CHAPTER 10 SELECTION OF OPTIMAL BRIDGE TYPE

10.1 General

Biobio bridge is one of the longest bridges in Chile and requires substantial funds for the construction. Optimal type of structures are studied.

Several types of superstructures and substructures and foundations were examined and their combination was studied to define optimal type of bridge for new Biobio bridge. The optimal type of bridge will be selected under the following fundamental guidelines:

1. Determine the basic design condition for the comparison.
2. Nominate four types of bridges considered adequate at the construction site.
3. Conduct a preliminary design and quantity calculation using 4 types of superstructures and substructures.
4. Using the above, costs of various range of spans of superstructures and sub structure are calculated. Then total cost of the main bridge is evaluated for four systems.
5. Determine the most advantageous or desirable system by using analytic hierarchy process.

10.2 Scour Influence on the Foundation

A study of the river bed elevations shows that the maximum scour depth is 4.5 m below the river bed. Maximum scour depth is expected to be 6.0 m below the river bed. Therefore the elevation of the bottom of foundations was set at 9 m below the river bed.

10.3 Span of the Superstructure.

Based on the River Structure Code of Japan, the minimum span for the New Biobio Bridge will be over 75 m. However, there are differences between Japan and Chile, such as Japan suffers Typhoon every year. It is therefore difficult to apply the Japanese code to Chile directly. Minimum span of the new bridge, therefore will be 35 m taking into consideration the span of the Juan Pablo II bridge and the railway bridge. The maximum span length considered was 65 m because of the following reasons;

1. Subsurface conditions at the construction site are considered adequate for the foundation and the cost of the foundation will be less. The total cost for the construction of the bridge tends to be influenced by the cost of the superstructure, which generally costs less when the spans are shorter.

2. Special considerations are required if the span of the bridge is over 60 m. Longer spans would require deeper girders, and more complicated systems not applicable in this specific situation.

3. The length of the approach road must be short and elevation of the bridge must be low to reduce the construction cost of sub-structure. The approach road will be long, and the elevation will be increased if the girder height is high.

10.4 Bridge Types for Comparative Study

(1) Type of Superstructure

Four types of superstructure were nominated for the determination of optimal type of bridge. The types of bridges which were examined, included:

1. Simple post tensioned concrete I - girder. (Fig. 10-1)
2. Continuous steel plate girder.(Fig. 10-2)
3. Continuous post tensioned concrete hollow slab.(Fig. 10-3)
4. Continuous post tensioned concrete box girder.(Fig. 10-4)

(2) Type of Foundation and Substructure

1. Type of Foundation

The geological and hydrological survey shows the bottom of the foundation is expected at 9.0 m below the river bed. Direct foundation or caisson foundation are considered adequate type of foundation for such depth.

2. Type of Substructure

Two types of substructures are taken into consideration.

1. Hammerhead pier (Fig 10-2)
2. Solid Shaft Pier (Fig 10-3, Fig 10-4)

10.5 Selection of Optimal Bridge Type

The optimal bridge type was selected not only by cost of construction, but also by considering various other factors. The factors considered for the selection of optimal bridge type are cost, construction period, ease of construction, aesthetic point of view, ease of maintenance and durability against earthquake

Analytic Hierarchy Process (AHP) is applied to solve the optimal bridge type setting in this study. The AHP is a priority ordering method for use as a factor in decision making. The several steps for setting priorities by AHP are as follows:

Step 1. Determine the evaluation factors used for bridge priority setting.
Step 2. Compare and evaluate the factors for relative importance.
Step 3. Set the priorities of the bridge by using pairwise comparison matrix.

Based on the above derivations, the scheme proposed by the Study Team is the one using Continuous Post Tensioned Concrete Hollow Slab spans, 35 m each.

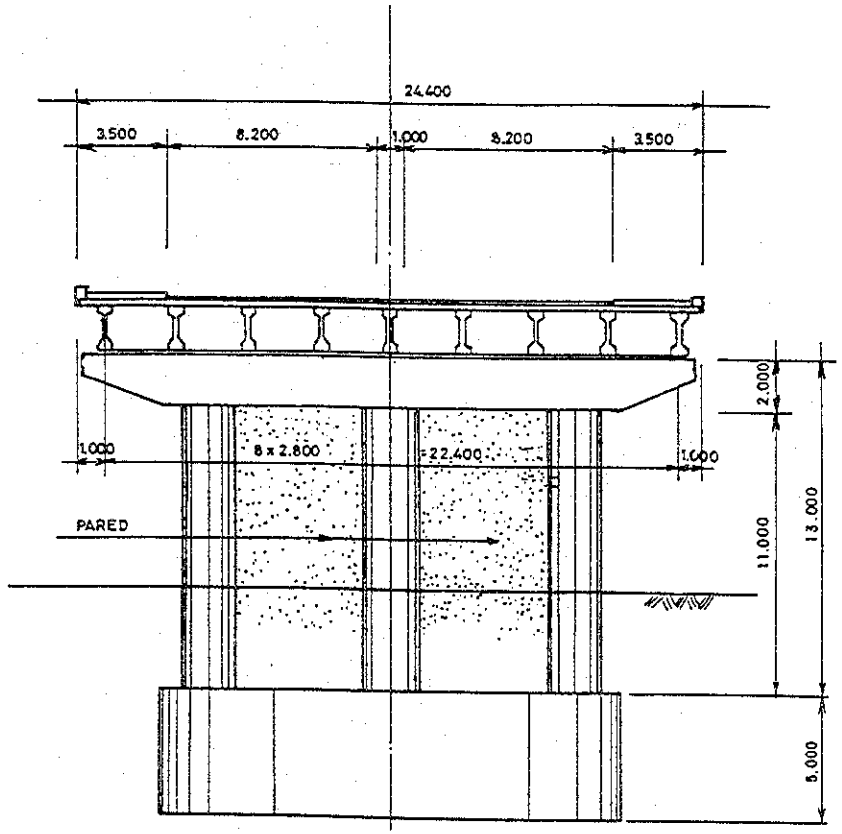


Figure 10-1 Symple Post-tensioning Girder with Dumbbell Pier on Pile Foundation

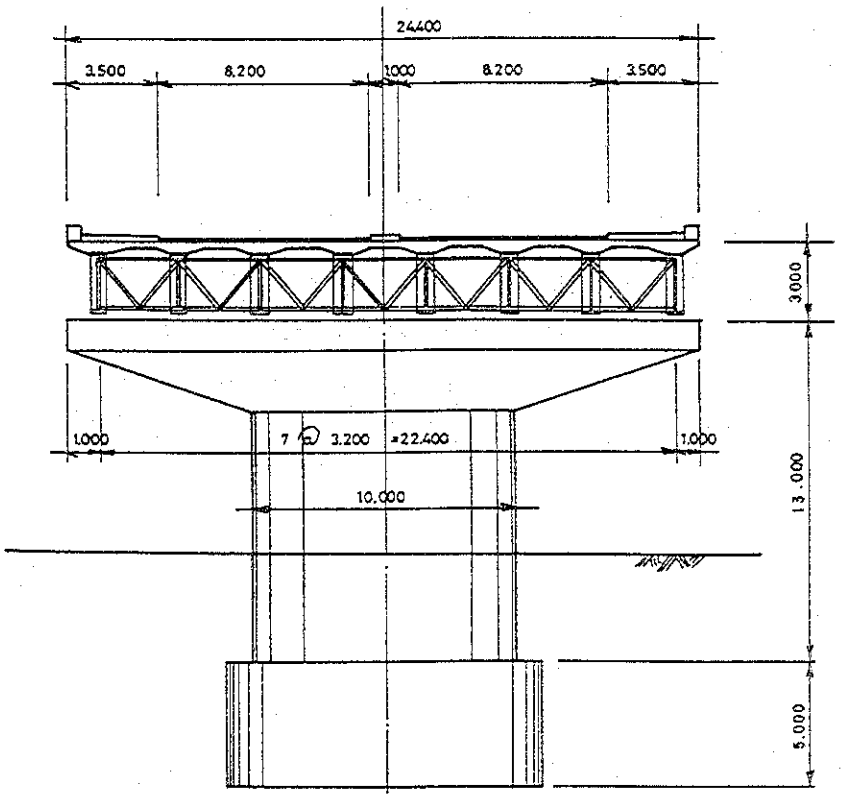


Figure 10-2 Continuous Steel Plate Girder with Hammer-head Pier on Pile Foundation

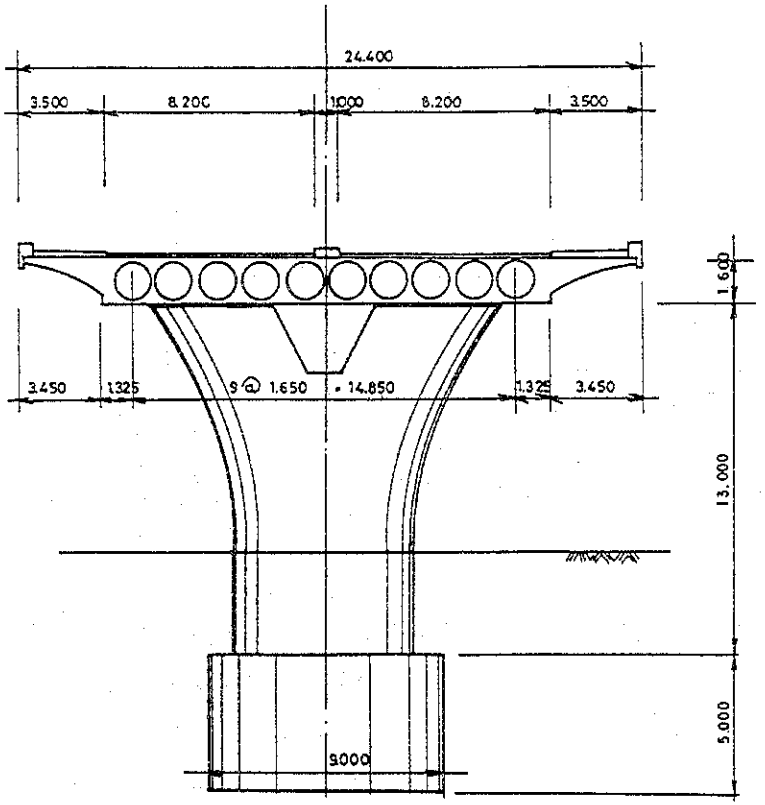


Figure 10-3 Continuous Post-tensioning Concrete Hollow-slab with Solid Wall Pier on Caisson Foundation

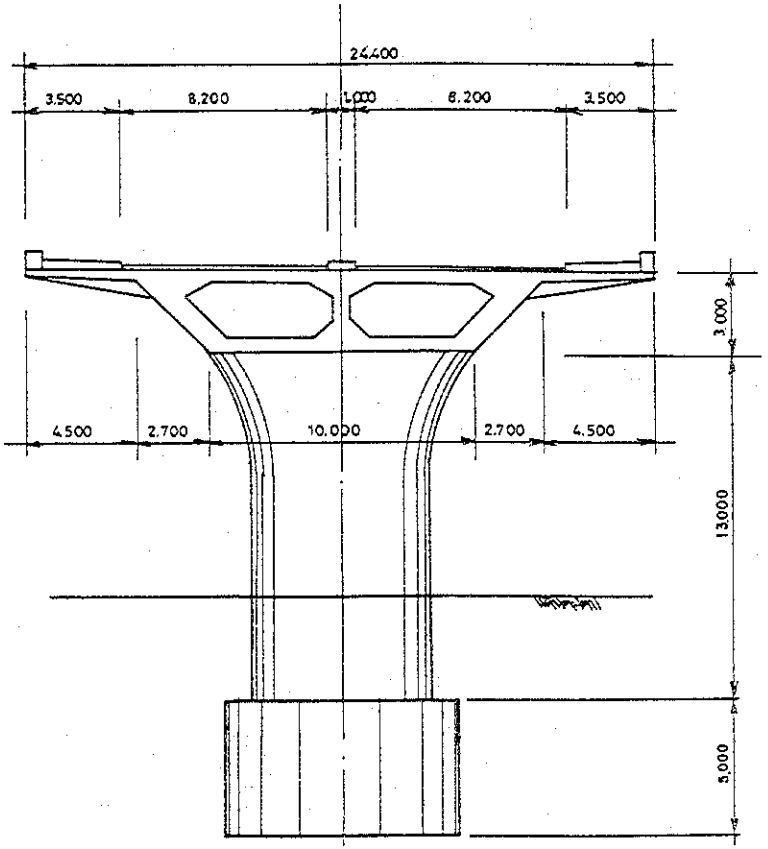


Figure 10-4 Continuous Post-tensioning Concrete Box Girder with Solid Wall Pier on Caisson Foundation

CHAPTER 11 PRELIMINARY DESIGN FOR THE BRIDGE

11.1 Type of Structure for the Study

Specification of the bridge being constructed on the Biobio river are summarized in Table 11-1.

Table 11-1 Specification of the New Bridge over the Biobio River

Total Bridge Length	6 x 8 x 35 m + 5 x 35 m = 1,855 m
Width	2 x 3.5 m + 2 x 8.2 m + 1.0 m = 24.4 m
Type of Superstructure	Post tensioned Concrete Hollow Slab
Type of Substructure	Solid Shaft Pier, Reverse T Abutment
Type of Foundation	Caisson Foundation
Design Load	AASHTO HS20-44 or Equivalent
Seismic Coefficient	Kh = 0.15
Number of Spans and Span Length	Continuous Eight Spans, 35 m each

Detail of the Bridge, see Figure 11-1, 11-2 and 11-3.

(1) Superstructure

The Study Team recommended a continuous post-tensioned concrete hollow slab bridge for the bridge over the Biobio river. This type of bridge can be constructed economically by using movable staging but the method can not be applied economically for the fly-overs because of the short bridge length. Therefore the simple post-tensioned I girder is considered adequate for the fly-over for the railway and Av. Pedro Aguirre Cerda.

It is recommended that the number of the continuous spans for the post-tensioned concrete hollow slab over Biobio river should be eight to ten spans, supported on the rubber shoe. By using this system, the reaction and forces of the earthquake from the superstructure will be distributed through the rubber shoe uniformly from the superstructure to the substructure.

(2) Substructure

Solid Shaft Pier with Caisson foundation are proposed as substructure for the bridge over the Biobio river. Rigid frame type piers are proposed for the fly-over. The combination of slender shaft and small size caisson make the construction cost small and good from the aesthetic point of view.

11.2 Tentative Construction Schedule

Tentative construction schedule is shown in Fig 11-4.

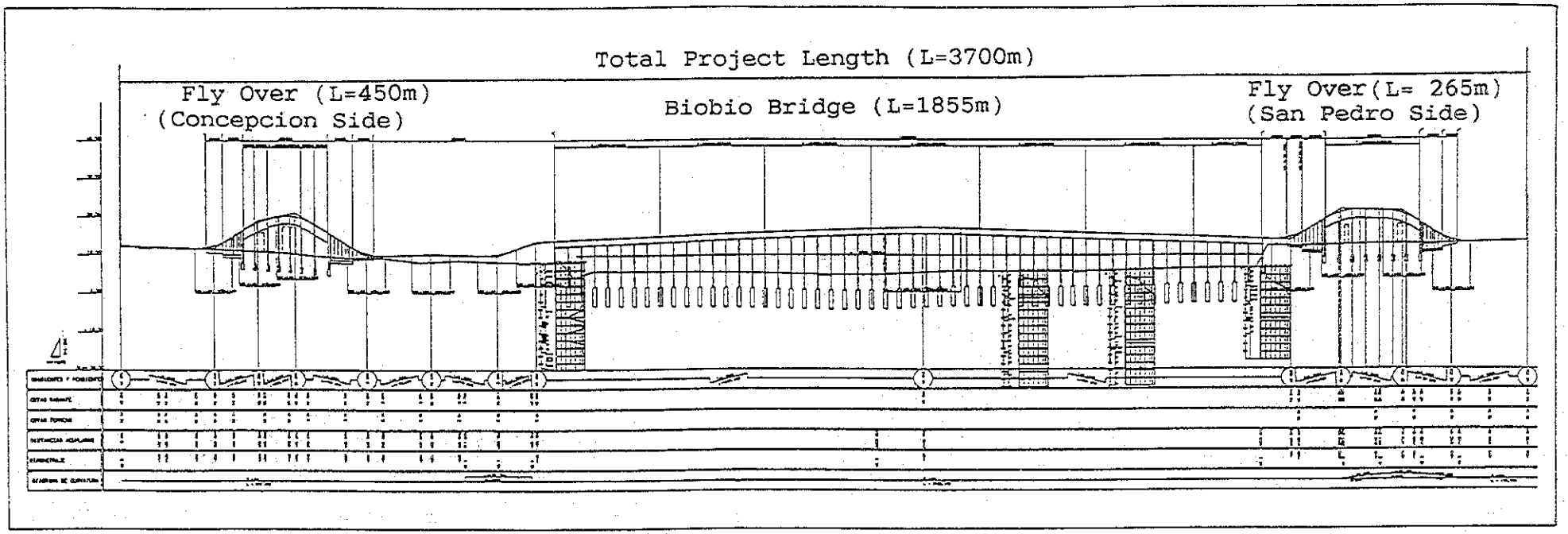


Figure 11-1 Project Profile

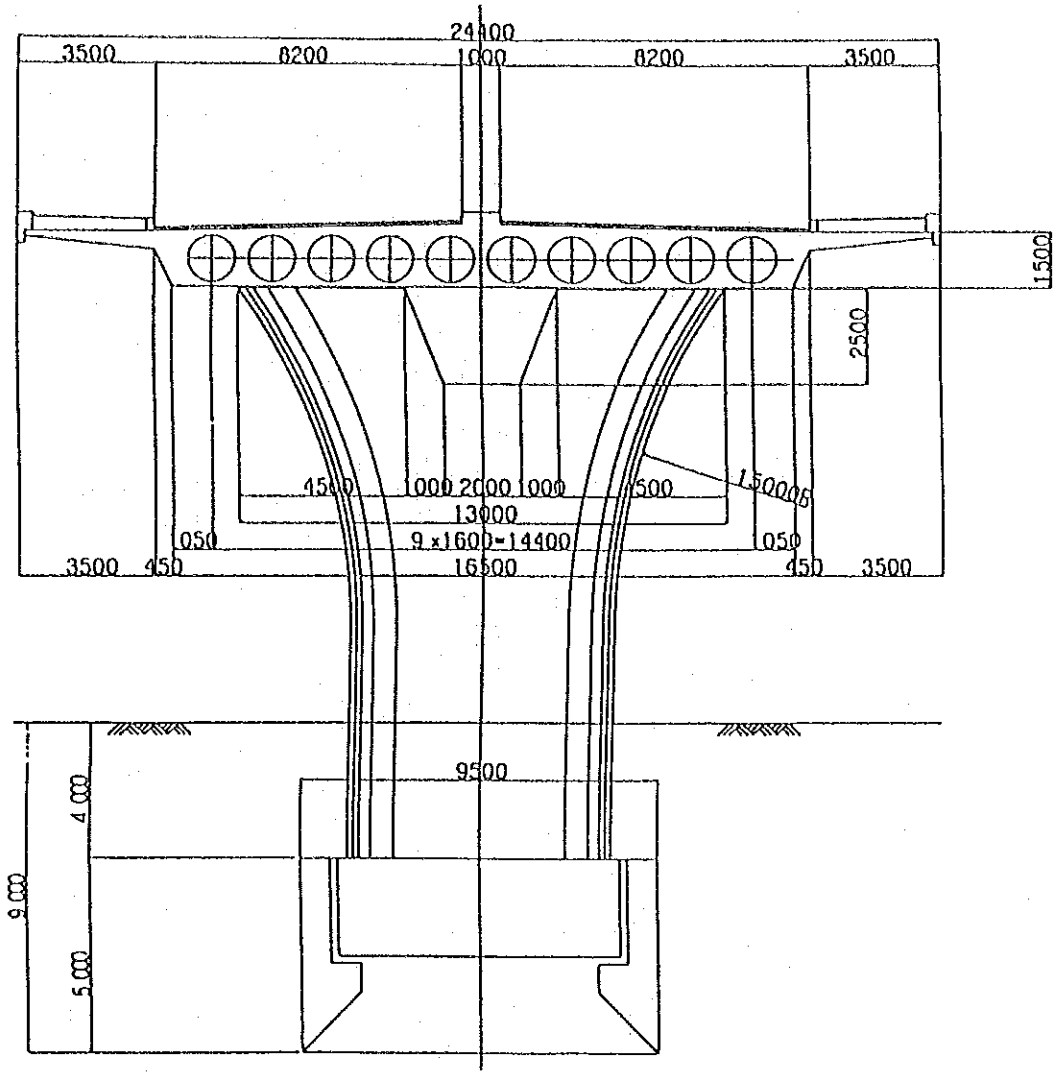


Figure 11-2 Cross Section of New BiobIo Blidge

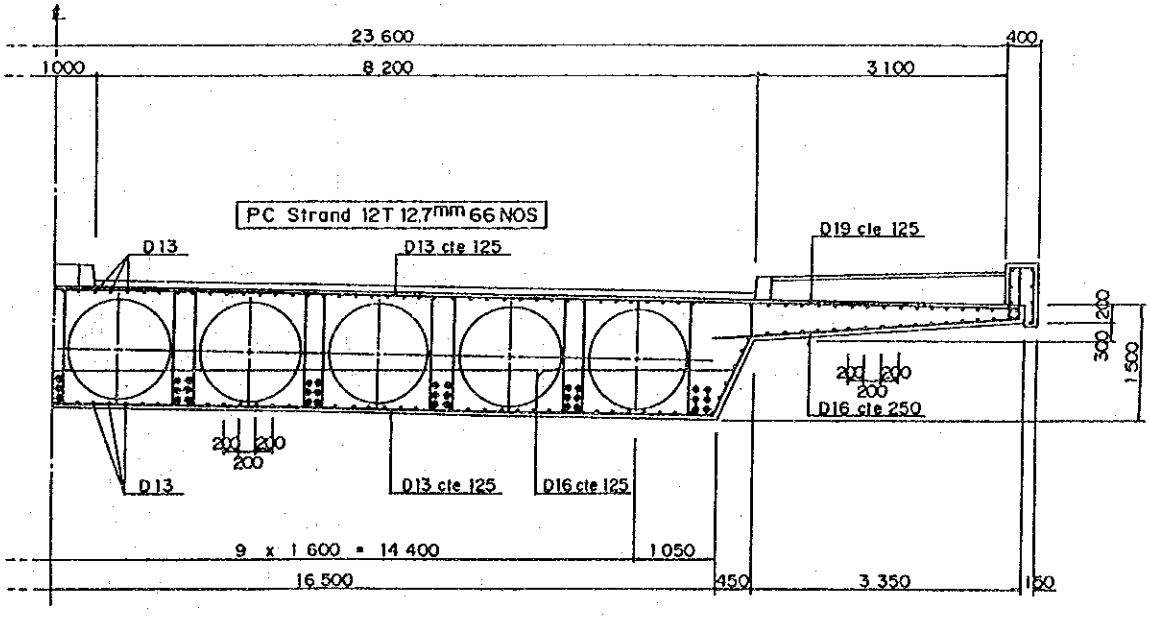


Figure 11-3 Cross Section of PC Hollow-slab

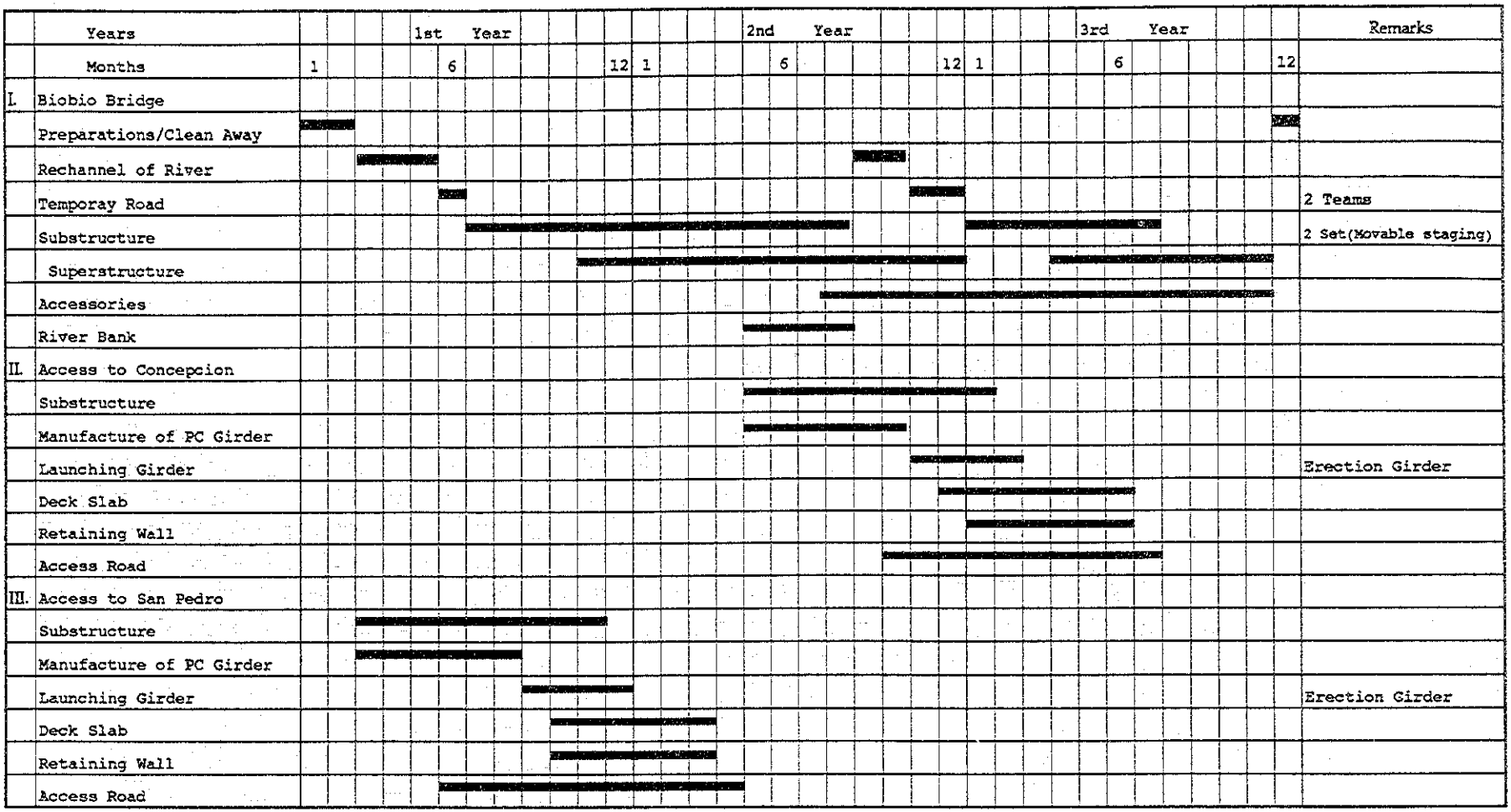


Figure 11-4 Tentative Construction Schedule

CHAPTER 12 COST ESTIMATES

Total construction cost is shown in Table 12-1. Total project cost is estimated at Ch.$ 28,476 millon (US$ 66.07 millon, converted at the rate of Ch.$ 431.04 = US$ 1.00 as of December 30, 1993), of which the foreign currency portion is 26.3%.

Table 12-1 Construction Cost of New Biobio Bridge Project

(1,000 Ch.$, 1,000 US$)

Cost Item	Foreign Currency (1,000 US$)	Local Currency (1,000 Ch.$)	Total (X 1,000)	
			in US$	in Ch.$
1 New Biobio Bridge				
Rechannel of River	956.5	142,448.0	1,287.0	554,690.9
Temporary Road	1.2	4,917.2	12.6	5,433.1
Substructure	1,694.5	3,073,628.4	8,825.8	3,803,940.7
Superstructure	5,599.4	4,782,817.0	16,696.4	7,196,163.9
Accessories	437.6	848,669.9	2,406.7	1,037,272.2
River Bank	10.3	15,693.0	46.8	20,149.5
Subtotal	8,699.5	8,868,173.5	29,275.3	12,617,650.3
2 Access to Concepcion				
Substructure	71.1	181,408.6	492.0	212,043.7
PC Girder	190.0	291,723.5	866.8	373,609.3
Launching PC Girder	5.7	74,912.6	179.5	77,375.5
Deck Slab, etc.	82.7	212,937.7	576.7	248,576.3
Retaining Wall	51.3	126,505.1	344.8	148,612.3
Access Road(925m)	471.6	561,333.2	1,774.0	764,601.1
Subtotal	872.4	1,448,820.7	4,233.9	1,824,818.2
3 Access to San Pedro				
Substructure	71.1	181,408.6	492.0	212,043.7
PC Girder	220.8	310,032.2	940.1	405,194.5
Launching PC Girder	6.1	79,358.9	190.2	81,979.8
Deck Slab, etc.	86.7	234,041.6	629.8	271,427.1
Retaining Wall	47.3	116,773.9	318.3	137,180.6
Access Road(850m)	391.8	466,338.4	1,473.8	635,207.1
Subtotal	823.8	1,387,953.6	4,044.2	1,743,032.7
4 Direct Cost Total	10,395.7	11,704,947.8	36,533.4	16,185,501.2
5 General Expenses	2,079.1	2,340,989.6	7,510.7	3,237,100.2
6 Construction Cost	12,474.9	14,045,937.4	45,064.0	19,422,601.5
7 Engineering Cost	998.0	1,123,675.0	3,605.1	1,553,808.1
8 Contingency	1,247.5	1,404,593.7	4,506.4	1,942,260.1
9 IVA	2,649.7	2,983,357.1	9,571.6	4,125,360.6
10 Land Acquisition	0.0	1,432,288.0	3,323.2	1,432,288.0
11 Total Project Cost	17,370.0	20,989,851.2	66,070.3	28,476,318.3

Note: Expressed at 1994 price,converted at the rate of Ch.$ 431 = US$ 1.00

CHAPTER 13 ECONOMIC EVALUATION

13.1 Scope and Methodology of Evaluation

(1) Scope of Evaluation

1. Projection Period

Traffic forecast has been made for the year 1999 when the new bridge is deemed to open and the year 2010 which may be a limit of foreseeable future. Economic benefit by the bridge will be estimated for these two points of years and interpolated for 2000 to 2009 and extrapolated for the years beyond 2010, up to 2019.

2. Coverage of Traffic

The vehicle OD matrices used for traffic assignment cover all kinds of vehicles operated in the Study Area. Therefore, estimated benefit is not only from the traffic crossing the river, but also the traffic which does not cross the river which is affected by the traffic to/from the opposite side of the river.

3. Road Network

Road network used for the traffic assignment is basically same as the present network, with the following exceptions: (a) Closure of the old Biobio bridge, (b) Opening of Av.Costanera, (c) Widening of Los Carrera Av. and Up-grading of Prat Av. The other road projects will be disregarded because they are minor projects or will not affect the traffic crossing the river.

(2) Evaluation Procedure

Economic evaluation of a road or a bridge project will be made with so-called "cost benefit analysis". The cost and benefit accruing from a project are measured in terms of economic price.

All the transfer costs (taxes and subsidies) are deducted from the cost. In addition , in order to convert the financial cost of the project into the social cost, shadow wage rates are applied to labor cost and the shadow exchange rate is used as a multiplier to the foreign portion of the total cost. Benefits are savings in travel time cost and vehicle operating cost.

The economic benefit of the project counts only the most direct benefits, that is, savings in vehicle operating cost and in travel time cost. It does not count indirect benefits such as economic benefit from urban development around the new bridge.

After estimating costs and benefits from the year 1996 to 2020, evaluation indicators are calculated. They are internal rate of return (IRR), net present value (NPV) and benefit to cost ratio (B/C).

13.2 Economic Evaluation Results

(1) Base Case

Base case is the evaluation under the network conditions which are:

a. Old Biobio bridge is closed before 1999 when the new bridge is completed in order to avoid possible disasters.
b. Costanera Avenue is constructed before the year 2000.
c. Widening of Los Carrera st. and Prat st. are completed before 1999.
d. Other road conditions are same as at present.

Based on these conditions, traffic assignment was done by type of vehicles, by peak time and off-peak time, by "with project" and "without project" and for 1999 and 2010, to estimate benefits in those years. When calculating NPV and B/C, the discount rate is assumed to be 12 %, which is commonly used to evaluate a project in Chile.

Table 13-1 Cost-Benefit Cash Flow of New Biobio Bridge Project

(Million Ch.$)

Year		Cash Flow (Mill.Ch.$)			Discounted Cash Flow (by 12%)
		Cost	Benefit	B - C	
1	1996	5,733.5		(5,733.5)	(5,733.5)
2	1997	8,614.7		(8,614.7)	(7,691.7)
3	1998	6,654.6		(6,654.6)	(5,305.0)
4	1999	71.7	3,259.4	3,187.7	2,268.9
5	2000	71.7	3,752.6	3,680.9	2,339.3
6	2001	71.7	4,245.8	4,174.1	2,368.5
7	2002	71.7	4,739.0	4,667.3	2,364.6
8	2003	71.7	5,232.2	5,160.5	2,334.3
9	2004	71.7	5,725.4	5,653.7	2,283.4
10	2005	71.7	6,218.6	6,146.9	2,216.6
11	2006	71.7	6,711.9	6,640.1	2,137.9
12	2007	71.7	7,205.1	7,133.3	2,050.7
13	2008	71.7	7,698.3	7,626.5	1,957.5
14	2009	71.7	8,191.5	8,119.7	1,860.8
15	2010	71.7	8,684.7	8,612.9	1,762.4
16	2011	71.7	9,177.9	9,106.1	1,663.7
17	2012	71.7	9,671.1	9,599.4	1,565.9
18	2013	71.7	10,164.3	10,092.6	1,469.9
19	2014	71.7	10,657.5	10,585.8	1,376.6
20	2015	71.7	11,150.7	11,079.0	1,286.3
21	2016	71.7	11,643.9	11,572.2	1,199.7
22	2017	71.7	12,137.1	12,065.4	1,116.8
23	2018	71.7	12,630.3	12,558.6	1,037.9
24	2019	71.7	13,123.5	13,051.8	963.1
25	2020	(10,294.9)		10,294.9	678.2
Total		12,214.5	172,020.9	159,806.5	19,572.8

The internal rate of return (IRR) implied in the project is as high as 20.8 %, B/C is 2.04 and NPV amounts to Ch.$ 19,573 million, all of which assure high economic returns derived by the implementation of the new Biobio bridge project.

13.3 Sensitivity Analysis

Sensitivity analyses were made, by changing uncertain but influential conditions such as road network conditions, traffic demand, cost and benefit. The results of analyses are shown in Table 13-2.

Table 13-2 Sensitivity Analysis

Case		IRR (%)	NPV(Millon Ch.$)	B/C
1 Base Case		20.8	19,572.8	2.04
2 Costanera Av. not constructed		33.7	55,414.5	3.96
3 Old Bridge remains open		14.0	3,608.2	1.19
4 Demand	20 % less	13.1	1,877.1	1.12
	10 % less	16.2	9,674.5	1.43
	10 % more	23.1	24,083.2	2.34
	20 % more	25.2	27,118.0	2.88
5 Benefit	20 % less	17.7	11,961.3	1.64
	50 % less	12.3	544.2	1.03
6 Traveler's Time Value	20 % less	18.6	16,034.2	1.72
	50 % less	15.2	6,503.9	1.21
7 Cost	20 % up	18.3	15,740.3	1.70
	100 % up	12.1	410.1	1.01

13.4 Optimal Investment Year

After the three year construction period, the actualized value of the total construction cost of the new bridge in the first year of operation is Ch.$ 28,314 millon applying the compound interest method at 12% of interest rate. About 12% of the said amount, Ch.$ 3,158 millon, is the capital opportunity cost of the project.

Annual benefit of the project will exceed this amount in the 1999 for the first time. Therefore, the year 1999 is optimal for the commencement of service, and thus, the year 1996 is the optimal to start the construction.

CHAPTER 14 PROJECTS RELATED TO THE NEW BIOBIO BRIDGE

Construction of the new Biobio bridge will not only cause a change in urban traffic flow, but also accelerate urban development, which will be most remarkable in Costanera area (Zone 3). In this connection, it may be useful to suggest a proper urban development scheme for Zone 3 and a guideline for a traffic distributor plan, in order to maximize the positive effects by the new bridge construction.

14.1 Proposal for the Redevelopment of Zone 3

(1) Existing Conditions of the Project Area

Fig. 14-1 shows the existing land use of Zone 3. Low density residential and mixed use areas along the existing Costanera Street are formed on public land, without water supply, sewerage and sanitary facilities. The number of families inhabiting this area is about 1,000.

(2) Development Target and Policy

The development target of zone 3 can be manifested, in short, as "Creation of region-wide major activity center with high amenity and environmental quality". To create the new activity center, the following four strategies are established as the core of development policy.

1. Infrastructure Development:
2. Actualization of Rational Land Use:
3. Installation of Functional and Safe Transportation System:
4. Creation of Suitable Environment for an Urban Center:

(3) Development Framework

The total resident population of Zone 3 will be 15,000 and the total number of employed persons working within Zone 3 will be 11,000 in 2010.

(4) Land Use Policy

The function of the zone as the regional activity center will be best organized for efficiency and effectiveness by:

1. Improving Functions in Existing Location
2. Relocating and Improving Functions in Zone 3
3. Introducing New Functions to Zone 3.

(5) Land Use Plan

Taking into consideration the above-mentioned points, the land use plan is prepared as shown in Fig.14-2 and Table 14-1. Fig.14-3 illustrates the image of urban development in the Costanera Area, viewing from the top of the Concepcion railway station building toward the Biobio River.

Table 14-1 Planned Area by Land Use

Land Use	Area(ha)
1 Residential	21.8
2 Mixed (industrial/residential)	22.0
3 Industrial	16.6
4 Institutional	5.9
5 Commercial	7.7
6 Business/residential.Cultural	12.5
7 Riverside Park	22.7
8 Others	27.8
Total	137.0

14.2 Improvement of Road Network in and around Zone 3

(1) Concept of Road Network

The extension of Los Carrera Street to the New Biobio Bridge and the proposed New Costanera Avenue are the two major roads which will pass through Zone 3 and will be the east-west and north-south access routes to the zone, respectively. In addition, some improvements of road network in and around zone 3 are indispensable for keeping smooth flow of through traffic and for securing better access to and from the planned region-wide activity center. In order to create appropriate urban amenities, a pedestrian way network should be established.

The concept of road improvement plan related to Zone 3 is shown in Fig. 14-4.

(2) Road Network Development Plan

1. M. Zanartu Street

This four lane road connects the new Biobio Bridge to Los Carrera Street. From the river bank to the point between Lastarria and R. Claro Streets the road runs on ground level and then is elevated gradually to cross over the railroad tracks and A. Prat Avenue. The point where the elevated road goes down to ground level to connect with Los Carrera Street is between Serrano and Salas Streets.

2. Costanera Avenue

Costanera Avenue proposed in the Costanera Section Plan should be constructed on the reclaimed public land as a boulevard serving not only for carrying traffic but also for comfortable drives along the Biobio River. At the intersection with M. Zanartu Street, a diamond type separation is adopted. The number of lanes is 4.

3. Semi-arterial Roads

All semi-arterial roads have 4 lanes. In the east-west direction T. Rojas, A. Arrancibia, Bilbao, A. Bello and Esmeralda Streets are to be improved for conducting through traffic from the New Biobio Bridge to the downtown of Concepcion and for providing better access from the existing center to the planned new region-wide activity center.

In the north-south direction Errazuriz and M. Montt Streets are improved as semi-arterial roads. Errazuriz Street should be extended and widened to be enough for carrying traffic from high-class residential areas located along Pedro de Valdivia Avenue into the New Activity Center. M. Montt Avenue will play the important role of a connector of the two sides separated by M. Zanartu Street.

4. Pedestrian Way Network

A wide pedestrian shopping promenade will be constructed starting from Plaza Espana at the end of B. Arana Street and extending far to Plaza del Agua at the riverside of the Biobio River. In the north-south direction 3 main routes are planned. One is to connect the Business/residential/cultural areas with the Commercial area, another is for the Institutional areas and the last is a long riverside promenade.

5. Parking Facilities

Parking demand of inhabitants and employed persons in the zone should be met principally by attached private parking lots to houses and establishments.

For the visitors to the shopping mall and other facilities, a public outdoor parking is planned. The location is between the Institutional area and the Business/residential/cultural area, and the capacity is 1,500 vehicles (4.5 ha in area).

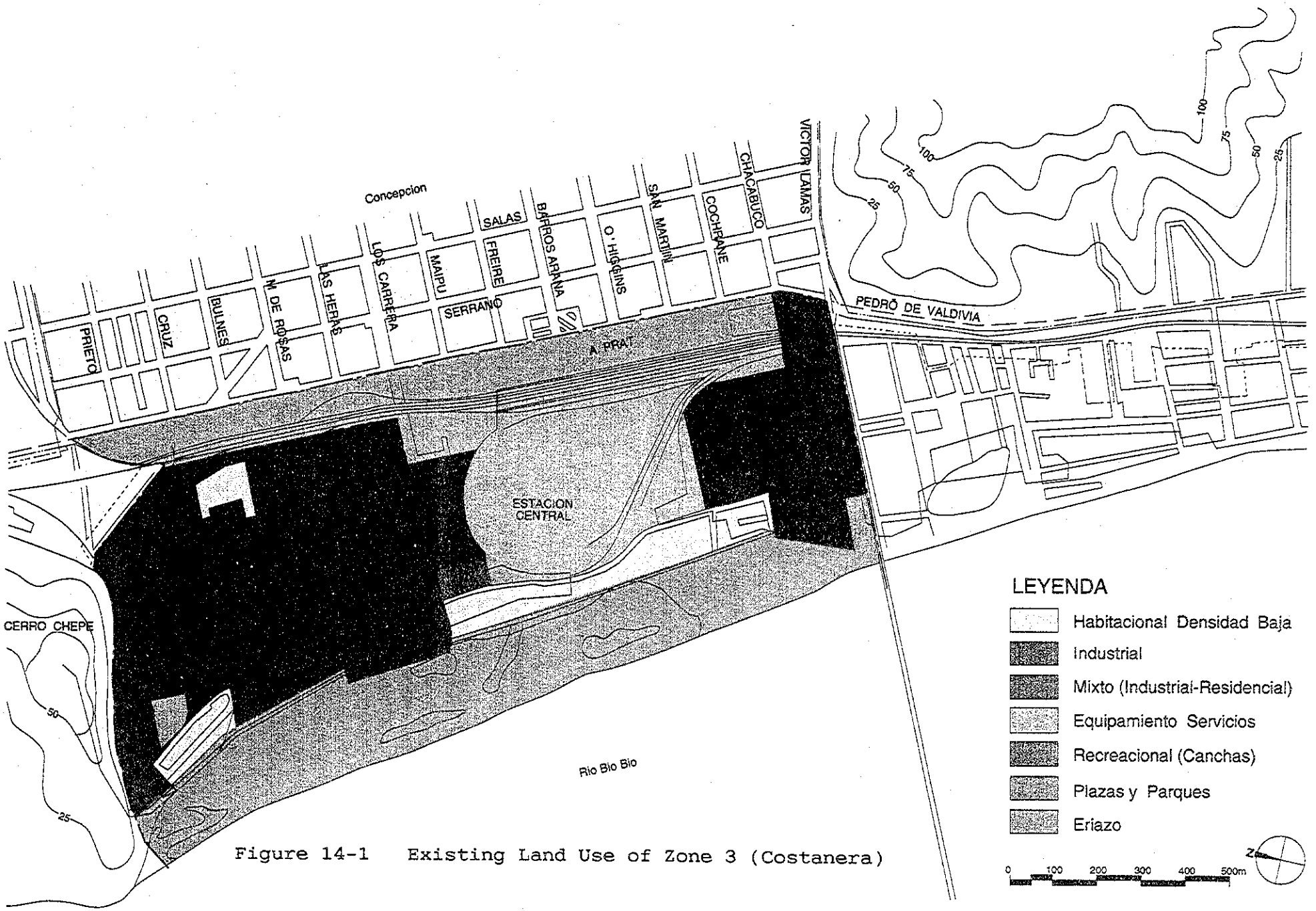


Figure 14-1 Existing Land Use of Zone 3 (Costanera)

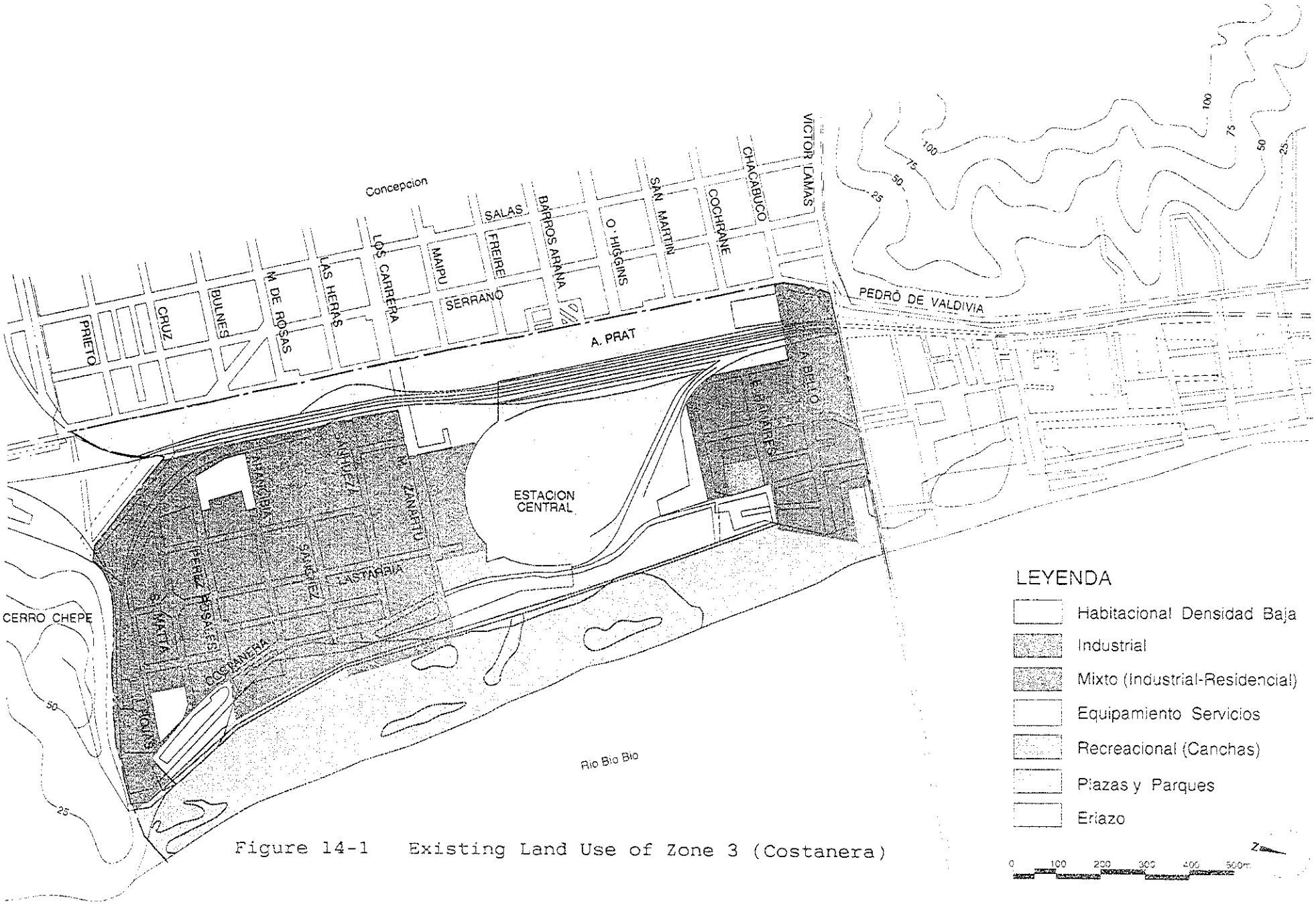
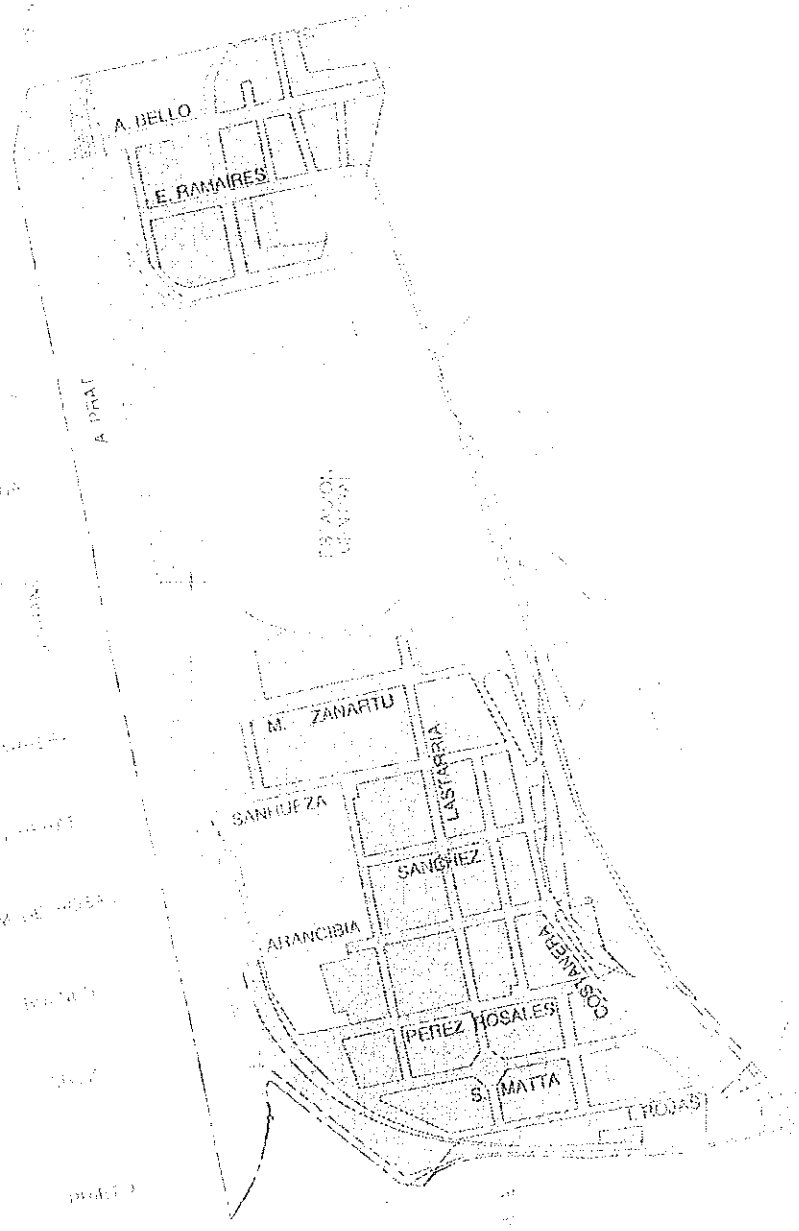


Figure 14-1 Existing Land Use of Zone 3 (Costanera)


A. BELLO
E.E. RAMAIRES
M. ZANARTU
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ARANCIBIA
COSTANERA
PEREZ ROSALES
S. MATTA
T. RODAS

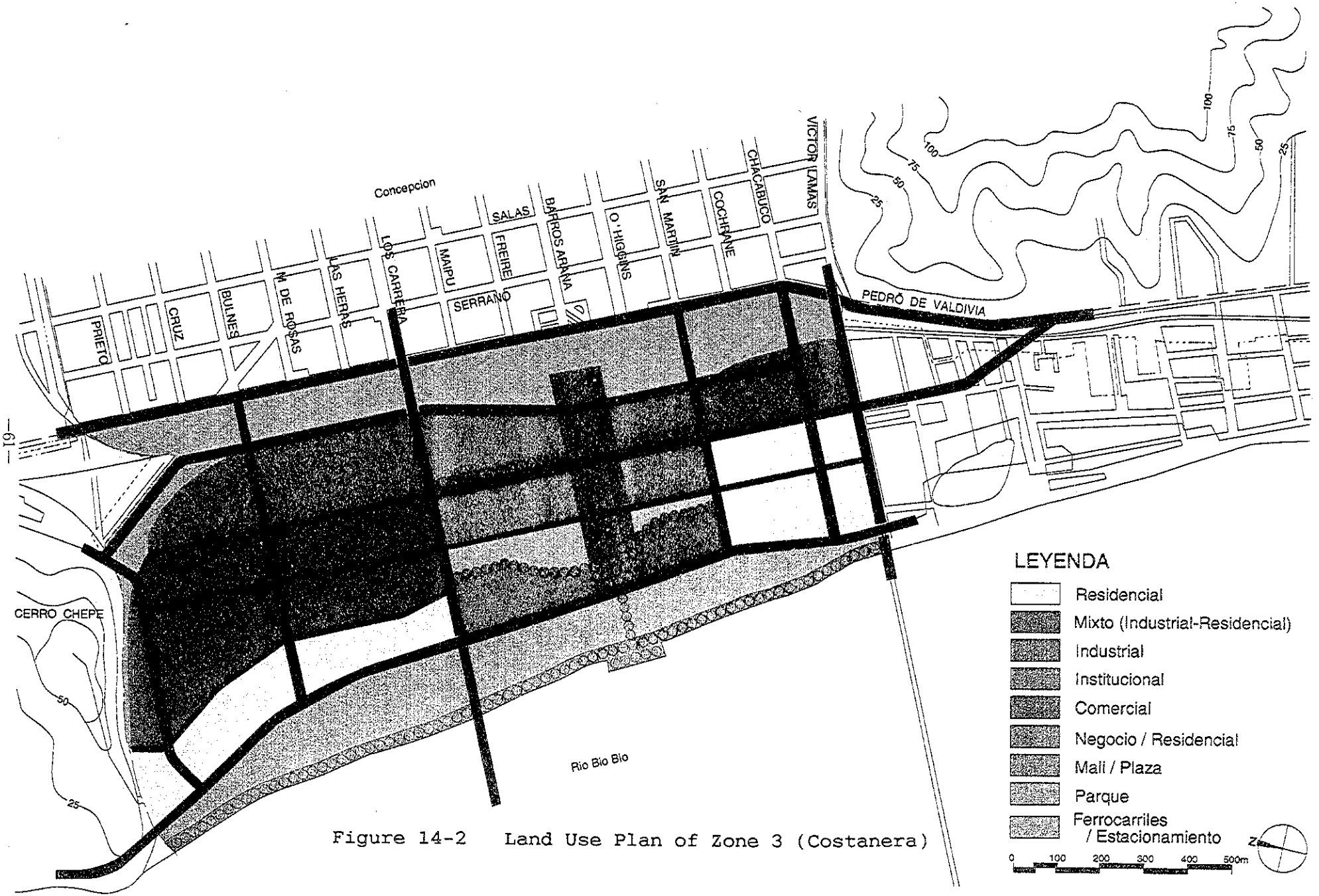

Figure 14-2 Land Use Plan of Zone 3 (Costanera)

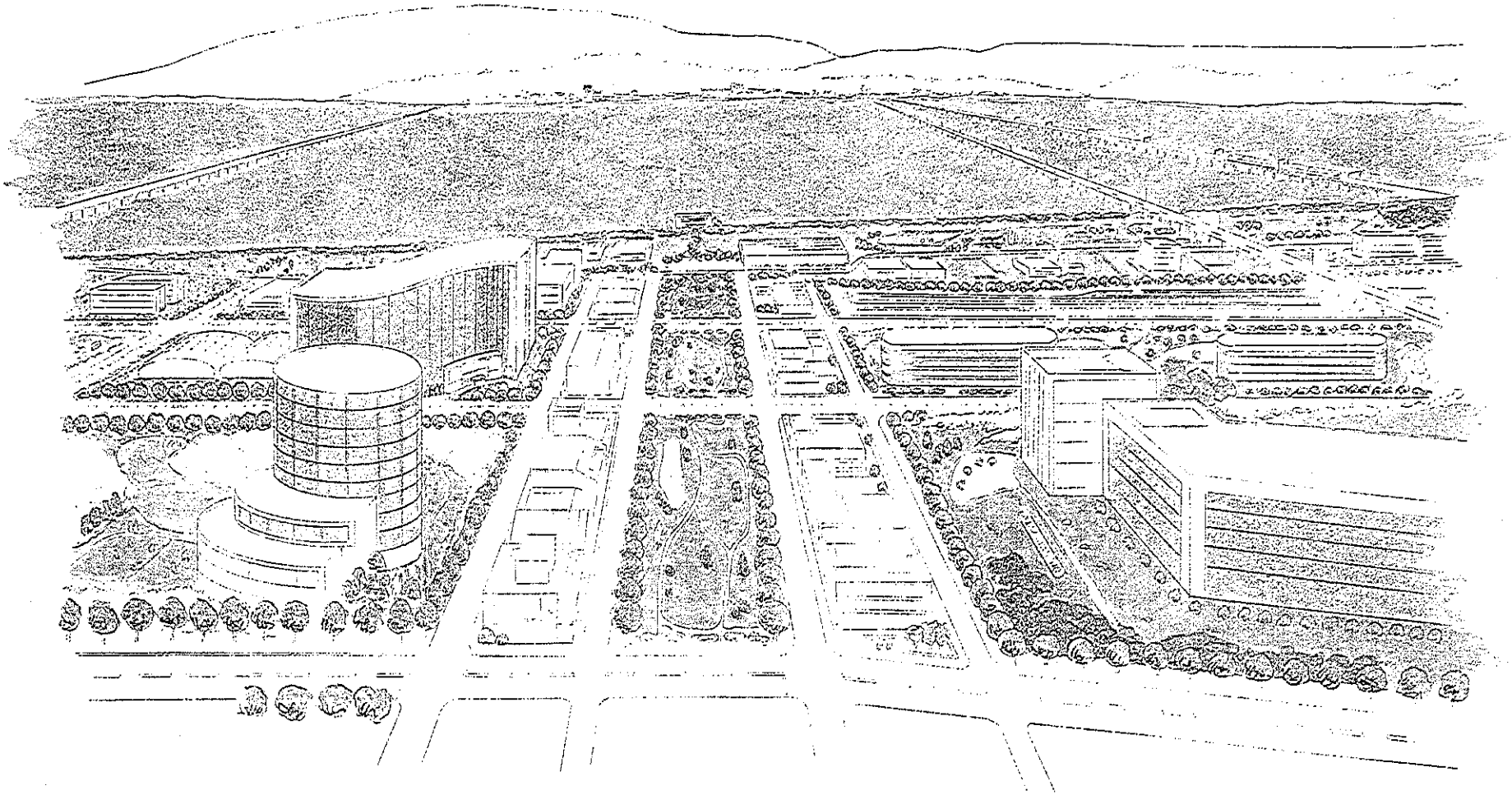

Figure 14-3 Image of New Activity Center

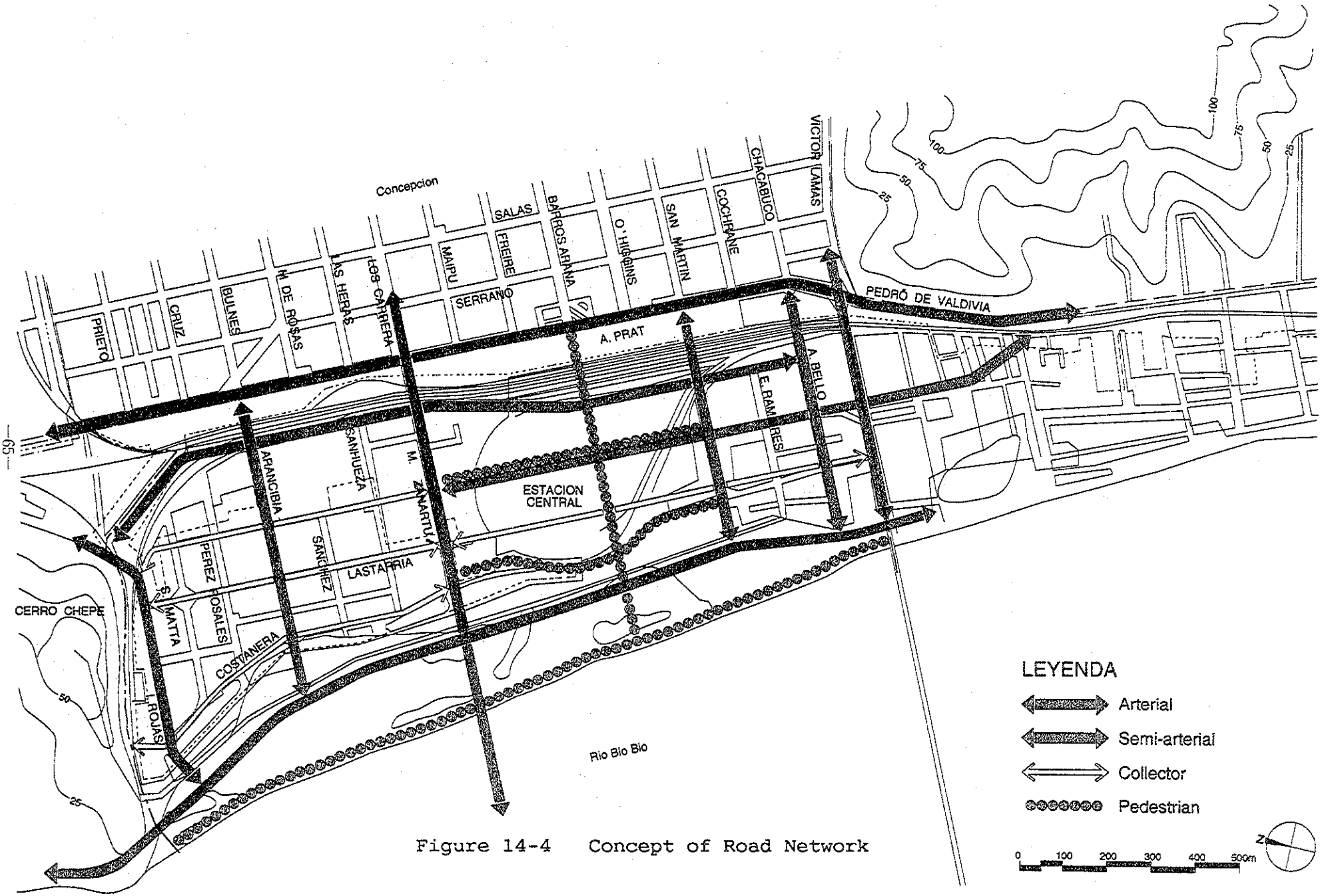

Figure 14-4 Concept of Road Network

CHAPTER 15 ENVIRONMENTAL IMPACT STATEMENT

15.1 Outline of Study

This study performs an environmental impact assessment of the Biobio River bridge construction project in Concepcion City, and seeks to determine whether or not environmental problems exist as a result of the implementation of this project. As a result of a site survey, it is considered that there is no large impact to worse the environment. Items classified as a small impact for the environment and it's countermeasures or compensation are listed in the Table 15-1.

Table 15-1 Environmental Impact, Evaluation and Countermeasures

Item	Main Impact	Evaluation	Countermeasure
Social Environment	Resettlement 29 Household	B	Compensation
	Traffic Safety	C	Set up traffic signal, traffic safety features
Natural Environment	Aesthetic	C	Bridge design
Pollution	Air Pollution	B	Disperse traffic
	Noise, Vibration	B	Disperse traffic, Control heavy vehicles
	Water Pollution	C	Construction method

Note ; A : Large impact predicted if no countermeasures taken
B : Slight impact predicted, some countermeasures or compensation required
C : Negligible impact, general consideration can avoid or mitigate the impact

15.2 Summary

Implementation of this project will have some impact in the areas of residential relocation, air pollution, noise, and vibration. However, air pollution, noise and vibration will increase even without the project because of the expected increase of traffic through economical development in the study area. Lesser impact is expected from the project in terms of transportation, living facilities, aesthetics, and water pollution.

It is considered that the effect on the environment of the "without project" case will be worse for the environment than the "with case". Air pollution, noise from traffic jams, traffic detours are considered to be worse in the area if the project is not implemented.

However, when over 60,000 vehicles are concentrated in the city, local environment problems can be expected. It will be necessary to disperse the traffic entering the central area of the city by implementing the "Biobio River North Dike Area Recovery Project" and the "Costanera Road Project"

CHAPTER 16 CONCLUSIONS AND RECOMMENDATIONS

On the second stage of the study, the optimal type of bridge and road alignment were studied based on the data collected in the First Stage of the study and on a preliminary design. Based on the traffic demand analysis carried out in more detail in this Stage and based on construction cost estimation and the economic analysis, the Study Team arrived following conclusions.

16.1 Conclusions

(1) The JICA Study Team concluded that the new Biobio Bridge along the extension of Los Carrerra St. and along the same alignment (Route Alternative No.4) is the best choice not only for economic reasons but also for the reasons below.

1. Concepcion City Authority is now implementing a project to widen Los Carrera St. into a six lane road, which will give the best access from the San Pedro side.

2. Due to restrictions of topography on the San Pedro side, access road of Alternative 1, 2 and 3 would allow the use of small radius curves. This is not desirable from the viewpoint of traffic safety and traffic control.

3. In case of Alternatives 1 and 2, all the traffic entering the downtown of Concepcion is forced to make left turns, which would not provide the condition for smooth traffic flow.

4. Alternative 4 is considered to be the best route to encourage and accelerate the urban development in the river-side area in Concepcion.

5. Alternative 4 has the least demand for land acquisitions.

(2) The most suitable structural scheme which is recommended is the one using continuous post tentioned hollow slab deck bridge, with 35 m spans supported on solid wall piers supported on caisson foundations.

(3) The total cost of the project is estimated at Ch.$ 28,476 million (US$ 66.1 million) at 1994 price, including approach roads and fly-overs on both sides. Three years will be needed for construction.

(4) The project is judged to be highly feasible, yielding 20 % as the internal rate of return (IRR) and has a net present value (NPV) of Ch.$ 19,573 million. The sensitivity analysis revealed that the feasibility is quite stable against changes in the road network conditions, a smaller increase in car ownership and a large increase in construction cost.

16.2 Recommendations

(1) Since the year 1996 is estimated as the optimal year to start the construction of the new Biobio bridge from the economic point of view, this project should be started as soon as possible.

(2) The Biobio Antiguo Bridge has reached the end of its service life. It should be closed, however, the MOP has expressed interest to keep it open until the new bridge is constructed, in which case certain maintenance works outlined in the report should be instituted, and the traffic should be reduced to passenger cars and emergency vehicles only.

(3) From an engineering and economic point of view, it is not feasible to upgrade the Biobio Antiguo Bridge.

(4) The improvement of road network related to this bridge should be continued. Especially, the improvement of Los Carrera Street, the Construction of the New Costanera Avenue and the development of a road network connecting the old city center in relation to " The Biobio River North-dike Area Recovery Project" should be undertaken.

(5) To disperse traffic concentrate into the central area of the city, construction of Costanera Road should be implemented.

(6) The peak hour traffic volume on the new bridge will exceed its design capacity in 2010. A study to evaluate the need for another bridge is recommended, by means of the evaluation of the traffic volume and trends, shortly after the opening of the New Biobio Bridge.

Based on the agreement for this study between Japanese Government and Chile Government, implementation of detailed study about the urban development plan of the area related to the Biobio Bridge is out of scope. The construction of the New Bridge, however, will have an important impact on the urban planning of Concepcion. It is also recommended to establish a detailed comprehensive urban development plan, to cope with the rapid growth of the south area of Concepcion and to aiming at unifying both sides of the river.

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