12.2 Construction Cost Estimates

12.2.1 Construction Quantity Estimates

1) General

On the basis of preliminary road design on a map which is at a scale of 1:2,000, the construction quantities were estimated.

The construction quantities were estimated as the individual segment that is Segment A (STA.0 - STA.19), Segment F (STA.19 - STA.84) and Segment C (STA.C-1 - STA.C-10)

2) Materials Quantity

a) Excavation and Embankment Volume

The Project Road is located at the flat terrain therefore, the excavation volume for road bed does not apply.

The embankment volume including settlement volume on Segment A, C and F are estimated as 219,940 cu.m. and 575,600 cu.m. Total about 800,000 cu.m are required. These embankment material should be transported from the borrow pit.

b) Pavement Material

The pavement material of the road and bridge is specified as cement concrete pavement and asphalt concrete pavement respectively.

The cement concrete pavement area including through traffic carriageway and frontage road of Segment A, C and F is estimated as 26,000 sq.m, 14,000 sq.m and 119,000 sq.m respectively.

The asphalt concrete pavement area of Segment A and Segment C is estimated as 33,000 sq.m and 5,000 sq.m respectively. There is no bridge in Segment F.

c) Drainage Material

Reinforced concrete box culvert (3.0 x 3.0) and pipe (Ø 1,500) are required for drainage treatment. The lengths of box culvert of Segment A, C and F were estimated at 26 m, 0 m and 421 m respectively. The length of culvert pipe (O 1,500) of Segment A, C and F were estimated as 182 m, 144 m and 1,200 m respectively.

d) Bridge Length

In Segment A, following bridges are planned.

* The length of viaduct for through traffic is 1,150 m.
* The length of bridge for ON Ramp is 105 m.

* The length of bridge for OFF Ramp is 105 m.
* The length of bridge for Frontage Road (ON Ramp) is 25 m.
* The length of bridge for Frontage Road (OFF Ramp) is 25 m.

In Segment C, following bridge is planned.

* The length of bridge for through traffic is 155 m.

3) Construction Quantity by Segment

The construction quantity by main working items was calculated for each segment and tabulated in the table of construction cost as shown in Appendix 12.2.1. In addition, the construction quantity of flyover bridge on "D" intersection was also estimated. The quantity of segments A & C is shown in Table 12.2.1.

12.2.2 Construction Cost Estimates

The basic assumptions on cost estimates of Thonburi Road Extension are the same as discussed in 9.7.1.

The project was devided by segments, MRR Flyover, A, C and F, and project costs were estimated by following two packages considering staged construction:

- Segment A & C including MRR Flyover; and
- Segment F.

1) Capital Cost

The capital costs for the Thonburi Road Extension Segment A & C, and the Segment F are summarized as shown in Table 12.2.1 and 12.2.2, and the total capital cost of the project is summarized in Table 12.2.5.

2) Maintenance Cost

The annual maintenance costs of both of the packaged segments are summarized in Table 12.2.3 and Table 12.2.4. The cost breakdown per km is shown in Appendix 9.7.2.

3) Construction Schedule

The Study Team estimated the construction schedule based on the concept discussed in Section 12.1, the 36 months for A & C segments was proposed as shown Fig. 12.2.1.

Table 12.2.1 Main Materials for Thonburi Road Extension Segments A&C

Item / Site	Main Bridge	Approach Bridge	Others	Total
Concrete cu.m				
fc = 350 kgf/sq.cm	1,200	14,220	1,730	17,150
fc = 240 kgf/sq.cm	3,850	19,860	4,770	28,480
Total cu.m	5,050	34,080	6,500	45,630
Cement ton 0.38 ton/cu.m	1,920	12,950	2,470	17,340
PC Tendon ton	70	860	110	1,040
Re-bar ton	700	4,290	880	5,870
Embank cu.m	1,000	173,400	45,540	219,940
PC pile 0.6 m	8,300	64,260	10,530	83,090
RC pile 0.2 x 0.2 m	2,300	7,680	6,140	16,120
Steel of Bridge ton	300	-	-	300

* Main materials for Segment F are pavement concrete of 21,100 cu.m and embakment of 575,600 cu.m.

Table 12.2.2 Capital Costs for Thonburi Road Extension Segments A and C

(Unit: 1,000 Baht, October 1986 prices)

Item	Financial Cost	Components (%) F	L	Tax	Economic Cost
a) Construction Cost					
MRR Flyover	67,632	36.7	63.3	9.6	61,152
Segment A	488,756	35.0	65.0	10.1	439,239
Segment C	98,905	34.7	65.3	9.9	89,138
Temporary Works	167,040	42.4	57.6	15.4	141,315
Direct Cost Total	822,333	36.6	63.4	11.1	730,844
Overhead	240,000	38.0	62.0	35.5	155,280
Total Construction Cost	1,062,333	36.9	63.1	16.6	886,124
Physical Contingency	77,667	36.9	63.1	16.6	64,774
Total	1,140,000	36.9	63.1	16.6	950,898
b) Engineering Service					
Detail Design Cost	34,200	50.7	49.3	10.7	30,533
Supervision Cost	79,800	40.0	60.0	11.4	70,710
Total	114,000	43.2	56.8	11.2	101,243
c) Land Acquisition					
Land Acquisition	303,000	-	100.0	4.3	290,000
Compensation	96,000	-	100.0	4.2	92,000
Total	399,000	-	100.0	4.3	382,000
Total Capital Cost	1,653,000	28.4	71.6	13.2	1,434,141

Note: F, foreign component
L, local component

Table 12.2.3 Capital Costs for Thonburi Road Extension Segment F

(Unit: 1,000 Baht, October 1986 prices)

Item	Financial Cost	Components (%) F	L	Tax	Economic Cost
a) Construction Cost					
Segment F	334,035	32.4	67.6	8.8	304,714
Temporary Works	46,000	26.0	74.0	13.0	40,020
Direct Cost Total	380,035	31.5	64.8	9.3	344,734
Overhead	111,568	23.0	77.0	33.9	73,746
Total Construction Cost	491,603	29.7	70.3	14.9	418,480
Physical Contingency	38,397	29.7	70.3	14.9	32,675
Total	530,000	29.7	70.3	14.9	451,155
b) Engineering Service					
Detail Design Cost	13,250	44.1	55.9	12.8	11,555
Supervision Cost	23,850	59.7	40.3	8.0	21,950
Total	37,100	53.9	46.1	9.7	33,505
c) Land Acquisition					
Land Acquisition	230,000	-	100.0	4.3	220,000
Compensation	19,000	-	100.0	5.3	18,000
Total	249,000	-	100.0	4.4	238.000
Total Capital Cost	816,100	21.7	98.3	11.5	722,660

Note: F, foreign component
L, local component

Table 12.2.4 Maintenance Costs for Thonburi Road Extension Segments A and C

(Unit: 1,000 Baht, October 1986 prices)

Item	Financial Cost	Components (%) F	L	Tax	Economic Cost
a) Annual Maintenance Cost of Viaduct & Bridge (1.67 km)	333,076	27.7	72.3	8.1	306,253
b) Annual Maintenance Cost of Road (1.60 km)	41,484	20.0	80.0	6.0	39,010
Total	374,560	26.8	73.2	7.8	345,263

Table 12.2.5 Maintenance Costs for Thonburi Road Extension Segment F

(Unit: 1,000 Baht, October 1986 prices)

Item	Financial Cost	Components (%) F	L	Tax	Economic Cost
a) Annual Maintenance Cost of Viaduct & Bridge (6.50 km)	169,052	20.0	80.0	6.0	158,977
Total	169,052	20.0	80.0	6.0	158,977

Note: F, foreign component
L, local component

Table 12.2.6 Capital Costs for Thonburi Road Extension Segments A, C and F

(Unit: 1,000 Baht, October 1986 prices)

Item	Financial Cost	Components (%) F	L	Tax	Economic Cost
a) Annual Maintenance Cost					
MRR Flyover	67,632	36.7	63.3	9.6	61,152
Segment A	488,756	35.0	65.0	10.1	439,239
Segment C	98,905	34.7	65.3	9.9	89,138
Segment F	334,035	32.4	67.6	8.8	304,714
Temporary Works	213,040	38.9	61.1	14.9	181,335
Direct Cost Total	1,202,368	35.0	65.0	10.3	1,075,578
Overhead	351,568	33.2	66.8	34.9	229,026
Total Construction Cost	1,553,936	34.6	65.4	16.0	1,304,604
Physical Contingency	116,064	34.6	65.4	16.0	97,449
Total	1,670,000	34.6	65.4	16.0	1,402,053
b) Engineering Service					
Detail Design Cost	47,450	36.5	63.5	11.3	42,088
Supervision Cost	103,650	44.5	55.5	10.6	92,660
Total	151,100	42.0	58.0	10.8	134,748
c) Land Acquisition					
Land Acquisition	533,000	-	100.0	4.3	510,000
Compensation	115,000	-	100.0	4.3	110,000
Total	648,000	-	100.0	4.3	620,000
Capital Cost Total	2,469,100	26.0	74.0	12.6	2,156,801

Note: F, foreign component
L, local component

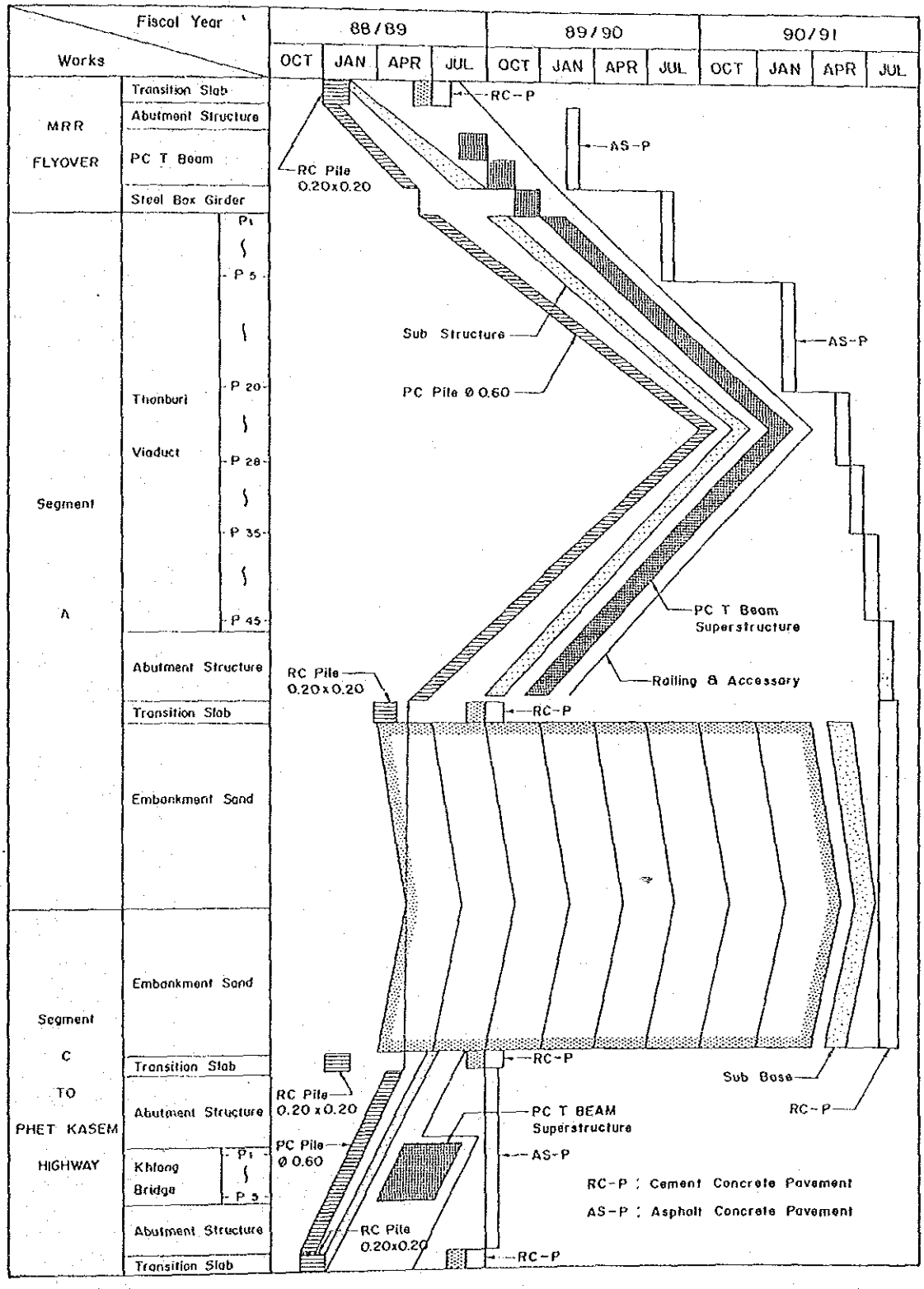


Fig. 12.2.1 Construction Schedule of Segment A&C

CHAPTER 13

EVALUATION OF THE ROAD

13.1 Economic Evaluation

Economic evaluation of the project road was made by comparing the cost and benefit streams from year 0 through year 25, which was assumed to be the last year of the evaluation period. The project road was assumed to be open to traffic by the year 5.

In addition to the project costs as and the maintenance costs as explained in the preceding section, the residual value of the project road cost was taken into account.

The residual value of a highway is the initial construction cost less the amount necessary to restore the road at the end of project life to the initial condition. Certain percentages of the initial costs of concrete surface and subbase would be required restoration work depending on the road type and subgrade condition. It was assumed in this study that 73.5% of the initial construction cost could be treated as the residual value of the project road.

Economic benefit was calculated as the consumer surplus derived from the total economic costs of vehicle operation and time value over the entire network for cases with and without the project. Figure 13.1.1 illustrates network schemes compared for 1991 and 2001/2011. Forecasted traffic volume in 1991, 2001 and 2011 are shown in Appendix 13.1.1. The total network cost was calculated for the morning peak hour and for the off-peak hour separately. The daily total cost was then obtained by adding the two after multiplying the period duration hours of 5 hours for peak (including evening peak) and 15 hours for off-peak respectively. The procedure is explained in more detail in Section 4.6.

The number of trips that can be assigned varies depending on the network because the model suppress trips wherever all routes are full or remaining routes require too long a detour. Generally, additional links in this part of Bangkok release a certain amount of hitherto suppressed trips. Additional trips take place because they are beneficial to trip makers. Otherwise they would not bother to produce these additional trips. These additional trips, however, are added on top of existing traffic. On road links from which no diversion to the project road is possible these additional trips force everybody else to bear higher costs, negating cost savings on links with less traffic due to diversion and the additional benefit to additional trips. In an extremely congested network such as in Bangkok it is possible that an alternative producing less generated traffic comes out as the one with the highest economic benefit. This suggests that without extensive improvements of intersections in the central area not much benefit can be expected by simply adding suburban road links except in their immediate vicinity.

Table 13.1.1 shows the results of economic cost calculations carried out by network assignment computer runs.

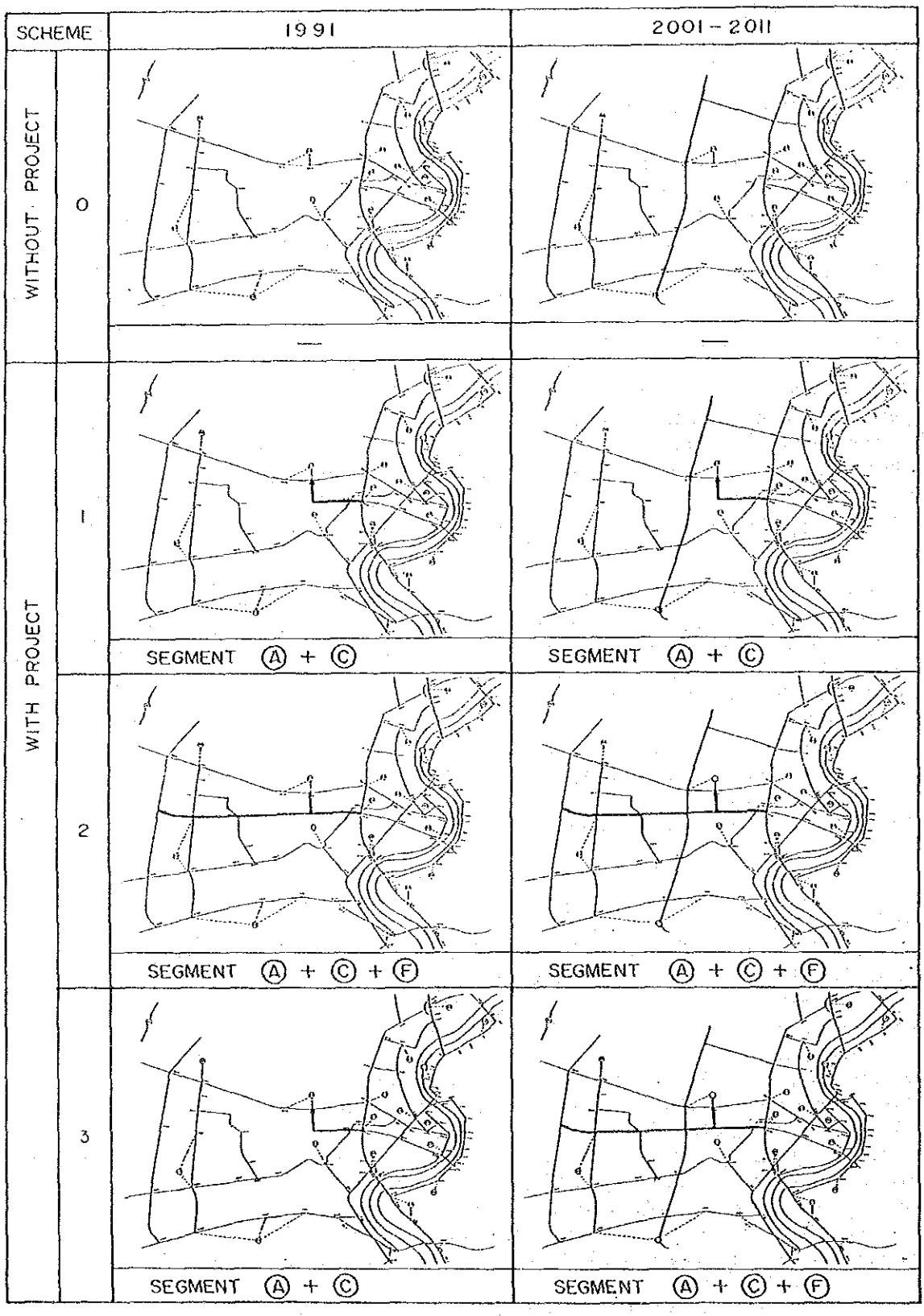


Fig. 13.1.1 Alternative Schemes

Table 13.1.1 Results of Alternative Assignments

Year	Period	Case	Loaded trip	Total veh.-km.	Total veh.-hr.	Total VOC (₿)	Time value (₿/veh.-hr.)	Unit cost (₿/trip
1991	MP	0	224,518	2,634,169	83,211	5,318,223	61.8	46.59
		1	225,746	2,627,666	81,277	5,277,107	61.8	45.63
		2	225,725	2,626,593	81,144	5,273,922	61.8	45.58
	OP	0	184,252	1,771,602	50,884	3,370,976	59.9	34.84
		1	184,372	1,763,313	49,362	3,339,761	59.9	34.15
		2	184,374	1,762,414	49,323	3,337,580	59.9	34.13
2001	MP	0	305,031	3,746,435	142,316	7,848,904	75.6	61.00
		1	308,515	3,762,589	143,305	7,888,296	75.6	60.68
		2	309,047	3,778,680	142,796	7,915,276	75.6	60.54
	OP	0	267,850	2,697,191	103,248	5,351,390	74.4	48.66
		1	269,752	2,701,936	101,962	5,340,100	74.4	47.92
		2	269,756	2,705,442	101,597	5,340,750	74.4	47.82
2011	MP	0	356,114	4,515,305	195,836	9,795,282	90.5	77.27
		2	362,580	4,578,406	201,936	9,974,466	90.5	77.91
	OP	0	329,301	3,526,991	151,270	7,169,742	89.8	63.02
		2	333,372	3,555,178	153,049	7,241,641	89.8	62.95

Several implementation strategies can be identified. The entire road can be constructed in its entirety including Segments A, C and F all at once, or the first stage can be limited to the construction of Segments A and C, and Segment F can be constructed in the second stage after a certain number of years. Table 13.1.2 summarizes the combinations of schemes considered to determine the best implementation strategy.

In addition the marginal benefit to be generated by Segment F was determined by taking the difference in the total traffic costs of Scheme 1 (A+C) and Scheme 2 (A+C+F).

Annual benefits thus calculated are shown in Table 13.1.3.

Construction costs and disbursement schedules were estimated for each Segment as shown in Table 13.1.4. Cost streams were established each of the cases including maintenance costs and benefit streams were estimated by means of interpolation for intermediate years. Details are shown in Appendix 13.1.2. Economic evaluation was made against these cost and benefit streams and the results are presented in Table 13.1.5.

The marginal feasibility of Segment F was evaluated by taking the difference in benefits of cases of Segment A plus C and Segment A plus C plus F and the construction cost of Segment F along. Several opening years were tested to determine the optimum opening year. It turned out that the opening year for Segment F of 1997 gave the highest return.

The overall economic feasibility is good for any of the cases. All show more than 30% of internal rate of return, confirming the high benefit associate with urban road improvements.

Although for the cases with the project road a 10% increase in population and locally generated and attracted traffic was assumed, actual increase could well be much higher. However, the role of the project as an inducer of development can only be maximized by implementing its full length upto Outer Ring Road. Considering the desirability of developing this part of Bangkok as oppose to the eastern and northeastern areas far from the central Bangkok to attain less expensive urban service costs such as the provision of utilities, the Study Team recommends that the project be implemented in its entire length.

Table 13.1.2 Project Implementation Alternatives

Scheme		Scheme 1991	2001	2011
1	Segment	A + C	-	-
2	Segment	A + C + F	-	-
3	Segment	A + C	F	-

Note: Benefits of all the above cases are defined as the difference in the total generalized costs between the case and the do-nothing case.

Table 13.1.3 Annual Traffic Benefit

(in million Baht)

Scheme	1991	2001	2011
1	1091	1268	108
2	1131	1494	127
3	1091	1494	127
Segment F (Marginal)	40	226	19

Table 13.1.4 Construction Cost Stream

(in million Baht)

Year	Segment A+C	F
1	413	250
2	262	136
3	547	207
4	213	130

Table 13.1.5 Economic Evaluation of Thonburi Road Extension

Scheme	Segment 1991	2001-	Net Present Value (million Baht)	B/C Ratio	IRR (%)
1	A+C	-	4,073	4.83	41.75
2	A+C+F	-	4,092	3.55	33.40
3	A+C	F	4,092	4.35	41.46

13.2 Effects on Traffic

Likely effects of the project on traffic would be quite complex because of the fact that the well developed road network in Bangkok is operated at near capacity in a wide area, making trip makers sensitive to changes in network and traffic conditions. The following summarizes the likely effects on traffic flow.

1) Effects of Project on Traffic Volume

A screenline is a line which separates an area completely into two subareas. Any trip from one subarea to the other must cross the screenline. Two screenlines were examined, one the Chao Phraya River (Screenline A) and the other just west of the heavily built-up area along the western bank of the river (Screenline B). They are shown in Figure 13.2.1.

Two cases of network were tested. First was without the project road, the second with the project road (C and F route).

Effects of the project on the river crossing traffic are shown in Table 13.2.1 and Table 13.2.2. The total river crossing traffic would increase by 2% or 200 pcu both directions during the morning peak hour in 2001. The project would increase the overall system capacity of the network and release the above amount of trips which could not have been made otherwise.

The project road would draw the inbound traffic from the Wat Sai Bridge and add them on Sathorn Bridge, Existing Krungthep bridge and New Krungthep bridge and divert the outbound traffic from Existing Krungthep bridge, Siphraya bridge and Wat Sai bridge to New Krungthep bridge and Rama VI Bridge. In case of Memorial bridge, New Memorial bridge, Krungthon bridge and Pinklao bridge would not be much affected sine their locations are in the central area, the traffic volume on them are already at capacity. Traffic generated by Thonburi Road Extension fills the access routes in the Southern half of the network and some of the long distance river crossing traffic from Bangkok side switch to the Rama VI bridge.

The total screenline A volume increase by 833 (inbound direction) while for the screenline B the amount is 3018. This indicated that about three forth of the additional traffic crossing the screenline B do not go much further than the river.

It was assumed that the project road would induce 10% more population in the immediate vicinity, namely zones 78 and 79. As a result, the number of trips was increased by about 650 pcu in trip generation and about 600 pcu in trip attraction around project road in 2001 morning peak hour. Even higher volumes of hetherto suppressed trips would be released by the project. The effect of the project on traffic volume was first examined with regard to screenline volumes.

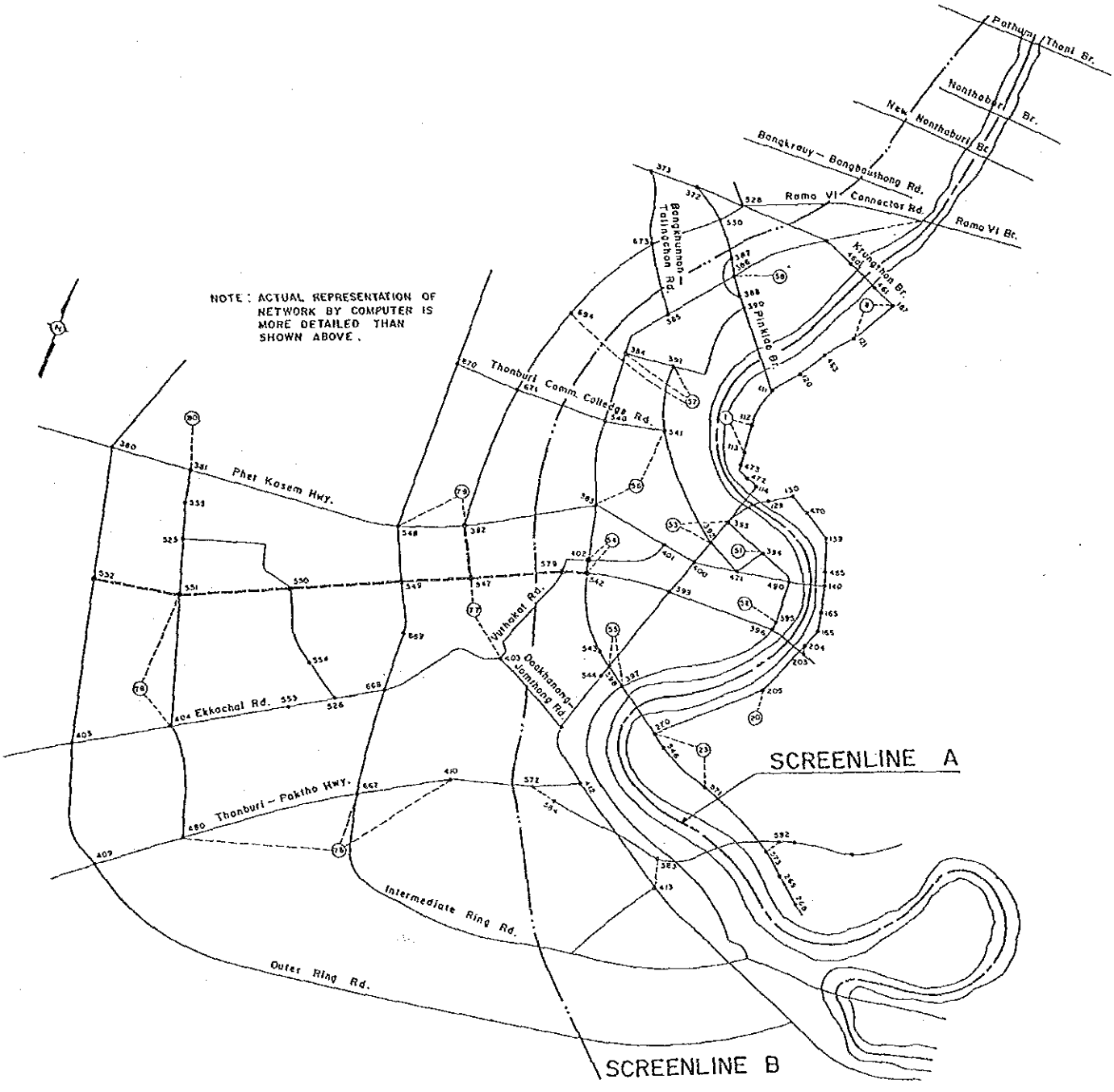


Fig. 13.2.1 Location of Screenlines

Table 13.2.1 Screenline A Traffic Volumes (2001 Morning Peak Hour)

Bridge Name	W/O TRE inbound	W/O TRE outbound	With TRE inbound	difference +	difference -	With TRE outbound	difference +	difference -
Pathumthani Br.	1057	45	1054		3	45	-	-
Nonthaburi Br.	677	1647	659		18	1652	5	
New Nonthaburi Br.	1576	2557	1487		89	2535		22
Rama VI Br.	3343	4318	3338		5	4429	111	
Krungthon Br.	3969	2086	3930		39	2040		46
Pinklao Br.	5189	2358	5221	32	-	2341		17
Memorial Br.	2207	1280	2192		15	2314	34	
New Memorial Br.	5076	1815	5073		3	1890	75	-
Siphraya Br.	2129	2132	2130	1	-	1964	-	168
Sathorn Br.	3776	4462	4473	697	-	4470	8	-
Krungthep Br.	461	949	567	106	-	711	-	238
New Krungthep Br.	2680	2072	3184	504	-	2839	767	
Wat Sai Br.	3234	3486	2892		342	3341	-	145
Phrapradaeng Ferry	2162	2196	2169	7	-	2225	29	-
Total	35,536	31,403	38,369	1,347	514	31,796	1029	636
Net Difference				+833 (2.2%)			+393	(1.3%)

Table 13.2.2 Screenline B Traffic Volumes (2001 Morning Peak Hour)

Line Name	W/O TRE inbound	W/O TRE outbound	With TRE inbound	difference +	difference -	With TRE outbound	difference +	difference -
Pathumthani Br.	1057	45	1054		3	45	-	-
Nonthaburi Br.	677	1647	659		18	1652	5	
New Nonthaburi Br.	1576	2557	1487		89	2535		22
Bangkrauy-Bangbua Thong Rd.	1649	895	1661	12		897	2	
Rama VI Connector Rd.	1211	0	1220	9		0		
Krungthon Br. Approach	2329	1039	2362	33		1145	106	
Pinklao Br. Approach	1920	1854	1987	67	2070	216		
Bangkhunnon-Talingchan Rd.	391	1235	448	57		1274	39	
Thonburi Commercial College Rd.	265	1255	102		163	2054	799	
Phet Kasem Highway	2767	2823	2698		69	1373		1450
Thonburi Road Extension	-	-	4732	4732		4126	4126	
Wutthakat Rd.	1675	1650	1500		175	1020		630
Daokhanong-Jomthong Rd.	1969	1650	1757		212	1623	-	27
Thonburi-Paktho Highway	2925	2566	1855		1070	2159		407
Intermediate Ring Rd.	2484	1687	2393		91	1715	28	
Outer Ring Rd.	13	11	11		2	7		4
Total	22,908	20,914	25,926	4910	1892	23,695	5321	2540
Net Difference				+3018 (13.2%)			+2781	(1.3%)
Total Trips Assignment	305,031					309,047		
Difference						4,016 (1.3%)		

The local nature of the effects of Thonburi Road Extension on induced traffic is more evident when compared with the total number of trips which could be assigned on the entire Bangkok network. Only 30% of the total additional trips cross the river.

13.3 Environmental Impact Assessment

13.3.1 Environmental Impacts on Surrounding Area

The National Environmental Board requires two types of environmental assessment be carried out before the implementation of a major project. The first one is the Initial Environmental Examination (IEE) and the second one is the Environmental Impact Statement (EIS). It is required that for any major project the former, IEE, be conducted to assess impacts in rough terms and to determine whether the latter, EIS, should be carried out or not. The NEB has issued guidelines for the preparation of the above two documents, namely "NEB Guidelines for Initial Environmental Examination", the "General Guidelines for Preparation of Environmental Impact Statements", and "Supplemental EIS Guidelines for Specific Project Categories". The NEB indicates that during the phase of feasibility study IEE should be prepared and EIS during the detailed design phase. As indicated in the NEB guidelines an IEE is an initial examination based on preliminary information at hand or which can be readily obtained, and which is carried out with a very limited budget.

The environmental assessment in this study falls in the category of IEE rather than EIS. The Guidelines suggest that the following environmental resources/values could be covered:

Physical Resources	- Surface Water (hydrology/quality) - Ground Water (hydrology/quality) - Air Resources (meteorology/quality) - Soils/Soil Quality - Geology/Seismology
Ecological Resources	- Fisheries/Aquatic Biology - Forestry/Wildlife
Human Use Values	- Water supply - Highways/Railways - Agricultural Development - Flood Control Drainage - Power Generation/Transmission - Recreation - Mining - Industries - Land Uses
Quality of Life Values	- Socio-Economic (including: Human Ecology, Public Health, Public Safety, Economic and Social Structure, Institutional Values)

- Cultural Values
- Aesthetic Values

It is apparent that some of the items above are irrelevant to this project. The following presents preliminary assessment of possible impacts expected by the project.

1) Ecological Resources

a) Fisheries/Aquatic Biology

Unlike the area south of Thonburi-Paktho Highway there is no commercial agriculture in the project area. As none of the khlongs will be required to be permanently closed by the project road, no significant changes in the existing aquatic biology is expected to take place.

b) Forestry/Wildlife

There is no significant natural forest in the project area. All woodlands are either orchards or of trees planted around settlements. A significant amount of orchard; in the order of 15 Ha., will have to be taken. The project area is not known for any particular wildlife or the abundance of wildlife. Since the project road will pass through the sparsely settled area, however, there will be some impacts on existing wildlife.

2) Human Use Values

a) Water Supply

According to the Metropolitan Waterwork Authority's Master Plan of 1984, the entire project area will be covered by the MWA's central system. The Master Plan does not assumes the existence of the project road. The project is not expected to conflict with the implementation of the master plan at this stage. However, a care should be taken in the detailed design stage.

b) Highways/Railways

The contribution of the project road in terms of improving the road network in Bangkok has been detailed elsewhere in this report. The project will not disturb the operation of the existing railway as it will be grade separated.

c) Agricultural Development

Although the project road will take away a significant amount of agricultural land, the immediate effect of the road will be the intensification of agricultural activities as it greatly improves accessibility to the central Bangkok markets. Judging from the amount of land available, intensifying suburban agriculture will coexist with expanding residential areas for a long time.

d) Flood Control/Drainage

The project road with adequate planned drainage is not expected to have any detrimental effects on flood control.

e) Industries

According to the DTCP's General Plan, almost the entire area of the project area is classified as the low density residential area. There are already some industrial activities along Sukha Pibun Road. With the discouragement by Government siting of new industrial activities in the project area can be limited.

f) Land Use

Impact on the land use will be high. Population growth in the project area will be accelerated due to migration. Conversion of agricultural land to residential use will take place in a large scale as it is taking place along Bangkok Noi - Nakorn Chaisi Highway. The likely scale of such changes has been estimated as shown in Progress Report (II).

3) Quality of Life Values

a) Socio-economic and Cultural Values

Value system of the residents in the project area will gradually change as the predominant life style will change from rural to urban. This will inevitably bring changes in institutional structure of villages and districts.

b) Aesthetic Values

The appearance of enbankment cutting through the flat land will be a major aesthetic change in the area. However, the subsequent conversion of agricultural land to residential land in many places will be an even more striking visual change. Some establishments along the road may be quite prominent. Depending on their appearance, the aesthetic value of the area could deteriorate.

13.3.2 Environmental Impacts on Roadside Area

Environmental impacts on roadside area mainly comprise noise, air pollution and vibration induced by traffic.

1) Air Pollution

Air Pollution can be measured by the amounts of Carbon Mooxide (CO), Nitrogen Dioxide (NO), sulfur Dioxide (SO) and others. All of these are emitted by the exhaust of vehicles.

Mitigation of air pollution should be done primarily by improving vehicles themselves. It is very difficult to mitigate air pollution by road structure. Increased traffic volume would increase air pollution. However, the road section between STA.0 - STA.12 was designed as a viaduct with a height of about 10 m. Generally speaking, when the origin point of air pollution is 10 m high, it is expected that the air pollution can be dispersed by wind. This means that air pollution on this section may not be significant.

During the construction period, it is expected that the traffic volume will be increased by construction equipment and transportation of construction materials and congestion severer. Air pollution including dust will be increased in the project area. However, most of the Project Road is located in fields, air pollution including dust problems may not be significant.

2) Vibration

Traffic induced vibration in road operation is mainly caused by heavy vehicles.

At present, environmental standards for traffic induced vibration do not exist in Thailand and it is very difficult to provide mitigation measures for traffic induced vibration by the road structure itself. However, it is expected that traffic induced vibration will not be significant. Care should be taken during the construction period to minimize vibration by heavy construction equipment.

3) Noise

a) Noise Level

The level of traffic induced noise will depend on the vehicle type, surface condition of road, traffic volume, running speed, and so on. Almost all big cities in the world have traffic induced noise problems as in Bangkok Metropolitan Area.

Mitigation measures against traffic induced noise should be sought in vehicles themselves and road structure design.

At present, there are no traffic induced noise level standards in Thailand. Only noise standards for automobiles and boats or ships are prepared. The standard noise level is 85 dB(A), measured 7.5 m away from the exhaust pipe or 100 db(A) at 0.5 m away from the exhaust pipe.

As shown in Fig. 13.3.1, noise level decreases according to the distance from origin point of noise. Noise level decrease characteristics are different by type of road structure, at grade road type or viaduct type.

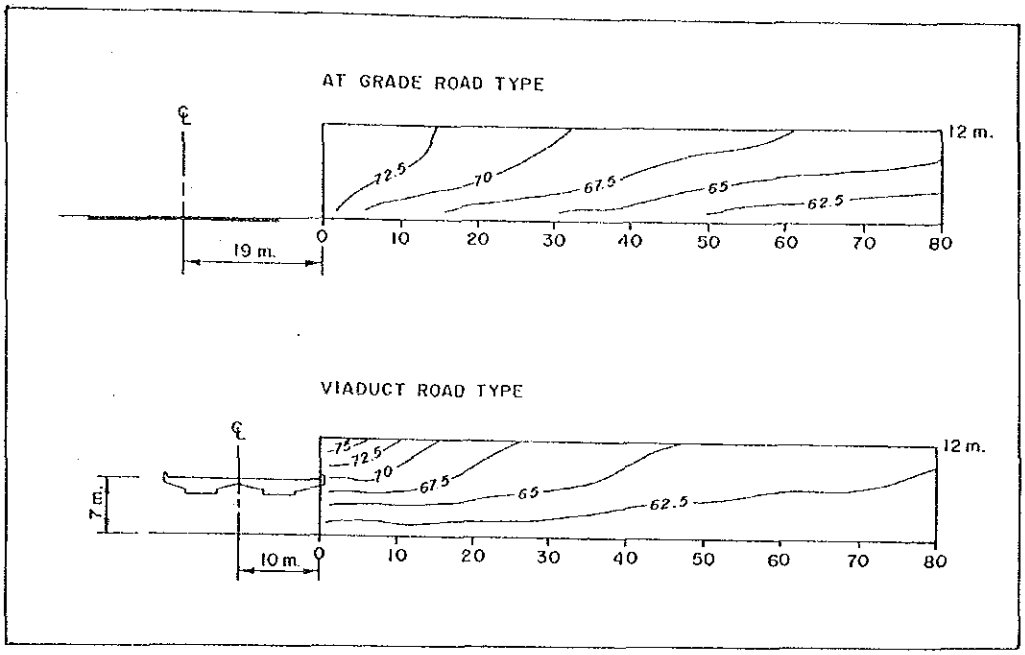


Fig. 13.3.1 Noise Level Contour Line Map

Noise levels shown in Fig. 13.3.1 were calculated by the following assumptions.

- Running speed at 60 km/h.
- Traffic volume at 1,600 V/H/Lane on both directions.
- Truck percentage at 15 percents.

The noise levels at 35.0 m away from the center of the Project Road of at grade road type and viaduct type can be seen as 70 dB(A) and 65 dB (A) respectively from Fig. 13.3.1.

b) Mitigation Measures

Evaluation of mitigation measures against traffic induced noise is difficult in Thailand due to the lack of standards for noise level. However, it is recommended that a noise barrier be constructed on both sides of viaduct section which is STA.0 to STA.12 of the Project Road. Basic considerations to introduce the noise barrier were as follows:

* Existing environment of these area is to be kept in comparatively good conditions.

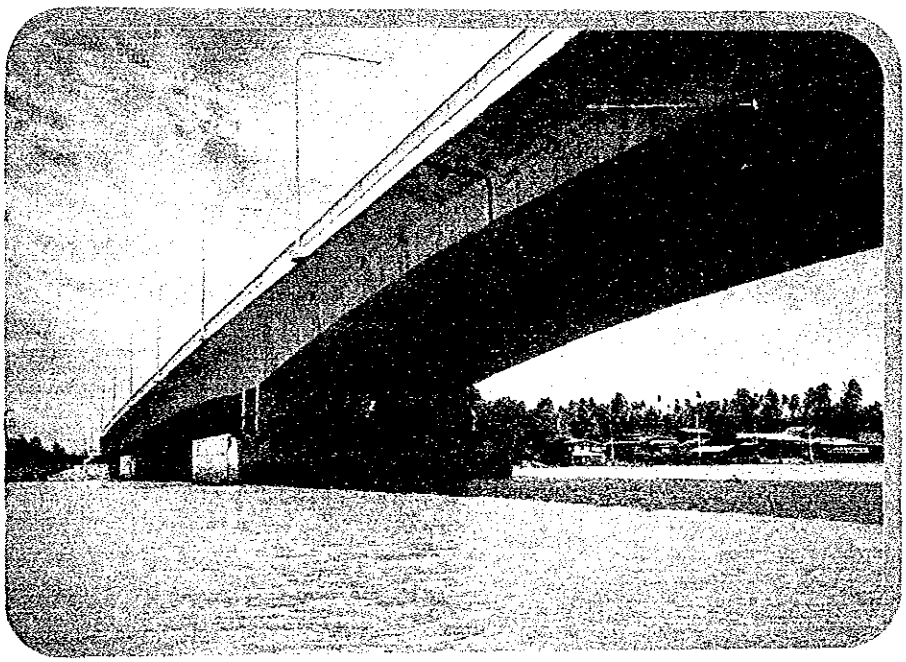
* When the Project Road is constructed, the noise level will increase.

* There are spaces to construct the noise barrier on the viaduct.

* The construction cost of noise barrier in comparison with the total construction cost is low.

It is recommended that shrubs and other vegetation be planted on both sides of the road and on the median of at grade road section from STA.19 to STA.84.

PART V
THE PROJECT



CHAPTER 14

IMPLEMENTATION PROGRAM

14.1 Project Outlines

14.1.1 New Krungthep Bridge

The central part of Bangkok Metropolitan Area, which is divided by the Chao Phraya river, is encircled by Middle Ring Road. Work will shortly be completed to make this trunk ring road 6 or 8 lanes throughout its length except for river crossing. It crosses the river by the Rama VI bridge in the north and by the Krungthep bridge in the south. Public Works Department has already started working to replace the existing 2-lane Rama VI bridge by a new 6-lane bridge. The Project calls for a construction of a new 4-lane bridge next to the existing Krungthep bridge in the downstream side with existing bridge to be used as a 2-lane bridge.

- Main bridge length 442 m

  Type of structure
  Three spans continuous PC box girder
  111 m + 220 m + 111 m

  Navigational clearance in center
  34 m in height and 60 m in width

- Approach bridge length 1,422 m

Thonburi side bridge length		787 m
PC box girder	18 spans	645 m
RC hollowed slab	10 spans	142 m
Bangkok side bridge length		635 m
PC box girder	15 spans	529 m
RC hollowed slab	8 spans	106 m

- Interchange and Approach

Thonburi side	
Approach length	126 m
Rampway length	400 m
Bangkok side	
Approach length	229 m
Rampway length	480 m

14.1.2 Thonburi Road Extension

There exists a dearth of roads in the western bank of the Chao Phraya river in Bangkok Metropolitan Area. Among the only three radial trunk roads, the oldest Phet Kasem highway is heavily congested, due in part to the fact that its connection with its main gateway to the east bank, the Sathorn bridge (Taksin bridge) is not direct. In comparison, the other two, Thonburi - Paktho are or soon to be directly connected with bridges, i.e. Thonburi - Paktho highway with the Wat Sai bridge and Bangkok Noi - Nakhon Chaisri highway with they Pinklao bridge and the Krungthon bridge. A project is underway to extend the access road to the Sathorn bridge to Middle Ring Road. The Project is to further extend the direct access to Sathorn bridge up to Outer Ring Road thus adding another major radial road in the west bank.

The Project consists of the following two phases.

First stage construction of a short bypass of 3.3 km.

Middle Ring Road flyover	4 lanes	0.4 km
Segment A	6 lanes	1.9 km
Segment C	4 lanes	1.0 km

Second stage construction of a connector of Segment A with ORR, 6.5 km

Segment F	4 lanes	6.5 km

14.2 Project Cost

14.2.1 New Krungthep Bridge

The capital cost of the project is 1,885 million Baht as follows:

Table 14.2.1 Summary of Capital Costs for New Krungthep Bridge Construction

(Unit: million Baht, October 1986 prices)

Main Items	Financial Cost	Components (%) F	L	Tax	Economic Cost
a) Construction Cost	1,500	40.5	59.5	16.9	1,247
b) Engineering Service	150	40.4	59.6	10.9	135
c) Land Acquisition	235	-	100.0	4.3	225
Total Capital Cost	1,885	35.4	64.6	14.7	1,607

14.2.2 Thonburi Road Extension

The capital cost of the project is 2,469 million Baht as shown in Table 14.2.2.

Table 14.2.2 Summary of Capital Costs for Thonburi Road Extension

(Unit: million Baht, October 1986 prices)

Main Items	Financial Cost	Components (%) F	L	Tax	Economic Cost
1) First Stage (Segment A & C)					
a) Construction Cost	1,140	36.9	63.1	16.1	951
b) Engineering Service	114	43.2	56.8	11.2	101
c) Land Acquisition	399	-	100.0	4.3	382
Subtotal	1,653	28.4	71.6	12.9	1,434
2) Second Stage (Segment F)					
a) Construction Cost	530	29.7	70.3	14.9	451
b) Engineering Service	37	53.9	46.1	9.7	33
c) Land Acquisition	249	-	100.0	4.4	238
Subtotal	816	21.7	78.3	11.4	722
Total Capital Cost	2,469	26.2	73.8	12.4	2,156

14.3 Implementation Schedule and Fund Requirements

The opening year of both the projects is planned for 1991/1992 fiscal year, the second stage of the Thonburi Road Extension Project should immediately follow the completion of the first stage. Both projects are economically feasible with estimated IRR values of 20% and 40% respectively.

The implementation schedule and fund requirements by year for the New Krungthep Bridge Project are shown in Fig. 14.3.1 and the Thonburi Road Extension Project are shown in Fig. 14.3.2 & 14.3.3.

The detailed calculation paper on fund requirements by year are attached in Appendix 14.3.1.

Items	Calendar Year	1987	1988	1989	1990	1991
	Fiscal Year	86/87	87/88	88/89	89/90	90/91
Design and Tender						
Land Acquisition and Compensation						
Construction and Supervision					(36 Months)	
- Work Schedule -						
Main Bridge -	Substructure			(65%)	(35%)	
	Superstructure				(35%)	(65%)
Approach Bridge -	Substructure			(65%)	(35%)	
	Superstructure				(35%)	(65%)
Interchange and Access Road				(25%)	(50%)	(25%)
Temporary				(70%)	(20%)	(10%)

Fund Requirement	Total Cost	(Unit: 1000 Baht)			
Design and Tender	45,000	45,000			
Land Acquisition	235,000	235,000			
Supervision	105,000		31,500	42,000	31,500
Construction	1,500,000		507,064	492,737	500,199
Total Fund by Year	1,885,000	280,000	538,564	534,737	531,699

Note: October 1986 prices

Fig. 14.3.1 Implementation Schedule for New Krungthep Bridge Construction Project

Items	Calendar Year	1987	1988	1989	1990	1991
	Fiscal Year	86/87	87/88	88/89	89/90	90/91
Design and Tender		■	■			
Land Acquisition and Compensation			■			
Construction and Supervision				■	(36 Months) ■	■
- Work Schedule -						
MRR Flyover				(25%)	(65%)	(10%)
Segment A -	Bridge Works			(15%)	(70%)	(15%)
	Road Works			(20%)	(40%)	(20%)
Segment C -	Bridge Works			(15%)	(75%)	(10%)
	Road Works			(15%)	(55%)	(30%)
Temporary Works				(70%)	(25%)	(5%)

Fund Requirement	Total Cost	(Unit: 1000 Baht)			
Design & Tender	34,200	34,200			
Land Acquisition	399,000	399,000			
Supervision	79,800		23,940	31,920	23,940
Construction	1,140,000		293,619	618,364	228,017
Total Fund by Year	1,653,000	433,200	317,559	650,284	251,957

Note: October 1986 prices

Fig. 14.3.2 Implementation Schedule for Thonburi Road Extension Project (1st Stage)

Items	Calendar Year	1991	1992	1993	1994	1995
	Fiscal Year	90/91	91/92	92/93	93/94	94/95
Design and Tender						
Land Acquisition and Compensation						
Construction and Supervision					(30 Months)	
- Work Schedule -						
Drainage Works				(45%)	(45%)	(10%)
Road Works				(35%)	(55%)	(10%)
Pavement Works					(35%)	(65%)
Temporary Works				(70%)	(25%)	(5%)

Fund Requirement	Total Cost	(Unit: 1000 Baht)			
Design and Tender	13,250	13,250			
Land Acquisition	249,000	249,000			
Supervision	23,850		4,770	11,925	7,155
Construction	530,000		157,185	230,582	142,233
Total Fund by Year	816,100	262,250	161,955	242,507	149,388

Note: October 1986 prices

Fig. 14.3.3 Implementation Schedule for Thonburi Road Extension Project (2nd Stage)

14.4 Action Program

14.4.1 Action List

The actions to be required for the realization of the projects recommended are listed below:

- Decision by the Cabinet
- Preparation of Land Acquisition and Funding
- Detailed Design
- Acquisition of Land
- Tender
- Construction & Supervision
- Opening to Public

The most important action is the preparation of land acquisition and funding which will have to be carried out by PWD.

The preparation of land acquisition involves the issuance of a Royal Decree. This should be done as soon as possible based on the preliminary design by this study unless the detail design could be completed prior to the issuance. The preparation of the project fund request should also be accelerated.

Following points are recommended:

- Preparation of the fund including engineering services by Consultants should be immediately provided under one package including design work, detailed right of way plan, tendering service and construction costs due to the tight schedule.

- The issuance of a Royal Decree for the Second Stage construction of the Thonburi Road Extension should also be done at the same time as for the first stage construction because successive implementation is required.

14.4.2 Action Program

In order to achieve the efficient implementation of the projects, the following initial actions are recommended to be taken before the start of construction.

Table 14.4.1 Action Program

Actions	1987				1988				1989	
	Jan.	April	July	Oct.	Jan.	April	July	Oct.	Jan.	April
Decision by the Cabinet	⊙									
Preparation of Land & Fund	⊙				Issuance of a Royal Decree					
Detailed Design			⊙							
Acquisition of Land				⊙						
Tendering							⊙		Signs of the Contract	
			Pre-Qualification							
Start of Construction								⊙		
					Issuance of Notice to Proceed					

CHAPTER 15

CONCLUSIONS

15.1 New Krungthep Bridge Construction Project

The Study Team has concluded that a New Krungthep Bridge should be immediately constructed for the following reasons.

1. The existing Krungthep bridge is of bascule type which presents no constraints as to navigational clearance for ships with high masts, but opening of the bridge once or twice a day causes an estimated economic loss of 22 million Baht per year to traffic.

2. The forecast total traffic volume at the Krungthep bridge is approximately 170,000 ADT in 2011 as compared to only 50,000 ADT in 1986, and is about to exceed the capacity of the present 12 m four-lane carriageway.

   Therefore, increasing of traffic capacity of the Krungthep bridge is urgently required.

3. Only two measures of increasing the traffic capacity are considered possible, namely:

   - Widening of the existing bridge; or
   - Construction of a new bridge.

   These measures are discussed below:

   Widening of the bridge

   The superstructure of the existing Krungthep bridge has insufficient capacity to carry the heavy live load of the HB-45 unit of BSI, which has been determined as the standard load in Thailand for current traffic.

   Strengthening of the said superstructure is, however, impossible unless the bascule girders can be permanently fixed.

   On the other hand, it was confirmed that the current policy of the Navy is not to move the Bangkok dock, a main repair facility for ships upstream of the bridge, implying that the bascule girders be kept operational. Therefore, without further mentioning the judicial difficulty in moving private river facilities upstream in case of shutting the navigation passage of the existing bridge, it can be concluded that the increasing of traffic capacity by means of widening is not practicable.

Construction of a new bridge

If nothing is done to cope with the present saturated traffic conditions in MRR and the present bridge is impaired and has to be closed as a consequence thereof there would be an economic loss of about 740 million Baht per year.

A new fixed type Krungthep bridge is essential to save the economic loss mentioned above, provided that the existing bridge will be further used as a 2-lane bridge restricted to passage of light vehicles only.

4. The project cost of 1,885 million Baht for a 4-lane PC concrete bridge may be somewhat higher than for other recent bridges over the river, but urban infrastructure construction projects tend to become costlier as land use intensifies and price level rises in the recent economic situation of "stagflation" under surplus supply of money in the world.

   It may be noted that:

   - funding may be becoming easier;
   - The land acquisition is not expected to be a serious problem due to availability of government land mostly on existing roads; and
   - The New Krungthep Bridge itself has been long expected.

15.2 Thonburi Road Extension Project

The Study Team has also concluded that extending the Thonburi road up to ORR is recommendable for the following reasons.

1. The total population of BMR is expected to increase from 8.1 million in 1986 to 11.5 million by 2001 and 13.7 million by 2011.

   Land to the east of the Chao Phraya river has already been developed, it is reasonable to expect Thonburi to be developed comparably once road networks have been provided.

2. The existing Thonburi Road provides direct access to the Taksin bridge which has a 6-lane carriageway.

   Construction of a short L-shaped bypass of 3.3 km between the Phetkasem highway and the existing Thonburi road which will be connected with MRR is urgently required to divert traffic from the Taksin road - Wonguian Yai roundabout in the Thonburi area which is the most seriously congested in BMR.

The bypass route follows the arterial ring road, immediately outside of MRR, planned by DTCP; therefore, it will provide a connection with the approach to the new Rama VI bridge which will also be implemented soon; and

3. Extending the road by 6.5 km up to ORR as a parallel road with the Phet Kasem highway will improve accessibility in the Thonburi area, and encourage a significant amount of new development.

The viability of the Project is demonstrated by the high IRR which exceeds 30% based on the desirability of developing this part of Bangkok as opposed to the eastern ad northeastern area.

JICA