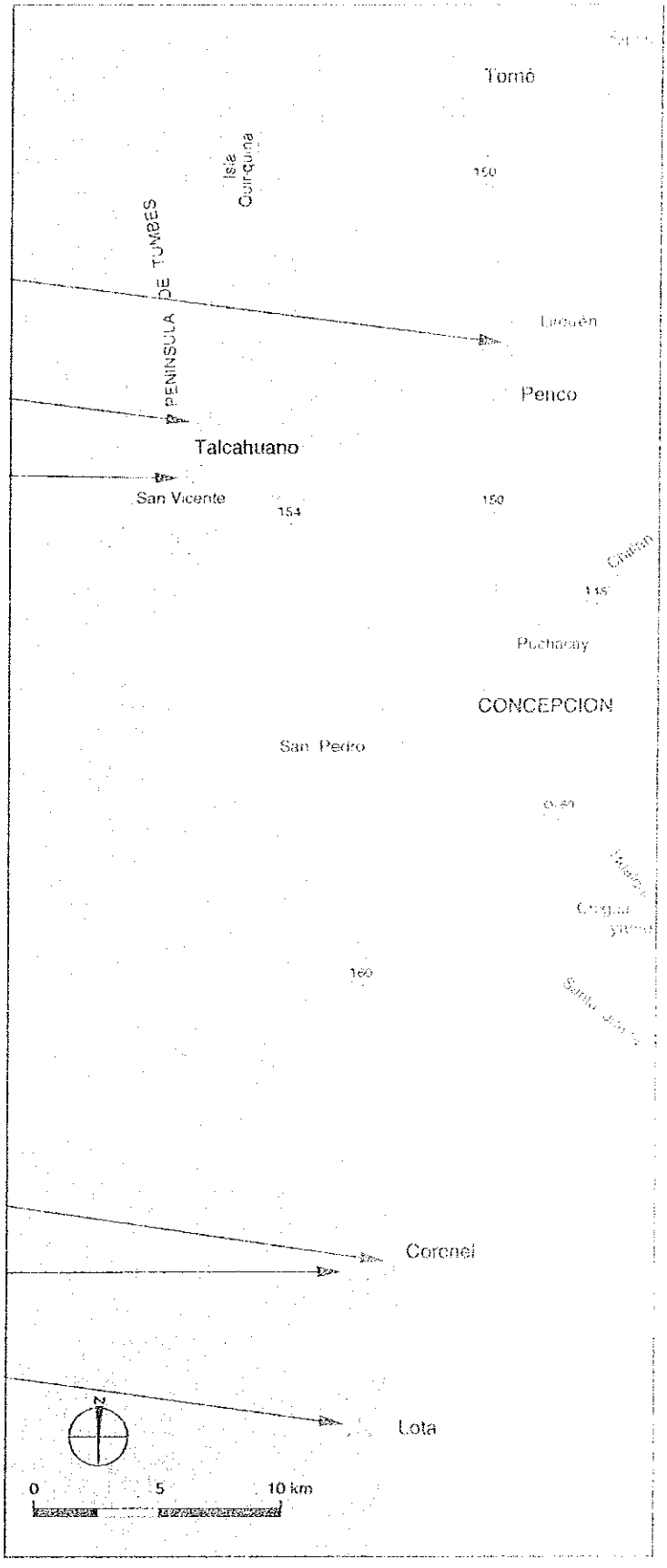
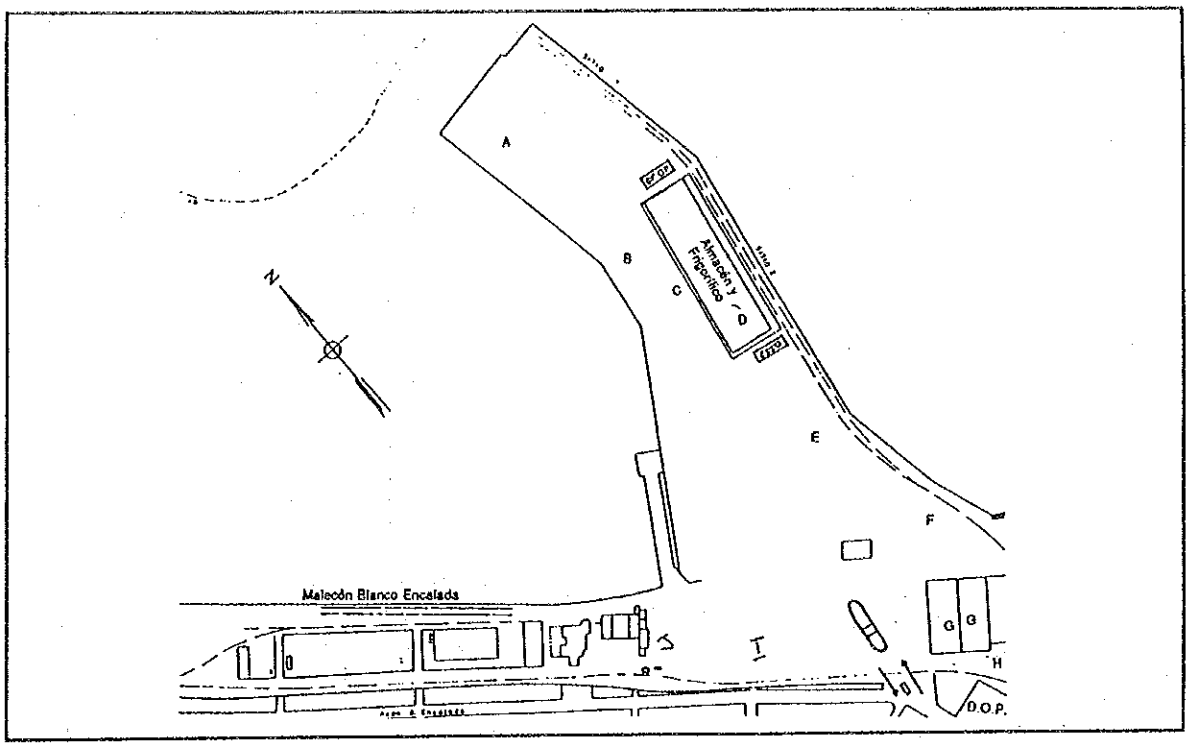
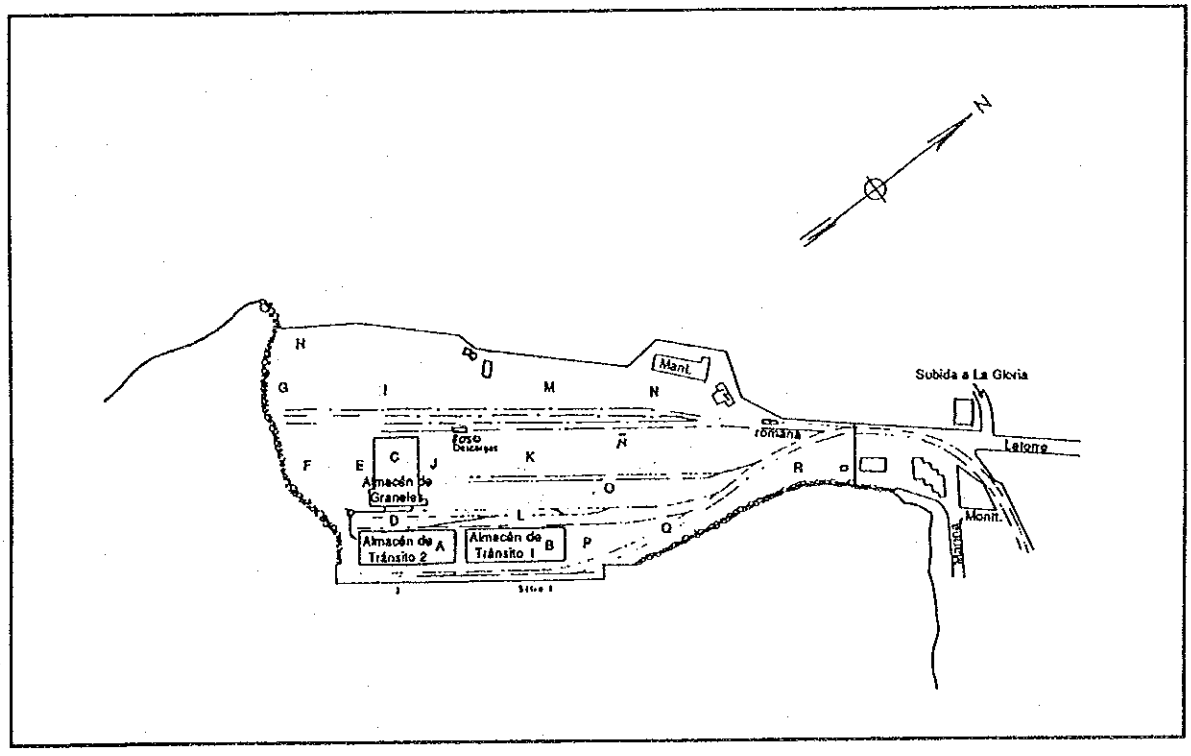


Fig. 5-6 Port in the Study Area



(1) Talcahuano



(2) San Vicente

Fig. 5-7 Layout of Talcahuano Port and San Vicente Port

There are ten flights daily, transporting 21,123 passengers in 1992, a 20 % increase over the previous year (Table 5-8). Over 96 % of passengers are to/from Santiago. The volume of air-cargo is not significant, 315 tons in 1992.

There is no large-scale improvement project for Carriel Sur airport, except for expansion of the transit room in the passenger terminal building.

Table 5-8 Air-cargo and Passengers of Carriel Sur Airport

Años	Carga(ton)	Pasajeros	Vuelos diarios
1991	286	169.730	10
1992	315	211.235	10

Source: Dirección de Aeropuertos, Departamento de Programación,MOP

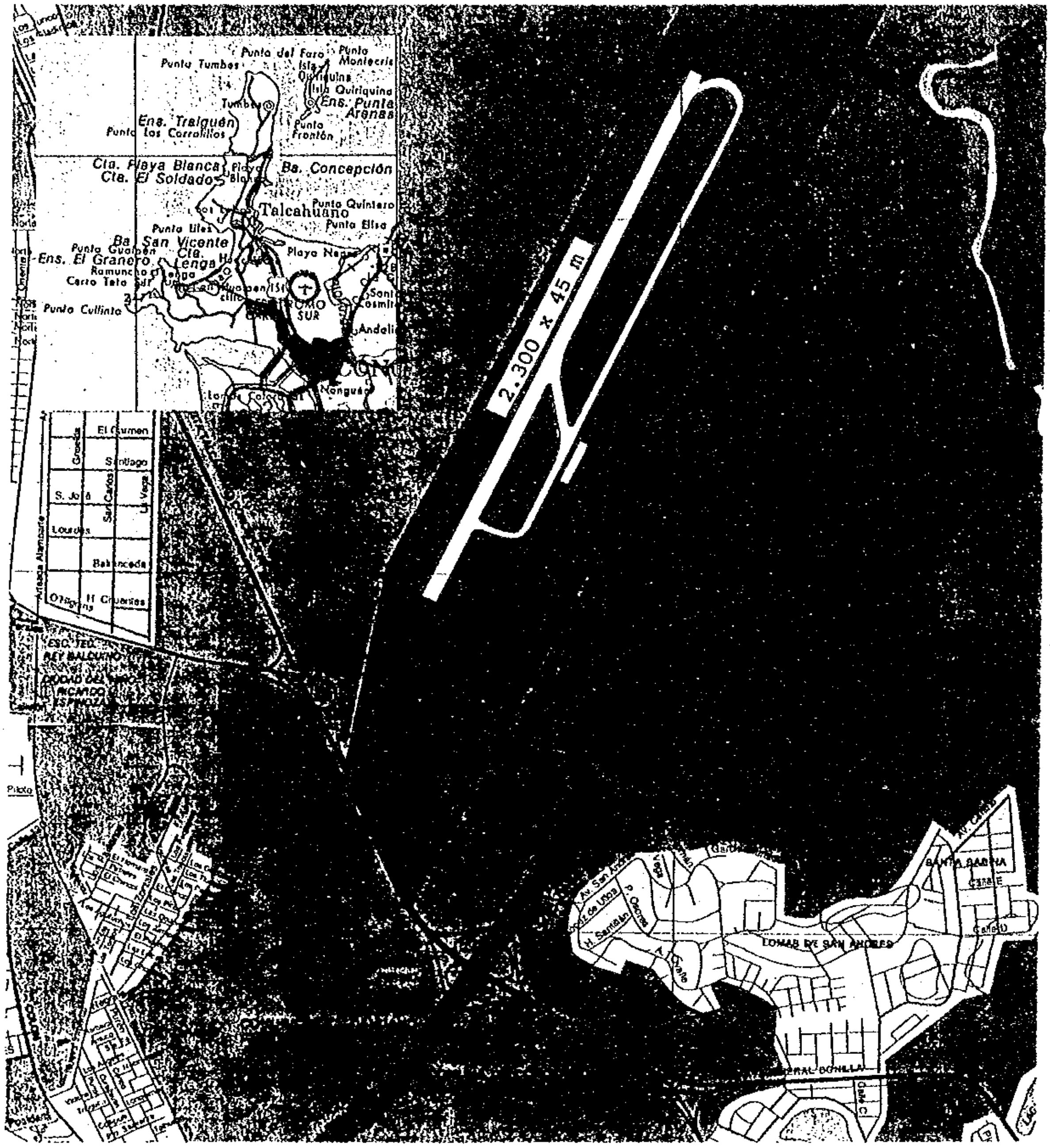


Fig. 5-8 Location of Carriel Sur Airport

CHAPTER 6. FORECAST OF FUTURE TRAFFIC DEMAND

6.1 Procedure for Traffic Forecast

The main purpose of traffic forecast is to estimate the future traffic demand in 2010 and in opening year 1999 on each alternative new bridge route. As the project bridge is located in an urban area, however, the following process was taken into account in order to reflect the characteristics of urban road traffic:

1. To divide traffic zones in the central area of Concepcion into as small as possible sections, because the densities of traffic generation/attraction in the area are higher than other areas and because the project site is very close.

2. To prepare 2(two) types of O-D matrix:

   Peak-hour vehicle O-D matrix
   Off-peak hour vehicle O-D matrix

3. To reflect the effects of traffic congestion in the central area on the in-flows from the new bridge. This item requires vehicle O-D matrix which contains all O-D pair vehicle traffic, not only traffic crossing the river but also O-D traffic in the central area.

The existing data made by DICTUC(*) in 1989 were applied and combined with the traffic survey data by the Study Team to satisfy the above items.

DICTUC : Departamento Ingenieria Civil De Transporte Pontificia Universidad Catolica "Encuesta Origen-Destino De Viajes Del Gran Concepcion"

The procedure for traffic forecasting consists of the following steps:

1) Establishment of present (1993) vehicle O-D matrix

   1. River crossing traffic only ---- from O-D survey by the Study Team (1993)
   2. Other O-D traffic ---- from DICTUC survey results (1989)
   3. Combination of above 2(two) O-D matrix
   4. Estimation of present Peak and Off peak hour vehicle O-D matrix, applying peak hour ratio