JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

No. 52

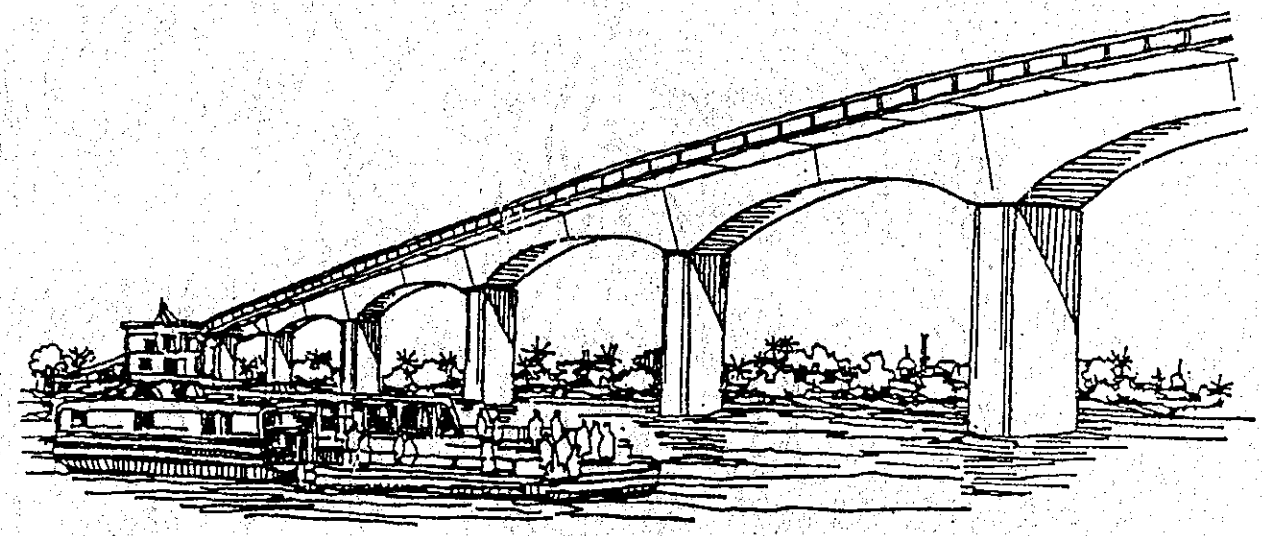
MINISTRY OF COMMUNICATIONS

THE GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

社会開発調査部報告書

THE STUDY
ON
CONSTRUCTION OF THE BRIDGE OVER THE RIVER RUPSA
IN KHULNA
(Phase I)

FINAL REPORT
SUMMARY



MARCH 1999

PACIFIC CONSULTANTS INTERNATIONAL
JAPAN OVERSEAS CONSULTANTS

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MARCH

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The following foreign exchange rate is applied in the study :

US$1.00 = 48.00 Taka (as of December 1998)

PREFACE

In response to a request from the Government of the People's Republic of Bangladesh, the Government of Japan decided to conduct the Phase I study on the Construction of the Bridge over the River Rupsa and entrusted the study to the Japan International Cooperation Agency.

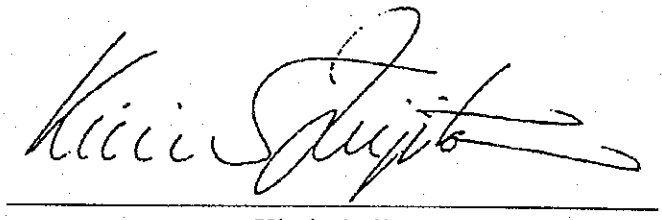
JICA selected and dispatched a study team headed by Mr. Kenji Maruoka of Pacific Consultants International, consisting of Pacific Consultants International and Japan Overseas Consultants to Bangladesh, three times between July 1998 and March 1999. In addition, JICA set up an advisory committee headed by Dr. Yuzo Akatsuka, Professor/Dean of Faculty of Regional Development Studies, Toyo University to examine the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Bangladesh and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Bangladesh for their close cooperation extended to the study team.

March 1999



Kimio Fujita
President
Japan International Cooperation Agency

March 1999

Mr. Kimio Fujita
President
Japan International Cooperation Agency

Letter of Transmittal

Dear Sir,

We are pleased to submit herewith the Final Report of "The Study on Construction of the Bridge over the River Rupsa in Khulna (Phase I)" in the People's Republic of Bangladesh.

The report contains the results of study which was carried out by Pacific Consultants International in association with Japan Overseas Consultants between July 1998 and March 1999. The report consists of three volumes of Summary, Main Report and Appendix.

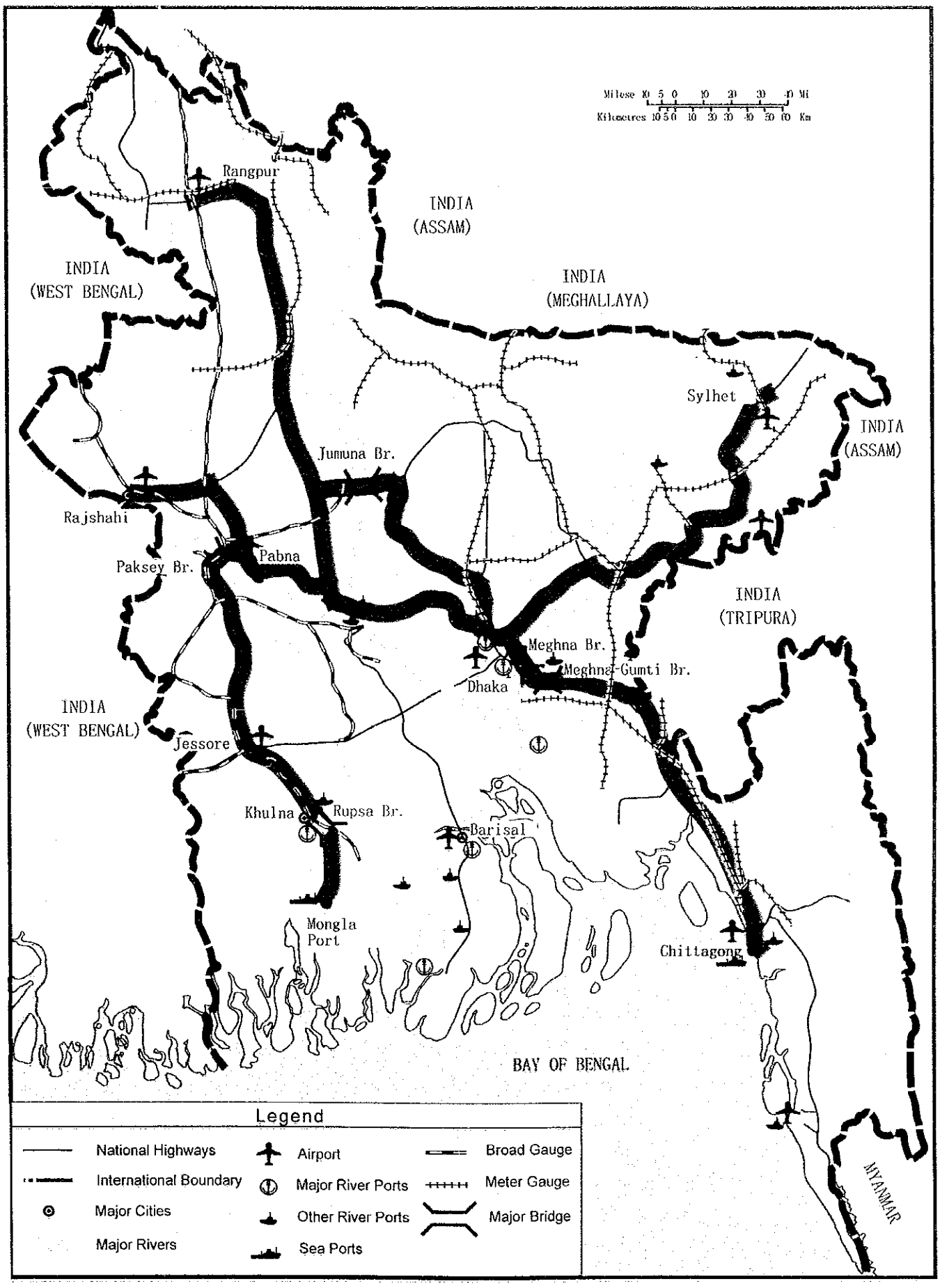
The Summary briefly illustrates the findings of the whole study. The Main Report consists of 17 chapters and presents current road, railway and inland waterway transport profile, formulation of transport master plan and the scope of work for Phase II.

It recommends that the Study should proceed to Phase II as soon a s possible. The Appendix contains the supporting data including detailed results of several field surveys carried out by us in Bangladesh.

We wish to express grateful acknowledgment to the personnel of your Agency, Ministry of Foreign Affairs, Advisory Committee, Ministry of Transport, Ministry of Construction and Embassy of Japan in Bangladesh, and also to officials of the Ministry of Communications, Government of Bangladesh for their assistance extended to the Study Team. The Study Team sincerely hopes that the results of the Study will contribute to the development of road network in Bangladesh.

Yours faithfully,

Kenji Maruoka
Team Leader
The Study on Construction of the Bridge over the
River Rupsa in Khulna (Phase I)



Map of Project Area

DEFINITIONS AND ABBREVIATIONS

(1) Agencies

ADB	Asian Development Bank
BIWTA	Bangladesh Inland Water Transport Authority
BR	Bangladesh Railways
CPA	Chittagong Port Authority
DOE	Department of Environment, Ministry of Environment and Forestry
JICA	Japan International Cooperation Agency
JMB	Jamuna Multipurpose Bridge
KCC	Khulna City Corporation
KDA	Khulna Development Authority
RHD	Roads and Highways Department, Ministry of Communications
WB	World Bank

(2) Technical Terms and others

5FYP	5th Five Year Plan
B/C	Cost Benefit Ratio
BEB	Broad gauge, Electric, Bonvardier
BG	Broad Gauge
BITSS	Bangladesh Integrated Transport System Study
BS	British Standards
EAM	Equilibrium Assignment Method
EIRR	Economic Internal Rate of Return
EPZ	Export Processing Zone
FDI	Foreign Direct Investment
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
Ghat	Platform to the water's edge
IEE	Initial Environmental Examination
IRR	Internal Rate of Return
ISIE	Initial Social Impact Examination
LPG	Liquefied Petroleum Gas
MG	Meter Gauge

MMT	Multi Modal Terminal
MPA	Mongla Port Authority
MPADP	Mongla Port Area Development Project
N.P.V	Net Present Value
NGO	Non Governmental Organization
O & M	Operation and Maintenance
OD	Origin and Destination
PAPs	Project Affected Persons
PC	Prestressed Concrete
PCU or pcu	Passenger Car Unit
POL	Petrolcum Oil Lubricants
ROW	Right-of-Way
RRP	Railway Recovery Program
STRADA	System for Traffic Demand Analysis developed by JICA
TEU	Twenty Equivalent Units
Tk	Taka
Zila	Administrative sub-unit of Division and group of Thanas

PROJECT SUMMARY

1. COUNTRY	The People's Republic of Bangladesh
2. NAME OF STUDY	The Study on Construction of the Bridge over the River Rupsa in Khulna (Phase I)
3. COUNTERPART AGENCY	Roads and Highways Department, Ministry of Communications
4. OBJECTIVE OF STUDY	To formulate a master plan for integral components of transport development and construction plan of the Bridge

1. STUDY AREA Khulna city, Mongla Port and its surroundings

2. TARGET YEAR Year 2015

3. ECONOMIC FRAMEWORK 5.0 % p.a.(1996/97 - 2014/15)

4. DEMAND FORECAST FOR MONGLA PORT

1) Cargo Demand for Mongla Port in 2015	5,811,000 tons (excluding Nepalese Cargo)
2) Nepalese Cargo for Mongla Port in 2015	400,000 tons (including 41,000 TEUs of Containers)
3) Cargo Handled at Jetty in 2015	2,125,000 tons (including 242,000 TEUs of Containers)

5. TRAFFIC DEMAND FORECAST

Traffic Demand on the Bridge in 2015 Western Route 11,153 veh./day

6. FORMULATION OF TRANSPORT MASTER PLAN

Development Scenario-2 : the Bridge with Multi Modal Terminal is evaluated as the optimum alternative for the Study from the following aspects;

a) Although it is presumed that most of these container cargo would be transported by land transport means through the improved future land transportation networks in the hinterland of Mongla Port, the major portion of the inland transport of the port cargo would be still performed by inland water vessels.

b) Although future land transportation network will be improved toward the north as the hinterland of Mongla Port, Cargo Movement beyond Khulna subject to rail transport is estimated 478,000 tons/year at most, that is medium.

7. SETTING OF ALTERNATIVE PLANS AND EVALUATIONS

(1) Evaluation on Alternative Plans for Railway Extension to Mongla Port

- The scheme of railway extension to Mongla Port opening has negative financial internal rate of return (FIRR) at all alternative plans.
- The sensitivity analysis also reveals that freight revenue could not collect debts without purchasing costs of locomotives and wagons.
- The scheme of rail-cum road bridge is to be studied as an alternative plan of road bridge considering railway extension beyond Year 2015.

Alternative	Outline of Scheme			Internal Rate of Return (IRR)	
	Route	Bridges	Rail-cum	Total Investment	w/o Loco & wagon
ALT R-1	Eastern R.	Bhairab/Atai/	x	-40.0%	-18.4%
ALT R-2	(B Route)	Atherobaki & 6 Br.	0	-39.2%	-5.4%
ALT R-3	Western R.	Rupsa & 6 Br.	x	-39.7%	-15.2%
ALT R-4	(A Route)		0	-39.4%	-8.9%

(2) Selection of Route Location of Khulna Bypass

The **Western Route** is superior to the eastern route not only from the qualitative viewpoints of planning parameters but also economic indices.

	Alternative	Route Location	Direct Construction Cost			Economic Analysis			Social Costs			Affected Houses
			Bridge	Others	Total	IRR	B/C	N.P.V	Land	Comp.	Total	
1	ALT 1-1	Western R.	1,341.1	1,186.8	2,527.9	30.5%	3.01	M.Tk. 3,711	73.2	19.7	92.9	25
2	ALT 1-2	(A Route)	1,718.1	1,195.4	2,913.5	27.7%	2.62	M.Tk. 3,432				
3	ALT 1-3		1,874.4	1,191.5	3,065.9	26.7%	2.49	M.Tk. 3,323				
4	ALT 1-4		2,126.9	1,168.6	3,295.5	25.4%	2.32	M.Tk. 3,162				
5	ALT 1-5		2,180.2	1,351.0	3,531.2	24.1%	2.17	M.Tk. 2,988				
6	ALT 3-1	Eastern R.	2,581.0	1,467.7	4,048.7	13.2%	1.09	M.Tk. 282	167.6	107.6	275.2	297
7	ALT 3-2	(B Route)	3,307.2	1,541.9	4,849.1	10.9%	0.92	-M.Tk. 295				
8	ALT 3-3		3,607.1	1,511.0	5,118.1	10.2%	0.87	-M.Tk. 491				
9	ALT 3-4		4,011.7	1,462.5	5,474.2	9.4%	0.82	-M.Tk. 751				
10	ALT 3-5		4,196.2	1,818.8	6,014.9	8.2%	0.75	-M.Tk. 1,138				

(3) Evaluation on Cross Sectional Configuration

- Among five alternative plans*[1] on the selected western route, **ALT 1-3** is selected as the most recommendable alternative plan for Phase II study of Rupsa Bridge form technical and economical viewpoints.

Note : *[1] is referred to Fig. 1 (page V).

OUTLINE OF THE STUDY

The Study on Construction of the Bridge over the River Rupsa in Khulna (Phase I)

- Study Period : July, 1998 - March, 1999
- Counterpart Agency : Roads and Highways Department (RHD), Ministry of Communications

1. Background of the Study

The Government of Bangladesh has exerted great efforts in the construction of bridges as well as the improvement of transport network connecting Dhaka, the capital city of the country, to four major regions severed by the rivers of Jamuna, Padma (Ganges) and Meghna, each of which is crisscrossed by thousands of tributaries and branches of the major rivers.

Khulna city, the 3rd biggest city and the hub of commerce and administration in the south-western region, will be connected to Dhaka by the all-weather and non-river interruption road after the completion of on-going Paksey Bridge. However, National Highway No.7 as a major arterial road in the study area has serious traffic bottlenecks, and the incremental congestion of the ferry terminal at Rupsa ghat increases transport costs as well as aggravating the severance of the local community. On the other hand, Mongla Port, as the 2nd port in Bangladesh, is expected to play an expanded role in future in consideration of integral components of transportation development and increasing traffic to the east and the north, and further, to the sub-regional freight traffic movement to India, Nepal and Bhutan.

Under such circumstances, the construction of bridge over the Rupsa river will realize the strategically important transport network between Dhaka, Khulna and Mongla without river interruption.

In response to the request of the Government of Bangladesh, the Japan International Cooperation Agency (JICA) dispatched the preparatory study team headed by Dr. Yuzo AKATSUKA, and both parties have agreed to the Scope of Work for the Study in March, 1998.

2. Study Objectives

The objectives of the Study are as follows;

(1) to formulate a master plan for integral components of transport development surrounding the Rupsa bridge;

(2) to formulate a plan for construction of the bridge over the river Rupsa in Khulna; and
(3) to transfer technology to Bangladesh counterparts.

3. Study Area

The study area covers Khulna city, Mongla Port and its surroundings in the south-western region consisting of Khulna Division, Barisal Division and Faridpur Zila of Dhaka Division.

4. Target Year

The target year of the plan is the year 2015 which accords with that of the studies implemented by the World Bank.

5. Outline of the Study

The Study was conducted regarding Rupsa Bridge and integral components of transport development surrounding the Bridge in accordance with the agreed scope of work.

5.1 Socio-Economic Framework

The Study was conducted on the basis of three possible economic frameworks for the future of Bangladesh, namely high growth, medium growth and low growth, taking the various economic forecasts such as 5FYP, WB, ADB and "Bangladesh Integrated Transport System Study" (Bangladesh Government, Planning Committee, June 1998) as preconditions.

Medium case of 5.0 % as long-term annual target for GDP growth is adopted for the forecast of cargo demand handling at Mongla port and traffic demand forecast.

5.2 Demand Forecast for Port Cargo

1) Cargo Demand of Mongla Port in 2015

The total port cargo demand for the Bangladeshi two seaports of Mongla and Chittagong is projected by commodity using correlation analysis with the GDP, and the total cargo at Mongla Port in 2015, excluding that to/from Nepal, is projected at 5,811,000 tons after examining the future shares of both ports due to inland transport development.

2) Demand Forecast for Nepalese Cargo

Assuming 4.0% annual growth of the Nepalese economy, the total Nepalese seaborne cargo is projected to reach 1,994 thousand tons in 2015 (476 thousand tons in '97/'98). This volume of cargo is allocated to the three ports, Mongla, Chittagong and Calcutta, and it is presumed that the most probable case is the one where Mongla Port has shares of 50% for dry bulk cargo and 20% for general cargo. The estimated volume of the Nepalese cargo handled at Mongla Port in 2015 is 400 thousand tons including 41 thousand TEUs of containers.

3) Cargo Handled at Jetty

The cargo that will be handled at the jetty is projected on the assumption that a small amount of bulk cargo in addition to all of container cargo and break bulk cargo will be handled at the jetty. The total cargo volume, all of which is to be transshipped by land transport modes, will reach more than 2 million tons (160 thousand tons in '97/'98).

5.3 Traffic Demand Forecast

Traffic assignment simulation is carried out using the software STRADA (System for Traffic Demand Analysis) supplied by JICA, using forecast future OD tables developed by socio-economic framework and future road network.

Based on the assignment results by case, traffic volumes crossing the bridge over the Rupsa River are analyzed by type of vehicles. Traffic demand on the Bridge for the year 2015 is forecasted 11,150 vehicles/day in the recommended case.

5.4 Formulation of Transport Master Plan

Deliberating the roles and functions of the Bridge as well as planning parameters supported by engineering considerations, three components of Khulna Bypass, Railway Extension to Mongla Port and Multi Modal Terminal were studied as related transport facilities.

Present Rupsa Ferry becomes serious traffic bottleneck to sustain Mongla Port and future development at the port area, and Khulna Bypass should be located in the western side of the Rupsa river to alleviate traffic congestion at Rupsa Ferry.

Development Scenario-2 : the Bridge with Multi Modal Terminal is evaluated as the optimum alternative for the Study from the following aspects;

a) Although it is presumed that most of these container cargo would be transported by land transport means through the improved future land transportation networks in the hinterland of Mongla Port, the major portion

of the inland transport of the port cargo would be still performed by inland water vessels.

b) Although on-going Paksey Bridge will be completed and future land transportation network will be improved toward the north as the hinterland of Mongla Port such as North-Western Region and Nepal, Cargo Movement beyond Khulna subject to rail transport is estimated 478,000 tons/year at most, that is medium.

5.5 Preliminary Engineering Study

(1) Highway Engineering Study

1) Major Design Controls

Highway Bridge

Design Speed	: 60 km/h
Maximum Grade	: 3.0 %
Minimum Vertical Curve at Crest	: 2,000 m

Rail-cum-Road Bridge

Maximum Grade	: 1.0 %
Minimum Vertical Curve at Crest	: 3,000 m

2) Study on Type of Rail-cum-Road Bridge

The scheme of rail-cum-road bridge in a whole stretch (ALT 1-6) was set aside from alternative plan of road for the following reasons;

- It is not reasonable that the vertical alignment of road should comply with considerably flatter grade of that of railway only to share the space of bridge to result in huge increase of bridge cost.
- There's a physical problem that the initial 4-lane road bridge has to be modified to a rail-cum-road bridge with a single track and 2-lane. It may be a seriously problem for RHD to have invested in such an inefficient manner.

3) Study on Alternative Cross Sections (Refer to Fig. 1)

The cross sections of five alternatives are studied based on undivided 2-lane with sidewalks warranted by traffic demand forecast as well as considering traffic characteristics and the scheme of rail-cum-road bridge only on main bridge.

(2) Bridge Engineering Study

Although the Study is still at a master plan level with limited data and information, the bridge engineering study aims at selecting suitable type of bridge and structures as far as it may be practical, giving basis for cost estimates and summarizing technical data and information for succeeding engineering study.

1) Main Bridge

Rupsa, Bhairab and Atai Bridge having the required minimum span length of 100 m, and Atherobaki Bridge of 50 m are separately examined. As the Main Bridges cross over the rivers, and are comparatively of a long span, the selection was made based on such factors as i) navigational requirements, ii) topography and geology, iii) river conditions, iv) aesthetics, v) constructability (degree of ease on construction), vi) construction cost, vii) construction period, viii) maintenance, ix) aviation requirements and x) technology transfer/new technology.

Rupsa, Bhairab and Atai Bridge (Required minimum span length=100 m)

Superstructure	: Continuous PC Box Girder (Tapered Girder Depth)
Substructure	: Wall Type with Ellipse Cross Section
Foundation	: Cast-in-situ Concrete Pile

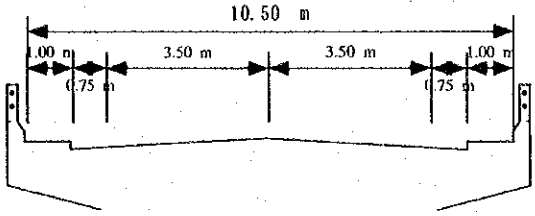
Atherobaki Bridge (Required minimum span length=50 m)

Superstructure	: Continuous PC Box Girder (Uniform Girder Depth)
Substructure	: Wall Type with Ellipse Cross Section
Foundation	: Cast-in-situ Concrete Pile

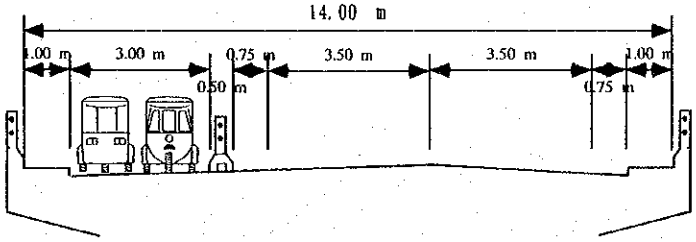
2) Approach Bridge

Factors dominating selection of the Approach Bridge are construction economy and constructability including the experience achieved in this country, somewhat different from those for the Main Bridge.

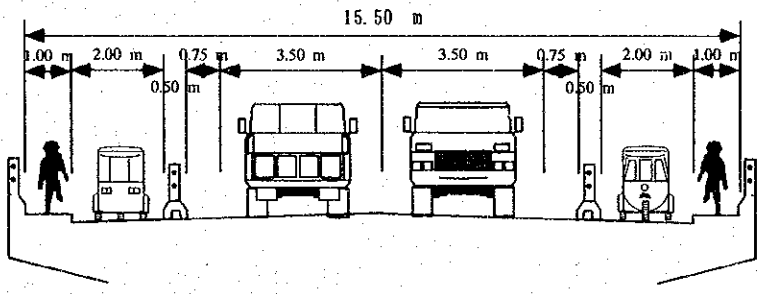
Superstructure	: PC Composite I-girder (Span length=30 m)
Substructure	: Wall Type with Rectangular Cross Section
Foundation	: Cast-in-situ Concrete Pile



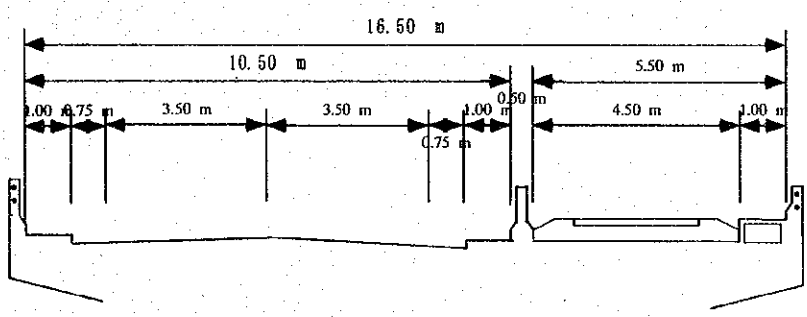
ALT 1-1 / 3-1



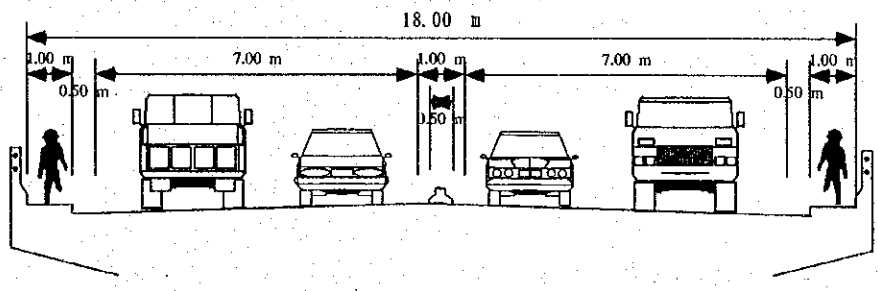
ALT 1-2 / 3-2



ALT 1-3 / 3-3



ALT 1-4 / 3-4



ALT 1-5 / 3-5

5.6 Initial Environmental and Initial Social Impact Examination

(1) Impacts on Social Environment

Hundred percent household survey was conducted along the social baseline through interview survey. The most issued social environment is found a severance of community. However, it is likely possible to move to adjacent farmland because the land holding rate rises nearly 90% and very limited number of tenant farmers or non-land holding farmers are found. On the other hand, since the surveyed area is a typical neighboring town or small-sized intensive farming in the suburbs of Khulna city, high positive or favorable impacts brought by road development are anticipated.

It is necessary to conduct more detailed survey along the social baseline in the course of implementation of the project, and plans for land acquisition and resettlement of affected inhabitants are required. Although no serious impact on natural environment is found due to passing open or farmland, some mitigation measures against drainage and irrigation channel will be required during construction and operation stage.

(2) Social Cost

Approach section of the Bridge except the space of river channel will incur social costs related to road development such as land acquisition and property compensation, and its degree or extent depend upon land use. Such social costs of the eastern route are estimated approximately three (3) times as high as that of the western route.

5.7 Alternative Plans and Evaluations

(1) Alternative Plans for Economic and Financial Analysis

Benefits are brought by savings of transport costs stemmed from traffic demand forecast on each alternative route, and they are estimated the same as among alternative plans on each route. Therefore, variation of project cost by each alternative plans can be covered by sensitivity analysis.

A financial analysis is conducted assuming Rupsa Bridge levying toll. Only ALT 1-1 : Undivided 2-lane with Sidewalks is analyzed because the Study is still at a master plan level and amount of toll revenue is estimated the same among each alternative plans.

(2) Evaluation on Alternative Plans for Railway Extension to Mongla Port

The scheme of railway extension to Mongla Port opening until Year 2015 has

negative financial internal rate of return (FIRR) at all alternative plans as shown in Table 1. The sensitivity analysis also reveals that freight revenue could not collect debts even if purchasing costs of five locomotives and 700 wagons are set aside from project cost.

Based on the Railway Recovery Program (RRP) agreed upon between the Government and ADB, by which Bangladesh Railway is obliged to act commercially, it is difficult to envisage a new rail line between Mongla and Khulna.

However, the scheme of rail-cum road bridge is to be studied as an alternative plan of road bridge because it never deny the possibility of railway extension beyond Year 2015.

Table 1 Results of Financial Analysis and its Sensitivity Analysis

Alternative	Outline of Scheme			Internal Rate of Return (IRR)	
	Route	Bridges	Rail-cum	Total Investment	w/o Loco & wagon
ALT R-1	Eastern R.	Bhairab/Atai/	x	-40.0%	-18.4%
ALT R-2	(B Route)	Atherobaki & 6 Br.	0	-39.2%	-5.4%
ALT R-3	Western R.	Rupsa & 6 Br.	x	-39.7%	-15.2%
ALT R-4	(A Route)		0	-39.4%	-8.9%

Notes :

1) Construction costs comprise fill, bridge, ballast, sleeper, rail and signaling.
2) O & M costs are estimated on the assumption that 5 locos & 700 wagons are purchased.
3) The scheme of rail-cum-road bridge is to share the portion of main bridge only.

(3) Selection of Route Location of Khulna Bypass

The western route of Khulna Bypass was recommended from the qualitative viewpoints of planning parameters such as land availability, future traffic demand, social aspects, construction economy and river morphology.

Table 2 presents additionally quantitative comparison of each route location, and it reveals that the western route is superior to the eastern route at almost all aspects, especially economic indices.

Therefore, the comparison and evaluation of cross sectional configurations are to be made only for the western route.

Table 2 Construction Costs and Indices of Economic Analysis of Alternative Plans

Unit : M. Tk.

Alternative		Route Location	Direct Construction Cost			Economic Analysis			Social Costs			Affected Houses
			Bridge	Others	Total	IRR	B/C	N.P.V	Land	Comp.	Total	
1	ALT 1-1	Western R.	1,341.1	1,186.8	2,527.9	30.5%	3.01	M.Tk. 3,711	73.2	19.7	92.9	25
2	ALT 1-2	(A Route)	1,718.1	1,195.4	2,913.5	27.7%	2.62	M.Tk. 3,432				
3	ALT 1-3		1,874.4	1,191.5	3,065.9	26.7%	2.49	M.Tk. 3,323				
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5	ALT 1-5		2,180.2	1,351.0	3,531.2	24.1%	2.17	M.Tk. 2,988				
6	ALT 3-1	Eastern R.	2,581.0	1,467.7	4,048.7	13.2%	1.09	M.Tk. 282	167.6	107.6	275.2	297
7	ALT 3-2	(B Route)	3,307.2	1,541.9	4,849.1	10.9%	0.92	-M.Tk. 295				
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10	ALT 3-5		4,196.2	1,818.8	6,014.9	8.2%	0.75	-M.Tk. 1,138				

Notes :

1) Direct construction cost of bridge covers costs between abutments and excluding 10% contingency.
2) In Rail-cum-Road bridge, direct construction cost of Approach Bridge for railway is not included.
3) 100 m span Continuous PC Box Girder with Cast In-situ Concrete Pile for Rupsa/Bhairab/Atai Bridge
4) 50 m span Continuous PC Box Girder with Cast In-situ Concrete Pile for Atherobaki Bridge
5) 30 m span Composite PC I-Girder with Cast In-situ Concrete Pile for Approach Bridge
6) 12% per annum discount rate applied to B/C and Net Present Value (N.P.V)

(4) Evaluation on Cross Sectional Configuration

ALT 1-3 is selected as the most recommendable alternative plan for Rupsa Bridge form the following reasons;

i) Rupsa Bridge is located in the urbanized area of Khulna and major users are expected local commuters. It is necessary to deliberate transport means for citizens such as auto-rickshaws and motorcycles, and accordingly separated lanes for slow-moving vehicles accommodate commuters as well as contribute traffic safety and steady flow of traffic.

ii) Since mixed traffic of slow-moving vehicles causes present traffic congestion taken place on National Highway No. 7, it is desirable that separated slow-moving vehicles enhance traffic safety as well as smooth traffic flow.

iii) This scheme has remarkable advantage to expand 2-lane carriageway up to 4-lane just in case that traffic demand might increase beyond forecasted one.

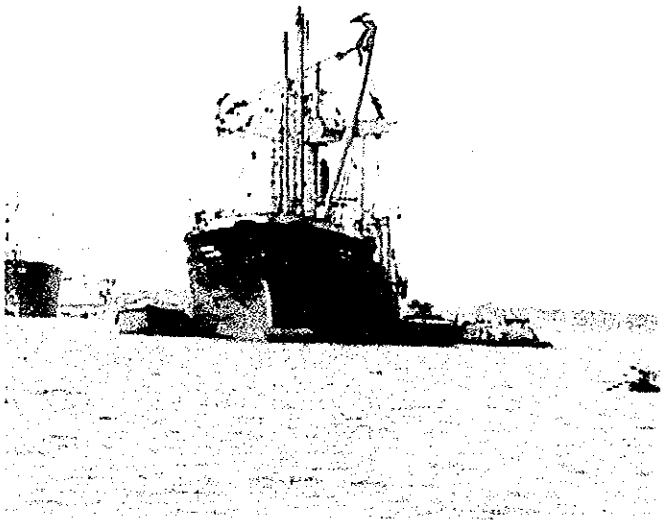


Photo-1 : Mongla Port

94% of cargo is handled at the mooring and anchorage berths.
This implies that Mongla Port greatly depends on inland
water transport for hinterland cargo movement.
Mongla Port has suffered from siltation due to a river port.

Photo-2 : Khulna-Mongla Road

Khulna-Mongla Road which was developed in 1985 by ADB assistance is designated as a major arterial road, but traffic volume remains low at 1,000 - 1,500 veh./day.
Rupsa Ferry, which exists on Khulna-Mongla Road, is so congested that it becomes the traffic bottleneck to hardly exploit the regional development potential.

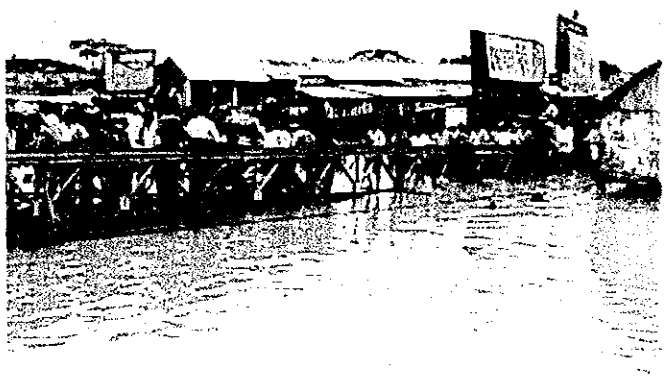


Photo-3 : Access Bridge at Rupsa Ferry

3 m high tidal fluctuation takes place at Rupsa Ferry.
The access bridge is always inundated during spring tide, and it cause to make traffic congestion worse.

Photo-4 : Traffic Congestion at Rupsa Ferry

Two ghats in both sides exist at Rupsa Ferry to operate two ferries simultaneously during peak hours, transporting daily passengers of 50,000 - 60,000.
Motorized vehicles manage to pass among predominant non-motorized traffic, consisting of pedestrian, rickshaws and carts.

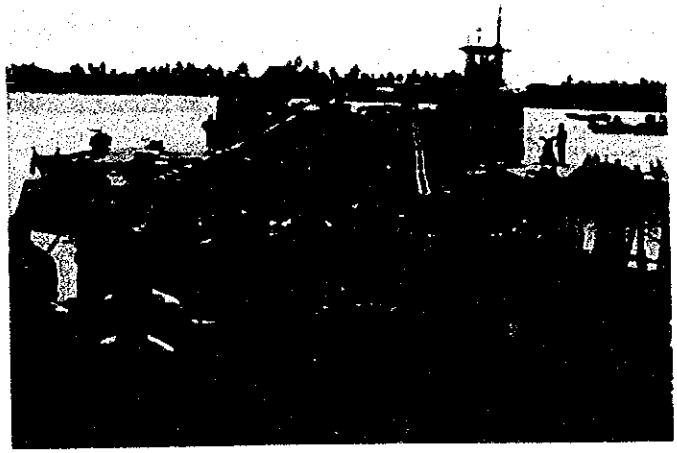


Photo-5 : Khulna Terminal at Rupsa Ferry

Very high non-motorized traffic exists at Khulna terminal, while high volumes of buses are found at Rupsa terminal.
Short trips are dominant in Khulna side and medium and long trips prevail in Rupsa side.

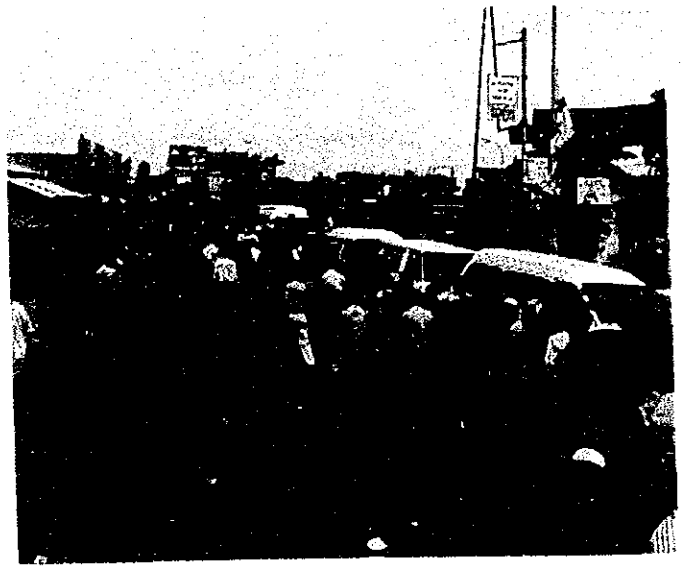
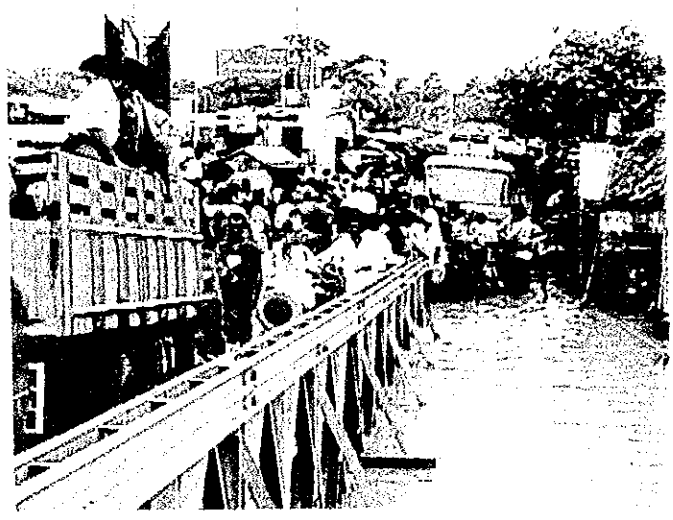


Photo-6 : Serious Traffic Congestion

Considerable number of passengers saturate traffic capacity to cause serious traffic congestion for motorized traffic.
It is often observed at peak hours that both directions of traffic conflict on approach road and access bridge.
The scheme of bridge construction is deemed a drastic measure to improve the situation.



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CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The Government of Bangladesh has exerted great efforts in the construction of bridges as well as the improvement of transport network connecting Dhaka, the capital city of the country, to four major regions severed by the rivers of Jamuna, Padma (Ganges) and Meghna, each of which is crisscrossed by thousands of tributaries and branches of the major rivers.

Khulna city, the 3rd biggest city and the hub of commerce and administration in the south-western region, will be connected to Dhaka by the all-weather and non-river interruption road after the completion of on-going Paksey Bridge. However, National Highway No.7 as a major arterial road in the study area has serious traffic bottlenecks, and the incremental congestion of the ferry terminal at Rupsa ghat increases transport costs as well as aggravating the severance of the local community. On the other hand, Mongla Port, as the 2nd port in Bangladesh, is expected to play an expanded role in future in consideration of integral components of transportation development and increasing traffic to the east and the north, and further, to the sub-regional freight traffic movement to India, Nepal and Bhutan.

Under such circumstances, the construction of bridge over the Rupsa river will realize the strategically important transport network between Dhaka, Khulna and Mongla without river interruption.

In response to the request of the Government of Bangladesh, the Japan International Cooperation Agency (JICA) dispatched the preparatory study team headed by Dr. Yuzo AKATSUKA, and both parties have agreed to the Scope of Work for the Study in March, 1998.

1.2 Study Objectives

The objectives of the Study are as follows;

(1) to formulate a master plan for integral components of transport development surrounding the Rupsa bridge;

(2) to formulate a plan for construction of the bridge over the river Rupsa in Khulna; and

(3) to transfer technology to Bangladesh counterparts.

1.3 Study Area

The study area covers Khulna and Mongla cities as shown in Fig. 1.1.

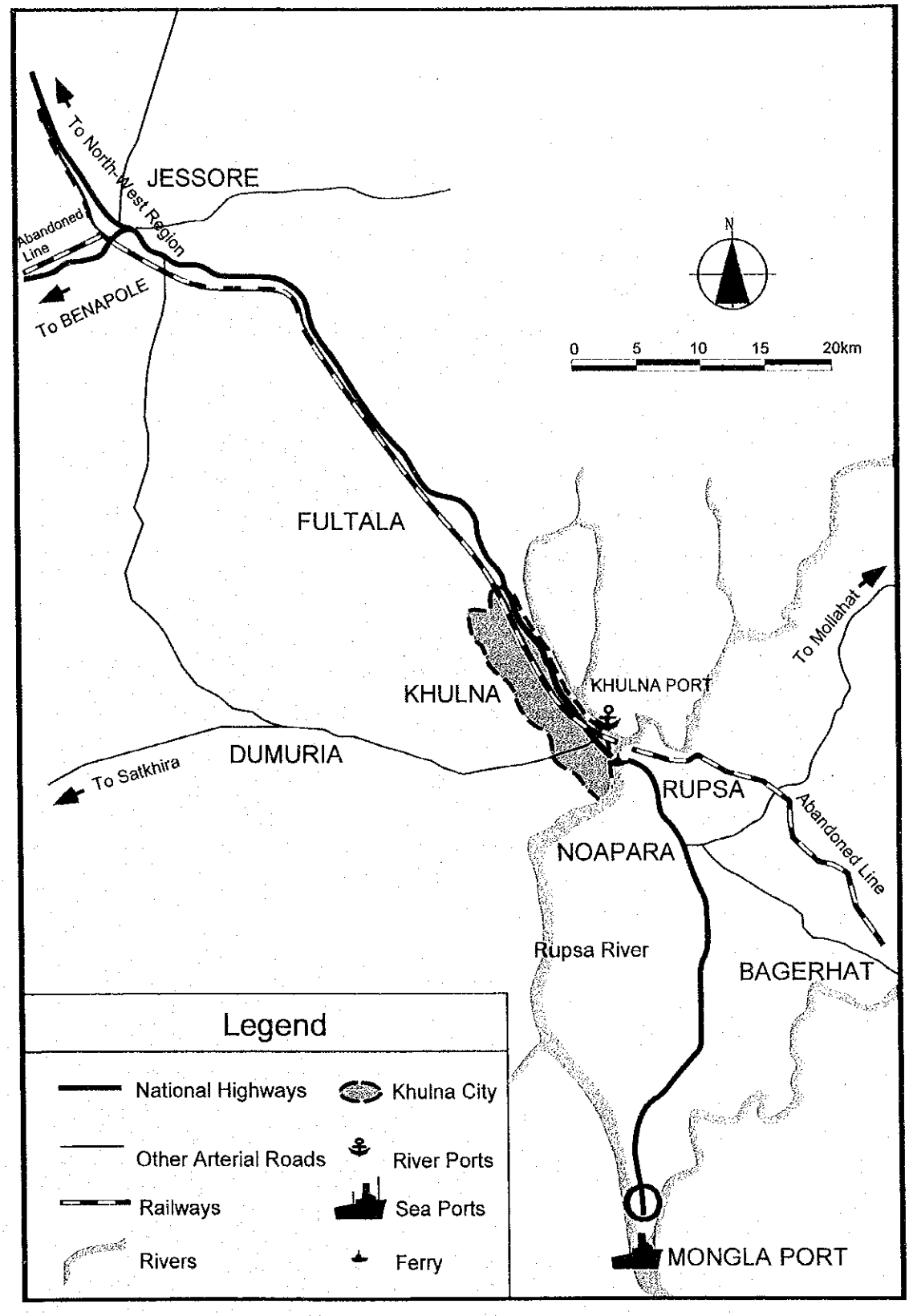

Fig. 1.1 Study Area

1.4 Target Year

The target year of the plan is the year 2015 which accords with that of the studies implemented by the World Bank.

1.5 Submission of Reports

Four (4) kinds of reports in English were submitted to Roads and Highways Department (RHD), Ministry of Communications until Final Report is prepared, namely; Inception Report, Progress Report, Interim Report, Draft Final Report.

1)	Inception Report	July 26, 1998
2)	Progress Report	September 14, 1998
3)	Interim Report	November 12, 1998
4)	Draft Final Report with Video Tape for Presentation	January 31, 1999

CHAPTER 2 SOCIOECONOMIC FRAMEWORK

2.1 Socioeconomic Outlook from Existing Data and Information

(1) Bangladesh Government Economic Growth Targets

The economic growth targets for Bangladesh are summarized in Table 2.1. In the 5th Five Year Plan (5FYP), the principal aims of the Government of Bangladesh are to:

- Aiming at raising the GDP growth rate to a level that will take Bangladesh to the threshold of takeoff in the shortest possible time and allow the pursuing of the poverty alleviation program more efficiently and generation of productive employment opportunities.

- Higher growth rate will be brought about through higher rate of investment and greater efficiency via productivity enhancing policy packages and skill development.

Based on these fundamental objectives, the 5FYP aims at an average annual growth in GDP of 7.3%. Annual average expansion in the electricity/gas sector and industrial sector are set higher than in other sectors at 25.0% and 15.3% respectively. The lowest target is the agricultural sector at 4.0%.

Population growth estimates for 2002, the final year of the 5FYP, is 132.5 million, 147.1 million for 2010, and 166.5 million for 2020.

Table 2.1 Scale of the 5FYP (at 1996/97 Prices)

	1996/97	2001/2002	Annual Growth Rate (%)
GDP (million TK)	1,402,235	1,993,504	7.3
Agriculture	418,306	508,933	4.0
Industry	129,765	263,919	15.3
Construction	82,346	115,495	7.0
Power, Gas	30,834	94,099	25.0
Transport	158,040	225,048	7.3
Housing Services	134,117	165,109	4.2
Public Administration	79,048	98,508	4.5
Health	19,184	27,541	7.5
Education	58,685	83,566	7.3
Trade Services	125,799	179,137	7.3
Banking, Insurance	28,084	37,583	6.0
Prof. & Misc. Services	138,026	194,565	7.1
Population (million)	123.8	132.5	1.36
Employment (x1000 persons)	49,071	62,312	4.1
Agriculture	30,912	36,918	3.0
Industry	3,650	6,466	10.0
Power, Gas	103	238	15.0
Construction	1,015	1,323	4.5
Transport, Communications	2,196	2,904	4.8
Trade, Other Services	11,195	14,463	4.4
Per Capita GDP (TK)	11,494	15,045	5.5

Note : Base year of Employment is 1995/96 (from Labour Force Survey).
Per Capita GDP is calculated by the Study Team.
Source : The Fifth Five Year Plan 1997-2002

(2) Economic Growth Prospects for Bangladesh as seen by the World Bank (WB)

According to the World Bank's "Bangladesh annual economic update 1997, economic performance, policy issues and priority reforms" (Oct. 1997), GDP growth estimates are as follows:

	GDP Growth Rate (%)
1996/1997	5.7
1997/1998	5.5
1998/1999	5.8
1999/2000	6.1
2000/2001	6.4
2001/2002	6.7
2002/2003	7.0

These GDP growth estimates are based on:

- Bangladesh has a good opportunity to improve prospects for economic growth and development by capitalizing on the intensified Foreign Direct Investment (FDI) interest shown in various sectors, particularly the energy sector.
- Benefits from potentially sizable FDI could be enhanced if the pace of reforms is accelerated, thus improving the investment climate.
- Furthermore, with the early resolution of the pending problems associated with exports of knitwear and frozen food, strong export performance could be maintained and improved by pursuing a competitive real exchange rate policy and continuing trade liberalization.

(3) Economic Growth Prospects as seen by the Asian Development Bank (ADB)

According to the "Country Economic Review, Bangladesh" (Oct. 1997) issued by the ADB, the GDP growth rates as based on two scenarios are as follows:

Scenario A: Major structural reforms are implemented effectively and macroeconomic stability is largely maintained during the projection period.

Scenario B: Maintenance of the status quo

The GDP growth rates based on the two scenarios are shown in Table 2.2.

Table 2.2 GDP Growth Rate Projections, 1998-2002

(%)

			Projections				
	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001	2001/2002
Scenario A							
Real GDP	5.4	5.7	6.0	6.4	6.8	7.0	7.1
Agriculture	3.7	6.0	2.5	2.8	3.0	3.0	3.0
Industry	5.3	3.6	8.5	10.0	11.5	12.0	12.2
Services	6.5	6.2	7.2	7.1	7.2	7.2	7.2
Scenario B							
Real GDP	5.4	5.7	4.6	4.7	4.7	4.8	4.9
Agriculture	3.7	6.0	2.5	2.6	2.5	2.5	2.5
Industry	5.3	3.6	4.8	5.0	5.2	5.4	5.5
Services	6.5	6.2	5.7	5.7	5.7	5.8	5.9

Source : Country Economic Review, Bangladesh (Oct. 1997, ADB)

2.2 Setting up a Socioeconomic Framework

Taking the various economic forecasts as preconditions, this Study has constructed the following framework for economic growth until 2015.

i) Annual average GDP growth prospects during each projection period were adopted as follows:

- 5FYP: 7.3%
- WB: 6.3%
- ADB Scenario A: 6.7%
- ADB Scenario B: 4.7%

ii) Using long term annual targets for GDP growth of 4.0 - 5.0% as suggested in the "Bangladesh Integrated Transport System Study" (Bangladesh Government, Planning Committee, June 1998), and considering the state of the Asian economy, an annual increase of 4.0% in GDP was adopted. Population estimates in the 5FYP were also used.

The socioeconomic framework under consideration is illustrated in Table 2.3 and Fig. 2.1. Using 1996/1997 as the base year, target average annual growth in GDP is estimated as:

- Based on 5FYP estimates: 5.5%
- Based on WB estimates: 5.0%
- Based on ADB Scenario A estimates: 5.2%
- Based on ADB Scenario B estimates: 4.4%

Table 2.3 Socioeconomic Framework

	1996/97	1997/98	1998/99	1999/00	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005	2009/2010	2014/2015	2019/2020
The 5FYP												
Population (million)	**123.8**			129.0		**132.5**			**137.8**	**147.1**	156.5	**166.5**
Growth Rate (%)	**1.75**					**1.36**			1.32	1.31		1.25
GDP (billion TK)	**1402.58**	**1486.90**	**1594.94**	**1713.89**	**1847.18**	**1998.48**	2144.36	2300.90	2468.87	3003.76	3654.53	
Growth Rate (%)	**5.7**	**6.01**	**7.27**	**7.46**	**7.78**	**8.19**	7.3	7.3	7.3	4.0	4.0	
WB												
GDP (billion TK)	**1402.58**	1479.72	1565.55	1661.04	1767.35	1885.76	2017.77	2144.89	2280.01	2773.99	3374.98	
Growth Rate (%)	**5.7**	**5.5**	**5.8**	**6.1**	**6.4**	**6.7**	7.0	6.3	6.3	4.0	4.0	
ADB												
(Scenario A)												
GDP (billion TK)	**1402.58**	1486.73	1581.89	1689.45	1807.72	1936.06	2065.78	2204.19	2351.87	2861.41	3481.34	
Growth Rate (%)	**5.7**	**6.0**	**6.4**	**6.8**	**7.0**	**7.1**	6.7	6.7	6.7	4.0	4.0	
(Scenario B)												
GDP (billion TK)	**1402.58**	1467.10	1536.05	1608.25	1685.44	1768.03	1851.13	1938.13	2029.22	2468.86	3003.74	
Growth Rate (%)	**5.7**	**4.6**	**4.7**	**4.7**	**4.8**	**4.9**	4.7	4.7	4.7	4.0	4.0	

Note : (1) Annual growth rates of GDP until 2004/2005 apply average annual growth rates during projection period in each scenario.
Average annual growth rates of GDP after 2004/2005 apply 4.0%.
(2) Boldfaced figures show the projected figures in each scenario. The other figures show the estimated figures by the Study Team.
Source : (1) The Fifht Five Year Plan 1997-2002
(2) Bangladesh Annual Economic Update 1997, Economic Performance, Policy Issues and Priority Reforms (Oct. 1997. The world Bank)
(3) Country Economic Review Bangladesh (Oct. 1997, Asian Development Bank)

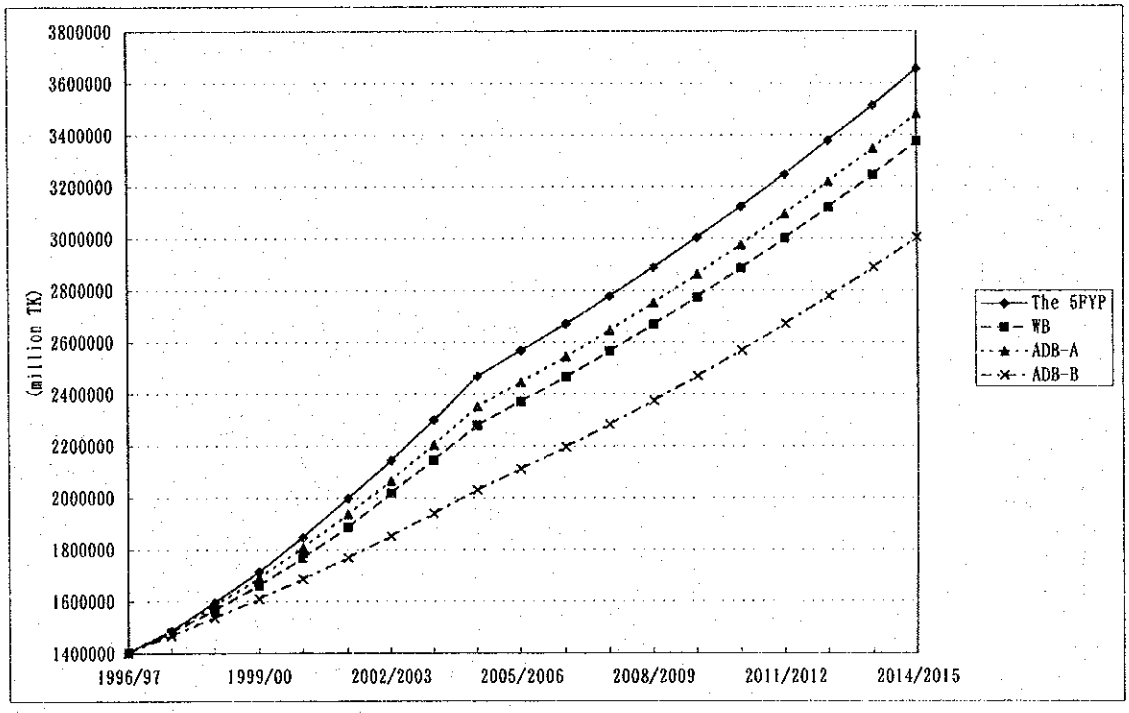

Fig. 2.1 GDP Estimates

According to these figures, three possible economic frameworks for the future of Bangladesh can be considered: high growth, medium growth, and low growth, as defined below.

	Average annual growth in GDP (1996/97 - 2014/2015)
- High growth case:	5.5%
- Medium growth case:	5.0%
- Low growth case:	4.4%

Hereafter in this study, the medium growth case as future economic framework is adopted for the forecast of cargo demand handling at Mongla port and traffic demand forecast.

2.3 Forecast for Vehicle Ownership

The motorized vehicle ownership is forecasted by the method of regression analysis based on the trend data of registered vehicles and per capita GDPs.

The correlation of number of registered vehicles and per capita GDPs in Bangladesh becomes clearly high. Based on the results of regression analysis, number of vehicles by type in the year 2015 is estimated. The results are shown in Table 2.4.

From the forecast results, level of vehicle ownership will increase from 4.1 vehicles/1000 persons in 1997/98 to 10.0 vehicles/1000 persons in 2014/2015.

Table 2.4 Forecast of Vehicle Ownership by Type

	Motorcycle	Autorickshaw	Car	Bus	Truck	All Vehicles
1989/90	125,000	30,200	92,650	25,000	37,200	310,050
1990/91	138,750	32,616	97,943	26,750	39,512	335,571
1991/92	150,171	36,796	101,806	28,820	40,752	358,345
1992/93	158,588	40,114	103,511	30,444	41,632	374,289
1993/94	165,360	43,863	106,634	32,335	42,723	390,915
1994/95	173,167	53,851	111,392	35,601	44,691	418,702
1995/96	182,035	68,039	119,020	38,156	48,175	455,425
1997/98	236,000	99,000	141,000	51,000	57,000	584,000
1999/2000	267,000	121,000	155,000	58,000	63,000	664,000
2004/2005	414,000	222,000	221,000	95,000	90,000	1,041,000
2009/2010	506,000	286,000	263,000	117,000	107,000	1,279,000
2014/2015	614,000	360,000	312,000	144,000	127,000	1,558,000

2.4 Frameworks for Socioeconomic Development in Surrounding Countries

(1) India

Projections for India's socioeconomic future can be summarized as follows:

- Despite an annual increase in population of 2% over the past 30 years, the annual average increase in population is projected to fall to 1.56%.

- A target average annual increase in GDP of 6.5 - 7.5% is to be achieved through the four central national policies of "Increasing quality of life", "Expanding opportunities for productive employment", "Regional balance", and "Self-reliance".

(2) Nepal

The Asian Development Bank's short term forecast for Nepal ("Country Economic Review, Nepal (Jan. 1998)) is estimated in Table 2.5:

Table 2.5 Nepalese GDP Growth Projection by ADB

(%)

	1995/96	1996/97	1997/98	1998/99	1999/2000
Real GDP Growth	5.4	3.8	3.5	4.0	4.5
Agriculture	4.4	3.4	2.8	3.5	4.0
Industry	5.8	3.5	3.4	4.0	4.4
Services	6.3	4.3	4.2	4.5	5.0

Source : Country Economic Review Nepal (Jan. 1998)

Moreover, the scale of Nepal's future economy can be predicted given demand forecasts for the handling of Nepal-related freight, as will be mentioned later in the description of Mongla Port. The economic growth by this Study's target year of 2015 were forecasted adopting the projected 4.0% average annual growth rate in GDP predicted in the short term by the ADB.

CHAPTER 3 CURRENT ROAD TRANSPORT PROFILE

3.1 Motorization

Number of registered motorized vehicles in Bangladesh is 462 thousand in 1995. The share of motorcycle was the highest 40.0%, followed by 26.1% for car and jeep, 14.9% for auto-rickshaw, 10.6% for truck and 8.4% for bus/minibus/microbus in descending order.

The growth rate during 1990 - 95 was 6.3% per annum, while that of microbus was the highest as 51.3% per annum during the same period, followed by motorcycle (5.6%), truck (4.2%) and car/jeep (4.0%).

The level of ownership for total motorized vehicles in 1995 was 3.9 vehicles per 1,000 persons.

In Bangladesh, rickshaws as non-motorized vehicles exceed the motorized vehicles in number of registration. The number of registered rickshaws in the whole country was approximately 473 thousand in 1995. The growth rate of rickshaws during 1990 - 1995 is 6.2% per annum.

The number of rickshaws per 1,000 persons in 1995 was 3.9 for the whole country and 4.6 for Khulna Former District.

3.2 Roads in the Study Area

Total length of roads under the RHD is 20,285 km in Bangladesh.

Roads in Khulna Zone accounts for 6.7% or 1,361 km, consisting of National Highway of 338 km, Regional Highway of 342 km and Feeder Road-A of 680 km. Low percentage of roads in Khulna Zone is found, especially of National Highway.

Roads in Khulna Former District which consists of Khulna Zila, Bagerhat Zila and Satkhira Zila comprise 53 km (13%) in length of 6.71 m wide or more and 301 km (78%) in length of 3.66 m wide or less, and it means three fourth of roads are one lane.

Percentage of unpaved roads are still high. Roads in Khulna Former District comprise 386 km (59%) in length of paved and 84.5 km (8%) in length of unpaved. More than 87% of roads are assumed having paved or treated surface in 1992.

Roads in Khulna Zone comprise 1,132 km (82%) in good or fair condition in 1996/97. It demonstrates that good road maintenance has been done.

3.3 Present Road Traffic Conditions

Salient features of road traffic in the study area are predominant non-motorized traffic,

consisting of rickshaws and carts. These slow-moving vehicles transport passengers and cargoes considerably, and motorized vehicles manage to pass among such movements. Even among motorized vehicles, trucks of quite an old vintage prevail and they also move slowly due to overloaded and shortage of horsepower.

Through traveled traffic is disturbed by many kinds of obstacles such as the existence of facilities, physical constraint, multipurpose use of road, road user's behavior, etc. Deep potholes, uneven cracks and eroded shoulder with significantly vertical gaps, which are often observed in the study area, are major physical constraints.

Road Network Density as well as Road Area Occupancy still remains low in the study area from the viewpoints of road planning.

Since only two ferry services accommodate vehicular traffic to cross the Bhairab/Rupsa river, east-westward traffic converges on Rupsa ferry. Number of ferry services for vehicular traffic seems to be too small, compared with 5.3 million in Khulna Former District population and related traffic demand severed by the Bhairab/Rupsa river.

3.4 Accomplishment and Development Direction

Recent road projects converge to increase capacity in such a certain corridor as Khulna - Satkhira and Khulna - Mollahat/Gopalganj to provide non-river interruption road linkage between Khulna and other district growth poles as well as between Khulna and Dhaka.

3.5 Rupsa Ferry

Rupsa Ferry, which exists on National Highway No. 7 and is operated under jurisdiction of the RHD, is so congested that it becomes the traffic bottleneck to hardly exploit the regional development potential. Two ghats in both sides exist at Rupsa Ferry to operate two ferries simultaneously during peak hours.

Cursory look about traffic at Rupsa ferry is as follows;

Annual Motorized Traffic: 293,000
Trucks : 70,000 Buses : 40,000
Passenger Cars : 167,000 Motorcycles : 16,000
Daily Passengers : 50,000 - 60,000

Problems related to ferry operations are as follows:

i) Approximately 3 m high tidal fluctuation takes place at Rupsa Ferry. Ferry ghat is always inundated during spring tide, and it cause to make traffic congestion worse.

ii) It is often observed at peak hours that both directions of traffic conflict on approach road or even on bridge, and neither traffic control nor enforcement is done.

3.6 Analysis on Traffic Count Survey

(1) Traffic Volume and Composition

No significant discrepancy is found in motorized vehicular traffic between traffic count data obtained from the RHD and traffic survey conducted by the study team.

Highest motorized traffic is observed in Khulna - Jessore section. Motorized traffic in this section has salient features such as high bus/truck percentage of 42% and 4.7 times as high as that of Khulna - Mongla road. Motorized traffic on other radial arterial roads remains low at the level of 1,000 - 3,000 veh. /day.

High non-motorized vehicles are also observed at every survey points, especially in the vicinity of Khulna city.

(2) Traffic Movement at Rupsa Ferry

Traffic movement at Rupsa Ferry is studied in implication with traffic count surveys at both sides of the ferry.

Following features are found;

i) Very high non-motorized traffic exists at Khulna terminal, while high volumes of buses are found at Rupsa terminal. Trip length of users may explain this change of modes, namely short trips are dominant in Khulna side and medium and long trips prevail in Rupsa side.

ii) High portion of buses at Rupsa terminal decline to cross the Rupsa river or may be controlled because of congestion and wait passengers in Rupsa side.

iii) Passenger cars, motorcycles and trucks are observed quantitatively the same at three survey points, and they are of through traffic.

iv) Remarkable peak traffic in morning and evening are observed. It reveals commuters are to be main traffic.

CHAPTER 4 CURRENT RAILWAY TRANSPORT PROFILE AND RAIL CARGO SURVEY

4.1 A brief look at the present state of Bangladesh Railways

Bangladesh Railways (BR) is operating approx. 2,700 route-km and 244 passenger trains and 47 freight trains run every day. The total railway revenue is Tk.2 billion a year employing are approx. 40 thousand personnel.

BR had approx. Tk. 0.8 billion in debt in 1996-1997 fiscal year. The debt of the previous fiscal year 1996/97 was Tk. 1.2 billion.

BR has two railway gauge systems. One is Broad Gauge (BG-1676 mm) which serves the western zone, and the other is Meter Gauge (MG-1000 mm) serving the entire eastern zone and northern part of the western zone. On the west, BG 833 km and MG 543 km are served, and on the east, MG 1,279 km is served.

For administrative purposes, BR divided into two zones, namely the East and the West. As stated above, the East is responsible for the 1,279 km of MG, and the West is responsible for the 833 km of BG and 543 km of MG. The head office of the East is at Chittagong and that of the West is at Rajshahi. The West zone is again subdivided into two divisions with the head office of BG division is at Paksey, and that of MG division is at Lalmanirhat (the northern end of the west zone).

In June 1998, the Jamuna Bridge is opened as a rail-cum-road bridge. Therefore, in near future, BR will develop some East-West connected railway service.

4.2 Study Area

Rupsa river is in the western zone. In the railway network, Rupsa river is between the Khulna station and the Rupsa East station, which are in the Broad Gauge section. Then the study area belongs to BG section area.

4.3 Present State of the Western North-South Corridor

(1) Main items of construction standard

i. Formation width: Single track 20ft.(6m), Double track 34ft. (10.2m)

ii. Alignment: Curvature: Horizontal 10 degree (R = 573ft. =172m)
Gradient:1/100 (There is a description up to 1/50 in the Schedule book)

iii. Construction clearance (gauge)

a) horizontal; 14ft.(4.2m)

b) vertical; 17' 9'' (5.4m, in case of electrified)

(2) Length of a train

In Khulna – Jessore section, a train length of 1,800ft. (540m) is applied. This length is for 60 wagons + loco/locos length. Here, a wagon length is 28 ft.(8.4m). Then the wagons' length without a loco/locos is 504m.

(3) Ability of the Locomotive

BR has 272 locomotives with 68 run on BG sections. In these locomotives, the type so-called "BEB" is mainly for the freight locomotive. The specifications of BEB type locomotive are as follows:

BEB; Broad gauge, Electric, Bonvardier

Weight; 105 tons. Length; 58ft. (17.4m).

Power; 2,400 HP.

Max. speed; 60 mph (96 km/h).

This BEB has enough power for the present freight trains for a total of approx. 2,000 tons (including tare weights).

(4) Track

In BG sections, three kinds of rail 90 A, 90 R, and 90 BS are used. These are all 45 kg/m rail, but of different shape. However, there is not much difference in the strength. All the BG sections use these 45 kg/m rail. As for sleepers, there are two kinds, wood sleeper and steel sleeper. A combination of both are used in most sections of BG.

At present, train speed is limited due to poor state of track such as below lack of ballast and sleepers.

One of the girders of the Hardinge Bridge across the Padma River was air-raided and train speed is now restricted to 25 km/h.

(5) Freight cars

Some of the features of the Freight cars used in BR are as follows:

- Freight cars in BG section have no air brake systems;
- Coupling system between freight cars is the chain and the damper type;
- Design axle load of a freight car is 22.5 tons (Tare weight is 10.4 tons); and
- No container is available in the BG section.

Apart from the Rupsa Bridge issue, if BR wants to survive in the competitive transportation world of freight, both air brake and automatic coupling system are essential.

(6) Present loading & unloading system, facility and equipment

The loading/unloading in the BG sections depends on manpower as no scene of the

mechanical loading and unloading is observed.

Loading/unloading lines are not so long enough, therefore, to make train composition, there shall be several times of freight cars shunting. It causes a train's staying time in a freight station long and decreases the effectiveness.

Some warehouses are not so suitable to the freight system. They are either far from the loading/unloading lines or not parallel to the lines.

In Khulna, Nawapara, and Daulatpur, access roads to the freight station are in poor condition. The entrance from the road to the station is always congested by the general traffics including rickshaws.

(7) Definite train diagram and room for new trains

There is no definite freight train diagram in Khulna – Jessore section.

In the diagram of Khulna – Darsana section, there seems to be a room for new trains, even though new trains also depend the operation of track condition, affordability of locomotives, rolling stocks, etc.

(8) Containerization

BR has applied the containerization in the eastern zone, and it is in great success. Both client and BR welcome the system. If there is an idea that the container train should run on the western north-south corridor by rail from Mongla port, an arrival side container base/bases is a must in the western inland area. And this might be a good chance to renew the freight system by rail in the western zone, including the introduction of the airbrake and automatic coupling to the freight cars.

4. 4 Rail Freight Survey

The present conditions of six railway stations in between Khulna and Jessore were surveyed.

All the inward and outward freight are surveyed on freight volume(tons), fares, OD, contents of the goods and date. The data are analyzed for one year period of July 1997 - June 1998. The results of the survey are tabulated in Table 4.1.

Table 4.1 Summary of Inward and Outward Railway Freight

Freight	Total Freight	Commodity	Origin-Destination	Remarks
Inward Total	524,000	Cement, Rice, Jute, Stone, Food, Wheat	440,000 tons (84%) from India	180,000 tons (16%) to barges
Outward Total	242,000	Wheat, Urea, Sleeper, Oil, Foodgrain	222,000 tons (92%) for domestic	20,000 tons (8%) for Nepal

Railway freight has following features:

① Inward freight tons are more than the outward freight.
② Most freight is from India by rail and that such freight would be influenced less by the bridge.
③ Railway freight is in the strong influence of inland barges.
④ Rail transport would become advantageous without handling at Khulna and Nawapara.
⑤ Too many freight stations exist in the western section.
⑥ Very high fluctuation was found in monthly freight handling.

4. 5 Railway Passenger Survey

Railway passenger survey was also conducted in Khulna – Jessore section.
Railway passenger transport has following features:

① 20% decrease between July 1997 and July 1998 was found in Khulna station.
② The service level of bus in the section Khulna – Jessore is superior to that of railway in term of frequency.
③ There is no convenient normal train service from Khulna for Jessore.

4.6 Desirable Conditions for the Bridge Study from the Viewpoint of Railway

Desirable design criteria of rail bridge is summarized in case that the bridge might be rail-cum-road type.

(1) Gradient : 1/100 or less, considering relationship between traction power of locomotive and length of a freight train.
(2) Axle load : 22.5 tons.
(3) Construction gauge and refuge space : 6 m wide (Single) and 10m (Double).

4.7 Shared Rail Transportation from the Jetty of the Mongla Port in 2015

The total handling tons at the jetty of the Mongla port is estimated 2,125,000 tons in 2015, and 763,000 tons among them could be transshipped by land transport. It is likely possible to predict that 478,000 tons among 763,000 tons are assumed long-haul freight and could be transported by railway.

4.8 Estimation of Freight Revenue in case of Railway Extension to Mongla Port

Freight revenue is estimated in Table 4.2 in case that railway should be extended to Mongla Port.

Table 4.2 Estimated Revenue

Transportation	Charge rate (Tk./ton)	Freight tons	Income (M.Tk.)
Mongla-N.W.R.	430	203,000	87
Mongla-Indian Border	430	275,000	118
Total			205

4.9 Costs for the Railway Extension to Mongla

The cost estimation of railway extension to Mongla port needs the construction cost, rolling stock cost and the transportation cost (operation and maintenance).

(1) Rolling stock cost

Required number of rolling stocks are estimated based on data and information obtained from BG section of BR. Cost of rolling stocks are estimated based on prices prevailing in an international market, namely $0.12 million/wagon and $2.5 million/loco.

Table 4.3 Rolling Stock Costs

Wagons ($0.12 million /wagon)		Locomotives ($2.5 million /loco.)		Total
700 wagons	$84 million	5 locos	$12.5 million	$96.5 million

(2) Construction cost

Construction cost of railway extension is estimated as follows.

Table 4.4 Construction Costs

Route	Cost
Eastern Route	Tk. 7,083 million ($148 million)
Western Route	Tk. 4,960 million ($103 million)

(3) Transportation cost by rail (Operation and Maintenance)

Actual transportation cost of BR is reported as Tk. 293.2/train-km, while the train-km against 478,000 ton/yr is calculated to be 214,000. Accordingly, total transportation cost is estimated Tk. 62.7 million($1.31 million).

CHAPTER 5 CURRENT WATER TRANSPORT PROFILE AND DEMAND FORECAST FOR MONGLA PORT

5.1 Status-quo of Mongla Port

(1) Cargo throughout of Mongla Port

Table 5.1 shows cargo throughput statistics of Mongla Port, including container handling. While the total cargo throughput of Mongla Port has not greatly increased, registering only 1.4% per annum, the handling volume of containers shows remarkable growth, 17.2% per annum on a tonnage basis, and 17.0% per annum on a TEU (Twenty Equivalent Unit) basis. These figures, however, are much smaller than those of Chittagong Port.

Table 5.1 Cargo Throughput of Mongla Port

(Figures in thousand metric tons and thousand TEUs)

Year	Import			Export			Total		
	Total	Container		Total	Container		Total	Container	
		Tons	TEUs		Tons	TEUs		Tons	TEUs
88/89	1,882	4.8	7.1	637	79.0	6.9	2,519	83.8	14.0
89/90	1,892	11.2	8.8	695	96.4	9.0	2,587	107.7	17.8
90/91	1,904	6.1	7.5	557	82.2	7.7	2,461	88.3	15.2
91/92	2,054	5.6	6.8	596	79.2	6.8	2,650	84.7	13.6
92/93	1,758	7.5	6.4	621	72.3	6.3	2,379	79.8	12.7
93/94	1,463	16.4	7.6	467	85.7	7.6	1,931	102.1	15.2
94/95	2,120	19.5	8.1	706	92.0	9.1	2,826	111.5	17.2
95/96	2,443	56.5	9.5	396	91.4	9.2	2,839	147.9	18.8
96/97	2,171	56.6	10.4	521	105.2	6.3	2,692	161.8	16.7
97/98	2,339	27.8	9.6	528	116.2	9.9	2,867	143.9	19.5

Source; Statistics of the MPA

Nepalese cargo with the total volume of 476 thousand tons was handled at seaports in '97/'98, among which 41 thousand tons of fertilizer was handled at Mongla Port.

Calcutta Port has been a dedicated port to handle the Nepalese sea cargo with well developed port and land infrastructure as well as special treatment of the Nepalese cargo, while Mongla Port has not played a significant role in the

Nepalese sea transportation, as referred to Table 5.2.

Table 5.2 Nepalese Cargo Throughput of Three Ports

(Figures in thousand metric tons)

Year	Calcutta Port (incl. Haldia)			Mongla Port Import	Chittagong Port Import	Total
	Import	Export	Total			
90/91	297	7	303	0	0	303
91/92	362	9	371	0	0	371
92/93	319	39	358	0	0	358
93/94	265	37	302	0	0	302
94/95	381	72	453	0	0	453
95/96	396	64	460	0	0	460
96/97	399	86	485	0	27	512
97/98	319	89	408	41	27	476

Source; Statistics of Calcutta Port Trust, MPA, and CPA

With a small amount of cargo volume, the hinterland of Mongla Port is very limited, in particular for container cargo, that is, 80% of import and 50% of export containers goes to/comes from the Khulna area, probably due to a lack of proper land transport infrastructure.

(2) Port Facilities

Mongla Port has 5 jetty berths, 8 single moorings, and 19 anchorage berths now in use. Approximately 94% of cargo is handled at the mooring and anchorage berths, leaving the share of the jetty berths at only 6%. This implies that Mongla Port greatly depends on inland water transport for hinterland cargo movement. The jetty berths are underutilized, partly because of an inefficient land transportation system.

Mongla Port has suffered from siltation due to a river port. The MPA has carried out dredging works to maintain the maximum draft of a navigable vessel at around 7m, which is highly thought of by port users.

5.2 Cargo Demand Forecast

(1) Forecast Methodology

First, the total cargo demand for the two Bangladeshi seaports is projected assuming 5.0% per annum economic growth rate. Secondly, after examining the future shares of both ports due to inland transport development, the cargo demand for Mongla Port is calculated. The Nepalese cargo is projected in the

same manner; that is, the total projected cargo is broken down to that for Mongla Port.

(2) Cargo Demand for Bangladeshi Seaports and Functional Allotment

The total port cargo demand for the Bangladeshi two seaports is projected by commodity using correlation analysis with the GDP on the assumption that the Bangladeshi economy will grow at 5% per annum, as referred to Table 5.3.

Table 5.3 Cargo Throughput of Bangladeshi Seaports in 2015

(Figures in thousand metric tons)

Year	Import									
	General Goods	POL	Cement	Food-grain	Fertilizer	Clinker	Edible Oil	Sugar, Salt	Others	Total
97/98	4,099	2,794	2,001	1,164	737	604	366	105	30	11,900
2015	14,711	6,661	2,200	1,450	1,478	3,271	484	130	71	30,456
Year	Export								Grand Total	
	Jute, Jute Goods	Garments	General Goods	Fertilizer	Naphtha	Shrimp	Others	Total		
97/98	763	343	339	331	110	17	151	2,055	13,955	
2015	985	1,844	681	869	100	75	815	5,369	35,825	

(3) Cargo Demand for Mongla Port in 2015

The total cargo at Mongla Port in 2015, excluding that to/from Nepal, is projected at 5,811,000 tons, more than double the present volume, as referred to Table 5.4.

Table 5.4 Cargo Throughput of Mongla Port in 2015

(Figures in thousand metric tons)

Year	Import									
	General Goods	POL (LPG)	Cement	Food-grain	Fertilizer	Clinker	Edible Oil	Sugar, Salt	Others	Total
97/98	65	0	955	285	412	604	0	0	19	2,339
2015	856	79	1,100	363	739	1,635	0	0	53	4,825
Year	Export								Grand Total	
	Jute, Jute Goods	Garments	General Goods	Fertilizer	Naphtha	Shrimp	Others	Total		
97/98	504	0	4	0	0	17	2	528	2,867	
2015	660	92	134	0	0	75	24	985	5,811	

Notes; "Mongla Port Area Development Project Study" financed by the ADB estimated the cargo demand for Mongla Port in 2010 as 6.05 million tons.

"Bangladesh Port System Development Project Study" financed by the WB estimated that in 2016/2017 as 5.79 million tons.

(4) Container Cargo Demand

The volume of containerized cargo is projected assuming containerization ratio for each commodity, namely, 100% for all the commodities except jute and jute goods.

The container cargo volume is projected to greatly increase, reaching more than ten times the present level, as referred to Table 5.5.

Table 5.5 Container Cargo Throughput of Mongla Port in 2015

(Figures in thousand metric tons)

Year	Import			Export						Grand Total
	General Cargo	Others	Total	Jute, Jute Goods	Garments	General Cargo	Shrimp	Others	Total	
97/98	24	4	28	99	0	0	17	0	116	144
2015	856	53	909	396	92	134	75	24	721	1,631

(5) Demand Forecast for Nepalese Cargo

Assuming 4.0% annual growth of the Nepalese economy, the total Nepalese seaborne cargo is projected to reach 1,994 thousand tons in 2015 (476 thousand tons in '97/'98). This volume of cargo is allocated to the three ports, Mongla, Chittagong and Calcutta, and it is presumed that the most probable case is the one where Mongla Port has shares of 50% for dry bulk cargo and 20% for general cargo. The estimated volume of the Nepalese cargo handled at Mongla Port in 2015 is 400 thousand tons including 41 thousand TEUs of containers.

(6) Cargo Handled at the Jetty

The cargo that will be handled at the jetty is projected on the assumption that a small amount of bulk cargo in addition to all of container cargo and break bulk cargo will be handled at the jetty. The total cargo volume, all of which is to be transshipped by land transport modes, will reach more than 2 million tons (160 thousand tons in '97/'98), as referred to Table 5.6.

Table 5.6 Handling Forms of Port Cargo

(Figures in thousand metric tons)

Handling Form		Cargo Volume in 2015
Jetty	Container	1,940 (242 thousand TEUs)
	Conventional	185
River		4,086

(7) OD Pattern of Jetty Cargo

The future OD table of the cargo handled at the jetty is constructed taking into account the effects of the opening of the two bridges, Rupsa and Paksey, and the present cargo movement pattern which is grasped with the existing data and additional interview surveys. The hinterland of Mongla Port is expected to expand to the western region and slightly to the Dhaka area.

(8) Port-Related Land Traffic

Port related land traffic is defined as that generated from the port area, which covers the public jetty, cement factories, a planned LPG distribution depot, a planned EPZ, and port administration facilities. All the traffic is projected as the number of container trailers, trucks, and passenger vehicles, assuming the average tonnage loaded on a truck, a load factor, and a coefficient between the number of trucks and that of business vehicles etc. While currently the number of trucks generated from Mongla Port is not so large, the future land traffic is projected to reach approximately 5 thousand trips a day, as referred to Table 5.7.

Table 5.7 Total Land Traffic Generated from the Port Area

(Figures in trips/day)

	97/98			2015				
	Trucks	Passenger Vehicles	Total	20 foot Trailers	40 foot Trailers	Trucks	Passenger Vehicles	Total
Jetty	120	60	180	600	360	140	550	1,650
Cement LPG	100	50	150	0	0	1,220	610	1,830
EPZ	0	0	0	0	0	(200)*	1,300	1,300
Total	220	110	330	600	360	1,360	2,460	4,780

Note; Theoretically, most of this movement is between the EPZ and the jetty.

CHAPTER 6 TRAFFIC DEMAND FORECAST

6.1 Present OD Tables

Traffic survey in the study area was carried out for grasping the present traffic conditions and getting the fundamental data to forecast the future traffic demand crossing the Rupsa river. The present OD tables by vehicle type were made based on the results of roadside interview survey.

Table 6.1 shows the present OD matrix by seven (7) combined zones. Fig. 6.1 represents desired lines based on the present OD traffic volumes.

6.2 Future OD Tables

(1) Control Total

Forecasts on national transport demand as published in the "Bangladesh Integrated Transport System Study" (BITSS) by the Planning Committee of the Government of Bangladesh are arranged in the following Table 6.2.

Table 6.2 Future National Transport Demand

Year	Passenger (billion passenger-Km)	Freight (billion ton-Km)
1974/75	17	2.6
1984/85	35	4.8
1988/89	57	6.3
1992/93	66	9.0
1996/97	72	10.2
1997/98	77	10.9
1999/2000	89	13
2004/2005	116	17
2009/2010	150	23
2014/2015	196	30

Note : 1) Values for passenger-Km and ton-Km in 1997/98 are estimated by the Study Team.
Source : BITSS

This study applies the forecast results for total traffic demand (control total) derived within the national transport plan constructed by BITSS as priority planning figures. Accordingly, this study applies future increases between 1998 and 2015 of 2.54 times for passenger demand, and 2.75 for freight demand.

(2) Modal Share Analysis by Different Transport Modes

Based on the trend of transport demand, the future modal share has been forecasted in the BITSS as shown in Table 6.3.

Table 6.3 Transport Demand and Modal Shares

Year	Passenger					Freight				
		Modal Distribution					Modal Distribution			
	Passenger-Km (billion)	Road (%)	Rail (%)	Watert (%)	Total (%)	Ton-Km (billion)	Road (%)	Rail (%)	Watert (%)	Total (%)
1974/75	17	54	30	16	100	2.6	35	28	37	100
1984/85	35	65	20	16	100	4.8	48	17	35	100
1988/89	57	68	17	15	100	6.3	59	11	30	100
1992/93	66	75	12	13	100	9.0	61	7	32	100
1996/97	72	73	13	14	100	10.2	63	7	30	100
1997/98	77(1.00)	-	-	-	100	11(1.00)	-	-	-	100
1999/2000	89(1.15)	76	10	13	100	13(1.19)	65	10	25	100
2004/2005	116(1.50)	79	10	11	100	17(1.56)	68	11	21	100
2009/2010	150(1.94)	80	10	10	100	23(2.11)	70	11	19	100
2014/2015	196(2.54)	82	10	8	100	30(2.75)	72	11	17	100

Note : 1) Data relate to Mechanized transport only and data relating to raod transport referes to Bus, Truck, Car and other four wheelers.
2) Values for passenger-Km and ton-Km in 1997/98 are estimated by the Study Tewam.

Source : BITSS

As regards passenger transport demand, the share of road transport indicates an upward trend from 73% in 1996/97 to 82% in 2014/15, while the rail and waterway shares show some decreasing trend during the same period. In the case of freight transport, the share of road transport shows some increasing trend from 63% to 72% while the share of waterway transport may decline to 11% from 30%. The share of rail transport is forecasted the marginal increase, due to alignment of rail on the JMB and establishment of rail link between Joydebpur and the bridge site.

Increase in road transport of passengers and freight will be guaranteed by the shared use of the JMB, the building of the Dhaka Eastern Bypass and the construction of road bridges at Paksey and Bhairab.

Based on the BITSS forecasts, road transport of freight and passengers between 1998 and 2015 is expected to increase by factors of 2.81 and 3.14, respectively, mirrored by a proportional increase in passenger and freight vehicles. In this light, the factor of 2.71 for increase in passenger vehicles (motorcycles, auto-rickshaws, cars and buses) can be considered to be reasonable.

Table 6.1 Present OD Table (All Vehicles)

Unit: veh./day

	Khulna City	Rupsa, Fakirhat, Rampal	Jessore, Northwest Area, Dhaka etc.	Satkhira etc.	Mongla port	Bagerhat, Barisal Division etc.
Khulna City	1990	129	2247	1360	242	130
Rupsa, Fakirhat, Rampal	133	481	19	8	164	233
Jessore, Northwest Area, Dhaka etc.	2160	11	27	63	44	37
Satkhira etc.	1306	9	182	13	1	1
Mongla port	130	182	34	5	3	108
Bagerhat, Barisal Division etc.	185	273	49	10	90	2
Mollahat etc.	24	363	2	8	2	29

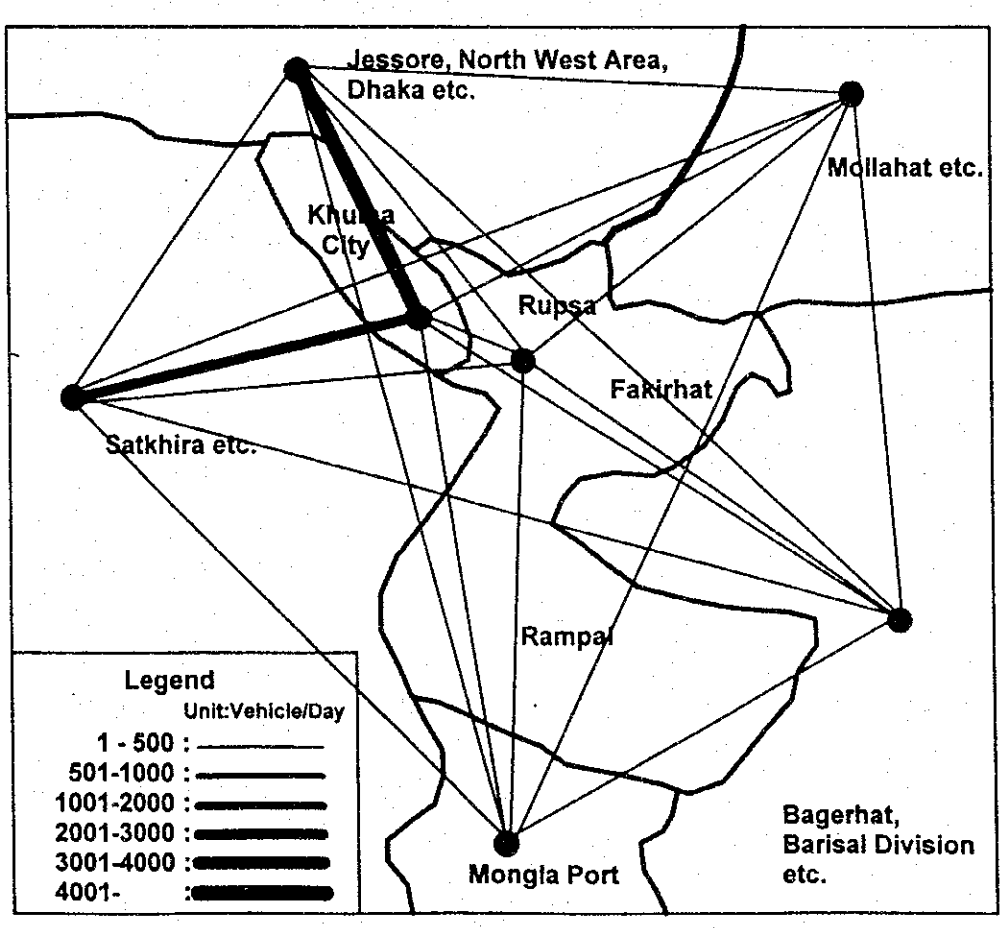

Fig. 6.1 Desire Line (All Vehicles) in 1998

(3) Future Traffic Volumes by Zone

Forecasting of future traffic volumes in the various zones is carried out using future passenger and freight total demand (control total) figures as well as socioeconomic indicators by zone.

Indicators used in this Study include zonal population for forecasting passenger traffic volumes by zone and freight traffic demand forecast done by BITSS on the Zila level.

(4) Traffic Patterns Analysis at the Rupsa Ferry Ghat

As indicated, the Rupsa Ferry is normally congested; in particular, the auto-rickshaws and busses which bear the burden of so much of public transport avoid boarding the ferry for reasons of efficiency. Instead, passengers are let off at the ghat, cross by ferry, and then board auto-rickshaws or busses once again to take them to their destinations. This situation is expected to be much ameliorated by the construction of the bridge across the Rupsa River.

The latent traffic demand for Rupsa River crossing that will arise upon the construction of the bridge can be forecasted on the basis of Origin-Destination studies of the existing situation.

(5) Vehicular Traffic Volumes Arising from Mongla Port Freight Handling

2,125,000-ton cargo handled at the jetty of Mongla Port in 2015 are applied in the forecasting of vehicular traffic volumes arising from the harbor freight handling. Moreover, the vehicular traffic volumes in the case of the railway extension from Khulna to Mongla Port are examined here. In this case, it is forecasted that a part of long-distance freight transport demand (for example, freight transport demand to North-Western Region and Nepal) would be mainly diverted to rail transport.

(6) Future OD Table Forecasting

Based on the information presented above, the procedure for the construction of OD tables describing future traffic conditions is as follows:

a) Future OD projections are mainly constructed following the Present Pattern procedure.
b) OD traffic volume estimates prepared by the Present Pattern Methods should be adjusted for future traffic flow patterns forecast at the Rupsa Ferry ghat area.
c) Further, existing OD tables on vehicular traffic arising from the handling of freight at Mongla Port can be adjusted by the projected increase in freight

handled at this port. Furthermore, in the case with railway extension, adjustment to the OD tables will be necessary.

6.3 Projection of Future Traffic Volume

Traffic assignment simulation is carried out using the software STRADA (System for Traffic Demand Analysis), supplied by JICA.

Traffic assignment is conducted using the Equilibrium Assignment Method (EAM) found in the JICA STRADA program. The equilibrium assignment is based on the total system optimization and loads the OD trips to the network so as to minimize the total travel time in the network.

Traffic assignments are executed using forecast future OD tables and the road network as described. The resulting six cases are shown in the following Table 6.4.

Table 6.4 Traffic Assignment Cases

Network	Future OD	
(Bypass route)	without Railway Extension	with Railway Extension
Route A(without Rupsa Ferry)	CASE 1	CASE 2
Route B(with Rupsa Ferry)		
with KDA Bypass	CASE 3	CASE 4
without KDA Bypass	CASE 5	CASE 6

Based on the assignment results by case, traffic volumes crossing the bridge over the Rupsa River are analyzed, and the results are shown in Table 6.5.

Table 6.5 Traffic Volumes Crossing Bridge over Rupsa River

	Present (Ferry) (vehicles/pcu)	CASE 1 (vehicles/pcu)	CASE 2 (vehicles/pcu)	CASE 3 (vehicles/pcu)	CASE 4 (vehicles/pcu)	CASE 5 (vehicles/pcu)	CASE 6 (vehicles/pcu)
Motorcycle	381/114	1117/335	1120/336	967/290	1003/301	977/293	977/293
Autorickshaw	30/30	2536/2536	2536/2536	2279/2279	2350/2350	2292/2292	2294/2294
Car	232/232	1120/1120	1120/1120	1012/1012	1041/1041	1012/1012	1013/1013
Bus	211/528	3465/8663	3512/8779	2902/7255	3037/7592	2944/7360	2978/7445
Truck	409/818	2915/5829	2556/5112	2637/5274	2337/4673	2636/5271	2273/4546
Total	1263/1722	11153/18483	10844/17883	9797/16110	9768/15957	9861/16228	9535/15591
Average Trip Length (Km)	-	53.5	53.3	68.5	69.5	68.9	68.6

Results of traffic assignment are shown in Fig. 6.2.

Traffic demand on the Bridge is forecasted 11,150 vehicles/day in Case-1 (Route A and without Railway Extension) and 9,800 vehicles/day in Case-3 (Route B and without Railway Extension), while average trip length is 53.5 km in Case-1 and 68.5 km in Case-3, that is 28% increase. It is obvious that Route B forces vehicles to make detour and meets traffic demand in lesser degree.

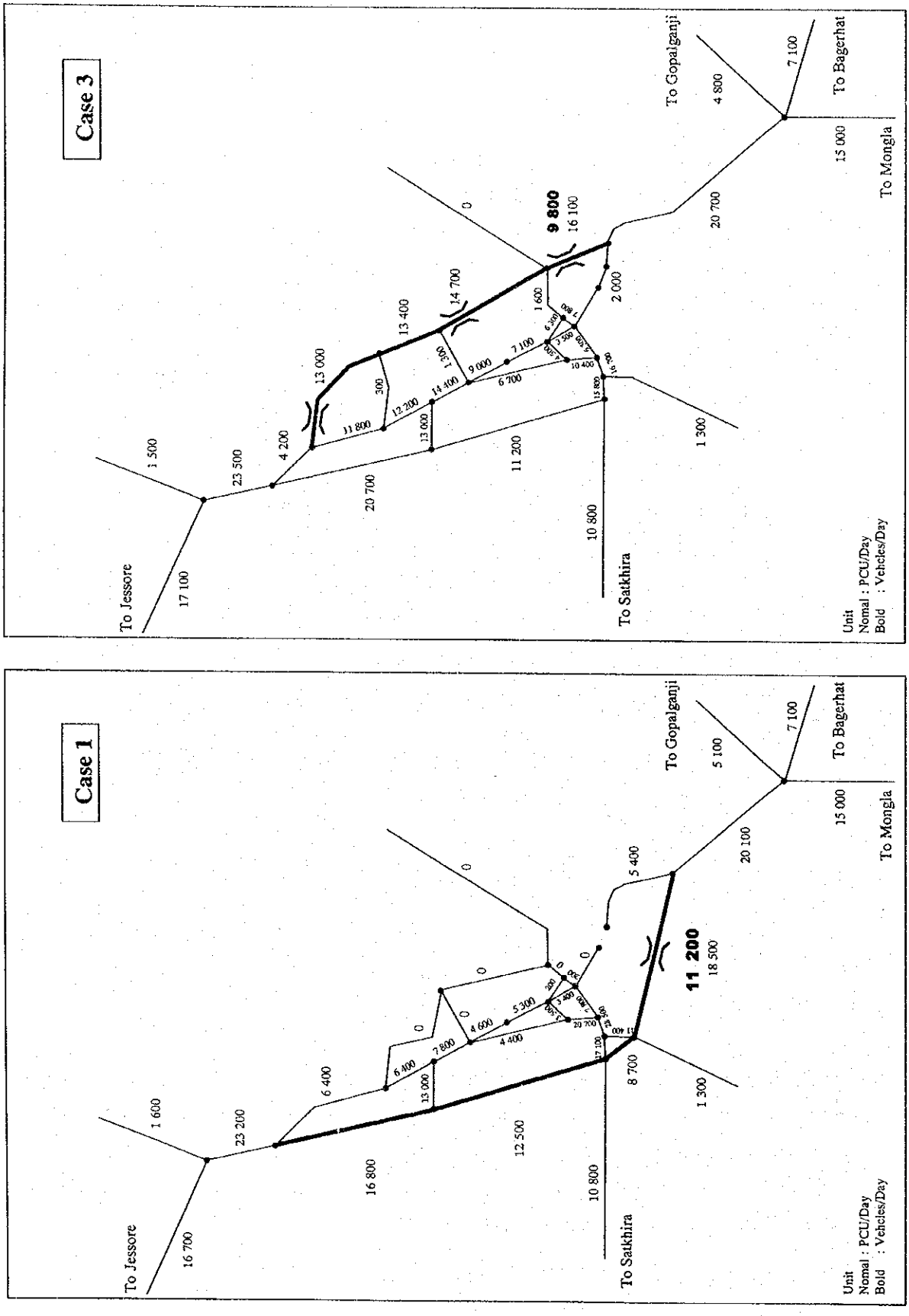

Fig. 6.2 Traffic Assignment Volumes