社会開発協力部報告書

No. 58

DEMOCRATIC SOCIALIST
REPUBLIC OF SRI LANKA
GREATER COLOMBO ECONOMIC COMMISSION

THE FEASIBILITY STUDY ON COLOMBO-KATUNAYAKE EXPRESSWAY AND NEW PORT ACCESS ROAD CONSTRUCTION PROJECT

FINAL REPORT

TEXT

JANUARY, 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

DEMOCRATIC SOCIALIST
REPUBLIC OF SRI LANKA
GREATER COLOMBO ECONOMIC COMMISSION

THE FEASIBILITY STUDY ON COLOMBO-KATUNAYAKE EXPRESSWAY AND NEW PORT ACCESS ROARD CONSTRUCTION PROJECT

FINAL REPORT

SUMMARY AND RECOMMENDATION
TEXT
APPENDIX

JANUARY, 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

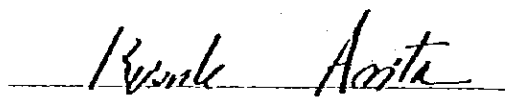
In response to the request of the Government of the Democratic Socialist Republic of Sri Lanka, the Government of Japan decided to conduct a feasibility study on the Colombo-Katunayake Expressway and New Port Access Road Construction Project and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Sri Lanka a study team headed by Mr. Akira Asahi (Japan Bridge & Structure Institute, Inc. and Kokusai Kogyo Co., Ltd. Joint-Venture) from December 1982 to October 1983 under the guidance of the Supervisory Committee chaired by Mr. Masaya Tokumaru, Ministry of Construction of the Government of Japan.

The team held discussions with the officials concerned of the Government of Sri Lanka on the Project and conducted a field survey in Sri Lanka. Subsequently, further studies were made in Japan and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Democratic Socialist Republic of Sri Lanka for their close cooperation extended to the team.

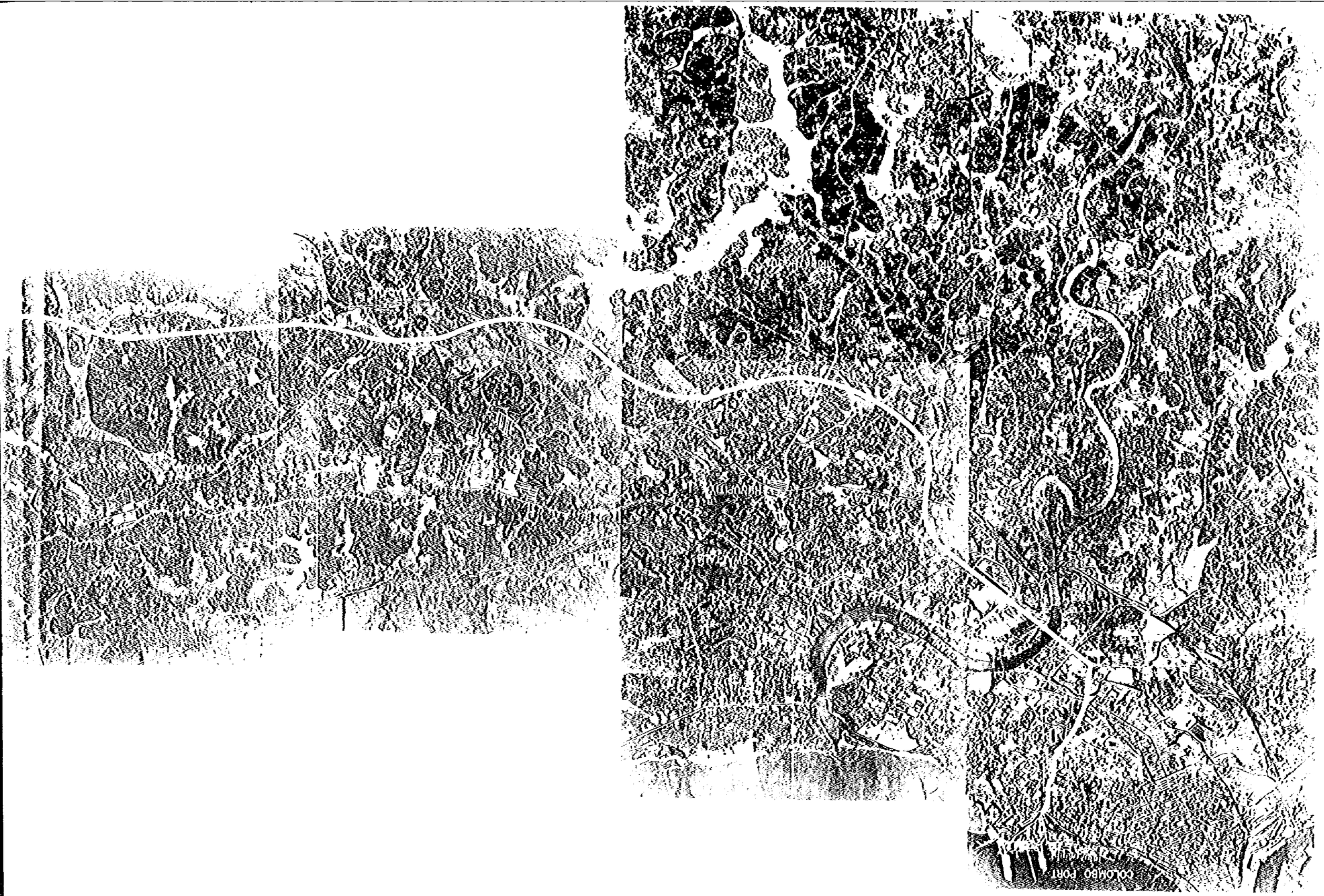
January 1984



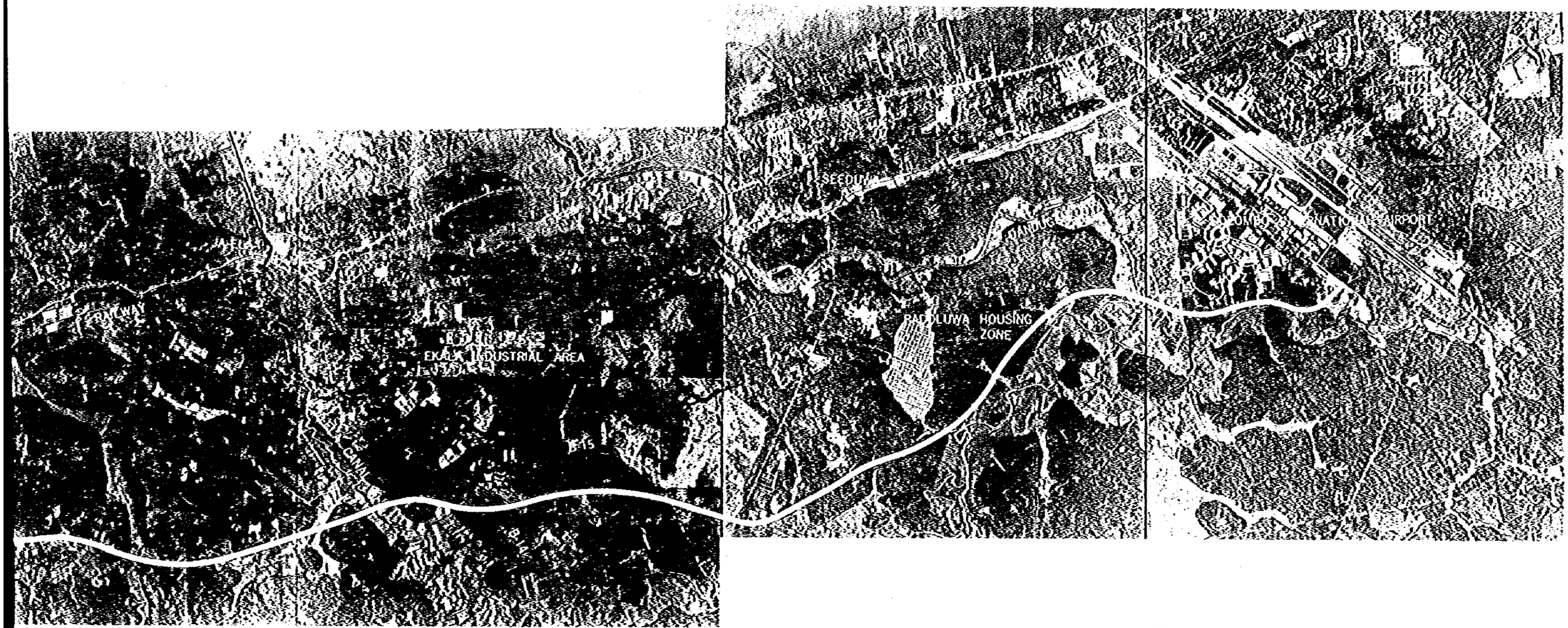
Keisuke Arita

President

Japan International Cooperation Agency


COLOMBO FORT


KANDANA
EKALA INDUSTRIAL AREA
HOUSING ZONE
0
COLOMBO

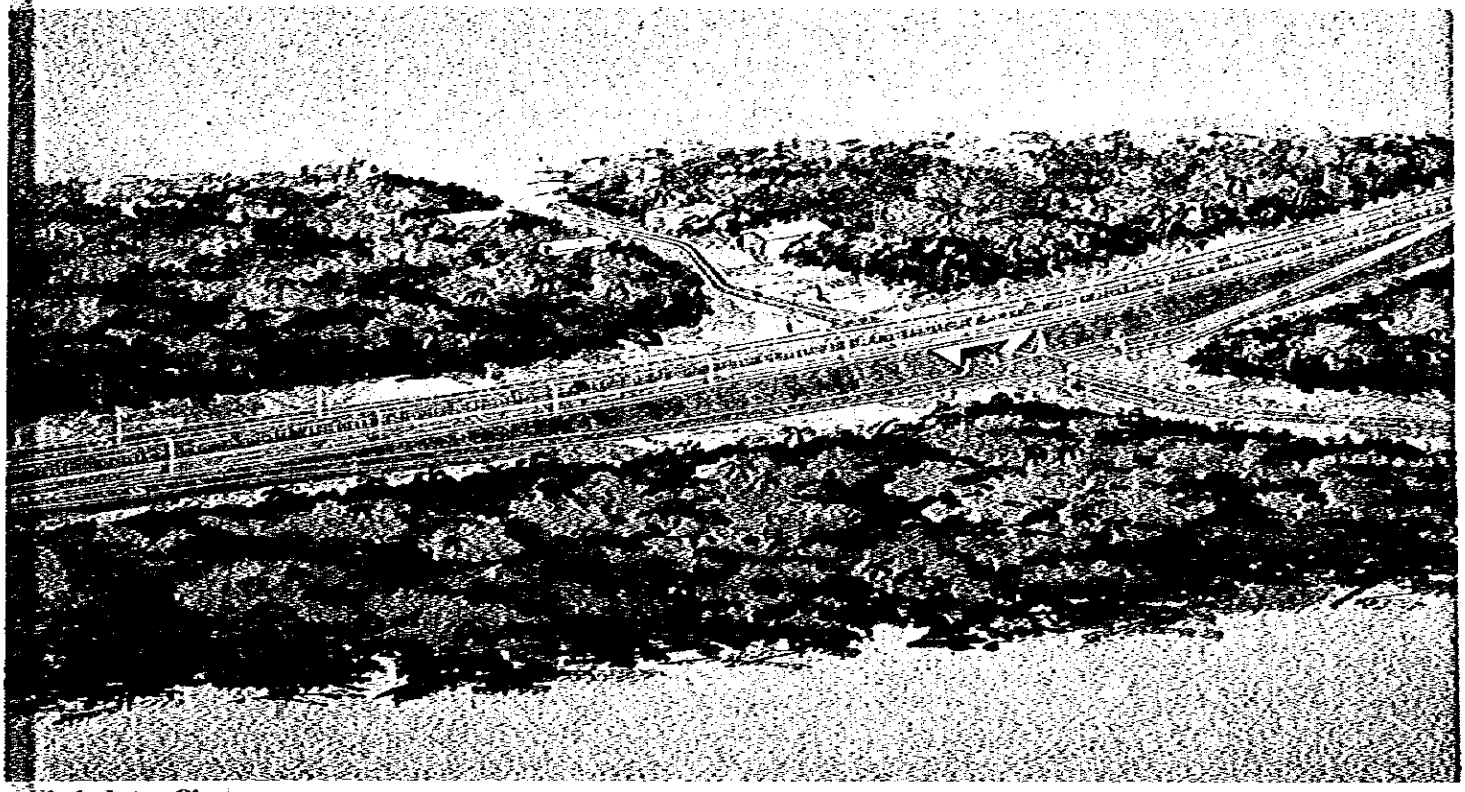


1:40,000

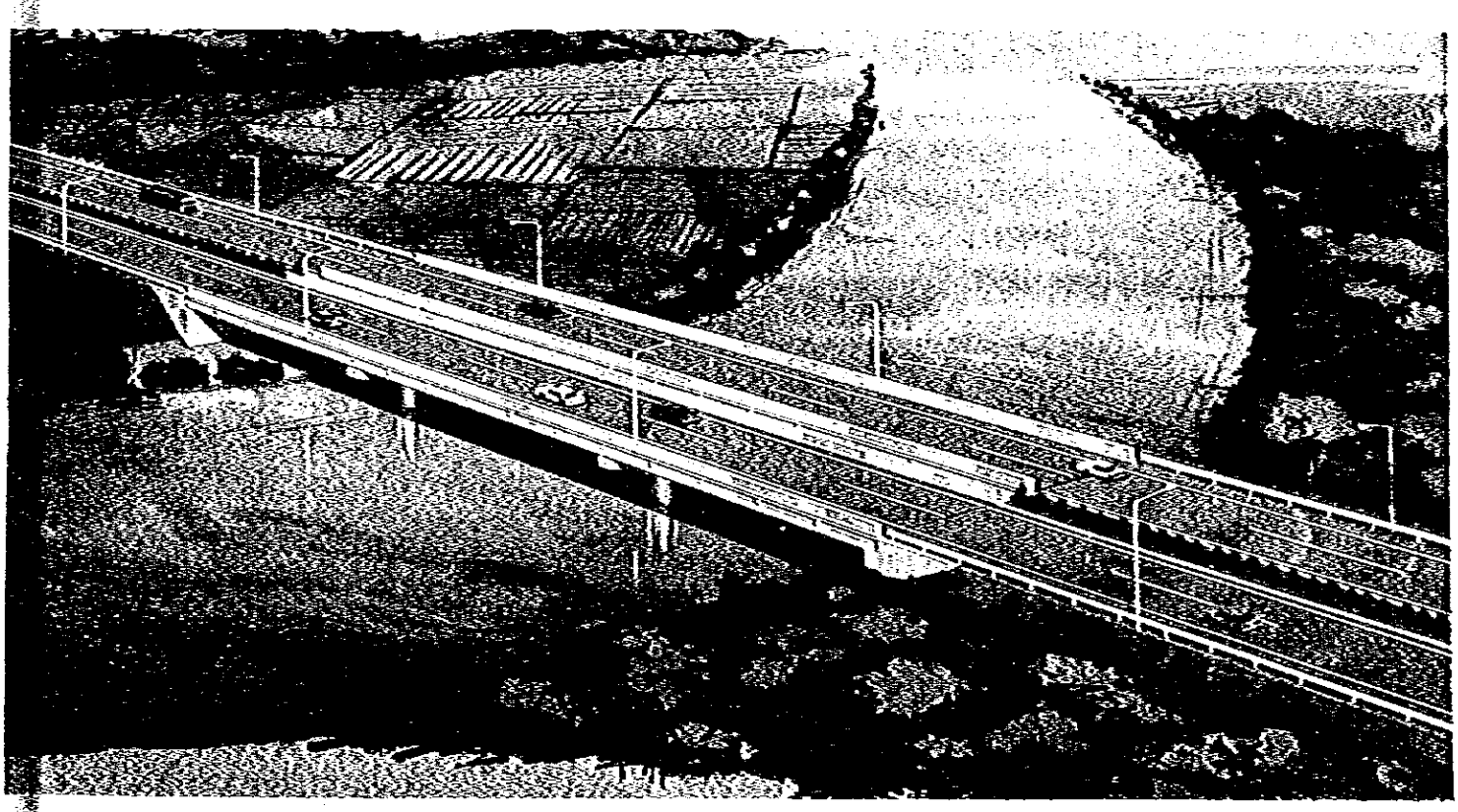
0 5km

COLOMBO KATUNAYAKE PROJECT ROAD

Bird's Eye View of Colombo - Katunayake Expressway (Upper left is the K.I.P.Z. and Colombo International Airport)

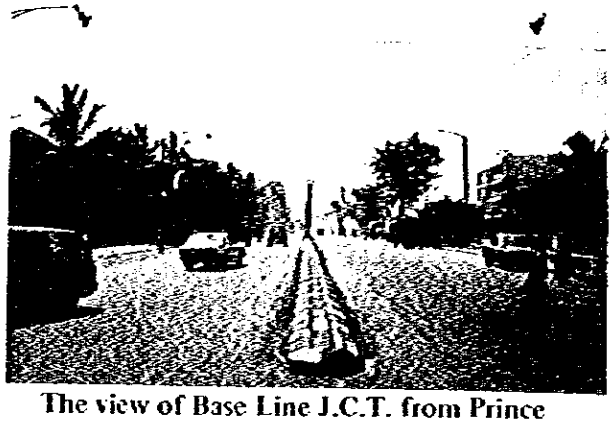


Ekala Inter Change
(Diamond Type. Extending to Colombo City on the left and Colombo International Airport on the right.)

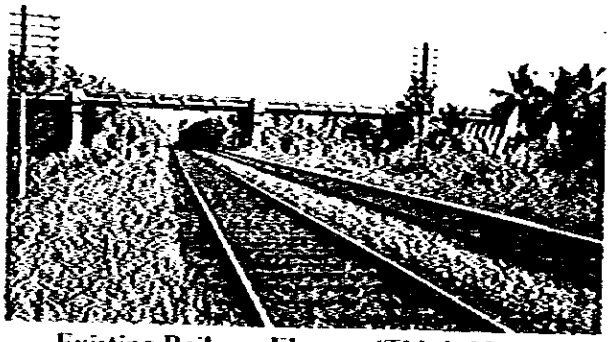


Dandugam Oya Bridge (Three simple span post-tention beam bridge L = 80 m)

Alutumawatta Road (Near the beginning point of Project B. The New Port Access Road passes through under this road)



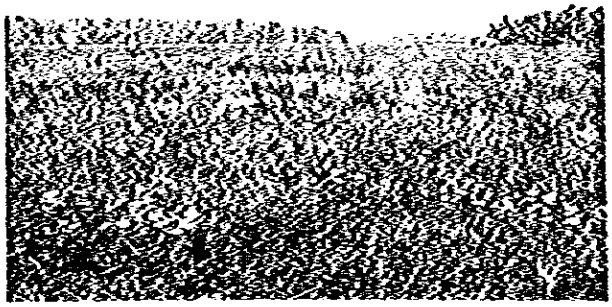
The view of Base Line J.C.T. from Prince of Wales J.C.T. (This road will be improved for use as part of Project B)



Existing Railway Flyover (This bridge is adopted for Project B)

Peliyagoda Area (The container yard and the new canal is under construction as the part of the Integrated Development Project.)

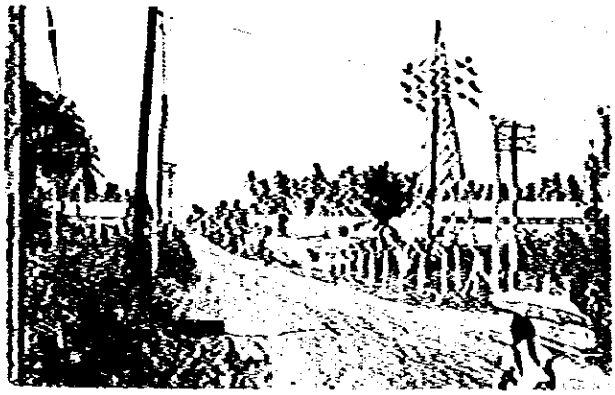
Kandy Road (Near the connecting point of Project A and Project B)



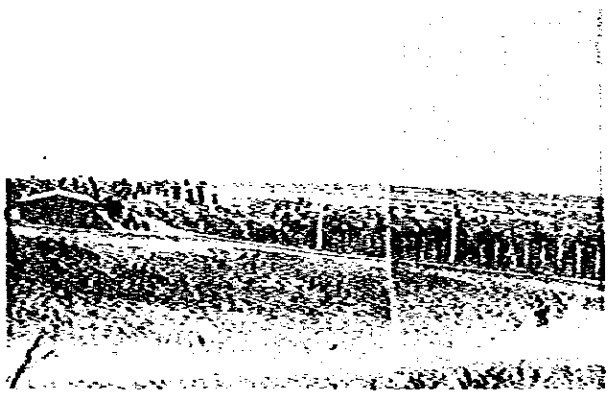
The marsh spread over the south of Ragama. (The embankment over the marsh is for the railway constructed 100 years ago with 3 or 4 meters height.)

Access Road to Ekala I.C. (On the viewer's side of this road, 1 km long new road is planned for the access to A-3 road.)

Crossing point of Dandugam Oya
(Proposed site for 80 meter bridge)



Access Road to K.I.P.Z. I.C. (Many factories along this road in K.I.P.Z.)



Colombo International Airport (Ending point of Project A)

TABLE OF CONTENTS

SUMMARY (Table)

SUMMARY (Figure)

TABLE OF CONTENTS

TABLE LIST

FIGURE LIST

ABBREVIATIONS

Abbrv.	Meaning
AASHTO	American Association of State Highway Transportation Officials
ADT	Average Daily Traffic
Approx.	Approximately
Appx.	Appendix
ASTM	American Society for Testing and Materials
B/C	Benefit/Cost
BIPZ	Biyagama Investment Promotion Zone
CBD	Central Business District
CBR	California Bearing Ratio
CIF	Cost Insurance Freight
cm.	centimetre
(S.L.) C.T.B.	(Sri Lanka) Central Transport Board
DOH	Department of Highways
D.W.T.	Dead Weight Ton
Fig.	Figure
F.I.R.R.	Financial Internal Rate of Return
Ft.	Feet (Foot)
GCEC	Greater Colombo Economic Commission
G D P	Gross Domestic Product
GNP	Gross National Product
H, Hr.	Hour
HWL	Highest Water Level
IPZ	Investment Promotion Zone
IRR	Internal Rate of Return
JICA	Japan International Cooperation Agency
JRA	Japan Road Association
KIPZ	Katunayake Investment Promotion Zone
kg.	kilogram
km.	kilometre

Lb.	Pound
m	metre
mm	millimetre
MSL	Mean Sea Level
NHDA	National Housing and Development Authority
No.	Number
NPV	Net Present Value
OD	Origin Destination
p.a.	per annum
(S.L.) P.A.	(Sri Lanka) Ports Authority
Pass.	Passenger (s)
P C	Prestressed Concrete
P.C.U.	Passenger Car Unit
Phase I	Study period from 17 Dec. 1982 to 14 March 1983
Phase II	Study period from 23 April to 16 Oct. 1983
Q-V	Quantity-Velocity
Ref.	Refer to
R/C	Revenue/Cost
Rs.	Sri Lanka Rupees
SDCC	State Development and Construction Corporation
Sq.	Square
T	Ton
TR	Technical Report
TRRL	Transport and Road Research Laboratory
UDA	Urban Development Authority
U.N.	United Nations
VOC	Vehicle Operating Cost
Vol.	Volume

SUMMARY AND RECOMMENDATION

A. CONCLUSIONS AND RECOMMENDATIONS

A.1 INTRODUCTION

A.1.1 Objective of the Study

This feasibility study conducted by the Japan International Cooperation Agency at the request of the Government of Sri Lanka, is aimed at the evaluation of technical and economical feasibility of the Project Road linking Katunayake and Colombo and the financial viability of a part of this road as a Toll Expressway.

A.1.2 Characteristics of the Project

This Road Project is especially important because the following effects can be expected by the implementation of the Project.

a. Promotion of development within the GCEC Area of Authority and the neighbouring regions such as Gampaha District.

b. Promotion of the development of industries beginning with the Katunayake Investment Promotion Zone.

c. Betterment of the conditions for the attraction of industries and the creation of employment opportunities by improving the image of GCEC Area with the provision of this essential infrastructure.

d. Promotion of Tourism.

e. Smoothening of administration.

f Multiplier effects and repercussion effects due to the smooth linking of Colombo Port, Colombo International Airport, Katunayake Investment Promotion Zone and the City of Colombo.

g. Relieving of Negombo Road from traffic congestion.

h. Promotion of industrial and economic development of the country in general with the smooth flow of goods to and from the Port of Colombo and relief to traffic congestion in the city by the diversion of heavy cargo vehicles from the urban roads.

i. Facilitation of the materialization of future North-South Motorway with the implementation of the Expressway.

A.1.3 Description of the Project Road

The Project Area and the Project Roads are shown in Fig. 1. For the purpose of this Study, the Project is divided into two parts, Project A and B as explained below.

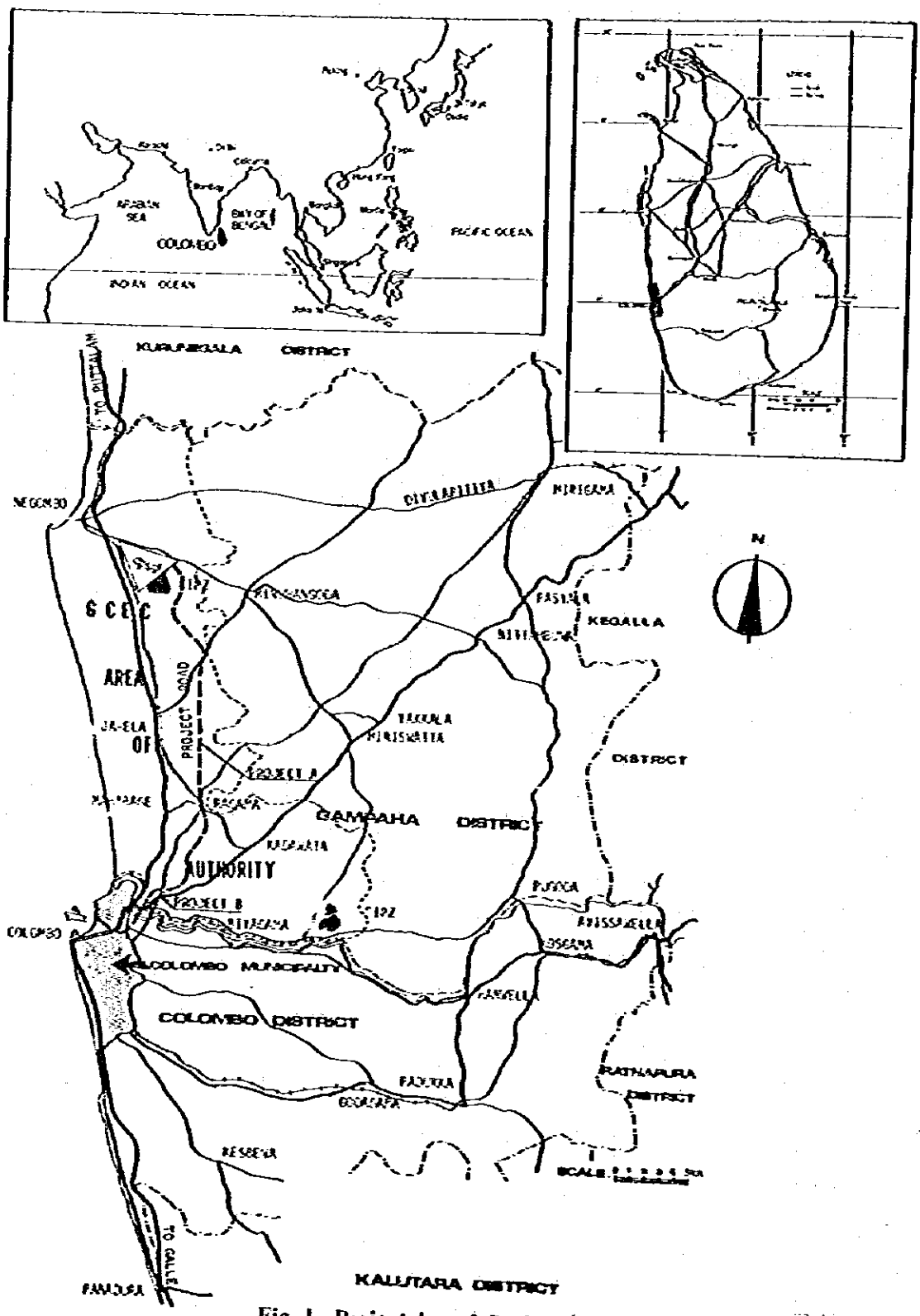


Fig. 1 Project Area & Project Roads

a. Project A

A fully access controlled expressway between Colombo International Airport and a proposed Interchange at Dalugama close to Colombo-Kandy (A1) road with an approximate length of 25.4 kilometers. This Expressway is further sub-divided into three road sections – K-1, K-2 and K-3. (Refer Fig. 2) for the purposes of study.

b. Project B

The Project B is the development of a highway from the Port of Colombo to connect Project A at Dalugama.

It is 5.7 kilometers long, allows some at grade intersections and utilises the New Kelani Bridge and some existing roads which are to be improved. This highway is further sub-divided into 3 road sections P-1, P-2 and P-3. (Refer Fig. 2) for study purposes.

Symbols Used for Identification of Road Sections

PROJECT A	
MAIN ROAD	25.4 km.
K-1: Dalugama IC – Ragama IC	7.1 km.
K-2: Ragama IC – Ekala IC	8.4 km.
K-3: Ekala IC – Airport	9.9 km.
Alternatives and affiliated roads	
K-4: Wewelduwa – Kiribathgoda (Access Road to Biyagama)	1.7 km.
K-5: Ekala IC – Negombo (A3) Road	3.1 km.
K-6: Dandugam – Airport (along A3 road and Canada Sri Lanka Friendship Road)	9.5 km.
K-7: KIPZ IC – Canada Sri Lanka Friendship Road	1.6 km.
PROJECT B	
MAIN ROAD	5.7 km.
P-1 : Colombo Port – Prince of Wales	1.5 km.
P-2 : Prince of Wales Avenue – Peliyagoda	1.3 km.
P-3 : Peliyagoda – Dalugama	2.9 km.
Alternatives and affiliated roads	
P-4 : Peliyagoda – Dalugama (along Kandy (A1 Road))	2.6 km.
P-5 : Peliyagoda – Wattala (on abandoned road project)	1.0 km.

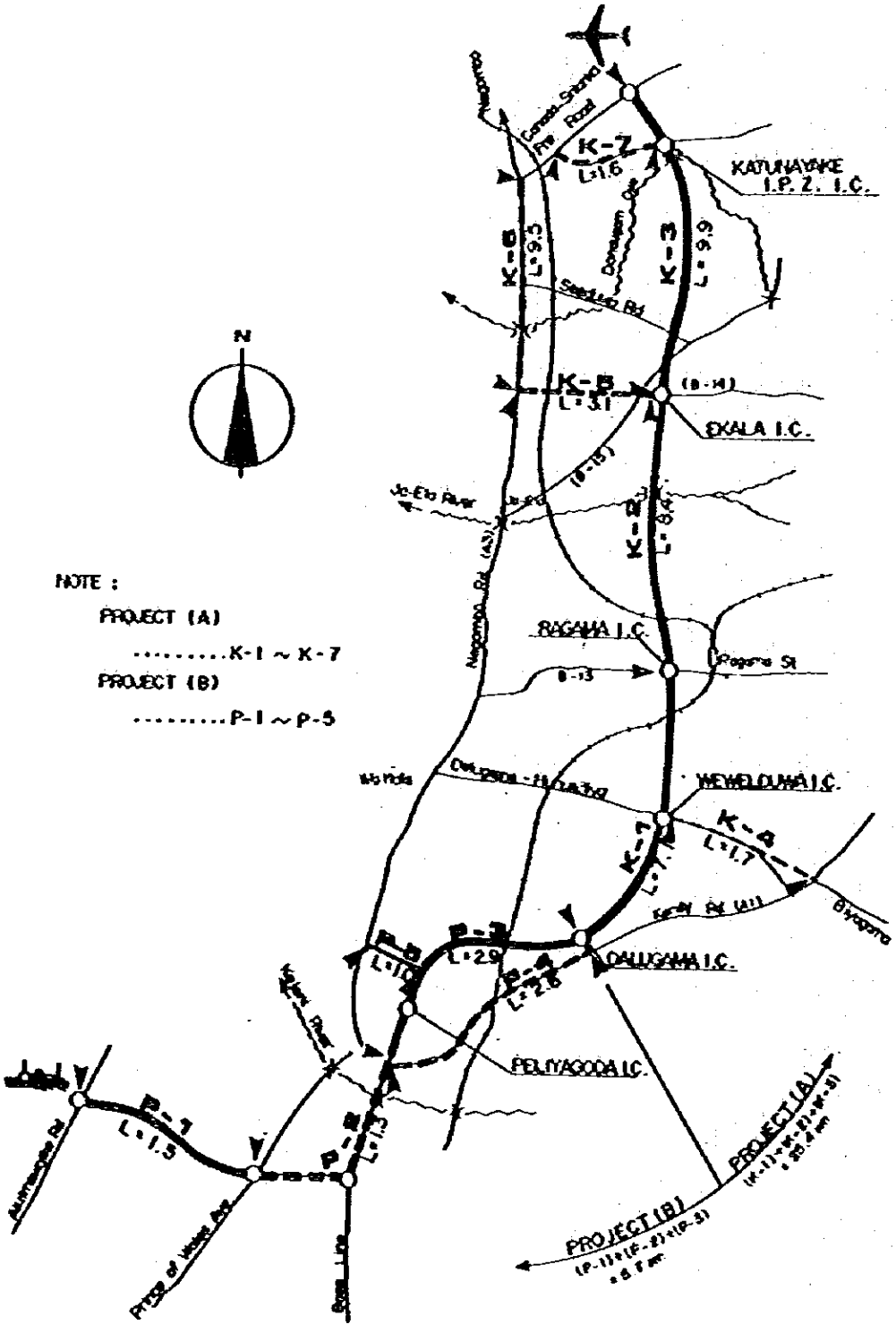


Fig. 2 Symbol Used for the Identification of Road Section

A.2 CONCLUSIONS

The major results of the Study are summarized below.

A.2.1 Importance of the Project

The project is of great importance as the development within the GCEC Area of Authority and the neighbouring regions, such as the District of Gampaha, will be accelerated and the industries in and out of the KIPZ will be promoted by the implementation of this Project, while it also contributes to the improvement of national industry and economy by the smoothening of flow of goods between the Port of Colombo and the other parts of the country, especially the industrial areas north of Colombo such as the Investment Promotion Zones at Katunayake and Biyagama.

A.2.2 Future Traffic Volume

The future traffic volume in each road section varies depending on the case considered. The traffic volume forecast for the selected plan which proposes the simultaneous implementation of Project A and Project B is given in Table 1.

Table 1: Future Traffic Volume (All vehicles)

(Unit: Vehicle/day)

Interval	Year	1990	2000
K-3	Airport – KIPZ	4,500	13,300
	KIPZ – Ekala	11,500	21,600
K-2	Ekala – Ragama	17,300	36,500
K-1	Ragama – Wewelduwa	18,800	39,500
	Wewelduwa – Dalugama	26,000	50,300
P-3	Dalugama – Peliyagoda	33,000	40,300
	Peliyagoda – Kandy Road	40,600	58,400
P-2	Kandy Road – Baseline Rd.	43,700	90,500
	Baseline Rd. – Prince of Wales Avenue	25,900	46,200
P-1	Prince of Wales Ave. – K.C.C. Perera Mawatha	23,500	45,800
	K.C.C. Perera Mawatha – Port	33,700	65,100

A.2.3 Project Cost

The cost of this Project as a whole is Rs. 1,226.2 million at 1983 prices as shown in Table 2, and the Project A costing Rs. 923.3 million and the Project B costing Rs. 302.9 million.

The Foreign Currency Component of the Project Cost is Rs. 688.0 million and the Local Currency Component is Rs. 475.0 million corresponding to 59.2% and 40.8% respectively of the cost excluding the Taxes.

Table 2: Project Cost

(in Rs. million at 1983 prices)

Item \ Component	Foreign	Local	Tax	Total
PROJECT B				
Construction	161.72	67.18	14.24	243.14
Land Acquisition	–	38.63	–	38.63
Engineering Service	14.06	5.84	1.24	21.14
Total	175.78	111.65	15.48	302.91
PROJECT A				
Construction	471.26	117.26	43.93	694.45
Land Acquisition	–	168.50	–	168.50
Engineering Service	40.98	15.59	3.82	60.39
Total	512.24	363.35	47.75	923.34
Grand Total	688.02	475.00	63.23	1,226.25

A.2.4 Results of Economic Evaluation

Given in Table 3 are the results of economic evaluation for the case of simultaneous implementation of Projects A and B which was selected from among 5 cases after comprehensive evaluation from technical and economic view points and qualitative evaluation of indirect effects.

Table 3: Results of Economic Analysis

		Net Present Value NPV (in Rs. 1,000)	Benefit Cost Ratio B/C	Internal Rate of Return IRR (%)
Economic Evaluation* Original Case		1,646,702	1.96	18.5
Sensivity Test	Test I * Benefit -20% Cost +10%	803,819	1.42	15.3
	Test II * Project Life = 20 years	1,374,472	1.80	18.1
	Test III Discount Rate = 15%	753,324	1.41	18.5

Note: *Opportunity cost of capital is 12%

A.2.5 Results of Technical Evaluation

a. It is the route D that was selected as the optimum out of the 4 possible alternatives considered for each of the Projects A and B after a comprehensive evaluation from technical, economical and environmental view points. (See Fig. 3).

b. In both Project A and Project B, 4 lanes are recommended.

c. It is desirable to adopt the following vehicle speeds for the respective sections of the project roads.
   - Sections P-1, P-2 : 60 km/hr.
   - Section P-3 : 80 km/hr.
   - Expressway (Sections K-1, K-2 & K-3) : 100 km/hr.

d. Since the Project Roads pass partly through marshes and soft grounds, measures against soft soil conditions should be carefully studied. In order to cut down construction costs, it is recommended to adopt cheaper soil stabilization methods such as preloading (surcharge loading) where possible in place of sand pile and sand compaction methods.

e. In the flood prone areas, it is necessary to take into careful consideration of the hydrology, topography and geology of the area in the detailed design of the drainage and flood relief structures and the planning of temporary drainage systems during construction.

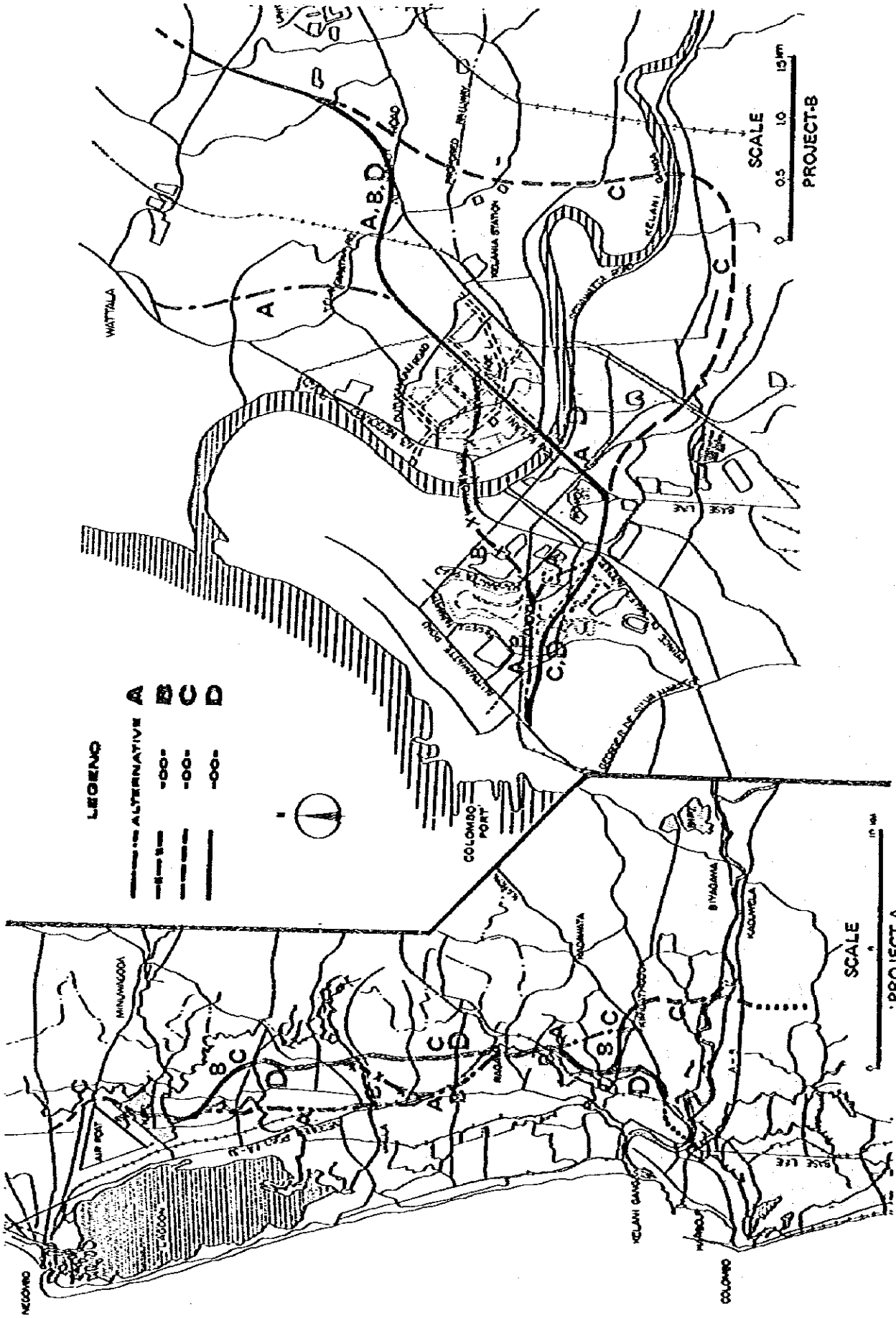


Fig. 3 Project A, B Route Alternatives

A.2.6 Results of Financial Analysis

Through financial analysis, the following conclusions were arrived on the viability of Project A as a toll expressway.

(1) When cost escalation due to inflation is not considered, the Financial Internal Return Rate (F.I.R.R.) is between 9.01% ~ 9.26%, and this is larger than the average interest rate of 9% for the project construction cost with a revenue/cost ratio of 1.00 ~ 1.03. And a repayment period is between 27 ~ 30 years. Therefore, in this case, the toll system of Expressway is financially viable.

(2) When cost escalation is considered, regular revisions (every 2 or 3 years) of the toll rate will be necessary.

(3) It is possible to cover maintenance cost by the toll revenue if the rate of cost escalation stays within 15% p.a.

(4) From the financial point of view, the distance proportional rate system is more desirable than the flat rate system.

(5) The state of conditions may change in the future, and therefore, a reinvestigation of the toll and operation system is desirable at the implementation stage to correspond with such changes.

A.3 RECOMMENDATIONS

A.3.1 Recommendations

a. Judging from the results of technical and economical evaluation and environmental studies, this Project is feasible with a minimum Internal Rate of Return (IRR) of 18.5% for the case of the simultaneous implementation. Even in the sensivity analysis for a 10% increase in costs and 20% decrease in benefit, the IRR is 15.3%.

b. Investment effects in the case of implementing both Project A and Project B is very much larger than in the case of implementing the Expressway project alone owing to the multiplier effects of the two projects, such as the acceleration of regional development by linking the strongholds of Colombo International Airport, KIPZ, Colombo Port etc. Therefore, Project A and Project B should be treated as a single project. Therefore, the simultaneous implementation of Project A and Project B is recommended.

c. The Expressway is expected to bring in not only the direct benefits but an enormous indirect development under a stepladder system with Negombo Road and the Expressway as the spines. Therefore, it is necessary to evaluate the project not only from the economical analysis along but comprehensively with a long term stand from the view point of National Economy.

d. Regarding the accessibility to the Expressway, there are two proposals; Plan A and Plan B. Plan A is an Expressway with three main interchanges (at Wewelduwa, Ragama and Ekala), an on-off ramp for the KIPZ and with entrace/exit facilities at Dalugama and Colombo International Airport.
Plan B with additional six on/off ramps to Plan A is recommended as it provides access from major feeder roads and contributes to development of the regional economy.

e. The Low Embankment Type is recommended for Section P-3 from economical and technical view points.

f. For this Project to function smoothly, it is necessary to improve the connected road network.
Conversion of the existing intersections along the Project Road at Prince of Wales Avenue, Baseline Road, Kandy (A1) Road and those along other related roads, to more efficient Coordinated Signal Controlled Intersections is recommended.
Further, it is recommended to improve the feeder road system by road widening, and constructing new roads where necessary.

g. In order to meet the future increased demand of traffic crossing the Kelani Ganga (River), it will be necessary to construct a third bridge at an appropriate time and location.
As a short term and interim measure against this situation, the widening of carriageway of the New Kelani Bridge to 6 lanes with sidewalks by cantilevered widening could be considered.

h. In promoting this Project, it is necessary to bear in mind of its future extension as the North-South Motorway.

i. For the smooth propulsion of the construction, operation and management of this Project, it is necessary to establish adequate systems and organizations for the design, construction execution and supervision, operation and management.

A.3.2 Implementation Program

The project is feasible, and moreover judging from the development effects and the multiplier effects generated by the simultaneous implementation of Project A and Project B, it is recommended to implement Projects A & B together (see Fig. 4).

Fig. 4: Implementation Schedule and Project Cost

	Year / Implementation Item	1985	'86	'87	'88	'89	'90	Total
(Project B)	Engineering Service							21.2
	Land Acquisition							38.6
	Construction							243.0
(Project A)	Engineering Service							60.4
	Land Acquisition							168.5
	Construction							694.6
Project Cost (in Rs. million at 1983 prices)	Foreign Currency	29.5	127.8	261.9	197.2	70.9		687.3
	Local Currency & Tax	90.3	193.9	127.0	94.3	33.5		539.0
	Total	119.8	321.7	388.9	291.5	104.4		1,226.3

A.3.3 Matters for Further Consideration

(1) Although the present study of this road project is only a Feasibility Study, the preliminary road and structural designs were studied as much in detail as possible so that as much of it may be of use in the future implementation stage. Therefore it is necessary to utilize as much of the selected route, the boring results and topographical survey results for major structure sites, etc. as possible during the implementation stage, and to plan the effective usage of such results.

However, since the selection of the route and preliminary designs were done using a 1:10,000 scale aerial photo map, it is necessary to use more appropriate topographic map and re-examine the Preliminary Engineering Study results at the future Detailed Engineering stage.

(2) In Sri Lanka, where an Expressway is to be introduced for the first time, possibilities are very high that a variety of problems have to be faced in the operation and use of the Expressway. Therefore, it is necessary to take adequate measures, such as those listed below, aimed at the effective and moreover smooth operation and utilization of the Expressway.

a. Integration of the three authorities; namely, the agency responsible for the operation and management of the roads, the Police responsible for the control of traffic, and the agency responsible for the fire-fighting and ambulance services into a single organization in order to promote smooth operation of the Expressway.

b. To educate the general public through the mass communication such as newspapers, radio and TV, on the correct usage of the Expressway taking efforts specially in the reduction of traffic accidents. Further, every effort should be taken to give the people of the region a clear understanding on the role of the Expressway and how to use it effectively. Measures should also be taken to totally prohibit entry and crossing of the Expressway.

(3) In extending the Expressway in the North and South directions and especially in extending a route across Kelani Ganga, it is desirable that the decision is made extremely carefully taking into consideration of the present and future road network comprehensive transport system, land use etc., of the Colombo Metropolitan Region and based on the fundamental data obtained from the surveys of person trips and flow of goods etc., if such surveys are possible.

B. SUMMARY

B.1 INTRODUCTION

B.1.1 Background of the Project

The Government of Japan, in compliance with a request of the Government of Sri Lanka, decided to undertake the feasibility study of the Colombo-Katunayake Expressway and the New Port Access Road Construction Projects within the Greater Colombo Metropolitan Region and assigned the Japan International Cooperation Agency (JICA) to carry out this study.

Accordingly, JICA dispatched a Preliminary Study Team to Sri Lanka between 17th September to 1st October 1982 and this Team had discussions with the relevant government authorities in Sri Lanka and made preliminary survey. After agreement was reached between the Greater Colombo Economic Commission (GCEC) and JICA, the latter dispatched a Study Team to Sri Lanka in December 1982 to carry out the feasibility study. The results of their study are summarized here.

Investment Promotion Zones are already set up by the GCEC at Katunayake and Biyagama close to the Capital City Colombo. Moreover, Colombo Airport Development Programme, Colombo Port Development Programme etc; were gradually launched with some satisfactory progress achieved already.

Nevertheless, traffic congestion due to increase of traffic and delay in the preparation of infrastructures for transport in the Colombo Metropolitan Region is becoming grave day by day.

Therefore realizing the urgent need to construct a road connecting Katunayake with the Colombo Port and Colombo City in order to relieve congestion of traffic between the organic nodes of major transport facilities such as the KIPZ, and Colombo City, the Government of Sri Lanka was compelled to make this request for the feasibility study.

The Terms of References of the Government of Sri Lanka for this project requests for the feasibility study on the construction of following two road projects

a. Project A
   Colombo-Katunayake Expressway with a length of approximately 25.4 km.

b. Project B
   New Port Access Road with a length approximately 5.7 km.

B.1.2 Objectives of the Study

The objectives of this study is to analyze and evaluate the feasibility of Projects A & B from technical and economical aspects taking into due consideration of the physical, social and economical environment of the project area and also to evaluate the financial viability of Project A as a Toll Road.

B.1.3 Study Approach

The major study items are given below. (Refer to Fig. B1-1)

- Selection of the Route
- Traffic Survey
- Traffic Projection
- Preliminary Engineering and Cost Estimates
- Economic Evaluation
- Financial Evaluation
- Implementation Programme

Taking into consideration of the following basic elements, the alternatives in this project were selected from among the possible and pertinent combinations of these elements.

- Route
- Road cross section (2 lanes or 4 lanes)
- Road structure (High embankment type or low embankment type, number of access points)
- Type of structures
- Improvement or reconstruction of feeder roads
- Stage construction according to road section

These alternatives were evaluated from the technical, economical and financial points of view and the optimum proposal is recommended after a comprehensive analysis.

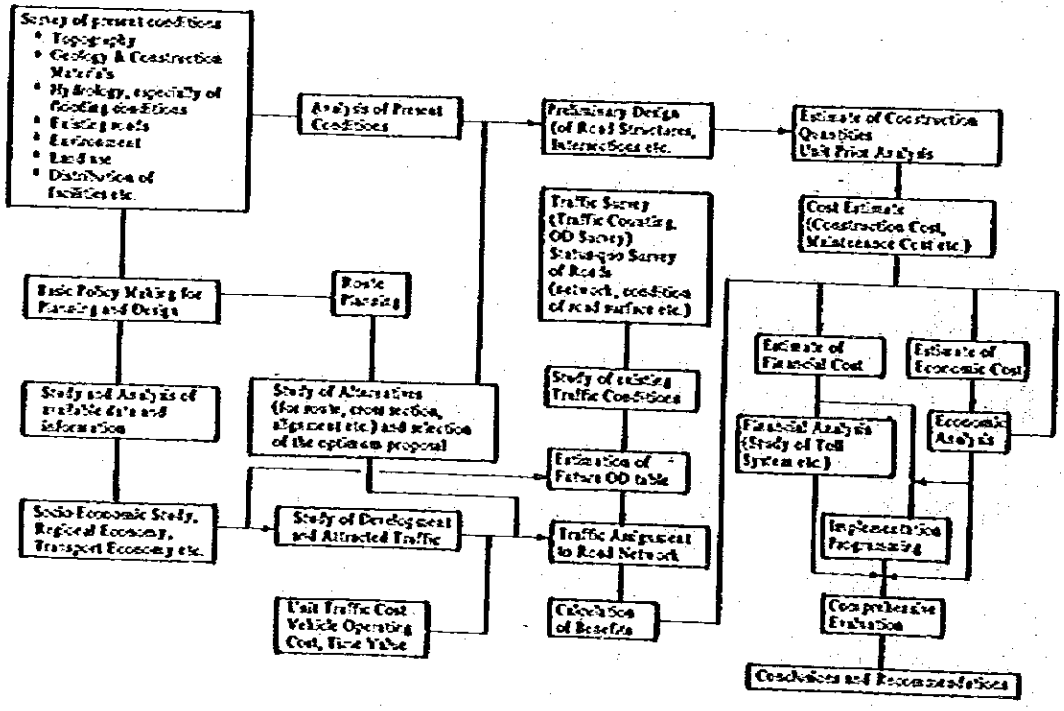


Fig. B1-1 Study Approach

B.2 PRESENT TRANSPORT CONDITIONS

B.2.1 Road Network

Outside the City of Colombo in the project area there are two main roads which are asphalt paved and two laned. The secondary network consists of single lane roads with 3.0 m ~ 4.0 m carriageways and 6.0 m ~ 7.0 road width. The total length of all types of roads in the project area is approximately 505 km.

B.2.2 Characteristics of Existing Traffic

There are four important areas in the project region whose traffic characteristics are important for an understanding of the prevailing transport conditions and also to appreciate the need for a new highway from Colombo to Katunayake. These are

- The Port of Colombo
- The City of Colombo
- The Study Area
- The International Airport and the Free Trade Zone at Katunayake

B.2.3 Traffic Volumes

Port traffic is important as 95% of the total shipping activity in the country is handled by the Port of Colombo. Transport from the Port by rail is 3% and the rest is by road haulage. About 8,000 vehicles of all types use the Port daily. Though there is 24 hour operation about 75% of traffic activity is during daytime. Of the Port traffic about 2/3 is distributed to the City and 1/3 outside its limits.

Traffic enters the City through nine points. The traffic volumes range from 10,000 to 50,000 p.c.u. (passenger car unit) per day. Peak hour volumes reach nearly 3,000 fast vehicles per hour. The Central Area road system is used by nearly 73.8% of Port traffic. Hence reorientation of Port traffic such as by the construction of the Port Access Road can make a significant reduction to Central Area traffic congestion.

The traffic volumes on the major arterial roads vary from 40,000 p.c.u. at the entrance to the City to about 10,000 p.c.u. towards the end of the project area. On the Airport Road traffic volumes reach 10,000 p.c.u. per day. On the secondary roads the maximum traffic volumes is about 6,000 p.c.u.

B.2.4 Vehicle Composition and Variation

In Port traffic the passenger to goods vehicle ratio is 40:60. The largest single category is the heavy lorry (30%) followed by motor cycles (21%), passenger cars (17%), vans (17%), container trucks (9.6%) and medium lorries (4.2%).

In the City the largest single contribution is by car traffic, followed by buses and motor cycles. There is a very high percentage of heavy vehicular traffic varying from 22% to 36%. Slow moving traffic also varies from 7% on some roads to as much as 60% on others.

The secondary road system also contain a high percentage of car traffic but is followed by motor and bicycle traffic. Hence in the vehicle composition slow traffic has a high ratio so also heavy vehicular traffic.

B.3 PROJECTION OF TRAFFIC DEMAND

B.3.1 Procedure

The future traffic volume of Project Road is mainly affected by the following two factors:

a. Trend expansion based on the past socio-economic activities in the planned development area such as industrial, housing, and so on.

b. The new activities in the planned development area such as industrial, housing, and so on.

At first, the volume and the pattern of future traffic are forecasted on the basis of trend expansion and then, traffic from the main developed areas like KIPZ, BIPZ etc. is added to that volume. The abovementioned traffic forecasting is done on the basis of the present origin-destination table. The outline of the traffic forecasting procedure is shown in Fig. B3-1.

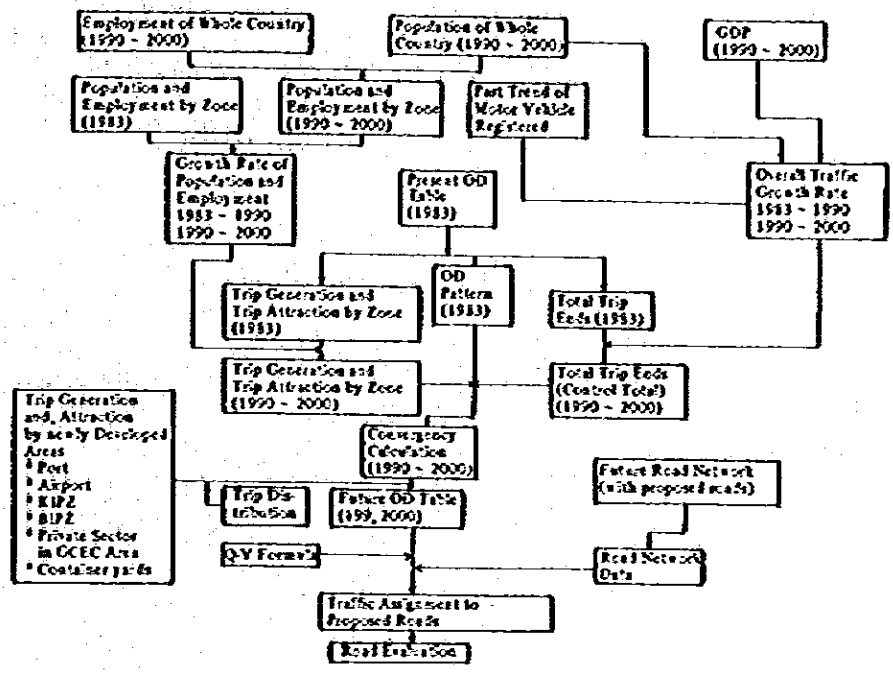


Fig. B3-1 Estimation of the Future Traffic Volume and Traffic Assignment to the Future Roads

B.3.2 Population and GDP

(1) Population

The objective region will have a population of 4.452 million in 1990 and 5.134 million in 2000 as against the 3.402 million of 1971 and 3.914 million of 1981. As a result, average annual growth rate for the objective region is slightly more than 1.4 percent toward the year of 2000. Table B3-1 shows the results of population projection by districts involved in the objective region.

Table B3-1: Results of Population Projection by Involved Districts

(Unit: 10^3 persons)

District	1971*	1981*	1990	2000
Colombo	1,498	1,698	1,902	2,157
Gampaha	1,174	1,389	1,624	1,928
Kalutara	730	827	926	1,049
Total	3,402	3,914	4,452	5,134

Remarks: * : Actual figures

(2) Employed Population

Labour force and employment in the objective region[1] were projected utilizing various ratios clarified from the past trend. Summarized in Table B3-2 is the projected labour force and employment in the objective region. Considering the growth rate, Secondary Sector shows the highest increase due to the industrial development plans such as the KIPZ and BIPZ in the objective region.

Table B3-2: Labour Force and Employment in the Objective Region

(Unit: 10^3 persons)

Item	1981*	1990	2000
1. Primary Sector	181 (15.0)	192 (12.1)	201 (9.6)
2. Secondary Sector	244 (20.2)	361 (22.7)	528 (25.2)
3. Tertiary Sector	608 (50.3)	809 (50.9)	1,070 (51.1)
4. Others**	175 (14.5)	227 (14.3)	295 (14.1)
Sub-total			
Employed	1,208 (100.0)	1,589 (100.0)	2,094 (100.0)
Unemployed	298	315	371
Total (Labour Force)	1,506	1,904	2,465

Remarks: 1)* : Estimated figures, based on "Labour Force and Socio-economic Survey, 1980/81" and "Census of Population 1971."

2)** : Activities not adequately defined.

3) ( ): Proportion to the total employment (Unit: %)

4) : Unemployment rate: 1981: 19.8%
1990: 16.5%
2000: 15.1%

Note: 1) The objective region consists of Colombo, Gampaha and Kalutara Districts.

(3) Gross Domestic Product (GDP)

In forecasting of GDP, the average annual increase rate was assumed towards the year 2000 by the Industrial Sector. (3.5% in Primary; 7.2% (1981 to 1990) and 6.7 % (1990 to 2000) in Secondary; 5.5% in Tertiary). Average growth rate of GDP will be resulted in 5.5 percent during the projection period. The results of this projection is shown in Table B3-3.

Table B3-3: Gross Domestic Product (GDP) and Contribution by Industrial Sector

(Unit: Rs. million)

Industrial Sector	1980*	1990	2000
1. Primary	18,221 (27.7)	24,833 (23.3)	35,030 (19.3)
2. Secondary	18,410 (28.0)	34,420 (32.4)	65,835 (36.3)
3. Tertiary	29,145 (44.3)	47,189 (44.3)	80,605 (44.4)
Total (GDP)	65,776 (100.0)	106,442 (100.0)	181,470 (100.0)

Remarks: 1) : At 1980 constant factor cost prices, discounted by the implicit GNP deflator.
2)* : Actual figures
3) ( ): Contribution rate (Unit: %)

B.3.3 Results of Traffic Assignment

(1) Estimation of Natural Growth Rate

The annual natural growth rates of future traffic volume were estimated by applying the results of the regression analysis on the relationship between No. of vehicles registered and population, GDP. They are shown in Table B3-4.

Table B3-4: Annual Average Growth Rate

Type of Vehicle	1980 ~ 1990	1990 ~ 2000	1983 ~ 2000
Passenger Car	8.0%	7.8%	3.63*
Lorry	8.2%	8.0%	3.75*

* Expansion factor

The total traffic volume in 1990 and 2000 based on the trend expansion reaches 1.7 times and 3.7 times respectively compared with the year 1983.

Considering that the annual growth rate of traffic on both Victoria and New Kelani Bridge is 9.5 percent between the year 1978 and 1983, our estimates are a little conservative.

(2) Trip Generation and Attraction

The projected number of trips of all vehicles generated from and attracted to the objective region reaches 189,000 (Expansion factor 3.6) in the year 2000, compared with the 53,000 trips in 1983. Among these trips, the trips by heavy lorries and containers are expected to increase by about four times the present number of trips, due to the increment of freight movement from Port and the newly developed area.

The projected number of trips by vehicle type is shown in Table B3-5.

Table B3-5: Projected Number of Trips by Vehicle Type

(Number of Trip Ends/Day)

Type of Vehicle	Number of Trips			Expansion Factor	
	1983	1990	2000	1983 ~ 1990	1983 ~ 2000
• Car, Taxi & Tricycle	15,499	26,968	57,394	1.74	3.70
• C.T.B* & Private Coaches	7,543	10,742	19,207	1.42	2.55
• Van & Middle Lorries	11,728	21,445	45,258	1.83	3.86
• Heavy Lorries & Containers	8,451	15,998	33,937	1.89	4.02
• Motorcycle	9,843	16,204	33,224	1.65	3.38
• All Vehicles	53,064	91,357	189,020	1.72	3.56

(3) OD Traffic Volume

The future origin destination pattern of the traffic can be summarized as follows:

a. The traffic volume with origin or destination in Colombo City crossing Kelani Ganga in the year 2000 reaches 3.6 times (about 100,000 vehicles that of 1983 (28,000 vehicles).

b. In 1983, the composition of the passenger cars and freight cars was almost the same. Towards 2000, the number of freight cars exceeds that of the passenger cars.

c. The traffic volume between Colombo and Peliyagoda shows the highest growth rate (6.3 times) up to 2000 and is followed by Wattala (4.1 times) and Dalugama (3.7 times).

B.4 TRAFFIC ASSIGNMENT

B.4.1 Procedure

The traffic assignment procedure to future road network is shown in Fig. B4-1.

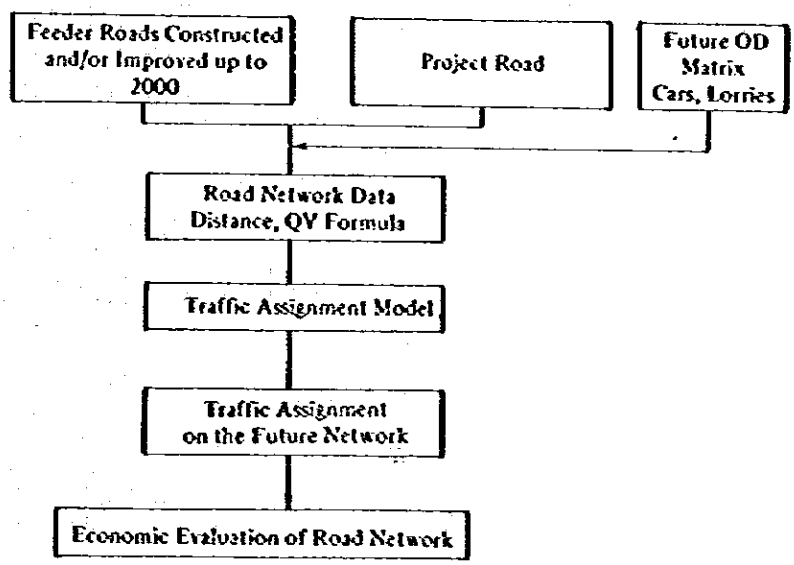


Fig. B4-1 Procedure for Traffic Assignment

B.4.2 Results of Traffic Assignment

Summarized in Table 1 are the estimated traffic assigned on each road section. Judging from this table, the following observations can be obtained:

a. The assigned traffic volume on Project B is comparatively large. The daily traffic volume on each section of this road is estimated to be more than 20,000 in 1990 and 40,000 in 2000. Especially, that on the section between Perera Mawatha to Colombo Port is estimated to be more than 30,000 in 1990 and 60,000 in 2000.

b. The assigned traffic volume crossing the New Kelani Bridge is considerably large. In 2000, that traffic volume reaches more than 90,000 per day. On the other hand, the assigned traffic volume on the Victoria Bridge is about 30,000.

c. The assigned traffic volume on Project A will have a larger traffic volume when Project B is constructed together with expressway.

d. The composition of passenger cars and freight cars of the assigned traffic is almost even on each road section.

e. Compared with the basic case where the Project Road would not be constructed, traffic congestion along A1 and A3 Road for the case with Project Road would be considerably decreased.

B.4.3 Relationship of Expressway and Railway

Judging from the existing railway frequency and capacity, the rail operation would not be able to meet the passenger demand in the future, due to the full development of KIPZ, the growth of air passenger traffic, the increment of job opportunities within Colombo City and Peliyagoda and so on. (For more details, see 'Report on Transport Requirements of the GCEC Area of Authority', GCEC, October, 1980).

Therefore, double tracking from Ragama – Katunayake is expected to improve the regular rail service, especially during peak hours as well as the electrification.

One purpose of the railway electrification is to utilize the surplus of electric power generated from Mahaweli Power Stations during hours of off-peak power to carry commuters.

The following items can be pointed out:

a. Even with the improvement of railway, it is difficult to stop the trend of growing car ownership as seen experienced in many developed and developing countries.

b. The power of inducement for industrialization is more reinforced by using road network (including expressway) than railway improvement alone.

c. The commodities and materials cannot be gathered from and distributed to many places smoothly without road network (including expressway) because the supply and demand places are scattered in a wide area. In other words a better door to door service can be provided by the road network.

d. On the other hand, the railway improvement will contribute to long trip passengers and long distance freight flows, and also contribute to commuting during the peak hours as a "line-transport service".

Therefore, expressway and railway will mutually take charge of a portion of functions of the other, although in some aspects they would be competitive.

B.5 PRELIMINARY ENGINEERING

B.5.1 Characteristics of the Project Road

Out of the two project roads, the Expressway (Project A) which has all its intersections fully grade separated, is a road necessary for interconnecting the key traffic origins such as Colombo International Airport, Colombo Port and Colombo City and especially to promote development in the GCEC Area of Authority and the surrounding region.

Colombo Port is an extremely important stronghold of traffic, which handles almost 95% of the cargo handled in the whole country and Project B is an ordinary highway designed to smoothen the traffic flow between the port and other strategic points of traffic origin and to relieve the City of Colombo from traffic congestion.

B.5.2 Survey for Preliminary Engineering

Following surveys were conducted in order to prepare the preliminary design of the project roads:

a. Field reconnaissance
   - survey of existing roads, rivers, structures, flood prone areas, terrain, geology and land use

b. Field surveys
   - preparation of contour photo map (scale 1:10,000), topographical survey, route survey and levelling

c. Geological investigations
   - mechanical boring, penetration tests and laboratory soil testing

d. Survey of the construction materials
   - fill material, aggregates, etc.

e. Survey of unit prices of materials and unit cost, equipment and labour

f. Survey of land values and prices

B.5.3 Design Standards

(1) Road Design Standards

After confirmation with the Government of Sri Lanka, the Standards of the Japan Road Association are basically used in the road design. However, in applying these standards every effort was taken to design the most economical and efficient road after sufficient consideration of the local conditions and the condition of existing roads in Sri Lanka. The main road design standards are shown in Table B5-1.

Table B5-1: Road Design Standard

Item	Unit	Project A	Project B
• Design Speed	km/hr	100	80,60
• Minimum Radius of Curvature	m	400	160
• Maximum Gradient	%	3	4
• Carriageway (per one-way)	m	3.25 x 2 = 6.50	3.25 x 2 = 6.50
• Median Width	m	4.00	2.00
• Left Shoulder	m	1.75	1.75 ~ 0.50

(2) Structure Design Standards

The Japanese Standards are adopted for the design of Highway Bridges and other structures. However, local precast concrete products for superstructure already designed on British Standards may be used after studying their applicability in accordance with the Japanese Standards. The design live load to be adopted for the design of bridges is either TL-20, TT-43 loading.

B.5.4 Survey of Alternative Routes

Four alternative routes were selected after careful field reconnaissance, collection of data and information , exchange of opinion and grasping of the conditions of the region along the proposed route including topography, geology, hydrology, land use and the distribution of facilities.

These alternatives were then subjected to a comprehensive evaluation based mainly on the following decisive factors and the alternative D was selected as the optimum route for the project.

a. Land use

b. Social and environmental factors
- division of community by the road
- distribution of facilities (such as Port, Airport, IPZ)
- impact on region and society
- environmental changes

c. Decisive factors in engineering design
- conditions of topography, geology, hydrology, etc.
- weak subsoil conditions
- balance in earthworks, hauling distance.

d. Construction cost

e. Transport
- present conditions of transport (traffic flow, traffic volume, OD pattern, transport modes etc.)

f. Road network
- relationship of the project road with A1, A3 Roads and Feeder Roads
- condition of road network
- future plans for roads such as the North-South Motorway.

B.5.5 Preliminary Design of the Project Road

In the preliminary design of the Project Roads, the aerial photo map and contour photo map (both scale 1:10,000) were used to select and compare alternative routes. To upgrade the accuracy, a route survey was executed along the recommended route.

The procedure for the preparation of the bill of quantities and the estimation of construction cost is shown in the flow chart in Fig. B5-1.

(1) Alignment Study

a. Horizontal Alignment

The following items were especially considered in the preliminary design of horizontal alignment.
- Adjustment with existing development plans (Colombo Port, Bloemendhal Area, Peliyagoda Area etc.)
- Use of Clothoid curves as transition curves for better comfort in driving.
- Avoiding of community division, etc. which cause major social problems.

Coordinate calculations and route surveys were done on the recommended route.

b. Vertical Alignment

In the preliminary design of the vertical alignment, the following items were considered.

- Maximum longitudinal gradient is 3% for Project A and 4% for Project B.
- Minimum longitudinal gradient is 0.3% for Project A and 0.2% for Project B.
- Vertical structural clearance is 5.03 m.
- In flood prone areas, the minimum embankment height is taken as 2.5 m considering a margin above the highest water level.
- Maximum cutting height is about 15 m.

(2) Cross Section

Typical cross section components for Project A and Project B are shown in Fig. B5-2. All have 2 lanes in each direction, and the carriageway width is 6.50 m except for the terminal part of Section K-3 of the expressway which has only 1 lane in each direction.

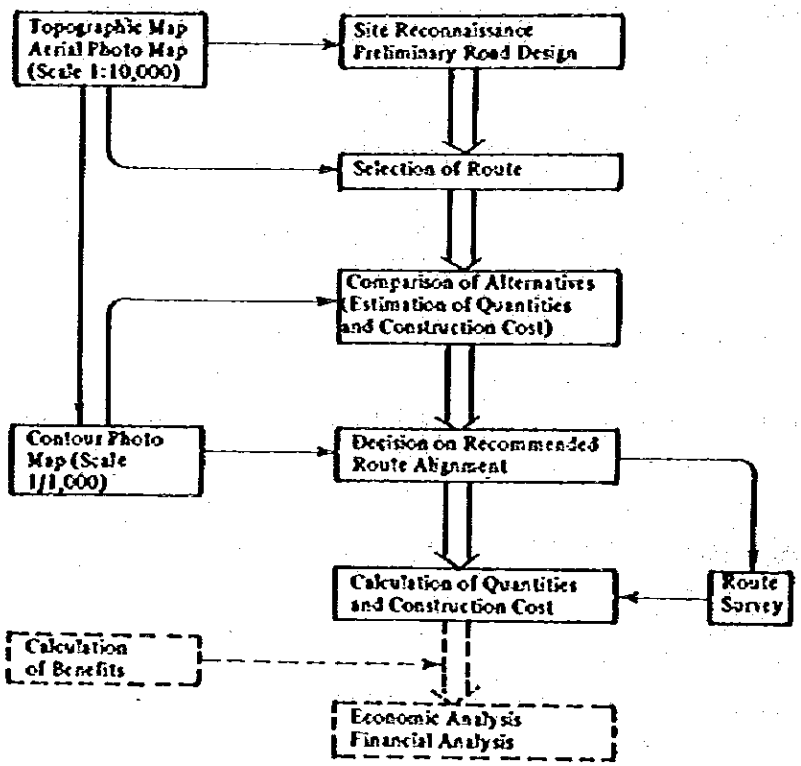
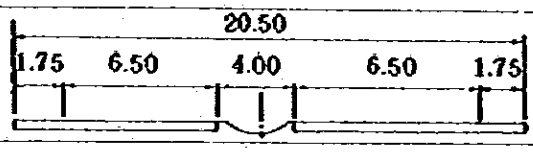
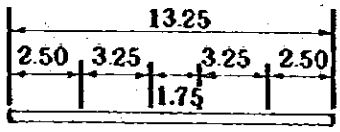
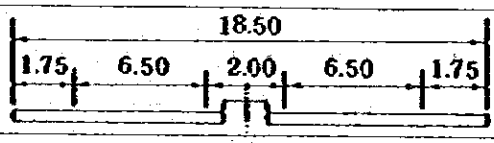
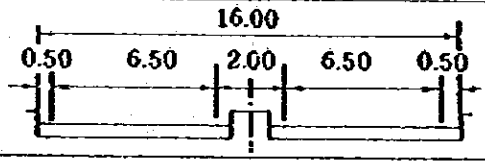


Fig. B5-1 Flow Chart of Preliminary Design

(Unit: m)

	Section of Road	Cross Section
Project A	K-1, K-2 K-3 (Ekala I.C. – KIPZ I.C)	
	K-3 (KIPZ I.C – CIAK I.C)	
Project B	P-3	
	P-1	

Note: CIAK I.C. – Colombo International Airport Katunayake I.C.

Fig. B5-2 Type of Cross Section

(3) Design of Interchanges and Intersections

a. Project A

On this 25.4 km long Expressway, there are 3 main interchanges (diamond type) and 7 on-off ramps (only accessible in the Colombo direction). Transport convenience of the area, and contribution to regional development are the main objectives in providing many access points through interchanges and on-off rampways. The average distance between these access points is 2.3 km.

b. Project B

Along this 5.7 km long road 5 intersections are planned. These include the existing intersections at Prince of Wales Avenue, Baseline Road, A1 Road whose improvement by signalization etc. is recommended. Location of the interchanges and intersections is shown in Fig. B5-3.

(4) Pavement Design

The Macadam road construction method has been applied to the highways in Sri Lanka. In this study the 'Manual for Design and Construction of Asphalt Pavement' (Japan Road Association), which conforms to the AASHTO, is used. However, in its application a prior comparison of the various design standards is done. The pavement thickness (inclusive of surface, binder, base and subbase courses) is designed to be 50 cm ~ 65 cm in order to sufficiently withstand heavy vehicle loads.

B. 5.6 Preliminary Design of Structures

(1) Basic Policy of Structural Planning

Based on the results of investigations of locally available materials and technology, survey of crossing roads and railways across the project roads, field investigations of flood prone areas and the results of topographical and geological surveys, the basic policy of the structure planning was decided sufficiently considering the local conditions and the design standards were set up accordingly. The basic policy of planning the structures are summarized as follows:

a. Local technology and materials should be used as much as possible.

b. Rationality of planning the structures is considered by establishing the standard designs.

c. Flood relief and drainage structures are planned practically and realistically in consideration of the flood records and the conditions of existing nearby structures.

(2) Standard Design

Standard designs were prepared for planning the large number of structures along the project roads adequately and rationally.

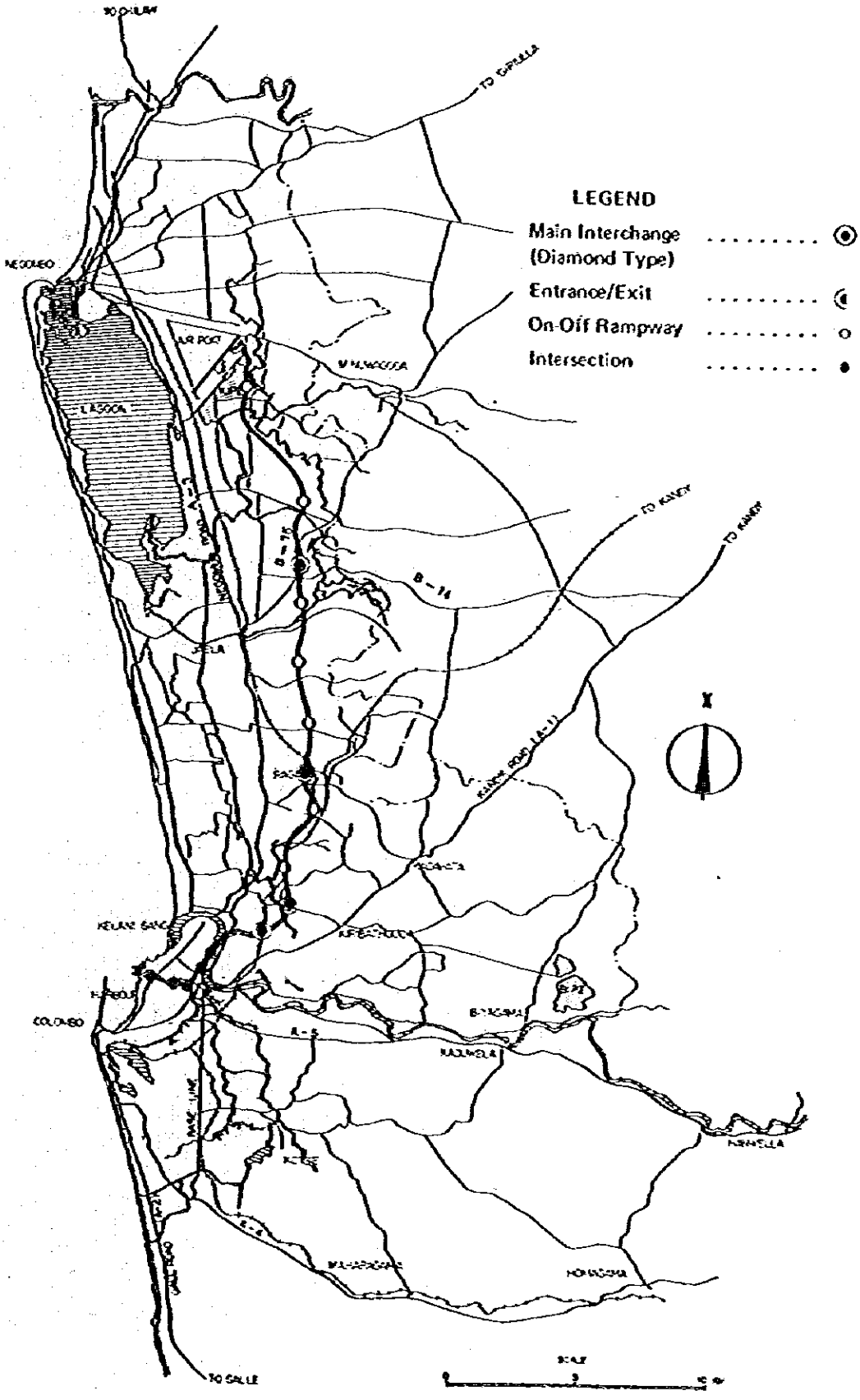


Fig. B5-3 Location of Interchanges and Intersections

Structures required along the project roads are listed below: (Table B5-2):

- Structures for road crossing
- Flood relief and drainage structures
- Overbridges
- Railway flyovers

Table B5-2: Details of Structures Along the Proposed Expressway and New Port Access Road

	Bridges (L = length)		Overbridges (L = length)		Box Culvert (D = dimension)		Pipe Culverts (ϕ = diameter)	
Project (A) K-1, K-2, K-3	$L = 10^m - 15^m$	14	$L = 28^m$	1	$D = 8^m \times 5^m$	3	$\phi = 1.8^m$	4
	$L = 15^m - 35^m$	6	$L = 2 \times 14 = 28^m$	12	$D = 3^m \times 3^m$	16	$\phi = 1.5^m$	5
	$L = 35^m - 80^m$	2	$L = 2 \times 28 = 56^m$	1	$D = 2^m \times 2^m$	27	$\phi = 0.9^m - 1.2^m$	6
	Total	22	Total	14	Total	46	Total	15
Project (B) P-1, P-3	$L = 10^m - 15^m$	2	$L = 28^m$	1	$D = 8^m \times 5^m$ (twin)	1	$\phi = 1.8^m$	1
	$L = 15^m - 35^m$	2					$\phi = 1.5^m$	4
	$L = 35^m - 80^m$	–					$\phi = 0.9^m - 1.2^m$	–
	Total	4	Total	1	Total	1	Total	5

(3) Planning of Major Structures

Among the above listed structures, the following major structures are specially taken into consideration for their importance and the outline is given below.

a. Entrance Structure of Colombo Port

Cast-in-situ concrete box culvert (8 m span twin box) is intended for crossing the existing Aluthmawatha Road at the entrace of the Port. A temporary bridge is planned to maintain the normal traffic on this road while the construction of the box culvert is in progress.

b. Horape Railway Flyover

Prestressed concrete beam bridge with a total span of 52 m is recommended, in consideration of future development plans for the intensification of railway traffic.

c. Dandugam Oya Bridge

3 span simple prestressed concrete beam bridge (total length = 80 m) is proposed to

cross Dandugam Oya. According to the result of flood analysis and investigation of the condition of existing bridges in the downstream of this river, cylindrical well foundation is employed for the substructure.

(4) Planning of Minor Structures

Standard designs are prepared for planning many minor structures adequately and rationaly. The following standard designs are applied to planning according to site topography and other regional conditions.

a. Pretensioned PC Slab Bridge	Span L = 10, 13, 16 m
b. Post tensioned PC Beam Bridge	Span L = 19, 23, 28, 35 m
c. Abutment (Spread footing and Pile foundation)	Height H = 4, 6, 8 m
d. Box Culvert	Dimension V = 5 x 5 ~ 8 m x 5 m
e. Pipe Culvert	Diameter ϕ = 0.9 ~ 1.8 m

B.5.7 Environmental Consideration

Environmental consideration of the project for the two stages, during and after its construction, was conducted from the physical, social and economical view points, and the protectional measures were also studied. The main items considered are listed below.

(1) During the Construction of the Project

a. Water pollution by muddy water from earth works, innundation, changes in drainage and irrigation facilities due to temporary blockage of waterways etc., and the countermeasures.

b. Damage to feeder roads by construction vehicles, influence on ordinary traffic and traffic accidents due to construction vehicles and the countermeasures.

c. Temporary regional partition due to closure of traffic on feeder roads at the crossings with the project roads or obstacles to regional integration due to use of detours, and their countermeasures.

(2) After the Project is Opened for Service

a. Erosion of slopes specially during rainy seasons, ground settlement where the project roads pass over marshes, soft weak ground and the countermeasures.

b. Innundation of areas around the project road, improvement needed in the waterways etc., connected to the drainage and flood relief structures on the project roads.

c. Traffic accidents on the Expressway and measures for traffic safety.

d. Distribution of motor vehicle pollution due to diversion of vehicles to the project roads.

B.6 ESTIMATION OF THE PROJECT COST

B.6.1 Construction Cost

(1) Construction Quantities

The quantities for main work items by alternatives are calculated based on the Preliminary Engineering Study.

(2) Unit Cost

The unit cost by main work items are analyzed from the aspects of material cost, labour cost, equipment etc., taking into consideration the local conditions in Sri Lanka and are split into three components i.e. foreign currency, local currency and tax.

(3) Project Construction Cost

Based on the quantities of main work items estimated and the unit cost analyzed, the construction cost is estimated in terms of the components of foreign currency, local currency and tax.

The construction cost is calculated in prices prevailing in May 1983 in terms of economic cost and financial cost. Economic cost consists of foreign and local currency and financial cost consists of foreign and local currency and tax.

The project construction cost by sections is shown in Table B6-1.

The procedure for cost estimation is shown in Fig. B6-1.

Table B6-1: Project Construction Cost (Case-5) (Financial)

Section / Item	Project (B)					Project (A)					Total	Remarks
	P-1	P-2	P-3 (L)	P-3	Sub-Total	K-1 (B)	K-2 (B)	K-3 (B)	Others*	Sub-Total		
• Earth Work	31.78	-	53.91	5.81	90.72	52.15	68.33	55.53	5.05	181.46	272.23	(33%)**
• Paving Work	19.69	2.71	31.76	3.47	56.54	59.69	61.91	61.36	21.70	204.66	261.20	(32%)
• Miscellaneous Work	10.53	5.18	21.99	5.33	43.03	26.24	24.76	39.55	6.14	97.69	140.56	(16%)
• Bridge	9.69	-	19.89	1.43	31.25	41.45	49.36	36.75	1.43	129.05	150.30	(19%)
• Construction Cost	69.69	7.89	127.82	15.13	211.03	179.44	204.36	154.19	34.03	573.86	815.29	(100%) 66%***
• Land Acquisition	33.53	-	-	-	33.53	46.56	45.44	51.45	8.19	146.53	180.16	13%
• Contingency	15.63	2.18	17.69	2.21	36.75	33.12	36.90	35.45	6.42	111.89	148.32	13%
• Engineering Services etc.	3.06	0.79	11.78	0.51	28.14	13.54	29.54	18.46	3.45	64.99	81.53	7%
• Project Cost	126.81	9.86	169.27	18.90	362.93	272.26	303.44	259.15	52.51	933.34	1226.23	100%
Road Length (KM)	8.59	1.30	2.90	-	5.36	7.14	8.39	9.31	-	25.44	31.70	
Total Cost/Road Length	8.3	7.6	58.1	-	52.6	38.1	36.2	25.3	-	36.3	38.3	

Notes: P-3 (L) : Low Embankment Type at Peliyagoda
K-1 (B) - K-3 (B) : Plan B (with 3 Main I/Cs and 7 On - Off Ramp-ways)

* Others = K-4, K-5, K-7
( ) : percentage of construction cost

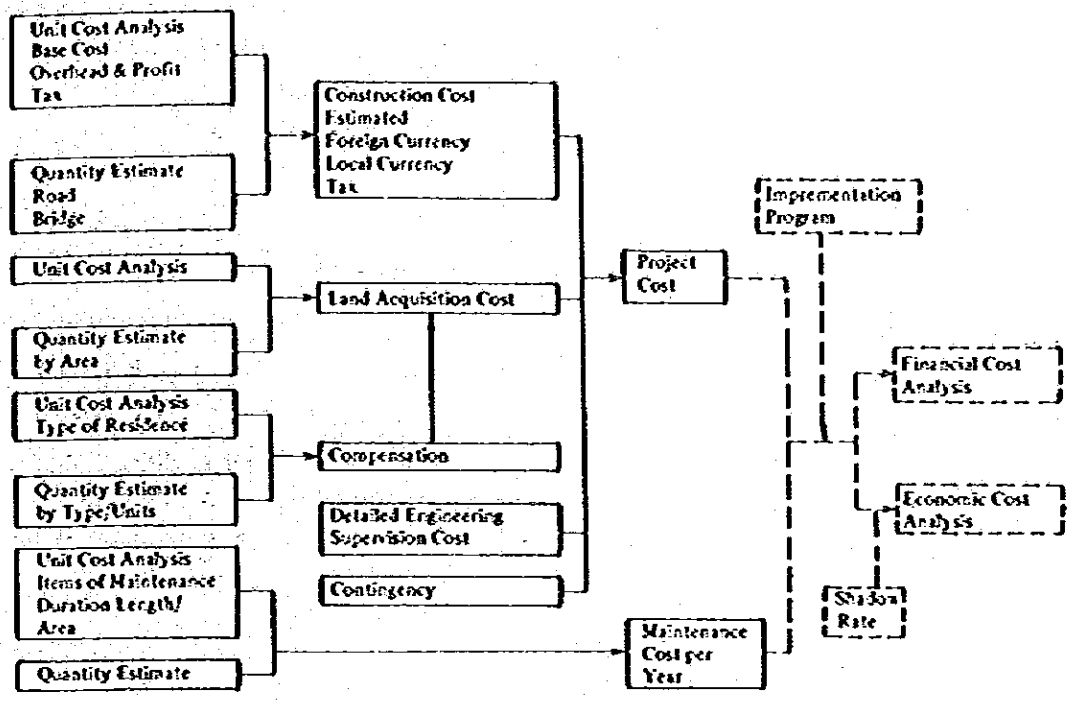


Fig. B6-1: Procedure for Cost Estimation

B.6.2 Land Acquisition and Compensation Cost

(1) Land Acquisition Cost

The land acquisition cost is estimated based on the unit cost and the land area acquired. The unit cost is obtained from data of GCEC and some other surveys. The land acquisition cost is shown in Table B6-1.

(2) Compensation Cost

In order to estimate the cost of compensation of the residences affected along the Project Roads, a survey was done to collect information on the value of residences, and to categorize these data according to location, structure, floor area and age etc. The number of houses affected were then counted by identifying them on a map of scale 1/10,000 and the data documented according to location, and the condition of house.

The compensation cost was estimated from the above to be included in land acquisition cost.

B.6.3 Maintenance Costs

In estimating the maintenance cost, as the data available in Sri Lanka were not sufficient, data from South-East Asian countries and Japan were also referred. The maintenance cost includes the costs of resurfacing, cleaning of surface, electricity, etc. The basic maintenance cost per year for a four lane road is estimated at Rs. 166,300 per km of road.

B.7 PROJECT EVALUATION

B.7.1 Evaluation Procedure

The procedure for the evaluation of the Project Roads is summarized in Fig. B7-1. The benefits of the Project were estimated as the traffic cost saving through the traffic assignment simulation. On the other hand, project costs were estimated as the economic costs by deleting taxes and by applying shadow prices. Cost Benefit analysis was conducted and qualitative analysis (socio-economic impact study) was added for comprehensive evaluation of the Project.

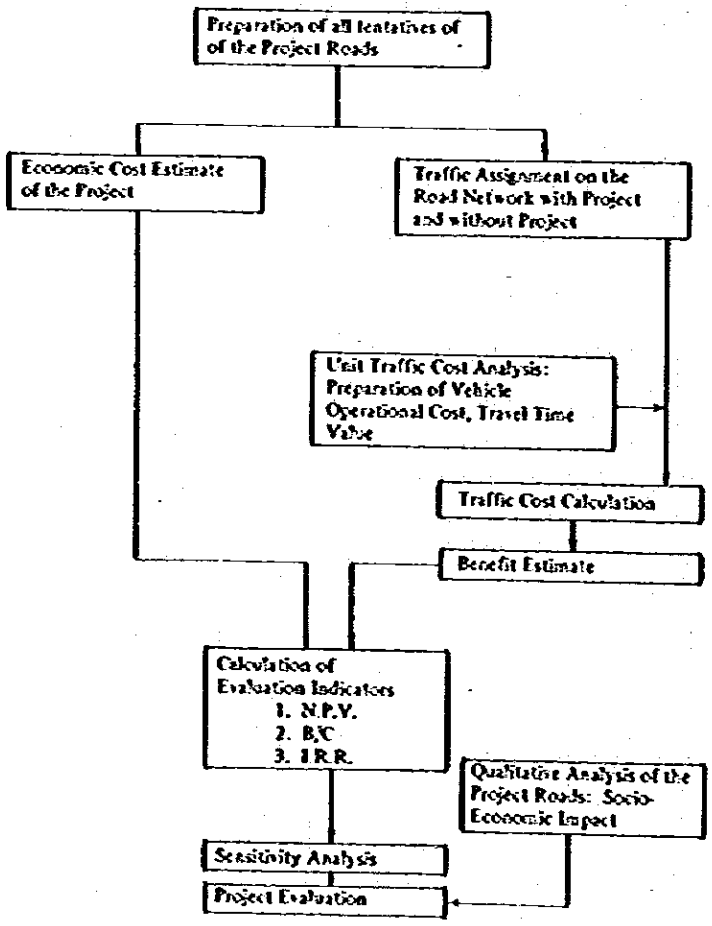


Fig. B7-1: Procedure for Project Evaluation

B.7.2 Indicators of Economic Evaluation

The project cost and benefit were compared with each other by calculating the following three indicators commonly used in economic analysis.

- Net Present Value (NPV)
- Benefit Cost Ratio (B/C Ratio)
- Internal Rate of Return (IRR)

B.7.3 Plan Considered for Economic Evaluation

The final plan considered for economic evaluation has the following features:

a. In both Project A and Project B, the road has a cross section with 4 lanes.

b. In Section P-3, the Low Embankment Type which necessitates the demolition of some abandoned structures is adopted.

c. In Project A, Plan B which allows 6 more access points from the feeder roads than in Plan A, is adopted.

d. Construction of Project A and Project B to be done simultaneously.

B.7.4 Economic Cost

The project costs were estimated, at first, based on the preliminary engineering study (refer to B-6). For the economic evaluation of the project, these costs were converted to economic cost by deleting taxes from financial cost and applying the shadow prices to foreign and local components. In this study, shadow rates 1.08 was applied to foreign component and 0.98 was applied to local component. The economic cost is shown in Table B7-1.

Table B7-1: Economic Cost

(in Rs. 1,000)

Foreign Currency	(1)	688,020
Local Currency	Land Acquisition (2)	207,130
	Construction (3)	267,870
	Sub Total	475,000
Tax		63,230
Total Financial Cost		1,226,250
Economic Cost 1.08 x (1) + (2) + 0.98 x (3)		1,212,704

B.7.5 Benefit Calculation

(1) Traffic Cost

Benefit of the project is divided into the following two components:

- Saving in vehicle operating cost (VOC)
- Reduction in travel time cost.

Therefore, benefit is estimated as the difference of traffic cost between without and with project. Traffic cost was measured by applying the unit traffic cost to traffic assignment process.

Unit vehicle operating costs estimated in this study are shown in Table B7-2. These costs consist of fuel, oil, tire, maintenance, depreciation, crew, registration, insurance and overhead cost.

Table B7-2: Vehicle Operating Cost (applied to traffic assignment)

(Rs./1,000 km)

Speed / Vehicle	5 (km/h)	10	15	20	25	30	35	40
Cars	7166	4942	4007	3453	3095	2838	2654	2521
Lorries	9155	6325	5111	4386	3917	3602	3338	3181
Speed / Vehicle	**45 (km/h)**	**50**	**55**	**60**	**65**	**70**	**75**	**80**
Cars	2415	2337	2279	2235	2217	2224	2234	2266
Lorries	3028	2938	2870	2836	2812	2817	2840	2894

The unit time cost of each passenger car was calculated by using the monthly household income and the monthly working hours by motor car owner and non-vehicle owner. The unit time cost of each vehicle type which was estimated from a composition by trip purpose and average occupancy rate of each vehicle is shown in Table B7-3.

Table B7-3: Travel Time Cost

Type of Vehicle	Rs./hour per vehicle
Private Passenger Car	16.21
Taxi	2.6
SLCTB* Bus	33.94
Private Line Bus	13.26

*: Sri Lanka Central Transport Board

Average unit time cost of cars was decided at Rs. 16.85/hour per vehicle by applying the weight of trip composition ratio of each vehicle.

(2) Benefit Calculation

Using the network assignment model, traffic cost and benefit were calculated as shown in Table B7-4 and Table B7-5.

Table B7-4: Estimated Traffic Cost (in year 1990, 2000)

(Economic Cost per day, Rs. 1,000 at 1983 prices)

Case	Vehicle Operating Cost		Passenger Time Cost	
	1990	2000	1990	2000
Without Project	8,030	18,466	604	1,432
With Project	7,692	16,769	486	1,118

Table B7-5: Benefit Calculation

(Rs. 1,000 per year at 1983 prices)

Year	1990	2000
Vehicle Operating Cost Saving	123,370	619,405
Passenger Time Cost Saving	43,070	114,610
Total Benefit	166,440	734,015

B.7.6 Economic Analysis

(1) Premises

In order to obtain the economic indicators, following premises were assumed:

a. Construction schedule

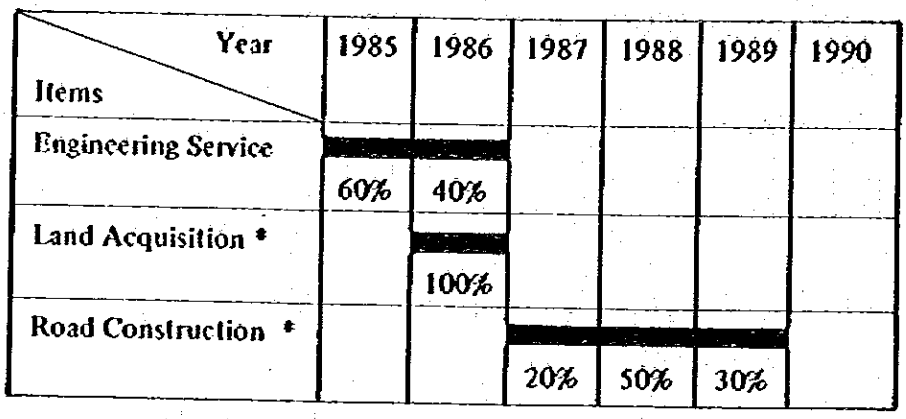
The preliminary construction schedule and the project cost expenditure schedule were assumed as illustrated in Fig. B7-2.

b. Project life: 25 years

c. Opening year for traffic: 1990 (as shown in Fig. B7-2)

d. Opportunity cost of capital: 12%

Fig. B7-2: Preliminary Construction Schedule



Note: *Including contingency.
Percentages mean the cost expenditure share by each item on each year.

(2) Evaluation

The results of the economic evaluation are shown in Table B7-6.

The economic indicators raised in Table B7-6 prove that the project is economically feasible with an internal rate of return of 18.5% and a benefit cost ratio of 1.96 at a discount rate of 12%.

B.7.7 Sensitivity Analysis

The purpose of the sensitivity analysis is to test the robustness of the priorities or feasibility of the project by changing some factors that affect the results. In this study, the sensitivity test was conducted in such a way as shown below:

TEST (I)	Benefit:	−20%
	Cost:	+10%
TEST (II)	Project life:	20 years
TEST (III)	Discount rate (Opportunity cost of capital:	15%

The results of the sensitivity tests are given in Table B7-6 In all the tests, combination of Projects A & B is feasible.

B.7.8 Project Evaluation

From the results of the economic analysis, and considering the induction power for development, the Expressway and the New Port Access Road together can be considered as one of the lifelines for the future national economy of Sri Lanka.

Table B7-6: Results of Economic Analysis

		Net Present Value NPV (in Rs. 1,000)	Benefit Cost Ratio B/C	Internal Rate of Return IRR(%)
Economic Evaluation* Original Case		1,646,702	1.96	18.5
Sensitivity Test	Test (I) Benefit −20% Cost +10%	803,819	1.42	15.3
	Test (II) Project Life = 20 years	1,374,472	1.80	18.1
	Test (III) Discount Rate = 15%	753,324	1.41	18.5

Note: *Opportunity cost of capital is 12%.
For the case of simultaneous implementation of Project A and Project B.

B.8 IMPLEMENTATION PROGRAM

B. 8.1 General

The project is feasible, and moreover judging from the development effects and the multiplier effects generated by the simultaneous implementation of Project A and Project B, it is recommended to implement Projects A & B together.

B.8.2 Implementation Schedule

The implementation schedule presented in Fig. B8-1 after careful study is the most recommendable.

The total construction period is estimated taken into consideration of the following basic data:

- Number of workable days (excluding rainy days and holidays)
- Scale of construction
- Number of major equipment available.

B.8.3 Investment Requirements

Based on the recommended implementation schedule, the investment requirements for each year is presented with their breakdown into the cost of final engineering services, land acquisition cost, and construction cost, and further divided into the foreign and local components. The prices are that of 1983. The investment requirements are shown by each item in Table B8-1.

Fig. B8-1: Implementation Schedule and Project Cost

Implementation Item \ Year		1985	'86	'87	'88	'89	'90	Total
(Project A)	Engineering Service							21.2
	Land Acquisition							38.6
	Construction							24.3
(Project B)	Engineering Service							60.4
	Land Acquisition							168.5
	Construction							694.6
Project Cost (in Rs. Million at 1983 prices)	Foreign Currency	29.5	127.8	261.9	197.2	70.7		687.3
	Local Currency & Tax	90.3	193.9	127.0	94.3	33.5		539.0
	Total	119.8	321.7	388.9	291.5	104.4		1226.3

Table B8-1: Annual Investment Requirements

(in Rs. million at 1983 prices)

Component / Year	Engineering Service			Land Acquisition	Construction			Total		
	Foreign	Local	Total	Total	Foreign	Local	Total	Foreign	Local	Total
(Project B)										
1985	9.4	4.7	14.1	19.3	–	–	–	9.4	24.0	33.4
1986	4.7	2.4	7.1	19.3	32.3	16.3	48.6	37.0	38.0	75.0
1987	–	–	–	–	97.0	48.9	145.9	97.0	48.9	145.9
1988	–	–	–	–	32.3	16.2	48.5	32.3	16.2	48.5
1989	–	–	–	–	–	–	–	–	–	–
Total	14.1	7.1	21.2	38.6	161.6	81.4	243.0	175.7	127.1	302.8
(Project A)										
1985	20.1	10.1	30.2	56.2	–	–	–	20.1	66.3	86.4
1986	20.1	10.1	30.2	112.3	60.7	33.5	104.2	90.8	155.9	246.7
1987	–	–	–	–	164.9	78.1	243.0	164.9	78.1	243.0
1988	–	–	–	–	164.9	78.1	243.0	164.9	78.1	243.0
1989	–	–	–	–	70.9	33.5	104.4	70.9	33.5	104.4
Total	40.2	20.2	60.4	168.5	471.4	223.2	694.6	511.6	411.9	923.5

Note: Tax is included in Local Currency

B.9 STUDY ON THE VIABILITY OF THE PROJECT (A) AS A TOLL EXPRESSWAY (FINANCIAL ANALYSIS)

B.9.1 Introduction

Financial analysis is usually carried out on projects which are accompanied with revenue. Therefore, in the case where Project A (the Expressway) is to be a toll road, a study must be done not only from an economic viewpoint but also from a financial viewpoint as well. The main objective of a financial analysis is to make clear whether or not the revenue from the Project itself is enough to carry out implementation, maintenance and operation. The contents considered are the items below:

(1) Investment costs (Construction cost)

(2) Annual financial expenditure

- Maintenance cost
- Operation cost
- Other financial costs

(3) Revenue calculation

(4) Financial evaluation indicators

- Revenue/cost ratio
- Financial internal rate of return (F.I.R.R.)
- Investment limit
- Repayment period

(5) Sensitivity analysis

(6) Management system of toll road

B.9.2 Method for Analysis

The method for financial analysis is summarized in Fig. B9-1. At first, the financial costs consist of construction cost, annual maintenance cost, annual operation cost and other annual financial costs (contingency and interest cost). Each cost item includes transfer elements such as taxes and duties.

Shadow prices which were applied to economic analysis were taken away in financial analysis. Furthermore, the effect of inflation on the construction cost is taken into account as well. Second, forecast of future traffic demand after introducing toll fee was carried out.

Method for traffic volume forcasting after introduction of toll fee is basically same as the one used in the economic evaluation. However, the route of each OD (Origin-Destination) pair was searched so as to minimize the trip cost T defined by the following formula:

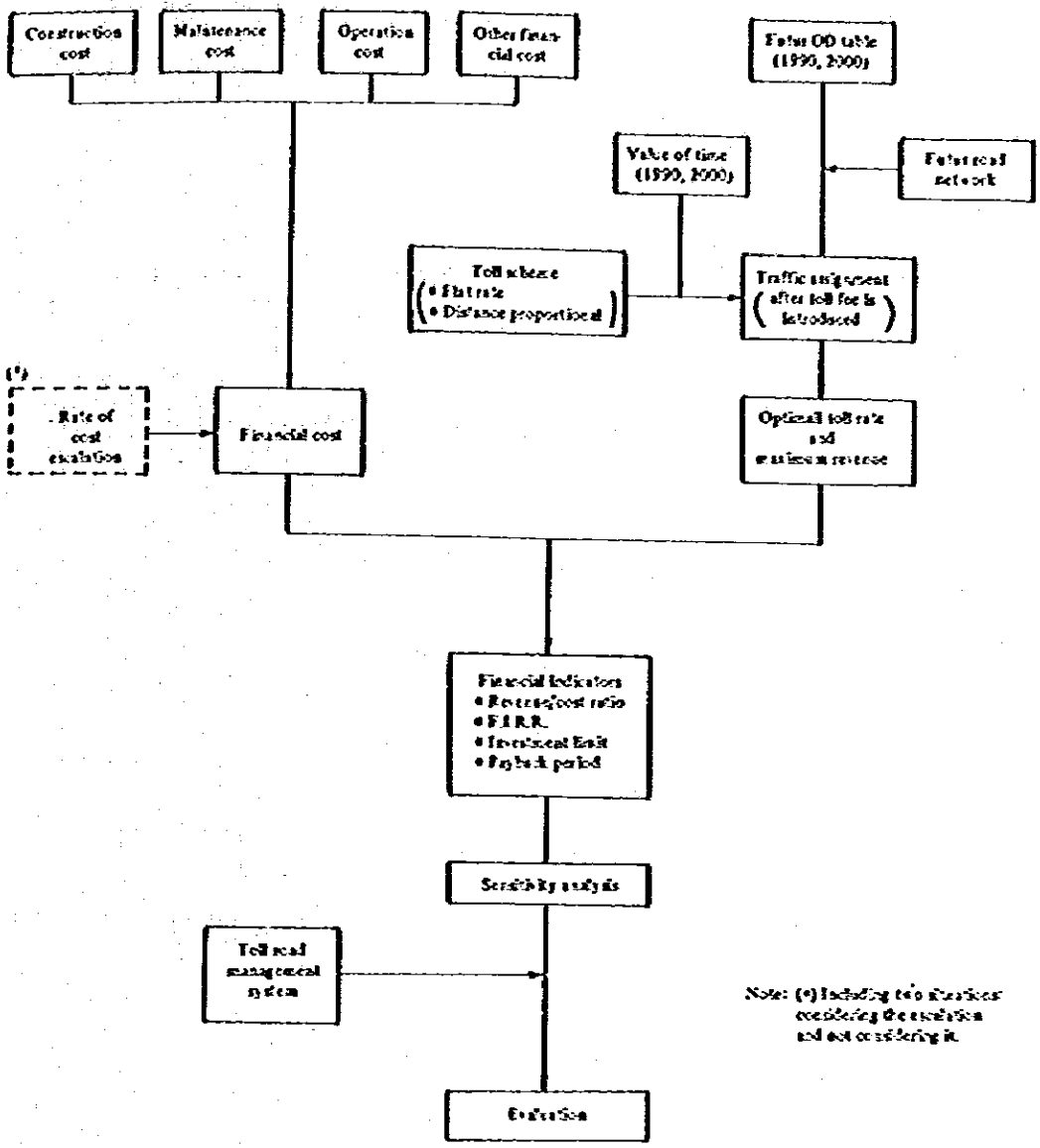


Fig. B9-1 Total Flow Chart for Financial Analysis

$$T = t + F/V$$

Here

T: trip cost (in terms of time)

t : original travel time (minutes)

F: toll charge (in Rs.)

V: travel time value (in Rs./minute)

By using financial project costs and toll revenue, four financial indicators listed below were calculated:

(1) Revenue/cost ratio (R/C ratio)

The R/C ratio is obtained by dividing the present value of revenue by that of cost:

Revenue cost ratio = R/C

$$R = \sum_{t=1}^{n} \frac{Rt}{(1+i)^t}$$

$$C = \sum_{t=0}^{n-1} \frac{Ct}{(1+i)^t}$$

Here

Rt: Revenue in the year (t)

Ct: Cost in the year (t)

i : Rate of interest

n : Repayment calculation period in years

If R/C ratio is more than unity, the project is financially viable.

(2) Financial Internal Rate of Return (F.I.R.R.)

The F.I.R.R. shows the rate of interest which gives the break even point between the present valve of revenue and that of cost as given by the following formula:

$$R(r) - C(r) = 0$$

$$R(r) = \sum_{t=1}^{n} \frac{Rt}{(1+r)^t}$$

$$C(r) = \sum_{t=0}^{n-1} \frac{Ct}{(1+r)^t}$$

Here

r : Financial Internal Rate of Return

Rt: Revenue in the year (t)

Ct: Cost in the year (t)

n : Repayment calculation period in years

If F.I.R.R. is more than the normal rate of interest, the project is financially viable. Namely, F.I.R.R. means the maximum rate of interest that the project could pay while repaying the project costs.

(3) Investment Limit

Investment limit means the maximum investment cost that can be covered by the annual revenue of the project and is shown by the following formula:

$$G = \sum_{t=1}^{n} \left\{ \frac{Rt}{(1+i)^t} - \frac{Kt}{(1+i)^{t-1}} \right\}$$

Here

G : Investment limit

Rt: Revenue in the year (t)

Kt: Expenditure in the year (t), such as maintenance cost and so on.

i : Rate of interest

n : Repayment calculation period.

If the Investment limit is more than the financial project cost (including the interest cost during the construction period), the project is also financially viable. Furthermore, the above formula shows that the annual revenue can cover annual expenditure such as maintenance cost, operation cost and so on as far as the Investment limit is positive, even if the construction cost can not be covered.

(4) Repayment period

In the above formula, when G is given a value and n is an unknown variable, the value of n arrived through astriction calculations is the repayment period (or Pay Back Period). Repayment period means the minimum period needed to pay back the amount of principal investment and interest. Therefore, the shorter the period, the better is the financial condition.

Sensitivity analysis was carried out by changing the factors as shown below and the variances in financial indicators were investigated.

1) Toll scheme (flat rate system, distance proportional system)

2) Composition ratio of foreign portion and local portion.

3) Cost escalation.

And finally, some suggestions on the toll road management system were provided in order that the Project-A (Expressway) could function as a toll road.

B.9.3 Financial Costs of the Project

(1) Construction Cost and Maintenance Cost

Financial construction cost of the Project was estimated at 923.5 million Rupees (in 1983 price). And the annual maintenance cost was estimated at 4.232 million Rupees (in 1983 price). Periodic maintenance costs (5 years and 15 years after opening) were counted as well.

(2) Operation Costs

In this study, 1% ~ 2.5% of annual revenue were counted as operation costs.

(3) Cost for Contingency

For several cases, 2% of the annual revenue was prepared as the contingency and for the rest of the cases none were prepared.

(4) Interest Cost

The interest of the foreign loan portion was presumed at 3% p.a., and for the local loan portion, the rate of 16% was applied with reference to the long term loans by the Central Bank of Ceylon. The composition ratio of foreign and local portion are as follows:

Foreign portion 55%
Local portion 45%

Using these ratios as the weights, the average rate of interest 9% was obtained.

B.9.4 Revenue Calculation

Two types of toll scheme: flat rate system and distance proportional rate system were prepared for the study, and traffic assignment was carried out for each type of toll system by varying the toll rates. In the result, the toll rates that brought about maximum revenue, traffic demand and maximum revenue at that toll level were calculated as shown in Table B9-1.

Table B9-1: Toll Rates that bring about the Maximum Revenue

Year	Toll Scheme	Toll rate (light vehicle)	Traffic Volume (trips/day)	Revenue (Rs./day)
1990	Flat rate System	10 Rs./trip	6,840	109,500
	Distance Proportional	0.5 Rs./km	6,510	85,600
2000	Flat rate System	–	–	–
	Distance Proportional	1.25 Rs./km	19,870	615,700

B.9.5 Financial Evaluation

(1) Premises

1) Repayment calculation period: 30 years
2) Composition ratio of foreign and local portion: Foreign = 55%, Local = 45%
3) Average rate of interest: 9% p.a.
4) Operation cost: 1.0%, 2.0%, 2.5% of annual revenue.
5) Annual revenue after the year 2000 were assumed to be the same revenue as in the year 2000.
6) Distance proportional rate system was assumed to be employed with the toll rate 0.8 Rs./km (in 1990, average rate) and 2.0 Rs./km (in 2000, average rage).
7) No consideration for cost escalation (but it will be taken into account in sensitivity analysis).

(2) The Results of the Evaluation

The financial indicators were calculated according to the above-mentioned premises

and shown in Table B9-2 as analysis No. 1 ~ No. 3 (the cost for contingency was also estimated in analysis No. 3 at 2.0% of annual revenue). As a result, R/C ratios were 1.00 ~ 1.03, F.I.R.R. were 9.01% ~ 9.26% and the investment limit was larger than total investment costs (including the interest during the construction period). Furthermore, repayment period necessitated was 27 ~ 30 years after opening for traffic. Therefore, Project-A (Expressway) as a toll road is financially viable as far as these results are concerned.

B.9.6 Sensitivity Analysis

The variances in financial indicators were investigated by changing some factors as shown below, and the results were expressed by TEST (I) ~ TEST (VII) in Table B9-3.

1) Toll rate system:
   Flat rate system with 16 Rs./trip (light vehicle) in the year 1990 and 40 Rs./trip (light vehicle) in the year 2000.
2) Composition ratio of loan:
   Foreign = 45% · Local = 55% (Average rate of interest is 10.2%)
   Foreign = 40% · Local = 60% (Average rate of interest is 10.8%)
3) The rate of cost escalation: 5.0%, 15.0%, 16.0%, p.a.

The results are summarized as follows:

(1) Financial viability of the flat rate system is not so strong as the distance proportional rate system (the differences of toll collection costs between flat rate system and distance proportional rate system are not taken into account here).

(2) When the composition ratio of local portion increases, the rate of interest for total investment costs also increase. And the boundary between financially viable area and unviable area is thought to exist where the ratio of foreign portion is 55% and local portion is 45%.

(3) There are no TESTS that can be financially viable when the cost escalation is taken into account.

(4) But, the investment limit can maintain positive value if the rate of cost escalation stayes within 15% p.a. Therefore, as far as the escalation can be kept under the level of 15% p.a., annual revenue will be able to cover the maintenance cost, operation cost and contingency.

Table B9-2: Results of Financial Analysis

Analysis No.	Conditions for financial analysis												Financial indicators			
	Cost escalation		Toll scheme		Level of toll rate		Annual operation cost	Annual deposit to contingency	Share of loans		Average rate of interest	Total investment cost **	Revenue /cost ratio *	F.I.R.R. *	Investment limit *	Repayment period
	Construction	Maintenance cost	Distance proportional	Flat	1990	2000			Foreign	Local						
1	-	-	O	-	(Rs./km) 0.8	(Rs./km) 2.0	1.0% of annual revenue	-	55%	45%	9%	(Rs. million) 1,198.3	1.03	9.26%	(Rs. million) 1,250	(Years) 27
2	-	-	O	-	"	"	2.0% of annual revenue	-	"	"	"	"	1.02	9.19	1,236	28
3	-	-	O	-	"	"	2.5% of annual revenue	2.0% of annual revenue	"	"	"	"	1.00	9.01	1,202	30

Note* Repayment period is assumed to be 30 years

** Average rate of interest is applied to construction period

Table B9-3: Sensitivity Test

TEST No.	Conditions for Sensitivity Analysis												Financial indicators			
	Cost evaluation		Toll scheme		Level of toll rate		Annual operation cost	Annual deposit to contingency	Share of loans		Average rate of interest	Total investment cost **	Revenue /cost ratio *	F.I.R.R. *	Investment limit *	Repayment period
	Construction	Maintenance cost	Distance proportional	Flat	1990	2000			Foreign	Local						
I	"	"	"	○	(Rs.) 16	(Rs.) 40	1.0% of annual revenue	"	55%	45%	% p.a. 9	(Rs. million) 1,198.3	0.99	8.98	1,196	31
II	"	"	"	○	"	"	2.5 % of annual revenue	2.0% of annual revenue	"	"	"	"	0.96	8.70	1,150	35
III	"	"	○	"	(Rs./km) 0.8	(Rs./km) 2.0	"	"	45%	55%	10.2%	1,239.5	0.84	9.01	1,032	More than 50
IV	"	"	○	"	"	"	"	"	40%	60%	10.8%	1,260.6	0.77	9.01	960	"
V	% p.a. 5.0	% p.a. 5.0	○	"	"	"	"	"	55%	45%	9	1,453.2	0.78	7.24	1,089	"
VI	% p.a. 15.0	% p.a. 15.0	○	"	"	"	"	"	"	"	"	2,099.8	0.39	-	66	-
VII	% p.a. 16.0	% p.a. 16.0	○	"	"	"	"	"	"	"	"	2,176.0	0.35	-	-202	-

Note* : Repayment period is assumed to be 30 years.

**: Average rate of interest is applied to construction period.

B.9.7 Management System of Toll Road

(1) Contents of Toll Road Management System

The toll road management system should include the following contents:

1) Supervision of toll road operation (including the toll collection).
2) Maintenance and repair of toll road facilities and equipment.
3) Traffic control, traffic safety and provision of information.
4) Administration for the implementation of above-mentioned works.

(2) Toll Collection System

In this Project, 2 types of vehicles (light and heavy) or 3 types (light, medium and heavy) will be proposed from the viewpoint of toll collection cost. And it is necessary to take notice that the toll collection cost tends to become higher in the case of distance proportional rate system compared with flat rate system.

Toll collection in distance proportional rate system will be in such a way that the delivery of the tickets will be at the on ramp and collection of toll fare at the off ramp. On the other hand, in the case of flat rate system, toll collection can be done at the on ramp only.

B.9.8 Conclusion

(1) The distance proportional rate system is desirable from the financial point of view, compared with the flat rate system.

(2) If the influence of the cost escalation is taken into account, the project will not be viable financially. Therefore, it is necessary to revise the toll rate periodically (once in 2 years or 3 years) refering to the general price level, then, soundness for financial aspects will be maintained by doing so.

(3) Even if the construction cost can not be completely paid back, it seems possible to cover the annual expenditures such as maintenance cost by the annual revenue.

(4) The conclusions mentioned above are those which were obtained from the assumptions prepared for the analysis. Hence, changes in the surroundings or the environment in the future should be taken into account carefully, and re-investigation is desirable at the stage of implementation in order to make the toll system and operation system correspond with such changes.