

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)  
NATIONAL CAPITAL REGION PLANNING BOARD (NCRPB)  
GOVERNMENT OF INDIA

**THE FEASIBILITY STUDY  
ON THE CONSTRUCTION OF EXPRESSWAYS  
IN THE NATIONAL CAPITAL REGION IN INDIA**

**FINAL REPORT**

**SUMMARY**

**MARCH 2000**

JICA LIBRARY



J 1157474 (6)

JICA

107

61.4

SSE

LIBRARY

PACIFIC CONSULTANTS INTERNATIONAL

S S F

J R

00-090







**JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)  
NATIONAL CAPITAL REGION PLANNING BOARD (NCRPB)  
GOVERNMENT OF INDIA**

**THE FEASIBILITY STUDY  
ON THE CONSTRUCTION OF EXPRESSWAYS  
IN THE NATIONAL CAPITAL REGION IN INDIA**

**FINAL REPORT**

**SUMMARY**

**MARCH 2000**

**PACIFIC CONSULTANTS INTERNATIONAL**



1157474 (6)

**The following foreign exchange rate is applied in the study:**

**US\$ 1.00 = Rs. 42.50 (as of August 1999)**

## PREFACE

In response to the request from the Government of India, the Government of Japan decided to conduct the Feasibility Study on the Construction of Expressways in the National Capital Region in India and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to India a study team headed by Mr. GUNJI Isamu, Pacific Consultants International Co., Ltd., four times between November 1998 to March 2000.

The team held discussions with the officials concerned of the Government of the Republic of India, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

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

I wish to express my sincere appreciation to the officials concerned of the Government of India for their close cooperation extended to the team.

March 2000

A handwritten signature in black ink, appearing to read 'Kimio Fujita', written over a horizontal line.

Kimio Fujita  
President  
Japan International Cooperation Agency





March 2000

Mr. Kimio Fujita  
President  
Japan International Cooperation Agency

**Subject: Letter of Transmittal**

Dear Sir,

We are pleased to submit herewith the Final Report of "The Feasibility Study on the Construction of Expressways in the National Capital Region in India".

The report contains results of the study which was carried out by Pacific Consultants International between December 1998 and March 2000. The report consists of three volumes of Summary, Main Report and Drawings.

The Summary briefly illustrates the findings of the entire study. The Main Report is comprised of 14 Chapters and presents current transport profiles, feasibility and implementation studies on the Project. It recommends that the Project should be implemented at the earliest opportunity, and necessary policy measures and actions should be taken so as to realize the "down-to-earth" blueprint in a timely manner. The Drawings compile plans and details associated with the preliminary design of the expressways, bridges and other structures.

We wish to express grateful acknowledgement to the personnel of your Agency, Ministry of Foreign Affairs, Advisory Committee, Ministry of Construction and Embassy of Japan in India, and also to officials of National Capital Region Planning Board, Government of India for their assistance extended to the Study Team. The Study Team sincerely hopes that the result of this study will contribute to the development of expressway network in India.

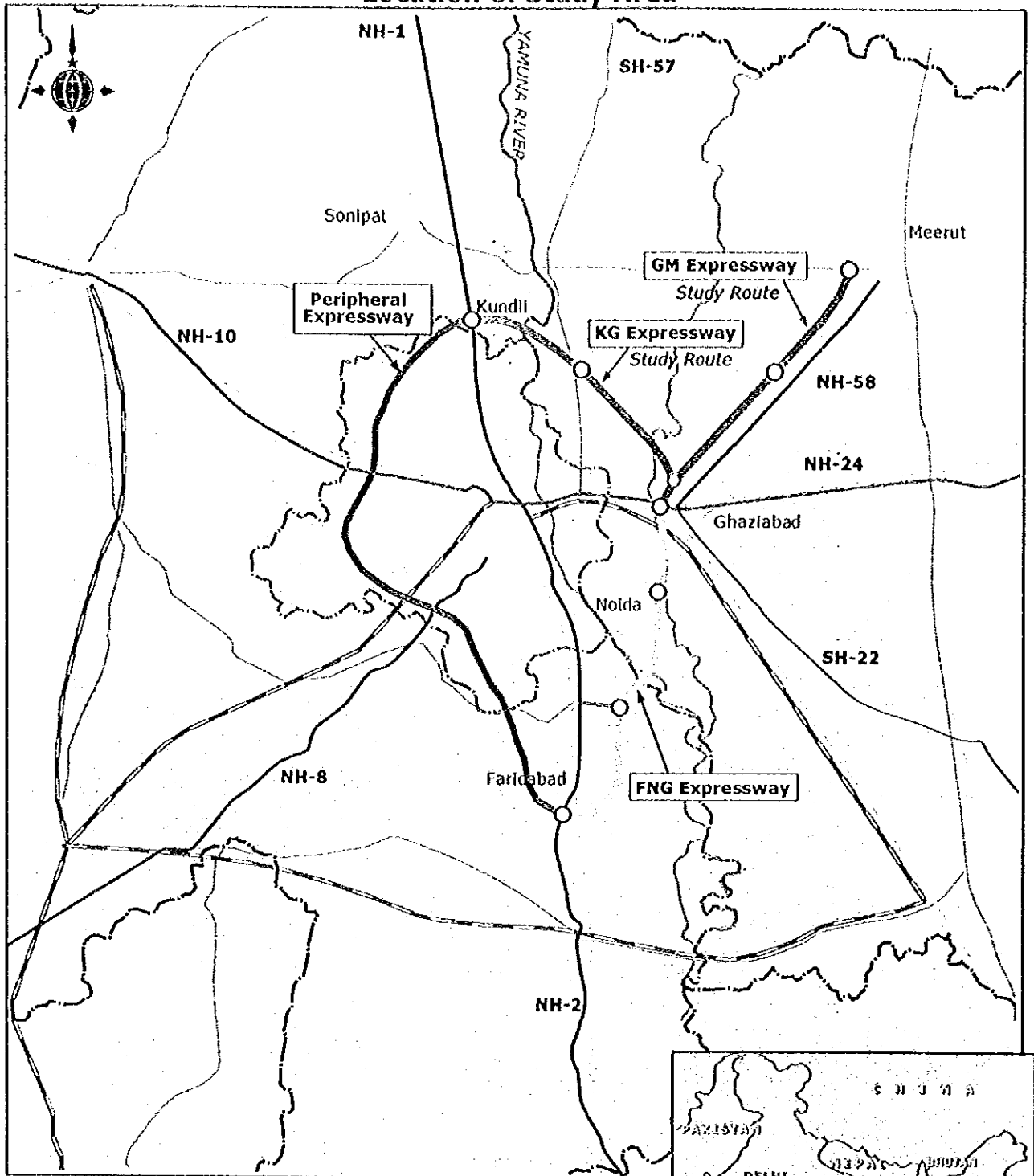
Yours faithfully,



---

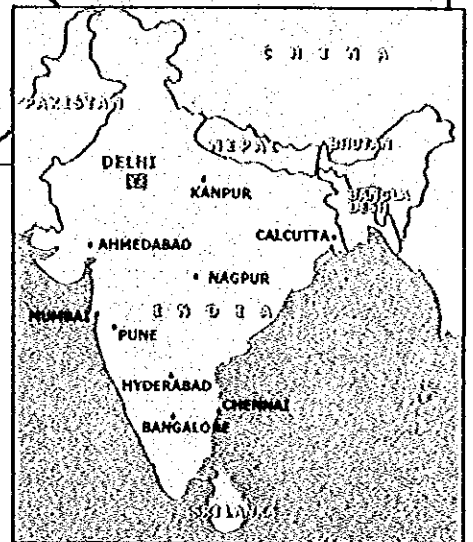
Isamu Gunji  
Team Leader, JICA Study Team  
The Feasibility Study on the Construction  
of Expressways in the National Capital  
Region in India

## Location of Study Area



**LEGEND**

- Study Routes
- FNG Expressway
- Peripheral Expressway
- National Highway
- State Highway
- Railway
- State Boundary
- NCR Boundary



## PROJECT SUMMARY

1. COUNTRY	The Republic of India
2. NAME OF STUDY	Feasibility Study on the Construction of Expressways in the National Capital Region
3. COUNTERPART AGENCY	National Capital Region Planning Board
4. OBJECTIVE OF STUDY	To carry out the feasibility study for K-G and G-M Expressways

1. STUDY AREA: North and Northeast vicinity of Delhi in the NCR and in the states of Haryana and U.P.

### 2. FUTURE TRAFFIC VOLUME

Section		Kundli - Khekra	Khekra - Junction	Meerut - Modinagar	Modinagar - Junction	Junction - Ghaziabad
Section Length		14.2 km	26.6 km	16.35 km	15.0 km	8.6 km
Traffic Volume (PCU/day)	Year 2006	41,200	30,900	24,300	27,700	43,100
	Year 2016	67,000	52,900	40,400	50,700	74,400
	Year 2026	112,800	98,100	75,200	101,300	132,300

### 3. NUMBER OF LANES AND STAGE CONSTRUCTION

Section		Kundli - Khekra	Khekra - Junction	Meerut - Modinagar	Modinagar - Junction	Junction - Ghaziabad
Number of Lanes	Year 2006	2 + 2	2 + 2	2 + 2	2 + 2	3 + 3
	Year 2022	3 + 3	3 + 3	3 + 3	3 + 3	4 + 4

### 4. PROJECT COST

Item	K-G Expressway (Kundli-Ghaziabad)		G-M Expressway (Junction - Meerut)		Total
	Local	Foreign	Local	Foreign	
- Unit: million Rs.					
- August 1999 Prices					
- US\$1.0 = Rs.42.50					
Initial Project Cost	7,023	484	3,605	237	11,349
Widening Cost	1,476	147	732	57	2,412
Overlay (for Initial width)	422	46	294	32	794
Overlay (for Ultimate width)	590	65	381	42	1,080

### 5. IMPLEMENTATION SCHEDULE

Description	1999	2000	2001	2002	2003	2004	2005	2006
Feasibility Study	█							
Final Engineering Design		█						
Land Acquisition			█	█	█			
Construction				█	█	█	█	█
Opening to Traffic								↓

### 6. ECONOMIC AND FINANCIAL INDICATORS

Section	EIRR
K-G and G-M	26.37 %
K-G Only	27.05 %
G-M Only	25.30 %

Section	FIRR *
K-G and G-M	10.4 %
K-G Only	9.6 %
G-M Only	8.9 %

\* at a toll rate of Rs.1.5/pcu-km

### 7. RECOMMENDATIONS

- 1) The results of the Study indicate that the Projects are technically sound and economically highly feasible.
- 2) The financial viability of the Projects is not satisfactory considering the prevailing Indian financial environments.
- 3) In these circumstances, the Projects should be implemented by PPP (Private-Public Partnership).
- 4) GOI/NCRPB should consider recourse financing or positively guaranteeing returns for private equity holders.
- 5) Public equity holders should not expect a high ROE to ensure a reasonable ROE to the private equity holders.
- 6) GOI/NCRPB should consider obtaining ODA funds with sovereign guarantee to improve the cash flow.
- 7) A toll rate of Rs.1.5/pcu-km is recommended, but reasonable periodic toll increase should be considered.



## EXECUTIVE SUMMARY

### The Feasibility on the Construction of Expressways in the National Capital Region in India

- Study Period: December 1998 - March 2000
- Counterpart Agency: National Capital Region Planning Board,  
Ministry of Urban Development

#### 1. Study Background

In response to the request of the Government of India, the Government of Japan decided to conduct "The Feasibility Study on the Construction of Expressways in the National Capital Region in India" (hereinafter referred to as "the Study").

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the cooperation programs of Japan, undertook the execution of the Study, and selected Pacific Consultants International, Japan, as the consulting firm to organize the JICA Study Team for the actual conduct of the Study.

#### 2. Study Objective

The purpose of the study is to carry out the feasibility study for the proposed Ghaziabad-Meerut Expressway and Kundli-Ghaziabad Expressway, the total length of which is approximately 80 km. The study also aims to conduct technical transfer to the Indian counterpart personnel in the course of the Study.

#### 3. Study Area

The study area includes such a direct influence area of the project as the north and northeast vicinity of National Capital Territory of Delhi (NCTD, which is generally referred as "Delhi"), and the National Capital Region (NCR) as a whole. NCR is comprised of four states, which are Uttar Pradesh (UP), Haryana, Rajasthan and NCTD.

#### 4. Existing Conditions of Study Area

##### 4.1 Social and Economic Conditions

###### (1) Population

The population of NCR increased from 19.0 million in 1981 to 26.4 million in 1991 at an annual growth rate of 3.3 percent, and it is estimated to be 34.2 million in 1999. Sub-regional population in NCR in 1999 is estimated at 13.3 million, 8.3 million, 10.8 million and 1.8 million persons for Delhi, Haryana, U.P. and Rajasthan respectively.

In NCR, the urbanization level has reached 52 per cent in 1991 and expected to reach 58% in 2001. The population density of NCR is estimated at 11.3 persons/hectare and that of Delhi at 89.3 persons/hectare in 1999.

## (2) Land Use

A total land area of NCR is 30,211 km<sup>2</sup>, in which Delhi occupies 1,483 km<sup>2</sup>, sub-regions Haryana 13,413 km<sup>2</sup>, U.P. 10,823 km<sup>2</sup> and Rajasthan 4,492 km<sup>2</sup>.

The existing land use of NCR in 1986-87 shows that the cultivated and non-agricultural land uses in Delhi account for 64% and 24% of the total land area respectively, whereas in Haryana 81% and 10%, in U.P. 82% and 11% and in Rajasthan 74% and 4%.

## (3) Economic Activities

NCR generates 4.6% of the India's Gross Domestic Product (GDP) in 1996, despite it shares only 1.0% of the total land area of India or 3.1% (in 1991) of the total population of India.

According to the World Development Report 1998/1999, India's GNP per capita in 1997 is US\$390 and it has increased at an average growth rate of 3.2% during 1996-1997. Available information about income in the Study area is the Net National Product (NNP) per capita, and which is Rs.6,049 at 1980-81 constant price in 1995-96 for Delhi, Rs.3,670 for Haryana and Rs.1,666 for U.P., while Rs.2,573 as the national average at 1980-81 constant price or Rs.12,097 at current price.

## 4.2 Transport Mode and Traffic

In Delhi there is currently no mass transit system, although a mass transit system is under construction. Delhi has a high urban population in comparison with other cities in India. It also has one of the highest per capita incomes in India and as a result has the largest number of motorized vehicles.

Early in the last decade Delhi was known for having the highest number of cycles of any city in India. This tendency towards personalized transport has continued and now has resulted in the replacement of the bicycle by private motorized transport in the form of cars and two wheelers. Between 1980 and 1995 the car fleet in Delhi increased at a rate of nearly 10 % per annum. In 1995, the number of two wheelers in Delhi is 1.7 million, three wheelers are 78 thousand, and cars are 763 thousand.

Non motorized transport still plays an important role in Delhi with over 1 million cycles in the city and a large number of rickshaws. These however are principally used for short distance trips.

The present traffic between Delhi and Ghaziabad shows the highest volumes in the Delhi area. The results of the traffic counts show that NH24 and its bypass carries 85,000 vehicles/day. NH58 between Ghaziabad and Modinagar carries 21,000 vehicles/day.

## 5. Project Outline

### 5.1 Future Socio-economic Framework and Traffic Demand Forecast

#### (1) Future Socio-economic Framework

The analysis of the socio-economic framework predicts that the NCR population in 2011 and 2021 will be 1.43 times and 1.71 times the 1999 population, respectively, and the NCR economic growth in 2011 and 2021 will be 1.79 times and 2.87 times that of 1999, as shown in Table 5.1.

**Table 5.1: Estimated Future Socio-Economic Framework in NCR**

Year	1999	2006	2016	2026
Population(x1000)	34,220	42,681	53,756	66,308
NSDP* (in Bill. Rs.)	636	926	1,482	2,371
Employment (x1000)	7,577	10,741	14,741	18,527

Note: \*Net State Domestic Product

Source: JICA Study Team

#### (2) Future Traffic Demand Projection

Based on the future socio-economic framework, future traffic demand was forecast in 5-year cycles for each of the years of 2006, 2011, 2016, 2021 and 2026.

Table 5.2 shows a summary of traffic demand forecast.

**Table 5.2: Summary of Traffic Demand Forecast**

	2006 <sup>1)</sup>	2016 <sup>2)</sup>	2021 <sup>2)</sup>	2026 <sup>2)</sup>
<b>K-G Expressway (pcu/day)</b>				
Kundli IC	41,200	67,000	87,400	112,800
Khekra IC	30,900	52,900	76,100	98,100
JUNCTION				
<b>G-M Expressway (pcu/day)</b>				
Meerut IC	24,300	40,400	56,700	75,200
Modinagar IC	27,700	50,700	75,500	101,300
JUNCTION	43,100	74,400	102,600	132,300
Ghaziabad IC				

Note: 1) with FNG Expressway

2) with FNG, Peripheral and G-M Expressway Meerut Extension

Source: JICA Study Team

## 5.2 Technical Aspects

### (1) Route Selection

A total of nine alternative route combinations was established, and these were examined from engineering and economic viewpoints. As a result of the comparison, the optimum route was selected for K-G and G-M Expressways from the aspects of engineering, environmental impacts, regional development, and economic feasibility.

The total route length of K-G Expressway (Kundli IC - Ghaziabad IC) is 49.00 km, and that of the G-M Expressway (Ghaziabad North Junction - Meerut IC) is 39.55 km.

### (2) Major Design Features

- a) A 120 km/hr design speed was applied for the entire expressway sections.
- b) Based on the traffic demand forecast, initial 4-lane/ultimate 6 lane stage construction was applied for Kundli - Junction and Junction - Meerut sections. Initial 6-lane/ultimate 8 lane stage construction was applied for the common section (Ghaziabad - Junction).
- c) A distance-based toll levy system was recommended for the expressways. Five interchanges, Kundli IC, Khekra IC, Meerut IC, Modinagar IC and Ghaziabad IC will be provided as either double trumpet or single trumpet type.
- d) A throughway toll plaza will be provided at the north of Ghaziabad IC, if Ghaziabad IC adopts the original partial cloverleaf type, as proposed in the FNG Feasibility Study. The toll plaza will not be necessary, if Ghaziabad IC adopts the trumpet type as recommended in this study.
- e) The total length of bridge and viaduct is 1.54 km taking up 1.9 % of the total length of the expressways. Precast PC I girders were recommended as the general superstructure type, because of the economy and ease of construction.
- f) Most of the earth work section is embankment. Total volume of embankment with borrow material is estimated to be 12 million m<sup>3</sup>.
- g) Flexible pavement was recommended with a view to lower initial investment cost, which contributes to a lower life cycle cost, than in the case for rigid pavement.

## 5.3 Project Cost

The project cost (the initial project cost) is Rp.11,349 million in 1999 prices as shown in Table 5.3.



**Table 5.3: Summary of Initial Project Cost**

[Unit: Rs. million]

Construction Cost	7,323
Land Acquisition & Compensation Cost	1,649
Engineering Cost	897
Administration Cost	449
Contingency	1,031
<b>Total</b>	<b>11,349</b>

Source: JICA Study Team

#### 5.4 Implementation Schedule

The total implementation schedule including construction time schedule in the earliest case is presented in Figure 5.1.

**Figure 5.1: Implementation Schedule**

	1999	2000	2001	2002	2003	2004	2005	2006
Feasibility Study	█							
Final Engineering Design		█						
Land Acquisition			█	█	█			
Construction				█	█	█	█	
Opening to Traffic								▼

Source: JICA Study Team

### 6. Project Evaluation

#### 6.1 Results of Economic Analysis

The economic analysis for determining the EIRR was carried out by using the conventional discounted cash flow method. The economic benefits quantified were the savings in vehicle operating cost, time costs and accident costs. The results indicated that the project is highly feasible from economic viewpoints.

	Length	EIRR
K- G and G-M	80.75 km	26.37 %
K-G Only	49.00 km	27.05 %
G-M Only	39.75 km	25.30 %

The sensitivity test shows that even the most severe case of -20 % benefit and +20 % cost still maintains an EIRR of 21.20 %.

## **6.2 Results of Financial Analysis and Implementation Study**

The financial analysis was carried out by performing case studies for setting possible financial structures for the project. The pre-tax FIRR for K-G and G-M Expressways in constant 1999 prices is 10.4 % which is much lower than acceptable commercial project implementation level. The result shows that a 100 % private sector concessionaire approach cannot meet long-term debt-service during the first 5 operational years even with 100 % off-shore financing, which could substantially reduce the financial cost as compared to domestic financing.

The possible implementation scheme would be a private or public sector dominated PPP approach, which should be able to reduce the project cost by risk sharing between private and public sectors, such as treating the land acquisition and compensation cost as "sunk" cost, or introducing ODA financing mechanism with some forms of government guarantee.

## **7. Environmental Aspects**

Maximum attention was paid in the process of optimum route selection to minimize adverse environmental impacts, in particular such social impacts as displacement of residents.

An Environmental Impact Assessment was carried out to identify possible adverse impacts and examine their mitigation measures. The EIA suggests that most of the possible adverse impacts can be mitigated, if the design is carefully prepared and proper construction methods are adopted. The most significant environmental problems will be displacement of residents and farms in the pre-construction phase, and noise/vibration/air quality impacts in the operational phase. Displaced families should be sufficiently compensated or resettled to suitable areas. Farms and factories acquired for the right of way should be sufficiently compensated. Noise/vibration/air quality problems are related to various factors, some of which can be mitigated by careful design for the roadside, and suitable construction methods.

## **8. Conclusion and Recommendations**

### **8.1 Implementation of the Project**

The results of the Study indicate that the projects are technically sound (no serious technical difficulty is anticipated for construction) and economically highly feasible. Taking into account the direct and enormous indirect benefits towards regional development in addition to the quantified savings in travel costs, the projects should be implemented at the earliest opportunity.

However, when the estimated constant pre-tax FIRR is compared with the prevailing interest rates and financial environment in India or even with possible off-shore financing

opportunities, the financial viability of the Projects is not satisfactory. It is necessary to consider the following measures and strategies toward implementation.

***Recourse/Non-recourse Financing:*** A recourse financing approach would strengthen the confidence of private investors and considerably reduce the private sector risk. If recourse financing is not possible, however, the GOI/NCRPB should consider positively guaranteeing returns for financing institutions and private equity investors.

***Equity Structure:*** If a public sector dominated PPP is established first, the shareholders of the Central and State Governments as well as NCRPB have to invest in the equity without expecting a high ROE to ensure a reasonable ROE to the private equity holders. In the case of a private sector dominated PPP, the GOI/NCRPB may also need to assume measures to safeguard the ROE for the private investors

***Debt Structure:*** India's financial market offers long-term funds at around 16 % interest for up to 10 to 12 years. The GOI/NCRPB should consider obtaining ODA funds from international funding institutions. This would involve a sovereign guarantee to the lender and assumption of the exchange rate risk. It would, however, provide a positive impact on private sector confidence and ease the burden on the project's cash flow.

***Toll Rate:*** The recommended toll rate of Rs.1.5/pcu-km should not exceed user benefits. However, the GOI/NCRPB should consider allowing periodic toll increase, perhaps in line with real per capita income increase, which would keep constant the toll impedance to expressway users in real prices.

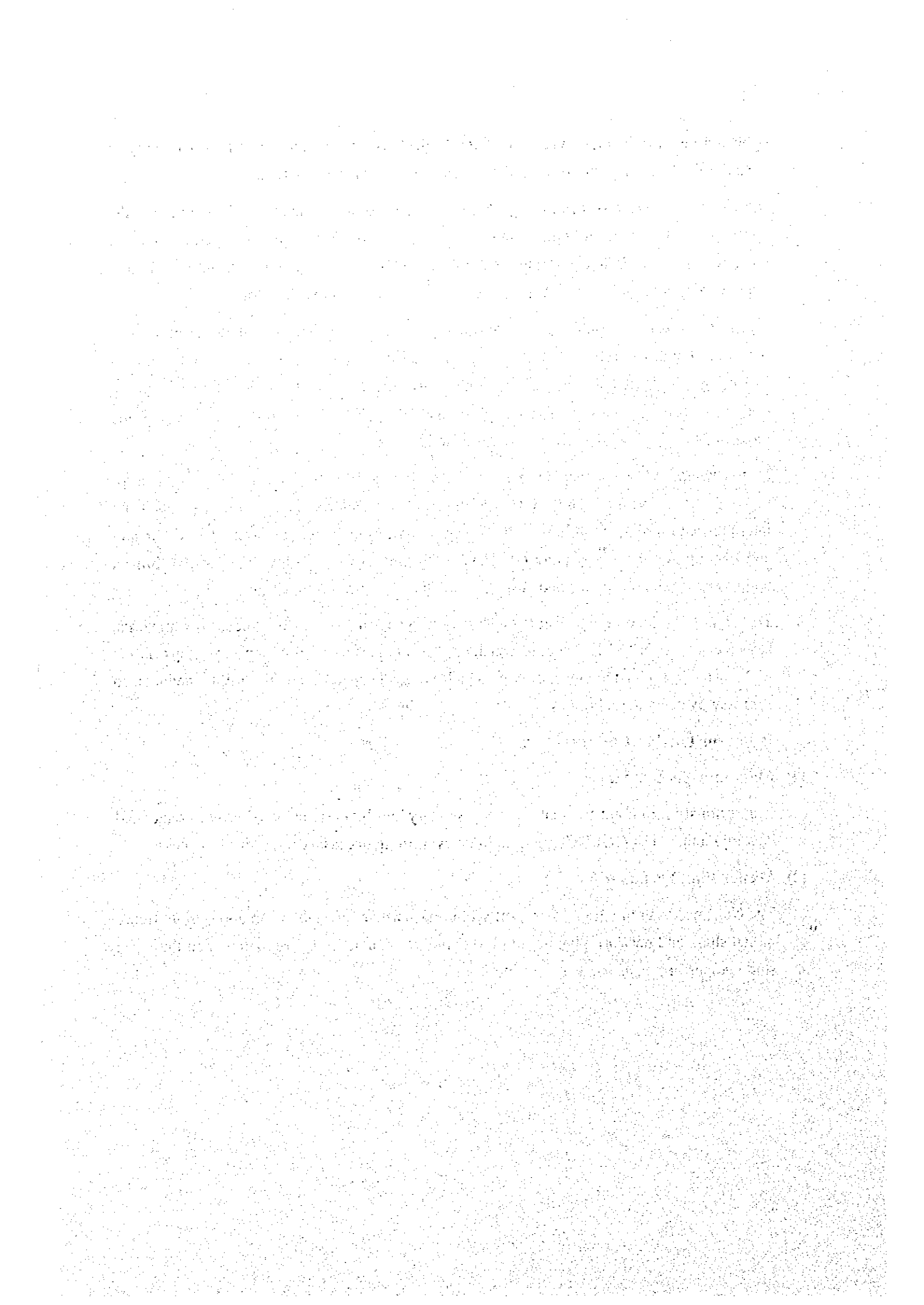
## **8.2 Issues for Further Consideration**

### **(1) Making A Success Story**

It is seriously important to create a "success story" at the early stage of private sector led development. The GOI/NCRPB should do everything necessary to realize a success.

### **(2) Master Plan Formulation**

The NCR needs an integrated transport sector master plan to establish an appropriate future modal share and network plan based on reliable traffic data. It is recommended that such study be performed as soon as possible.



**THE FEASIBILITY STUDY  
ON  
THE CONSTRUCTION OF EXPRESSWAY  
IN THE NATIONAL CAPITAL REGION  
IN INDIA**

**FINAL REPORT**

**SUMMARY**

**TABLE OF CONTENTS**

PREFACE  
LETTER OF SUBMITTAL  
PROJECT LOCATION MAP  
PROJECT SUMMARY  
EXECUTIVE SUMMARY  
DEFINITIONS AND ABBREVIATIONS

	<i>Page</i>
1. INTRODUCTION	
1.1 Study Background .....	1
1.2 Study Objective .....	1
1.3 Study Area .....	1
1.4 Study Approach and General Work Flow .....	2
2. EXISTING CONDITIONS OF STUDY AREA	
2.1 Physical Conditions .....	4
2.2 Social and Economic Conditions .....	4
2.3 Existing Transport Conditions .....	6
3. FUTURE SOCIO-ECONOMIC FRAMEWORK .....	10
4. TRAFFIC DEMAND PROJECTION .....	11
5. OPTIMUM ROUTE SELECTION	
5.1 Basic Policies for Route Selection .....	14
5.2 Control Factors in Route Selection .....	14
5.3 Optimum Route Selection .....	15

<b>6. PRELIMINARY ENGINEERING DESIGN</b>	
6.1 Future Traffic Demand and Number of Lanes -----	18
6.2 Preliminary Design of Interchanges, Toll Plazas and Rest Facilities -----	19
6.3 Preliminary Earthwork Design -----	19
6.4 Preliminary Design of Bridges and Culverts -----	19
6.5 Preliminary Pavement Design -----	20
<b>7. CONSTRUCTION PLANNING</b>	
7.1 Stage Construction Methods -----	21
7.2 Implementation Schedule -----	21
<b>8. EXPRESSWAY OPERATION AND MAINTENANCE PLAN</b> -----	22
<b>9. PROJECT COST ESTIMATE</b> -----	24
<b>10. ECONOMIC ANALYSIS</b>	
10.1 User's Benefit and Toll Level -----	25
10.2 Economic Evaluation -----	25
<b>11. INSTITUTIONAL, FINANCIAL AND IMPLEMENTATION ANALYSIS</b>	
11.1 Introduction -----	27
11.2 Institutional Enabling Environment -----	27
11.3 Financial Analysis -----	31
11.4 Implementation Analysis -----	35
<b>12. ENVIRONMENTAL IMPACT ASSESSMENT</b>	
12.1 Overview -----	39
12.2 Land Acquisition and Resettlement -----	42
<b>13. CONCLUSIONS AND RECOMMENDATIONS</b>	
13.1 Implementation of the Project -----	43
13.2 Issues for Further Consideration -----	44

## LIST OF TABLES

		Page
Table 2.1	Traffic Counts - 24 Hours -----	9
Table 3.1	Summary of Socio-economic Framework -----	10
Table 4.1	Summary of Traffic Demand Forecast -----	11
Table 4.2	Major Road Network Assumptions -----	12
Table 4.3	Impact of Various Expressway Configurations for Rs.1.5/pcu-km (2016) -----	13
Table 5.1(1)	Comparison of Alternative Routes: K-G Expressway -----	17
Table 5.1(2)	Comparison of Alternative Routes: G-M Expressway -----	17
Table 6.1	Traffic Demand Forecast and Number of Lanes -----	18
Table 6.2	The Number of Bridges and Culverts by Category -----	19
Table 6.3	Economic Comparison of Pavement Type -----	20
Table 9.1	Summary of Total Project Costs -----	24
Table 10.1	Financial User's Benefit and Level of Toll in 2006 -----	25
Table 10.2	Economic Internal Rate of Return -----	26
Table 10.3	Sensitivity Test -----	26
Table 11.1	Underlying Project Structures of Case Study 1 To Case Study 4 -----	32
Table 12.1	Potential Environmental Impacts of Expressway Projects -----	39
Table 12.2	Potential Environmental Impacts Caused by the Proposed Expressway Projects -----	40
Table 12.3	Environmental Management Plan for K-G & G-M Expressways -----	41

## LIST OF FIGURES

		Page
Figure 1.1	Basic Outline Work Flow -----	2
Figure 2.1	Major Roads Outside National Capital Territory of Delhi -----	7
Figure 2.2	Survey Sites within National Capital Territory of Delhi -----	8
Figure 2.3	Survey Sites Outside National Capital Territory of Delhi -----	8
Figure 4.1	Daily Traffic as a Function of Toll Rate -----	13
Figure 4.2	Daily Revenue vs Toll Rate (KG & GM) -----	13
Figure 4.3	Daily Revenue as a Function of Toll Rate -----	13
Figure 4.4	Daily Revenue as a Function of Time -----	13
Figure 5.1	Alternative Routes for Kundli-Ghaziabad Expressway and Ghaziabad-Meerut Expressway -----	16
Figure 7.1	Implementation Schedule -----	21
Figure 8.1	Centralized Traffic Management & Accident Measures -----	23
Figure 8.2	Distance-based Toll Collection System -----	23
Figure 11.1	Comments and Recommendations for Overall Regulatory Framework -----	28
Figure 11.2	Comments and Recommendations for Concession Agreement -----	29
Figure 11.3	Comments and Recommendations for Institutional Setup -----	30
Figure 11.4	Recommended Negotiation Attitude For The GOI/NCRPB (Part 1) ---	36
Figure 11.4	Recommended Negotiation Attitude For The GOI/NCRPB (Part 2) ---	37
Figure 11.5	Proposed Implementation Schedule & Timetable -----	38
Figure 12.1	Basic Methodology Adopted for the Environmental Impact Assessment -----	40



## DEFINITIONS AND ABBREVIATIONS

### (1) Agencies

AASHTO	American Association of State Highway and Transportation Officials
ADB	Asian Development Bank
CPWD	Central Public Works Department
CIDA	Canadian International Development Authority
DDA	Delhi Development Authority
DTC	Delhi Transport Corporation
GDA	Ghaziabad Development Authority
GOI	Government of India
IBRD/WB	International Bank for Reconstruction and Development / World Bank
IDFC	Infrastructure Development Finance Corporation
IL&FS	Infrastructure Leasing & Financial Services
IMD	Indian Meteorological Department
IRC	Indian Road Congress
JICA	Japan International Cooperation Agency
JBIC	Japan Bank for International Cooperation
MDA	Meerut Development Authority
MOEF	Ministry of Environment and Forests
MOF	Ministry of Finance
MOST	Ministry of Surface Transport
MOUD	Ministry of Urban Development
NCRPB	National Capital Region Planning Board
NHAI	National Highway Authority of India
PWD	Public Works Department

### (2) Technical Terms

AADT	Average Annual Daily Traffic
AC	Asphalt Concrete
ADT	Average Daily Traffic
B/C	Benefit Cost Ratio
BOD	Biochemical Oxygen Demand
BOOT	Build-Operate-Own-Transfer
BOT	Build-Operate-Transfer
CBD	Central Business District
CBR	California Bearing Ratio
DBM	Dense Bituminous Macadam
DDTV	Design Daily Traffic Volume
DNB	Delhi-Noida Toll Bridge
DUT	Delhi Union Territory
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ESAL	Equivalent Single Axle Load
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rate of Return
FNG	Faridabad-Noida-Ghaziabad
GDP	Gross Domestic Product
G-M or GM	Ghaziabad - Meerut

GMBA	Ghaziabad-Meerut Expressway Borrow Area
GRDP	Gross Regional Domestic Product
HCM	Highway Capacity Manual
HFL	High Flood Level
HWL	High Water Level
IC	Interchange
IDC	Interest During Construction
IEE	Initial Environmental Examination
IRR	Internal Rate of Return
IS	Indian Standard
ISBT	Inter-State Bus Terminal
JCT	Junction
K-G or KG	Kundli - Ghaziabad
KGBA	Kundli-Ghaziabad Expressway Borrow Area
kip	Kilo-pounds
LAA	Land Acquisition Act
LCV	Light Commercial Vehicles
LWL	Low Water Level
NCR	National Capital Region
NCTD	National Capital Territory of Delhi
NH	National Highway
NPV	Net Present Value
O-D	Origin-Destination
ODA	Official Development Assistance
O&M	Operation and Maintenance
PAP	Project Affected Persons
PC	Pre-stressed Concrete
PCU	Passenger Car Unit
PLR	Prime Lending Rate
PMU	Project Management Unit
PPP	Private-Public Partnership
PSI	Pavement Serviceability Index
RC	Reinforced Concrete
ROE	Return on Equity
ROW	Right of Way
Rs.	Indian Rupee
SC	Scheduled Caste
SH	State Highway
SPCB	State Pollution Control Board
SPD	Suspended Particulate-Matters
SPT	Standard Penetration Test
SPUR	Spatial Priority Urbanization Regions
SPV	Special Project Vehicle
Sta.	Station
STRADA	System for Traffic Demand Analysis
TP	Toll Plaza
TSP	Total Suspended Particles
U.P.	Uttar Pradesh
USD	US Dollar
VOC	Vehicle Operating Cost

## **1. INTRODUCTION**

### **1.1 Study Background**

Delhi has been achieving rapid urban growth with increasing population and economic development. This has created many urban problems caused by the concentration, and the needs for transport infrastructure development are getting more importance. To cope with these urban problems, the Government of India established the National Capital Region Planning Board (NCRPB) in 1985 to manage sustainable development plans of the National Capital Region (NCR). The existing regional plan gives the highest priority to transport development for the regional development, and plans to develop expressway network to connect urban growth centers in the NCR.

As a part of the expressway network development, the Government of India requested the Government of Japan to conduct a feasibility study for priority expressway projects. In response to the request of the Government of India, the Government of Japan decided to conduct "The Feasibility Study on the Construction of Expressways in the National Capital Region in India" (hereinafter referred to as "the Study") for the proposed Kundli-Ghaziabad (K-G) Expressway and Ghaziabad-Meerut (G-M) Expressway.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"); the official agency responsible for the implementation of the cooperation programs of Japan, undertook the execution of the Study, and selected Pacific Consultants International, Japan, as the consulting firm to organize the JICA Study Team for the actual conduct of the Study.

### **1.2 Study Objective**

The purpose of the study is to carry out the feasibility study for the proposed Ghaziabad-Meerut Expressway and Kundli-Ghaziabad Expressway, the total length of which is approximately 80 km. The study also aims to conduct technical transfer to the Indian counterpart personnel in the course of the Study.

### **1.3 Study Area**

The study area is the north and north-east vicinity of Delhi Union Territory within the NCR in the states of Haryana and Uttar Pradesh, which are related to the proposed expressway locations.

## 1.4 Study Approach and General Work Flow

The Study was carried out based on the scope of work which was agreed upon between National Capital Region Planning Board and JICA Preparatory Study Team in July 1998. The technical issues that the Study Team should give particular attention included the following:

- (1) Formulation of socio-economic framework
- (2) Establishment of design criteria and alternative corridors/route
- (3) Optimum route selection
- (4) Preliminary Design
- (5) Toll rate and collection system
- (6) Implementation Planning and Evaluation

The JICA Study Team mobilized to Delhi on December 1998, and conducted the Phase I Study till March 1999 in India, followed by the Phase II Study resumed in May 1999 and ended in August 1999, and Phase III Study from September 1999 to December 1999.

The major work items with approximate time schedule are shown in Figure 1.1.

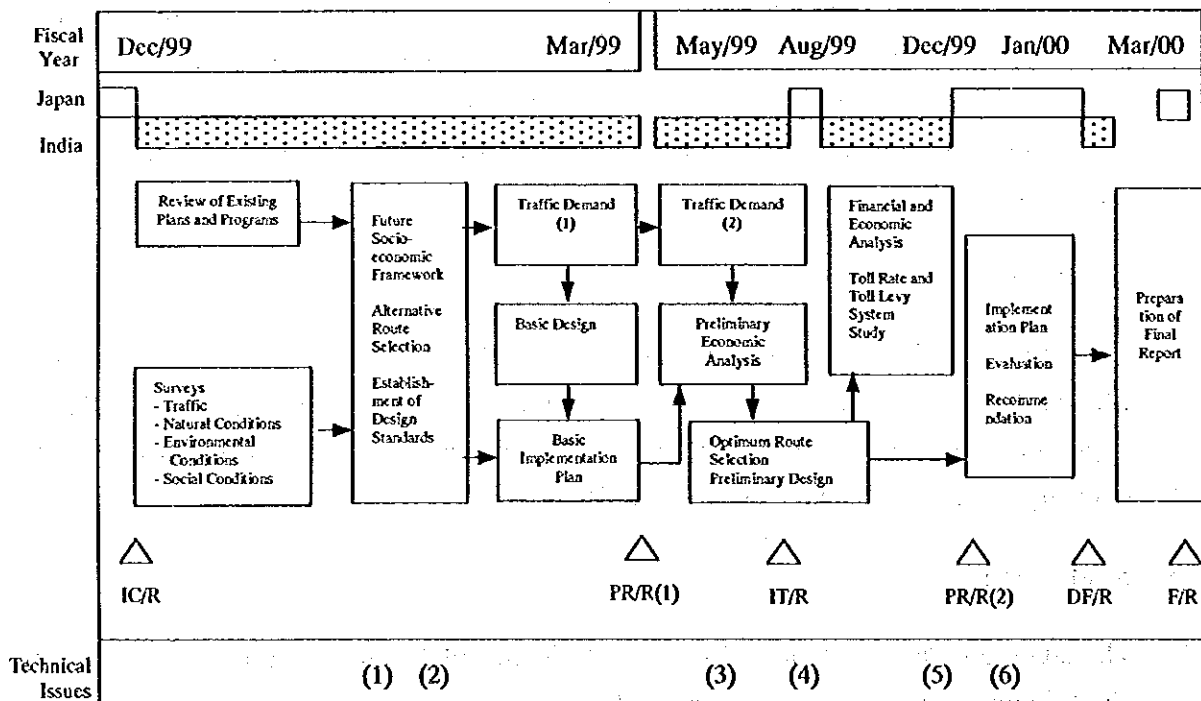


Figure 1.1: Basic Outline Work Flow

The Draft Final Report was prepared and submitted to the Indian counterpart in February 2000, as the result of all of the phases of the Study. A seminar was also held on

**“Expressway Development in the NCR with Special Reference to the K-G and G-M Expressways” on February 3, 2000 in Delhi. The seminar was attended by Mr. Jagmohan, the Honorable Minister of Urban Development, Mr. Bandaru Dattatraya, Honorable Minister of State for Urban Development, Mr. Lal Ji Tandan, Minister of Urban Development, Government of Uttar Pradesh and His Excellency Hiroshi Hirabayashi, Ambassador Extraordinary and Plenipotentiary, Embassy of Japan, and other 130 interested people from both public and private sectors, and successfully conducted.**

**The Final Report contains all of the study progress and outcomes of the entire Study, and submitted in March 2000.**

## **2. EXISTING CONDITIONS OF STUDY AREA**

### **2.1 Physical Conditions**

The Study Area is located at northern and eastern part of the National Capital Region. The NCR covers an area of 30,242 km<sup>2</sup> extending into three states namely Haryana, Rajasthan and Utter Pradesh in addition to the Delhi Union Territory.

Topographically the NCR has two major sub-units. These are alluvial plains which constitute the NCR terrain around Delhi, Haryana and U.P., and sand dunes which are prominent in Haryana and Rajasthan. Soil in the NCR generally consists of alluvial deposits in the Gangetic plains, showing correlation of the various sand and clay beds prevalent in Delhi.

The NCR is divided into two types of climate. One is the subtropical monsoon climate region characterized by mild dry winter and hot summer, which comprises of Meerut, Ghaziabad, Bulandshahr, and Panipat districts. The other is the tropical steppe characterized by semi-arid and hot summer, which comprises of Sonipat, Delhi, Rohtak, Gurgaon, Faridabad, Rewari, and Alwar districts.

The whole upper basins of Ganga and Yamuna receive copious rainfall causing floods in the NCR and adjoining regions. The annual normal rainfall of the NCR is 61 cm. 79 % is contributed by monsoon rainfall, and the rest is by that of other seasons.

In the NCR and adjoining areas it has been observed that May and June are the hottest months and January the coldest. Relative humidity is generally high in August and low in May. Strong surface winds persist in May and June and light winds during winter months. Extreme dryness and cold winter are experienced during certain periods of the year. Fairly comfortable climate is due to reduced day temperature during July to September.

### **2.2 Social and Economic Conditions**

#### **(1) Population**

NCR is comprised of National Capital Territory of Delhi (NCTD, generally referred to as "Delhi"), and sub-regions of Utter Pradesh (U.P.), Haryana and Rajasthan.

The population of NCR increased from 19.0 million in 1981 to 26.4 million in 1991 at an annual growth rate of 3.3 percent, and it is estimated to be 34.2 million in 1999. Sub-regional population in NCR in 1999 is estimated at 13.3 million, 8.3 million, 10.8 million and 1.8 million persons for Delhi, Haryana, U.P. and Rajasthan respectively.

The population growth of Delhi is more than 4 percent in the last three decades, which is partly because of in-migration to the capital city. In fact, the migrants to Delhi during 1981-1991 are estimated at 1.6million or 160 thousands annually and it contributes about 50 per cent of total population increase in Delhi. The migrants come from surrounding states, of which Uttar Pradesh shares 50 per cent of the total migrants to Delhi followed by 12 per cent of Haryana.

In NCR, the urbanization level has reached 52 per cent in 1991 and expected to reach 58% in 2001. The population density of NCR is estimated at 11.3 persons/hectare and that of Delhi at 89.3 persons/hectare in 1999.

## (2) Land Use

A total land area of NCR is 30,211 square kilometers, in which Delhi occupies 1,483 sq. kms, sub-regions Haryana 13,413 sq. kms, U.P. 10,823 sq. kms and Rajasthan 4,492 sq. kms.

The existing land use of NCR in 1986-87 shows that agriculture is the predominant use of land in the region. The cultivated area constituted about 80% of the total area of NCR. The land used for non-agricultural activity, namely urban and rural settlements, transport network, rivers and canals works out to 10.0% of the total area. The area of barren land, which includes rocky area, saline patches, and derelict land is 4.7%, while what is covered by forest is 2.1% of the total area.

The cultivated and non-agricultural land uses in Delhi account for 64% and 24% of the total land area respectively, whereas in Haryana 81% and 10%, in U.P. 82% and 11% and in Rajasthan 74% and 4%.

## (3) Economic Activities

NCR generates 4.6% of the India's Gross Domestic Product (GDP) in 1996, despite it shares only 1.0% of the total land area of India or 3.1% (in 1991) of the total population of India.

The major economic activity is agricultural sector in NCR, especially Uttar Pradesh and Haryana, and it accounts for more than 40 percent of the respective Gross State Domestic Product (GSDP) in both states, and which is higher than the share of India's agricultural sector of 30%.

The secondary sector shares about 30%, 19% and 25% of the respective GSDPs of Delhi, U.P. and Haryana in 1995-96, while the tertiary sector accounts for 70% of GSDP in Delhi, 38% in U.P. and 34% in Haryana. The change in economic activities from the primary

sector to the secondary or tertiary sectors can be observed in U.P. and Haryana. However little change is shown in the tertiary sector of Delhi, remaining almost constant at 70% since 1980.

According to the World Development Report 1998/1999, India's GNP per capita in 1997 is US\$390 and it has increased at an average growth rate of 3.2% during 1996-1997. Available information about income in the Study area is the Net National Product (NNP) per capita, and which is Rs.6,049 at 1980-81 constant price in 1995-96 for Delhi, Rs.3,670 for Haryana and Rs.1,666 for U.P., while Rs.2,573 as the national average at 1980-81 constant price or Rs.12,097 at current price.

## **2.3 Existing Transport Conditions**

### **(1) Transport Sector in the NCR**

In Delhi there is currently no mass transit system, although a mass transit system is under construction. Delhi has a high urban population in comparison with other cities in India. It also has one of the highest per capita incomes in India and as a result has the largest number of motorized vehicles.

Early in the last decade Delhi was known for having the highest number of cycles of any city in India. This tendency towards personalized transport has continued and now has resulted in the replacement of the bicycle by private motorized transport in the form of cars and two wheelers. Between 1980 and 1995 the car fleet in Delhi increased at a rate of nearly 10 % per annum. In 1995, the number of two wheelers in Delhi is 1.7 million, three wheelers are 78 thousand, and cars are 763 thousand.

In the current absence of an effective rail based transit mode, bus is the principal mode of public transport. Approximately 70 % of daily commuters use bus in Delhi. Even among those persons travelling between Delhi and the neighboring towns in the NCR, which are about 1.6 million trips per day, 63 % are depending on bus services.

Non motorized transport still plays an important role in Delhi with over 1 million cycles in the city and a large number of rickshaws. These however are principally used for short distance trips.

### **(2) Existing Road Network and Functions in the NCR**

In the NCR the road network is characterized by nine major radial inter-urban corridors in the regional network as shown in Figure 2.1. These radial routes consist of the national highways NH01, NH24, NH02, NH08, NH10 and NH58 and the state highways SH22 and SH57 in U.P., and SH13 in Haryana. The principal road transport sector in India is controlled by two groups namely the state and central governments. The Public Works



Department (PWD) of the State Governments are responsible for the state highways whilst the control of the national highways is vested in the Ministry of Surface Transport (MOST) and the National Highway Authority of India (NHAI).

### (3) Traffic Survey and Results

Several traffic surveys were undertaken for this study, which were Classified Traffic Counts (16 stations), Roadside Interview Surveys (10 location), Vehicle Axle Load Surveys (5 locations), Travel Time Surveys and User Opinion Surveys, and major survey locations are shown in Figure 2.2 and 2.3.

As summarized in Table 2.1, the present traffic between Delhi and Ghaziabad shows the highest volumes in the Delhi area. The results of the traffic counts show that NH24 and its bypass carries 85,000 vehicles/day. NH58 between Ghaziabad and Modinagar carries 21,000 vehicles/day.

The vehicle distribution shows that cars and two/three wheelers combined are more than 40 % of all traffic at every location. The impact of the truck ban against the truck traffic entering Delhi is clearly seen in the plot of truck traffic by time of day at the count sites for NH01 and NH02.

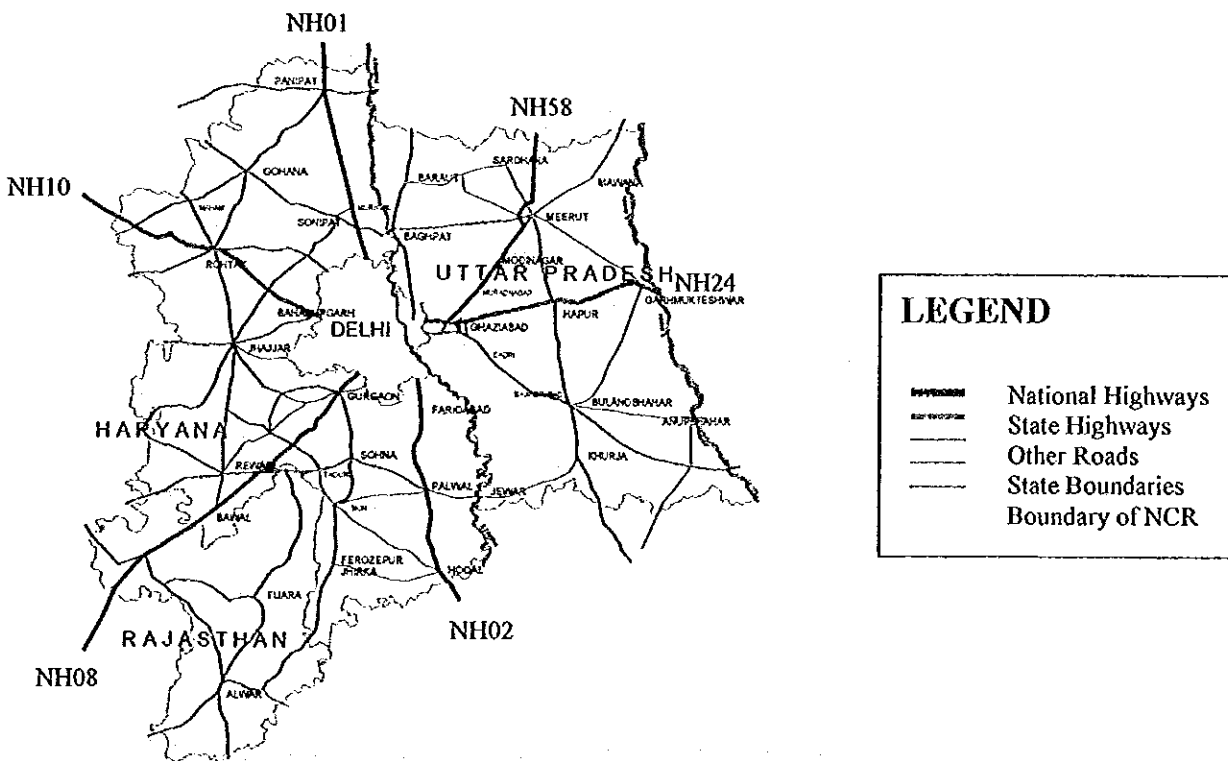
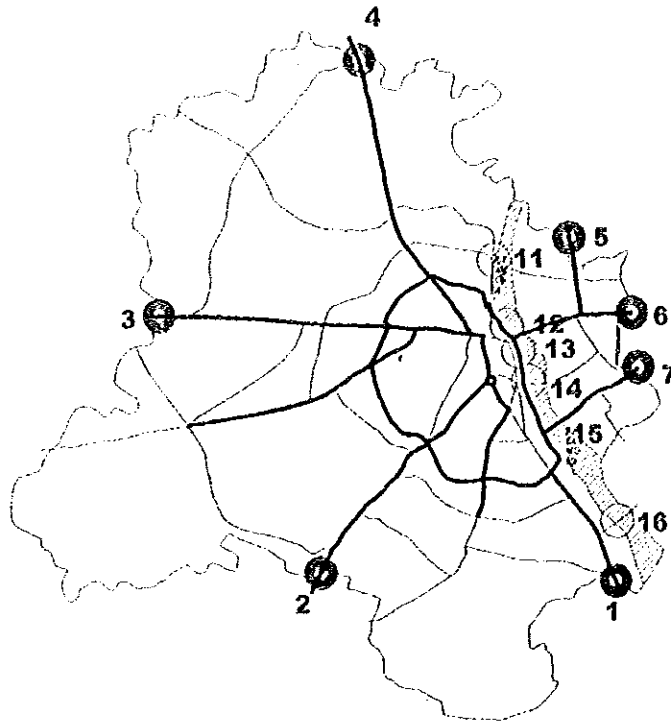
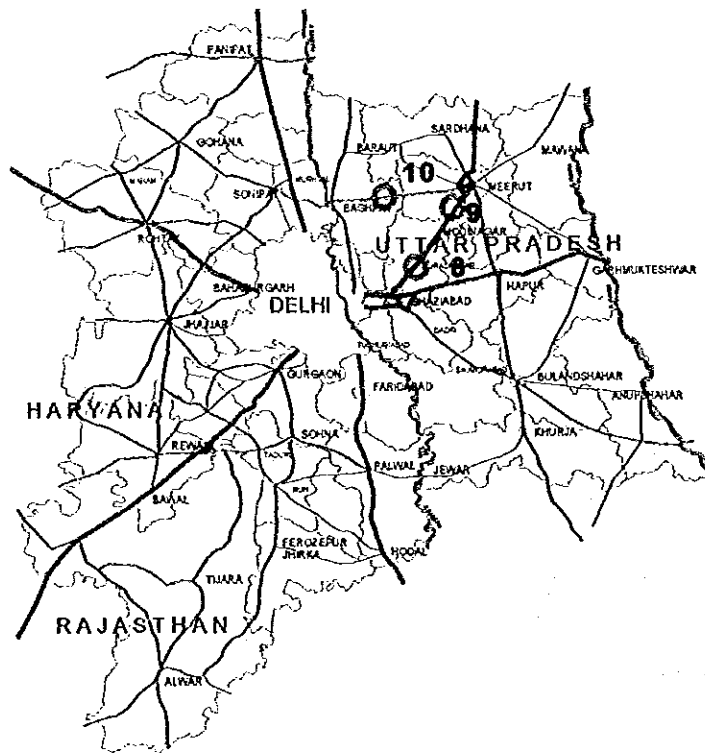


Figure 2.1 Major Roads Outside National Capital Territory Of Delhi



**FIGURE 2.2** Survey Sites within National Capital Territory of Delhi



**FIGURE 2.3** Survey Sites Outside National Capital Territory of Delhi

**Table 2.1: Traffic Counts - 24 Hours**

No	Description	Non-Motorized	Motor-	Auto-	Passenger	Bus	Trucks	Sub-Total	Motorized
		Vehicles	cycles	rikshaw	Car				Vehicles
		1	2	3	4	5	6	(4-6)	(2-6)
1	Boundary of Delhi -- NH 2	5,636	10,504	392	20,077	1,408	8,211	29,696	40,592
2	Boundary of Delhi -- NH 8	1,733	8,901	175	24,650	2,533	9,441	36,624	45,700
3	Boundary of Delhi -- NH 10	2,965	4,541	746	6,667	863	5,084	12,614	17,901
4	Boundary of Delhi -- NH 1	1,938	3,863	312	12,714	2,305	11,338	26,357	30,532
5	Boundary of Delhi -- SH 57	2,277	1,752	112	1,833	526	3,857	6,216	8,080
6	Bridge over Hindan -- NH24	8,085	15,122	8,317	22,578	7,924	15,514	46,016	69,455
7	Bridge over Hindan -- NH24 Bypass	6,670	5,003	1,732	5,807	1,221	2,803	9,831	16,566
8	Ghaziabad - Modinagar--NH 58	2,711	4,966	457	8,225	1,920	5,591	15,736	21,159
9	Modinagar - Meerut --NH 58	2,135	3,073	578	6,560	2,150	5,057	13,767	17,418
10	Meerut - Baghpat	866	514	14	492	193	1,029	1,714	2,242
11	Yamuna River -- Wazirabad Bridge	14,657	14,014	2,941	8,274	4,619	9,332	22,225	39,180
12	Yamuna River -- ISBT Bridge	14,989	19,637	13,460	21,342	6,853	13,957	42,152	75,249
13	Yamuna River -- Yamuna Bridge	30,465	19,054	12,275	8,290	335	1,279	9,904	41,233
14	Yamuna River -- ITO Bridge	16,097	58,837	16,795	48,361	9,340	2,831	60,532	136,164
15	Yamuna River -- Nizamuddin Bridg	7,477	34,889	6,411	53,011	4,397	7,675	65,083	106,383
16	Yamuna River -- Okhla Bridge	4,059	7,448	1,419	11,402	845	5,909	18,156	27,023

Source : JICA Study Team

### 3. FUTURE SOCIO-ECONOMIC FRAMEWORK

The future social and economic frameworks in the study area were established using such planning parameters as population, net state domestic product and employment, in order to estimate future traffic demand on the project expressways.

The future population estimation is based on the projection made by the Office of the Registrar General of India as well as on data obtained from the Population Foundation of India. The future economic growth rate for the NCR was, according to the past trend of economic growth in India and the NCR, assumed to be 6% per annum, which is a little higher than the long-term national average of 5% per annum.

The future social and economic frameworks were estimated consequently as shown in Table 3.1. These frameworks were broken down for the traffic demand projection into traffic zones based on census data, land use plans and other regional and urban development plans.

**Table 3.1: Summary of Socio-economic Framework**

[Unit: as indicated]

	1999	2001	2006	2011	2016	2021	2026
<b>Population (in thousands)</b>							
INDIA	990,293	1,012,386	1,095,637	1,178,889	1,259,944	1,341,000	1,415,000
NCR	34,220	36,367	42,681	48,994	53,756	58,518	66,308
Rest of NCR	215,917	223,874	245,357	266,839	289,261	311,682	327,773
North India	39,307	39,842	42,749	45,655	48,476	51,298	53,946
West India	142,392	145,445	157,242	169,039	180,801	192,563	202,504
Central India	78,822	80,661	88,096	95,530	103,191	110,852	116,575
South India	224,535	226,788	239,871	252,953	264,692	276,430	290,701
East India	255,100	259,409	279,644	299,878	319,768	339,658	357,193
<b>Net State Domestic Product (in Rs. Billion)</b>							
India	11,884	13,073	16,341	19,609	24,512	29,414	36,767
NCR	636	713	926	1,140	1,482	1,824	2,371
Rest of NCR	1,869	1,949	2,164	2,378	2,612	2,845	3,547
North India	668	724	873	1,022	1,218	1,415	1,764
West India	3,189	3,689	5,091	6,492	8,848	11,204	13,968
Central India	666	704	806	907	1,026	1,146	1,428
South India	2,775	3,084	3,924	4,765	5,989	7,214	8,993
East India	2,080	2,210	2,557	2,905	3,336	3,767	4,696
<b>Employment (in thousands)</b>							
INDIA	136,775	144,350	169,355	194,360	221,001	247,642	261,308
NCR	7,577	8,350	10,741	13,132	14,741	16,351	18,527
Rest of NCR	19,188	20,094	22,668	25,242	28,122	31,001	32,150
North India	5,290	5,429	6,018	6,608	7,232	7,856	8,262
West India	23,892	24,840	28,128	31,417	35,039	38,660	40,656
Central India	7,827	8,139	9,271	10,403	11,680	12,958	13,627
South India	47,007	50,733	62,733	74,734	88,118	101,502	106,743
East India	25,994	26,766	29,795	32,825	36,069	39,314	41,344

Source: JICA Study Team

#### 4. TRAFFIC DEMAND PROJECTION

Based on the future socio-economic framework, future traffic demand was forecast in 5-year cycles for each of the years of 2006, 2011, 2016, 2021 and 2026.

Table 4.1 shows a summary of traffic demand forecast.

**Table 4.1: Summary of Traffic Demand Forecast**

	2006 <sup>1)</sup>	2016 <sup>2)</sup>	2021 <sup>2)</sup>	2026 <sup>2)</sup>
<i>K-G Expressway</i> (pcu/day)				
Kundli IC	41,200	67,000	87,400	112,800
Khekra IC	30,900	52,900	76,100	98,100
JUNCTION				
<i>G-M Expressway</i> (pcu/day)				
Meerut IC	24,300	40,400	56,700	75,200
Modinagar IC	27,700	50,700	75,500	101,300
JUNCTION	43,100	74,400	102,600	132,300
Ghaziabad IC				

Note: 1) with FNG Expressway

2) with FNG, Peripheral and G-M Expressway Meerut Extension

Source: JICA Study Team

Several planned major road infrastructure projects are scheduled for completion between 2000 and 2006, the proposed opening year of the KG and GM Expressways. In particular, it is anticipated that the FNG Expressway and the Noida Toll Bridge will open prior to 2006.

The continuing road work programs within the NCR will include the widening and upgrading of existing road infrastructure, in addition to the major projects. The timing for implementation of major new projects is shown in Table 4.2.

**Table 4.2: Major Road Network Assumptions**

Project name	Year		
	2006	2016	2026
Noida Toll Bridge	✓	✓	✓
FNG Expressway	✓	✓	✓
Peripheral Expressway	×	✓	✓
Delhi Sonipat Panipat Expressway(DSP)	×	✓	✓
Strengthening and widening of Roads within NCR	✓	✓	✓
Delhi Noida Khurja Aligarh Expressway(DNK)	×	×	✓

source: JICA Study Team

Various network combinations of the projects listed in Table 4.2 were tested within the framework of different scenarios. A traffic demand model testing program was developed with the intention to determine the optimum network configuration of the K-G and G-M Expressways in combination with other expressway systems and an optimum toll rate. The impacts of alterations in major expressway configurations are estimated as follows:

**Table 4.3: Impact of Various Expressway Configurations for Rs.1.5/pcu-km (2016)**

Network Configurations	Daily pcu-km
Base Case: KG&GM + FNG + Peripheral	2,001,000 pcu-km/day
No FNG	- 2 %
No KG (GM Only)	- 41 %
No GM (KG Only)	- 37 %

Note: Based on a distance-based toll rate

Source: JICA Study Team

The daily revenue as a function of time for various toll rates is presented in Figures 4.1, 4.2, 4.3 and 4.4. The result shows that the revenue maximizing toll rate in 2006 is Rs.1.5/pcu-km. The results also suggests that a higher toll rate will maximize the revenue in later years.

Considering the fact that the first 5 to 10 year revenue is critical for sound financial operation, and the forecast in later years has higher uncertainties, it is recommended that the toll rate be Rs. 1.5/pcu/km.

Figure 4.1: Daily Traffic as a Function of Toll Rate

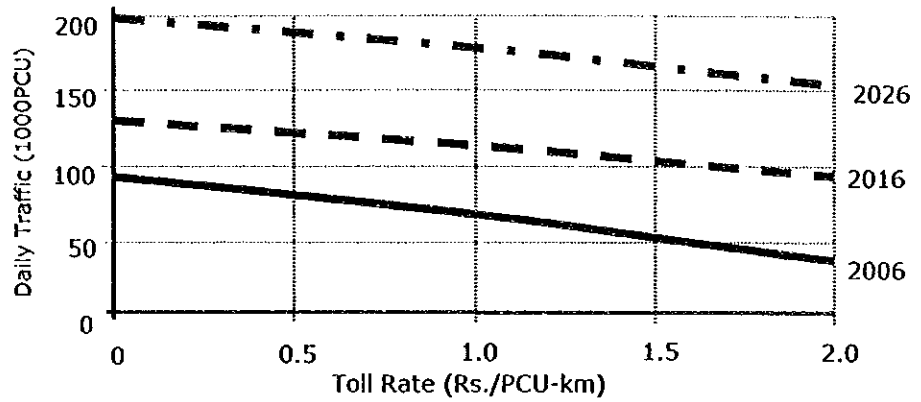


Figure 4.2: Daily Revenue vs Toll Rate (KG & GM)

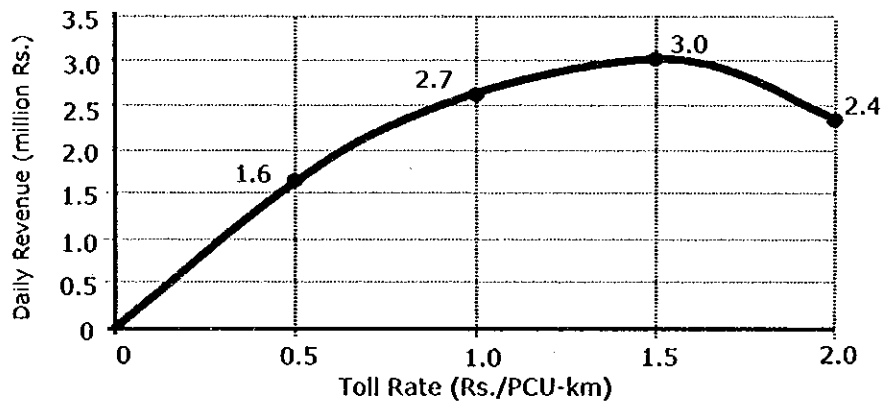


Figure 4.3: Daily Revenue as a Function of Toll Rate

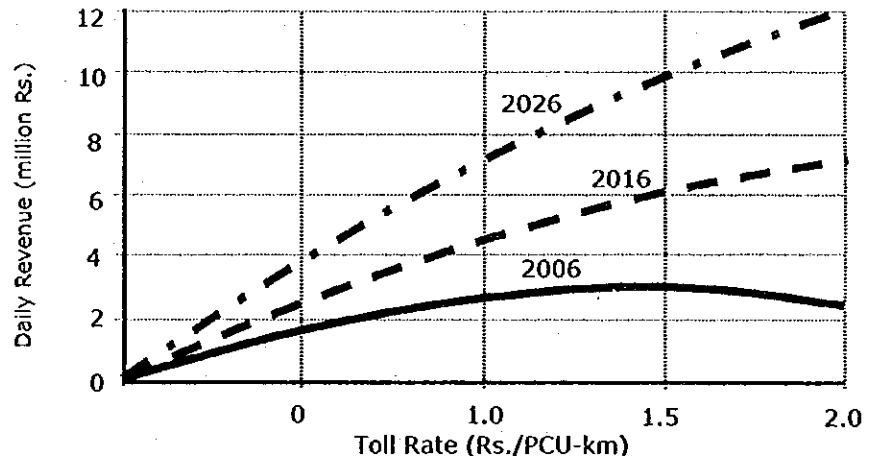
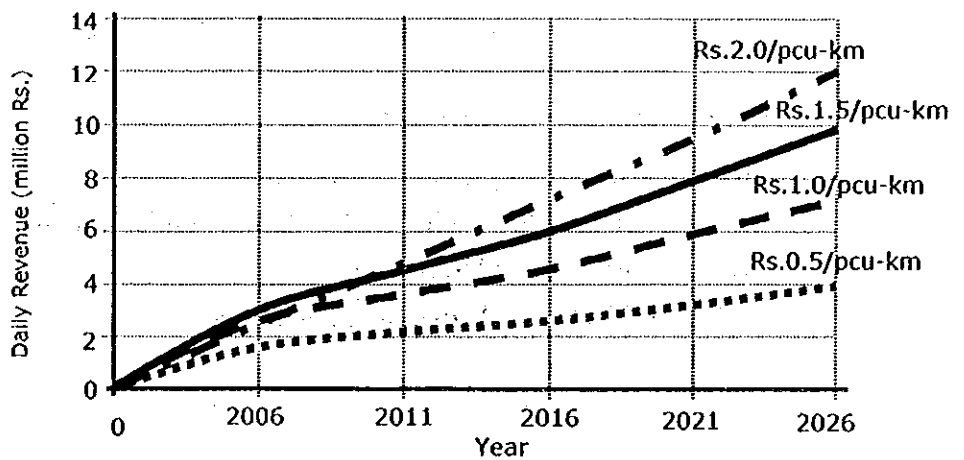


Figure 4.4: Daily Revenue as a Function of Time



## **5. OPTIMUM ROUTE SELECTION**

### **5.1 Basic Policies for Route Selection**

K-G and G-M Expressways are not an independent highway stretch but form a part of NCR Expressway Network. This makes the terminal locations of each expressway to be fixed, and the freedom of setting alternative routes were limited. The topographic conditions in the study area are homogenous, which made alignment alternatives quite homogeneous in terms of length and construction cost.

The identification of alignment alternatives and optimum route selection process, therefore, should consider more social and environmental aspects of the alignment alternatives. Particularly, how to avoid major control points will be an important issue in the process of optimum route selection. It is also important to predict the difficulty in right-of-way acquisition since it is a general tendency that right-of-way acquisition is a major controlling factor in project implementation schedule in India, as well as in many other countries.

### **5.2 Control Factors in Route Selection**

The topographic maps to a scale of 1:50,000 was used for the route selection as a main source of topographic information. The required new information was collected by the Study Team members by site investigation, interviews with State PWDs, and the result of the social survey.

Location of JUNCTION and INTERCHANGE is one of the major governing factors in selecting the expressway routes. Since K-G and G-M Expressways are part of NCR Expressway Network, (1) a Junction for the connection of K-G and G-M Expressways at north of Ghaziabad, and the terminal interchange locations of (2) Kundli (NH01), (3) Ghaziabad (NH24), and (4) Meerut (SH14) are considered as given conditions in the Study. In addition to these terminal interchanges, it is considered appropriate to locate an interchange on SH57 near (5) Khekra (1996 Population = 41,000) for K-G Expressway, and also to locate an interchange at (6) Modinagar (1996 Population = 143,000).

The major control points are as follows:

- Topography, Geology and River System,
- Village Communities, Religious Points and Public Buildings,
- Main Power Lines and Substations
- Industrial Plants and Agricultural Plantations



### 5.3 Optimum Route Selection

Three alternative routes were compared for each K-G and G-M Expressway configurations as shown in Figure 5.1.

Three alternative routes were established for K-G Expressway. Route-1 was based on the preliminary alignment proposed by U.P. PWD. It passes through Khekra and Rataul at their northern side, and the alignment is able to achieve larger radii of curves through the way. Route-2 tries to pass Rataul and Khekra at their southern side. Though Route-2 has an advantage of closer location to Tronica Industrial City, it passes through the west side of Yamuna River where future urbanization is expected, and it passes over a major irrigation canal, Drain No. 8, which requires an additional major bridge structure. Route-3 tries to follow the alignment of Route-2 and shift to Route-1 between Rataul and Khekra to avoid the disadvantages of Route-2.

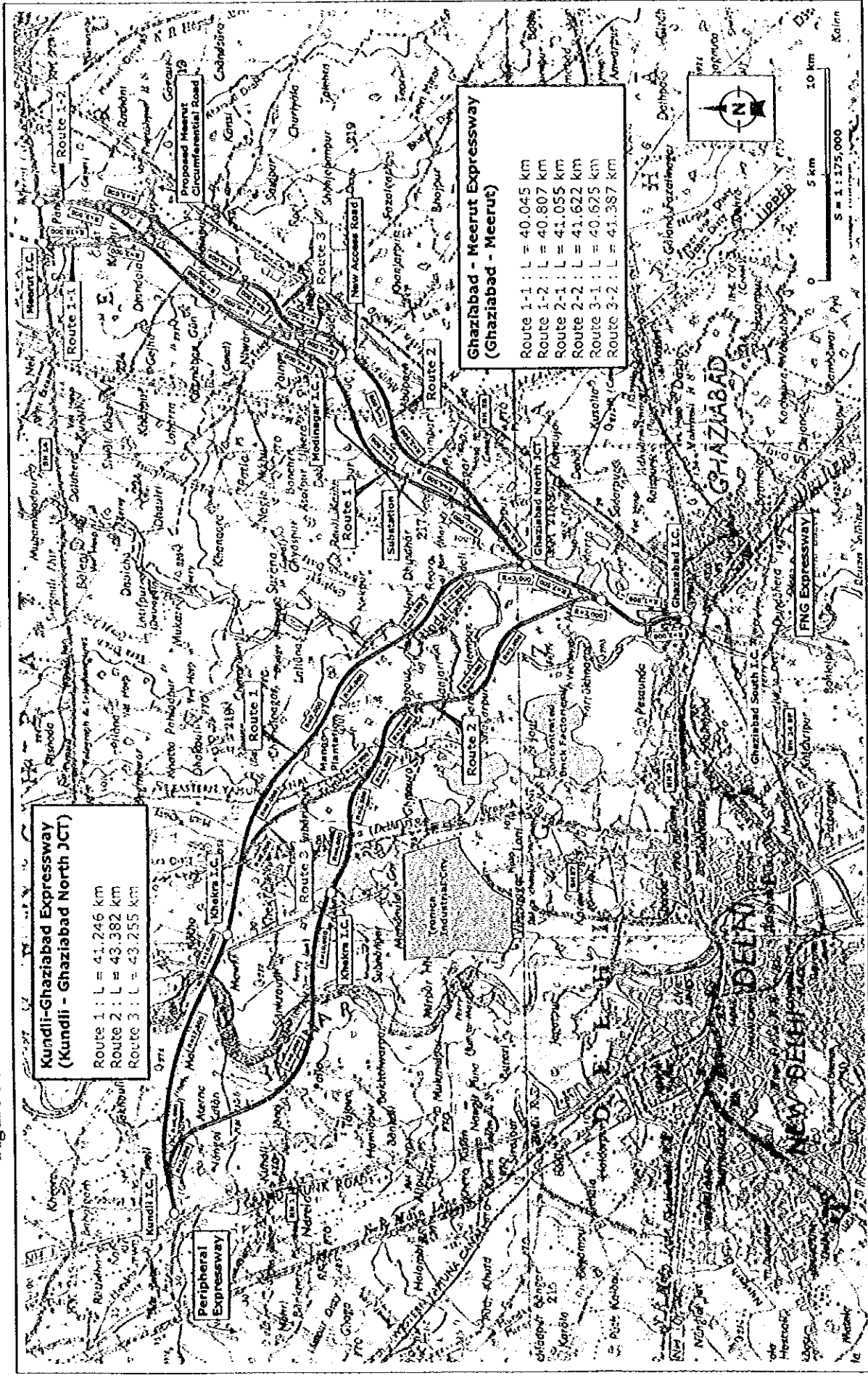
Three alternative route were also established for G-M Expressway. Route-1 tries to minimize its influence to the existing ribbon development along NH58 by keeping a certain distance from NH58. Route-2, on the other hand, tries to minimize an access length from Modinagar IC to NH58, since Modinagar IC needs a new access road from NH58. As a result, the alignment of Route-2 has to pass through more urbanized areas near NH58, and it requires more winding alignment. Route-3 tries to take an advantage of Route-2 for Modinagar IC access, and yet to avoid smaller curves between Modinagar IC and Meerut IC.

Aside from the discussion of the throughway alternatives of G-M Expressway, two alternatives for Meerut IC gives two alternatives to the throughway. The throughway alternatives are described as Route 1, 2 and 3, and the Meerut IC location alternatives are additionally described as Route 1-1, 1-2, and so on. This makes the total number of alternatives to be six for G-M Expressway.

Technical and economic evaluation was conducted for nine (9) alternative configurations combining three (3) K-G routes with three (3) G-M routes. Table 6.1 summarizes the technical evaluation of the alternatives. In addition, the economic evaluation indicators, such as the Economic Internal Rate of Return (EIRR), the Cost Benefit Ratio (B/C) and the Net Present Value (NPV) suggested that the combination of Alternative 1 for K-G Expressway and Alternative 1-1 for G-M Expressway scored the highest evaluation points in any of the above economic evaluation indicators.

The preliminary engineering design was thus undertaken along these selected routes.

Figure 5.1: Alternative Routes for Kundli-Ghaziabad Expressway and Ghaziabad-Meerut Expressway



**Table 5.1(1): Comparison of Alternative Routes: K-G Expressway**

Description	Unit	Route 1	Route 2	Route 3
<b>A. Geometric Aspects</b>				
1. Total Length	km	41.2	43.4	43.3
2. Number of Horizontal Curves	each	9	10	9
3. Smallest Radius	m	2,500	2,000	2,000
<b>B. Construction Features</b>				
1. Number of Facilities Crossed				
National/State Highways	each	2	2	2
District Roads	each	1	1	1
Railway Lines	each	1	1	1
Major Rivers and Canals	each	2	3	2
Minor Canals and Tributaries	each	6	6	6
2. Construction Works				
Earthwork Section	km	40.1	42.3	42.3
Bridge Section	km	1.1	1.1	1.0
Long Span Bridges	m	800	900	800
Other Bridges	m	258	248	238
Box Culverts	no.	9	11	15
3. Construction Cost Index		100	112	107
<b>C. Environmental Impacts</b>				
1. Communities Crossed	each	---	---	---
2. Brick Factory Areas Crossed	km	---	1.2	---
<b>D. Socio-economic Aspects</b>				
1. Service to Tronica Industrial City		Fair	Good	Fair
2. Contribution to Future Development		Fair	Good	Good
<b>Comparison (Ranking)</b>				
Geometry		1	3	2
Construction		1	3	2
<b>TOTAL RANKING</b>		1	3	2

**Table 5.1(2): Comparison of Alternative Routes: G-M Expressway**

Description	Unit	Route 1-1	Route 2-1	Route 3-1
<b>A. Geometric Aspects</b>				
1. Total Length	km	40.0	41.1	40.6
2. Number of Horizontal Curves	each	10	13	12
3. Smallest Radius	m	1,500	1,500	1,500
<b>B. Construction Features</b>				
1. Number of Facilities Crossed				
National/State Highways	each	2	2	2
District Roads	each	3	3	3
Railway Lines	each	---	---	---
Major Rivers and Canals	each	1	1	1
Minor Canals and Tributaries	each	8	10	8
2. Construction Works				
Earthwork Section	km	39.7	40.8	40.3
Bridge Section	km	0.3	0.3	0.3
Long Span Bridges	m	100	100	100
Other Bridges	m	190	230	200
Box Culverts	no.	8	14	12
3. Construction Cost Index		100	102	101
<b>C. Environmental Impacts</b>				
1. Communities Crossed	km	0.9	1.4	1.4
2. Brick Factory Areas Crossed	km	0.5	0.5	0.5
<b>D. Socio-economic Aspects</b>				
1. Accessibility to Modinagar		Fair	Good	Good
2. Contribution to Future Development		Good	Poor	Fair
<b>Comparison (Ranking)</b>				
Geometry		1	3	2
Construction		1	3	2
<b>TOTAL RANKING</b>		1	3	2
<b>Meerut IC Location</b>		<b>Route 1-1, 2-1, 3-1</b>		<b>Route 1-2, 2-2, 3-2</b>
Conformity to City Master Plan		○		×
Accessibility to City Center		△		○
Total Cost Effectiveness		○		△
<b>TOTAL RANKING FOR MEERUT IC</b>		○		△

## 6. PRELIMINARY ENGINEERING DESIGN

### 6.1 Future Traffic Demand and Number of Lanes

The result of future traffic demand forecast is summarized with the designated number of lanes in Table 6.1

**Table 6.1: Traffic Demand Forecast and Number of Lanes**

K-G Expressway		2006	# Lanes	2016	# Lanes	2021	# Lanes	2026	# Lanes
1	Kundli IC	41,200	Initial 2+2	67,000	2+2	87,400	2+2	112,800	Ultimate 3+3
2	Khekra IC	30,900	2+2	52,900	2+2	76,100	2+2	98,100	3+3
3	Junction								
G-M Expressway									
1'	Meerut IC	24,300	2+2	40,400	2+2	56,700	2+2	75,200	(3+3)
2'	Modinagar IC	27,700	2+2	50,700	2+2	75,500	2+2	101,300	3+3
3'	Junction								
4	Ghaziabad IC	43,100	(3+3)	74,400	(3+3)	102,600	3+3	132,300	4+4

Source: JICA Study Team

Note: a) Design Daily Traffic Volume (DDTV) (threshold capacity for design) is:

K-G	2+2	88,000	pcu/day	G-M	2+2	85,000	pcu/day
	3+3	133,000	pcu/day		3+3	128,000	pcu/day
	4+4	177,000	pcu/day		4+4	171,000	pcu/day

$$DDTV \text{ (pcu/day)} = BC \times N / K \times (0.5 / D) \times SLF$$

where,

BC: Base Capacity; 2,200 pcu/hr

N: Total Number of Lanes; 4, 6 or 8

K: K-factor (peak Hour Volume/AADT); 7.5 %

D: Directional Factor; 53 % for K-G, 55 % for G-M

SLF: Service Level Factor, v/c value for LOS=C; 0.8

- The number of lanes in parenthesis is a recommended value due to network balance, although it exceeds the minimum requirement.
- Traffic volumes are all Distance Based Toll Case
- The bold number of lanes is the proposed initial number of lanes (Year 2006), and ultimate number of lanes after widening (expected to be around Year 2021 - 2026).

The result of the traffic demand forecast shows a moderate traffic volume at the opening time, and an exponentially high growth in the distant future. This will make the scheme of stage construction most effective. Based on the result of the future traffic demand forecast and designed capacity for four, six and eight lanes expressways, the initial number of lanes are proposed to be 2+2=4 lanes for Kundli IC - Ghaziabad N. JCT and Meerut IC - Ghaziabad N. JCT sections, and 3+3=6 lanes for Ghaziabad N. JCT - Ghaziabad IC section. These lanes will be widened from four lanes to six lanes (Kundli IC - Junction and Meerut IC - Junction) and from six lanes to eight lanes (Junction - Ghaziabad IC) between the years 2021 and 2026.

## 6.2 Preliminary Design of Interchanges, Toll Plazas and Rest Facilities

**Interchanges:** The four interchanges of Kundli IC, Khekra IC, Meerut IC, Modinagar IC were designed as trumpet type, based on the previous discussion that trumpet type is more appropriate than cloverleaf type for toll road interchanges. Ghaziabad IC, which belongs to FNG Expressway, is also optionally designed and recommended as a trumpet type.

**Toll Plaza:** a throughway toll plaza will be necessary, if the FNG Expressway designs the Ghaziabad IC as a cloverleaf type. This toll plaza has been designed preliminarily based on the computation of necessary number of gates. This toll plaza will not be necessary, if the FNG Expressway adopts a trumpet type for the Ghaziabad IC.

**Rest Facilities:** the Guidelines for Expressway Design, which is under formulation in MOST, suggests that there are two types of rest facilities on Indian Expressways. These are the Rest Area, having an area of 10,000 m<sup>2</sup>, and the Service Area, having an area of 60,000 - 100,000 m<sup>2</sup>. It is recommended that one Rest Area be provided for both K-G and G-M Expressways each.

## 6.3 Preliminary Earthwork Design

The expressway structure will be mostly embankment. The highest embankment height will be as high as 11 m at the abutment side of grade separation bridges. A preliminary embankment stability analysis, therefore, has been performed using assumptions made from available geotechnical data. The result is that both embankment and the existing ground are silty soils. They will be stable against circular slip.

## 6.4 Preliminary Design of Bridges and Culverts

The necessary number of bridges and culverts resulting from the geometric design are listed in Table 6.2.

**Table 6.2: The Number of Bridges and Culverts by Category**

Category	K-G Expressway	G-M Expressway
Major River Bridge	2	---
Canal/Drain Overpass Bridge	6	9
Highway Overpass Bridge	2	1
Railway Overpass Bridge	1	---
Village Road Overpass Bridge	11	10
Canal/Drain Box Culvert	3	2
Cart Track Box Culvert	36	30

*Source: JICA Study Team*

## 6.5 Preliminary Pavement Design

Pavement life cycle design has been undertaken based on AASHTO Design Guidelines for an expected concession period of 30 years. Although flexible (bituminous) pavement is traditionally more popular in India, recent examples of rigid (cement concrete) pavement, such as used for NH02 in Haryana, shows that pavement type selection can be controversial. The life cycle analysis, therefore, has been performed for both flexible and rigid pavements. Its economics are compared as summarized in Table 6.3.

Flexible Pavement: Initial Design Period: 10 years, Overlay: 5 times after 11th year

Rigid Pavement: Initial Design Period: 20 years, Overlay one time after 21st year

**Table 6.3: Economic Comparison of Pavement Type**

	Flexible (Bituminous) (A)	Rigid (Cement Concrete) (B)	(B)/(A)
Initial Construction Cost (2006)	Rs.825	Rs.1,653	200.0 %
Overlay Unit Cost	Rs.455	Rs.303	66.6 %
Net Present Value (i = 12 %)	Rs.1,110	Rs.1,681	151.4 % (Rs.571)

Source: JICA Study Team

Note: Unit price for each pavement layer was referred to NH02 Upgrading Project, Faridabad District, Haryana PWD

## 7. CONSTRUCTION PLANNING

### 7.1 Stage Construction Methods

- (A) Outer Initial Lane Method implies constructing the embankment for the ultimate number of lanes, pavement will be for outer initial lanes, and it will be widened to the inner side without additional embankment.
- (B) Inner Initial Lane Method implies constructing the embankment and pavement for the initial number of lanes, and it will be widened to the outer side with additional embankment.

The analysis of the traffic demand forecast and the number of lanes reveals that the initial lane operation period will be very long ( about 20 years). Method (B) is therefore recommended, since it will be more advantageous. The bridges will be constructed so that the substructure will be for the ultimate number of lanes, and the superstructure will be for initial number of lanes. The superstructure will be widened at the time of expressway widening.

### 7.2 Implementation Schedule

The total implementation schedule including construction time schedule in the earliest case is presented in Figure 7.1. It assumes an overlap between Land Acquisition and Construction expecting that the critical path of Yamuna River construction can be commenced before completing entire acquisition of the right of way.

**Figure 7.1: Implementation Schedule**

	1999	2000	2001	2002	2003	2004	2005	2006
Feasibility Study	█							
Final Engineering Design		█	█					
Land Acquisition			█	█	█			
Construction				█	█	█	█	
Opening to Traffic								▼

Source: JICA Study Team

## 8. EXPRESSWAY OPERATION AND MAINTENANCE PLAN

The scope of expressway operation and maintenance works is divided broadly into three major components: (1) expressway maintenance, (2) traffic management, and (3) toll collection. The basic objectives of expressway maintenance are to secure traffic safety, smooth traffic flow and user comfort. The activities for maintenance can be categorized by their frequency and characteristics as ROUTINE MAINTENANCE, PERIODIC MAINTENANCE and INCIDENTAL MAINTENANCE.

An expressway operation requires A CENTRALIZED TRAFFIC MANAGEMENT SYSTEM. This is because traffic management on expressways needs a more sophisticated system than that on arterial roads. An expressway is an access-controlled, thus a segregated space from the at-grade road network. Once an accident occurs, it may take longer time for an ambulance or the police to reach the site than at-grade roads; even information on such accidents may not be transmitted immediately without a systematic traffic management system. Yet expressway users expect a higher level of service in traffic management, as well as in the physical quality of the facility, because they are paying money for using the facility. Figure 8.1: "Centralized Traffic Management and Accident Measures" shows a diagram for centralized traffic management and accident measures on expressways.

It is recommended, considering such nature of the expressway system, that the toll system on the K-G and G-M Expressways be DISTANCE-BASED. The decision on whether the toll expressway adopts a flat toll system or a distance-based toll system will affect the road user's usage patterns and the toll revenues. A flat toll system is effective and convenient to users of urban expressways, in the case of which the average trip distance is relatively shorter and the average frequency of usage per user is higher. A distance-based toll system, on the other hand, is effective and fair to users for inter-urban expressways, in the case of which the average trip distance is longer, and frequency of usage per user is lower.

Since the K-G and G-M Expressways are not a stand-alone road stretch, but constitute part of a network, A COMPUTERIZED TOLL COLLECTION SYSTEM is recommended. A single and simple toll road stretch can be operated by a simple system of issuing a small ticket at the entrance and collecting the necessary toll at the exit. In a network, however, it needs to identify all of the vehicles on the system. The system will need reliable cash management, which enables complete matching between registered or computed toll data and actually collected cash amount. Also, the system should be able to acquire and store complete data on traffic volume and revenues, origin-destination (OD) data, peak-hour, weekly, monthly and seasonal traffic volume fluctuations for better traffic management services. Figure 8.2: "Distance-based Toll Collection System" shows a schematic diagram for a computerized distance-based toll collection system.



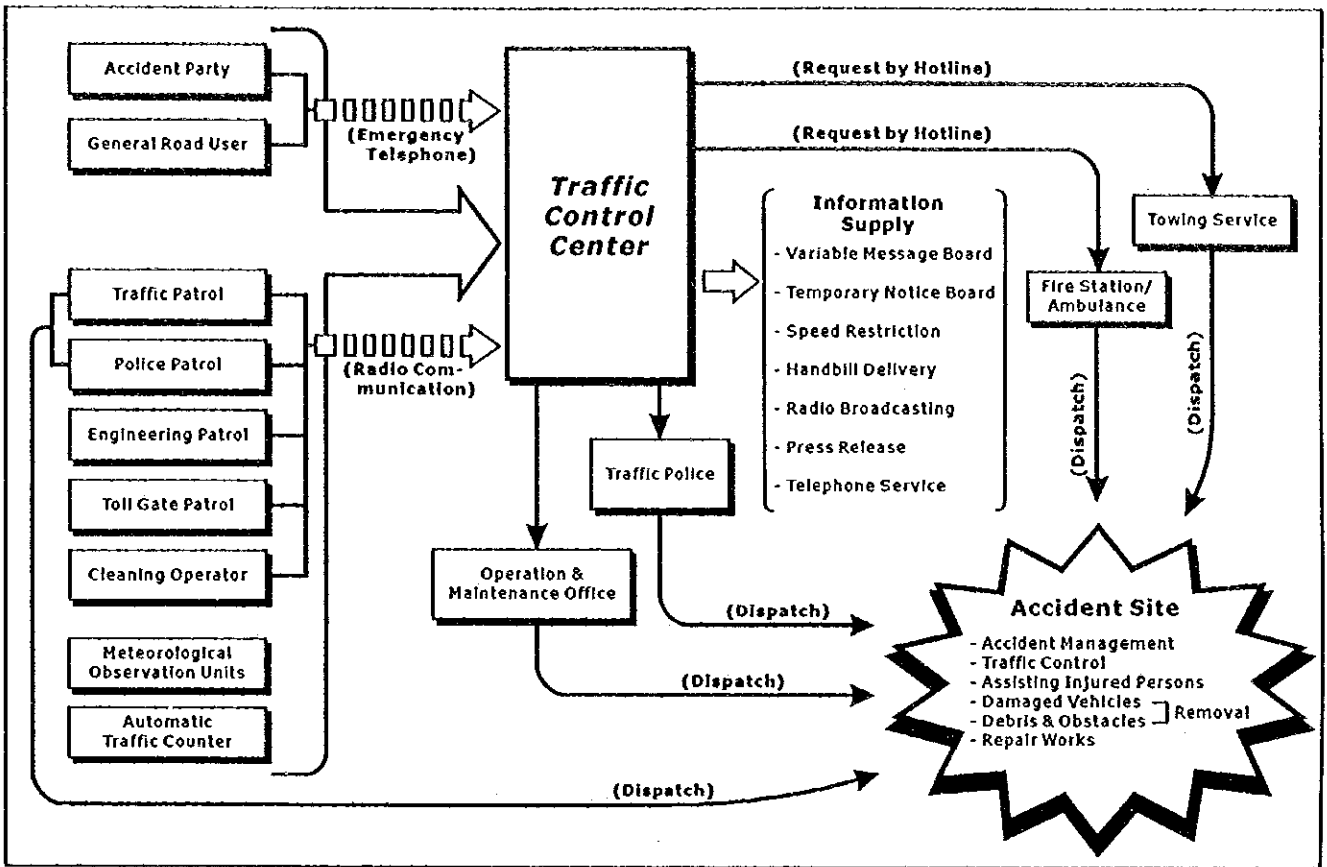


Figure 8.1: Centralized Traffic Management & Accident Measures

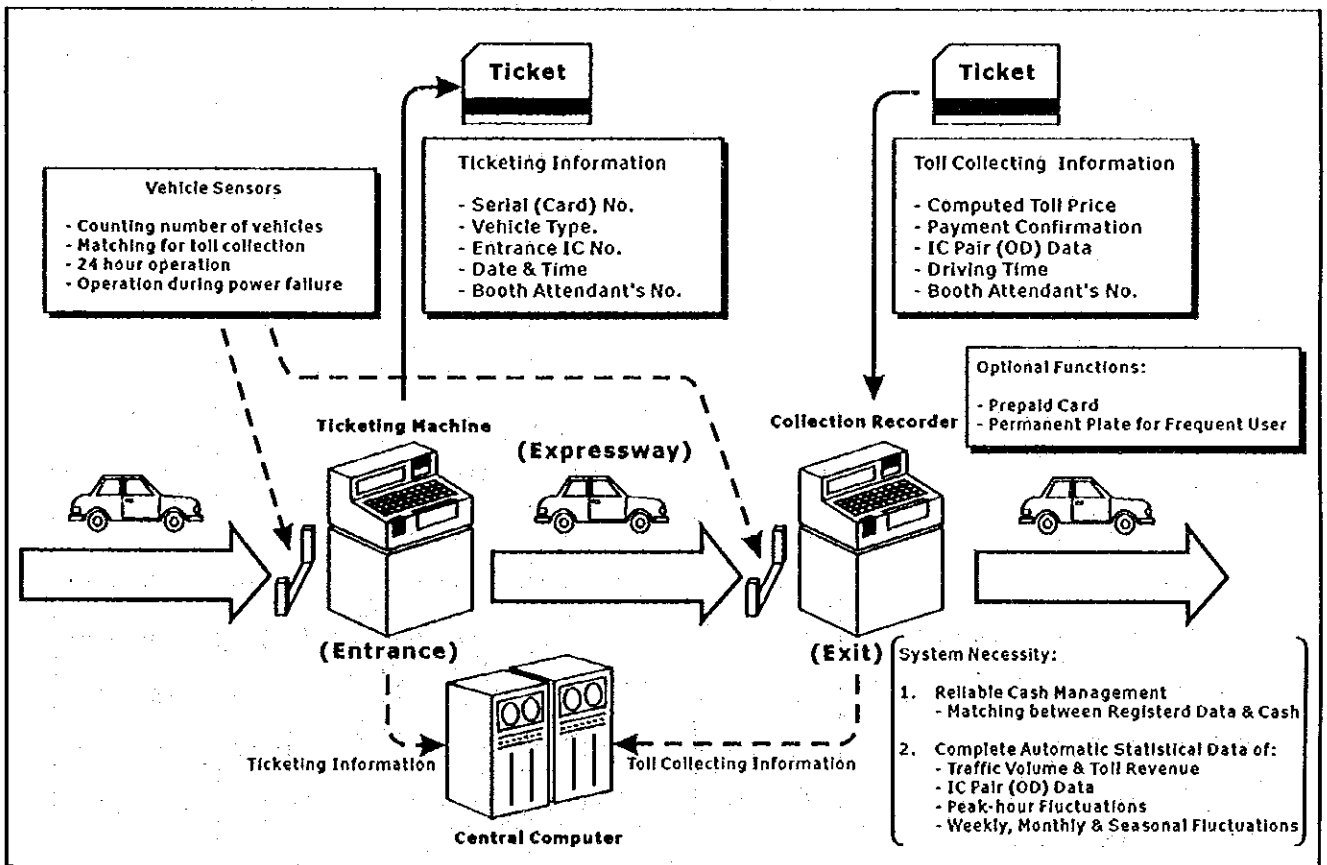


Figure 8.2: Distance-based Toll Collection System

## 9. PROJECT COST ESTIMATE

The estimate of the project cost is based on the results of the preliminary engineering design, quantity take-off of each work item and a study on construction methods. As boundary conditions, the estimated cost includes the cost of Kundli IC and Meerut IC as well as other intermediate interchanges, but does not include the cost of Ghaziabad IC since it is expected to exist as a terminal interchange of FNG Expressway when K-G and G-M Expressways are realized. All the construction works will be executed by contractors to be employed by the toll road development corporation of the expressway projects, whichever form of the corporation is going to be formed.

The initial total project cost, the future widening cost, and overlay costs for the initial lanes and ultimate lanes are computed and summarized in Table 9.1. The unit price of each cost component was determined based on the economic conditions prevailing in August 1999.

**Table 9.1: Summary of Total Project Costs**

[Unit: Rs.]

Item	K-G Expressway (Segment 1, 2, 3)		G-M Expressway (Segment 4, 5)		TOTAL
	Local Portion	Foreign Portion	Local Portion	Foreign Portion	
1. Initial Construction Cost	4,413,090,000	321,390,000	2,432,769,000	155,282,000	7,322,531,000
2. Land Acquisition and Compensation Cost	1,199,911,000	0	449,502,000	0	1,649,413,000
3. Engineering Cost ((1.+2.) x 10%)	474,749,000	118,686,000	243,003,000	60,750,000	897,188,000
4. Administration Cost ((1.+2.) x 5%)	296,718,000	0	151,877,000	0	448,595,000
5. Contingency ((1.+2.+3.+4.) x 10%)	638,532,000	43,924,000	327,849,000	20,968,000	1,031,273,000
<b>TOTAL INITIAL PROJECT COST</b>	<b>7,023,000,000</b>	<b>484,000,000</b>	<b>3,605,000,000</b>	<b>237,000,000</b>	<b>11,349,000,000</b>
5. Widening Construction Cost	1,234,501,000	107,348,000	613,418,000	39,155,000	1,994,422,000
6. Engineering Cost (5. x 10%)	107,347,000	26,838,000	52,205,000	13,052,000	199,442,000
7. Contingency ((5.+6.) x 10%)	134,152,000	12,814,000	66,377,000	4,793,000	218,136,000
<b>TOTAL WIDENING COST</b>	<b>1,476,000,000</b>	<b>147,000,000</b>	<b>732,000,000</b>	<b>57,000,000</b>	<b>2,412,000,000</b>
8. Overlay Construction Cost (Initial Width)	383,256,000	42,584,000	267,239,000	29,694,000	722,773,000
9. Contingency (10 %)	38,744,000	3,416,000	26,761,000	2,306,000	71,227,000
<b>TOTAL OVERLAY (Initial Width) COST</b>	<b>422,000,000</b>	<b>46,000,000</b>	<b>294,000,000</b>	<b>32,000,000</b>	<b>794,000,000</b>
10. Overlay Construction Cost (Ultimate Width)	536,577,000	59,620,000	347,251,000	38,584,000	982,032,000
11. Contingency (10 %)	53,423,000	5,380,000	34,749,000	4,416,000	97,968,000
<b>TOTAL OVERLAY (Ultimate Width) COST</b>	<b>590,000,000</b>	<b>65,000,000</b>	<b>381,000,000</b>	<b>42,000,000</b>	<b>1,080,000,000</b>

Source: JICA Study Team

## 10. ECONOMIC ANALYSIS

### 10.1 User's Benefit and Toll Level

It was established in the analysis of traffic demand forecast that a toll rate of Rs.1.5/pcu-km produced the maximum toll revenue. It is widely accepted as a principle of determining the toll rate that the toll rate should be determined within the limits of user's financial benefit deriving from the expressway.

The financial user benefit was estimated from the traffic assignment result of the potential expressway users, comparing the "with" and "without" project expressway conditions with each other. The benefit estimated as above, therefore, only reflects the direct benefit that the potential expressway user will receive from the project. This estimation is summarized in Table 10.1.

**Table 10.1: User's Financial Benefit and the Level of Toll in 2006**

Items		Unit	Pass.Car	Bus	Truck	Total
Total Driving Distance on Expressway		1000pcu-km	1,260	126	658	2,044
VOC	without/Total VOC	1000Rs.	33,548	1,519	17,010	52,077
	with/Total VOC	1000Rs.	31,207	1,451	16,006	48,663
	User's VOC Saving Benefit	1000Rs.	2,341	68	1,004	3,414
Travel Time Cost	without/Total Travel Time	1000Hr.	282	9	71	362
	with/Total Travel Time	1000Hr.	185	7	57	249
	User's Travel Time Saving	1000Hr.	97.0	2.0	14.0	113.0
	Time Value	Rs.	61.2	126.0	---	---
	User's Time Cost Saving	1000Hr.	5,936	252	---	6,188
Total User's Benefit (VOC+Time)		1000Rs.	8,277	320	1,004	9,602
User's Benefit per IPCU-km	VOC + Time	Rs/km				4.7
	VOC Only	Rs/km				1.7

Source: JICA Study Team

It was determined consequently that the toll rate of Rs.1.5/pcu-km fell within the expressway user benefit, even though benefit considerations were limited to saving in vehicle operating cost, i.e. Rs.1.7/pcu-km.

### 10.2 Economic Evaluation

The Economic Internal Rate of Return was calculated in order to examine the feasibility of the project expressway, as shown in Table 10.2.

From the system's development viewpoint, the KG Expressway shows the highest EIRR

with 27.05 %, followed by the KG/GM and GM only configurations. It is concluded that the project expressways area economically feasible in any of the cases.

**Table 10.2: Economic Internal Rates of Return**

Section	Length	EIRR
K-G and G-M	80.75 km	26.37 %
K-G Only	49.00 km	27.05 %
G-M Only	39.75 km	25.30 %

*Source: JICA Study Team*

The result of sensitivity test also assured the feasibility of the KG/GM Expressway as shown in Table 10.3.

**Table 10.3: Sensitivity Test**

		Investment Cost Increase			
		±0 %	+10 %	+15 %	+20 %
Benefit Decrease	±0 %	26.37 %	25.07 %	24.49 %	23.93 %
	-10 %	24.93 %	23.68 %	23.14 %	22.62 %
	-15 %	24.25 %	22.97 %	22.42 %	21.91 %
	-20 %	23.38 %	22.21 %	21.69 %	21.20 %

*Source: JICA Study Team*

The result of the sensitivity analysis proves the project is economically feasible from national economy viewpoint, since EIRR is found to be more than the opportunity cost of capital, which was estimated to be 12 %, in spite of many uncertain conditions.

## **11. INSTITUTIONAL, FINANCIAL AND IMPLEMENTATION ANALYSIS**

### **11.1 Introduction**

The prime objective of the institutional, financial and implementation planning analysis proposed here is to outline a down-to-earth blueprint for the timely realization of the KG-GM Expressways in India's National Capital Region (NCR), to be opened for traffic in 2006. It is commonly claimed that these expressways are needed, regardless of their financial viability.

### **11.2 Institutional Enabling Environment**

#### **The Legal And Regulatory Frameworks**

Further adjustments and fine-tuning is needed in India's enabling environment for large-scale private sector participation to be realized in highway/expressway development. Figure 11.1 summarizes the most pressing issues in the legal and regulatory framework and it recommends the type of action, which need to be taken over the short to medium term.

#### **The Model Concession Agreement**

The model concession agreement prepared by NCRPB, which is currently in place, is completely unsuitable to attract private sector participation in the realization of the KG-GM Expressways, or any other expressway in the NCR for that matter. Figure 11.2 summarizes the items, which need to be addressed, taking into account "best international practice", and it recommends a suitable policy direction for such measures.

#### **NCRPB & The Institutional Set-up**

There are also significant flaws and obstacles in the institutional set-up in general, and in particular as regards the NCRPB's potential, and capacity & capability to play a more proactive role in expressway implementation. Figure 11.3 summarizes the issues, which need to be addressed over the short-term, and it proposes a suitable direction for such adjustment measures.

Agenda Item	Conclusions & Comments	Policy Action Required	Target Of Policy Action	Time Frame
Standards & Norms, and Definitions	There is no official definition for expressways and/or super National Highways	Yes By Central Government	Establish a viable binding technical standard	ASAP. Over the short-term
	There is a need to establish clear non-political criteria for when state highways should form part of the national grid	Yes By Central and State Governments	Establish clear technical criteria for jurisdiction and responsibilities	ASAP. Over the short-term
Institutional Framework	The transport/road sector planning process needs streamlining	Yes By Central and State Governments	Establish a more coherent and systematic process, which ensures system integrity	Over the short- to medium-term
	The NCRPB's mandate & powers need to be strengthened. Its relations to other relevant planning bodies, such as the DDA, need to be clarified	Yes By Central and State Governments	Change, adjust or fine-tune the existing mandates, functions and responsibilities	ASAP. Over the short-term
	The NCRPB and NHAI need institutional strengthening	Yes By Central and State Governments	Enable both institutions to execute their mandate efficiently	ASAP. Over the short-term
Government Clearances	There are many clearances and also much "red-tape"	Yes By Central and State Governments	Establish a 'one stop' window at the appropriate entity	ASAP. Over the short-term
Land-ownership Rights	Is presently legally not possible for foreign entities	Yes By Central and State Governments	Clarify and adjust the legal situation	Over the short- to medium-term
Toll Rate Policy & Formulation	Toll rate levels are presently decided at the PMO level. However, there should be an independent regulatory authority ensuring across country fair rates	Yes By Central and State Governments	Consider positively the establishment of a regulatory & supervisory authority	Over the short- to medium-term
Incentive System	There may be a need to further clarify & streamline regulations regarding FDI and ECB	Yes By Central and State Governments	Adjust the rules in those areas, which need further clarification	Over the short- to medium-term
Concession Agreement	[ Is addressed separately]	[ Is addressed separately]	[ Is addressed separately]	[ Is addressed separately]

Source: JICA Study Team.

Notes: 1.) FDI = foreign direct investment. 2.) ECB = External commercial borrowing.

**Figure 11.1: Comments and Recommendations For The Overall Regulatory Frameworks**

Model Agreement Item	Observations & Comments	Required Action, if any
Traffic Demand Forecast	It is common that project sponsors don't "guarantee" the accuracy of traffic demand forecasts. However, NCRPB should support its own projects by making available all historical and related traffic modeling data.	Yes BY NCRPB
Bid-security & Forfeiture of Bid-security.	The bid-security of about US \$ 2.1 million is significant. The period for returning the bid-security is excessively long and needs to be shortened. The question of accrued interest needs to be clarified in favor of the bid-security provider, as is international praxis. The reasons of forfeiture of bid-security need to be clarified and reasonable.	Yes BY NCRPB
Time Schedule, Financial Closure & "zero point" Definition *]	The time schedule seems to be unrealistic as experience gained so far suggests. Financial closure occurs after signing of the concession agreement, making the point "zero" definition meaningless. This should be reviewed to introduce more flexibility.	Yes BY NCRPB
Performance Security	The performance security is with US \$ 6.3 million considerable. Keeping the performance security over the concession period of 30 years is unrealistic. The question of accrued interest needs to be clarified.	Should be negotiated between sponsors & investors
ROW Land Acquisition	This issue needs complete review. It is suggested that ROW land is purchased by the State Governments and leased to the concessionaire at a marginal or zero Rs. rate. The loan issues are to be scrapped altogether.	Yes By State Governments & the NCRPB
Real Estate Development Rights	It is recommended to grant them automatically, if really needed to improve financial viability of the project. The issues should be negotiated on a case-by-case basis.	Yes By State Governments & the NCRPB
Bid Evaluation Criteria	They should be made public, be clear and transparent from the beginning. They should not be limited to how much additional land over ROW is requested.	Yes, by State Governments & the NCRPB
Risk Assessment & Risk Distribution **]	The distribution of the various risk is completely inadequate in the model concession agreement. It needs comprehensive and in-depth review paragraph by paragraph. A fair risk distribution is one of the keys to successful private sector participation.	Yes, by State Governments & the NCRPB To be negotiated, item by item.

Source: JICA Study Team.

Notes: \*] The time schedule is attached in the Annexes.

\*\*] The individual issues are too numerous to be repeated here. Please consult with the model concession agreement.

**Figure 11.2: Comments and Regulations for Concession Agreement**

NCRPB Agenda Item	Observations, Comments & Recommendations
<b>General Statutory Mandate</b>	The general mandate of the NCRPB calls for the preparation, enforcement and implementation of the functional and sub-regional plans within the NCR. However, roads are explicitly excluded from the mandate, which creates a somewhat ambiguous situation. The NCRPB is also charged with the selection and approval of comprehensive priority projects. It is recommended to include roads/expressways into NCRPB's mandate.
<b>Plan Implementation</b>	Plan implementation rests with the participating States. However, the Government may wish to review this situation. It is difficult to see, how the NCRPB can be "responsible" for proper plan execution when the power to control such execution is completely beyond the institution's reach.
<b>Land Acquisition</b>	Land acquisition and title rights in any other property rests with the participating States. This situation should be reviewed, if the NCRPB is to be the signatory for expressway development, which involves ROW and real estate use rights to be transferred to a private concessionaire.
<b>Financing &amp; Funding Activities</b>	The NCRPB is to provide financial assistance for the implementation of priority projects in the NCR. The Government should consider positively to strengthen that function in one way or another. It may be desirable, in particular for expressway development, which involves substantial investment, to review as to whether the NCRPB should not also be enabled to be an asset holder. Strengthening the financial assistance function may also enable the NCRPB to act as guarantor.
<b>Institutional Capabilities &amp; Capacity</b>	There is a need to review the institutions capacities & capabilities in light of the above proposals. Control over NCRPB's planning cells now physically located with the State Governments should be reestablished. Proper consideration should be given to the institutional implications, if the NCRPB is to play a stronger role in expressway or project implementation.
<b>Inter-agency Coordination</b>	This aspects needs to be reviewed with a view to strengthen it. Particular attention should be paid to the relations with other planning entities, such as the DDA, and MOST and the NHAI. Twinning arrangements may be considered in particular for toll expressway development in the NCR.

Source: JICA Study Team.

**Figure 11.3: Comments and Recommendations for Institutional Setup**



## 11.3 Financial Analysis

### (1) Approach and Basic Financial Performance Results

Four case studies have been calculated with a view to establish the most feasible project structure and the fundamental financial merits of the KG-GM Expressways. The general difference between the four case studies are :

- **CASE STUDY 1:** Assumes a 100 percent private sector concessionaire. The conditionalities are tailored around the existing model concession agreement.
- **CASE STUDY 2 :** Assumes a 100 percent private sector concessionaire. The conditionalities are tailored around the existing model concession agreement. However, the project structure has been adjusted eliminating the long-term domestic loan.
- **CASE STUDY 3 :** Assumes a private sector dominated Private Public Partnerships (PPP) undertaking, and
- **CASE STUDY 4 :** Assumes a public sector dominated PPP.

The underlying project structures are summarized in Table 11.1.

### (2) Basic Financial Performance Results

The basic pre-tax FIRR was calculated for three different toll rate levels, in order to allow from the beginning for sensitivity testing, namely 1.0 Rs./km; 1.5 Rs./km; and 2.0 Rs./km. The simple pre-tax FIRR for the recommended optimal distance-based toll rate of 1.5 Rs./km is :

**Financial Internal Rate of Return (FIRR) = 10.4 percent.**

The cashflow and debt-service analyses calculated for the four case studies with their underlying project structures (as summarized in the previous Table 11.1 reveals that Case Study 1 and 2 have fundamental problems in to incur the negative cash flows after long-term debt service during their crucial first five years of operations.

Case Study 3 shows minor amounts of negative cashflow during the first two operational years. It is reasonable to assume that the two negative cashflows can be balanced out by slight adjustments in the project's structure. Case Study 4 shows positive cashflows during all first five operational years.

**Table 11.1: Underlying Project Structures Of Case Study 1 To Case Study 4**

Parameter	Case Study 1	Case Study 2	Case Study 3	Case Study 4
<b>Equity to Debt Structure</b>	30% to 70%	30% to 70%	40% to 60%	30% to 70%
<b>Equity Structure</b>	1.) Private concessionaire: 19.51% 2.) Other private domestic: 10.49%	1.) Private concessionaire: 19.51% 2.) Other private domestic: 10.49%	1.) Private concessionaire: 20.53% 2.) NCRPB* 14.73% 3.) Other private domestic companies : 4.74%	1.) Government entities: 22.50% 2.) Priv. domestic financing company : 7.50%
<b>Debt Structure</b>	1.) Land acquisition & compensation: LT domestic loan at i=13% n=10 years 2.) 50% of remaining debts: LT domestic loan at i=16% n=10 years 3.) 50% (the balance) LT foreign US \$ dominated loan at i=8.75% and n=30 years	1.) Land acquisition & compensation: LT domestic loan at i=13% n=10 years 2.) All other debts to be financed from LT foreign US \$ dominated loan at i=8.75% and n=30 years	1.) Land acquisition & compensation has been eliminated as a loan. It is treated as NCRPB equity. 2.) All other debts to be financed from LT foreign US \$ dominated loan at i=8.75% and n=30 years	1.) Land acquisition & compensation has been eliminated as a loan. It is treated as NCRPB equity. 2.) All other debts to be financed from LT foreign US \$ dominated loan at i=3.4% and n=30 years

Source: JICA Study Team.

Note: \* equivalent to Land Acquisition Cost

It must be concluded, therefore, that :

- Case Study 1 and 2, which represent the 100 percent private sector/concessionaire approach have to be rejected as being not feasible under given circumstances, and that
- Case Study 3 and 4, which represent the private and public sector dominated PPP approach, can be accepted as being feasible, in principle. The underlying features of Case Study 3 and 4 qualify, therefore, for “base case” considerations.

### **(3) Improving the FIRR**

A FIRR of 10.4 %, which is below the prevailing Indian lending rate of around 13 %, is not yet attractive enough to harvest ample private sector capital. Apart from other measures outlined below (such as toll rate increase) geared at increasing the FIRR, a sensitivity test has been undertaken to measure the impact on the project’s FIRR, if land acquisition and compensation cost are treated as “sunk cost” in the cash flow analysis. The test result shows that in such a case the project’s FIRR would increase to about 12 %.

Alterations in the concession period, however, are no suitable measure to improve the FIRR. This is due to the fact that the higher growth in traffic demand and therefore revenues takes place in the later years of the project’s life cycle. In fact, the pre-tax FIRR goes down considerably, if the concession period is shortened. The results of the computation are FIRR of 8.5 % for a 25 years concession period, 6.6 % for a 20 years and 1.3 % for a 15 years concession period.

### **(4) The Equity Holder’s Point-of-View**

The potential Return-on-Equity (ROE) has been investigated for the first ten crucial years of operations. The results of this test revealed that the accumulated net cash flows during the first ten years after taxes are Rs. 3,402.6 million and Rs. 6,504.7 million for the Case Studies 3 and 4 respectively.

Average annual ROE for all equity holders would be 7.6 % and 19.1 % for Case Study 3 and Case Study 4, respectively. The much higher ROE for Case Study 4 is possible, because of the much more favorable long-term concessional financing conditions than in Case Study 3, the long-term financing for which is at market rates. Potential ROE for private equity shareholders only (that is assuming zero ROE for other equity shareholders) during the first ten years would be 14.8 % and 76.3 % for Case Study 3 and Case Study 4, respectively.

## **(5) Conclusions & Basic Recommendations**

The following principles to be observed in the realization of the KG-GM Expressway project should be stated in conclusion that:

- The long-term debt structure in terms of borrowing terms (repayment periods) should match, at the lowest possible interest rate, the life cycle of the long-term assets, namely that of the KG-GM Expressways, and
- Adjustments in the project structure, that is equity to debt ratio, equity structure, and finally long-term debt structure, always lead only to a trade-off between these three project structure elements, and not to “the solution” for the given financing problem under consideration.

In addition to pure FIRR considerations, related functional criteria are introduced into the appraisal of the two principal potentials represented by Case Study 3 and 4.

A rationale and justifiable decision can thus be made based on an assessment of the combined results and conclusions of :

- The KG-GM Expressway’s basic feasibility measured in terms of its simple pre-tax FIRR and long-term debt service capability,
- The level of realism of the pursued project structure (equity to debt ratio; equity structure, and long-term debt structure), and
- The extent to which the KG-GM Expressway project features fit into the overall highway/expressway development landscape and contribute thus to and/or strengthen achievement of overall, individual project overriding policy objectives.

As long as privatization of expressway remains an overriding Indian policy objective for its development, management, operations and maintenance, private sector versus public sector dominated PPP alternatives are not an issue of principle.

It is clear from the basic assumption that the KG-GM Expressways are needed to be constructed regardless of their individual feasibility, that either way, public or private sector dominated PPP, the GOI and/or NCRPB will have to assume the basic risks associated with this endeavor. The only remaining issue is as to whether the GOI and/or NCRPB can find a strategic private partner in a timely fashion.

If this target cannot be realized timely, the GOI and/or NCRPB may wish, in order not to lose precious time, to proceed with a public sector dominated PPP, which is to be converted, as soon as possible, into a private sector dominated PPP.

The proposed public or private sector dominated PPP implementing entity should have the

following minimal functions:

- Execution and management of KG-GM Expressway projects, and
- Management, operations and maintenance of the Expressways.

## **11.4 Implementation Analysis**

### **(1) Guidelines For Government Position In Project Negotiations**

The basic strategy of the GOI and/or NCRPB in the actual negotiation process with potential private sector investors should be:

- To function as a facilitator for the establishment of a private sector dominated PPP. If this is not possible in the short-term, a clear timetable should be established for converting the then necessary public sector dominated PPP into a private sector dominated one
- The use of public funds necessary in this context should be viewed as “seed money” for the above purpose and for an early achievement of the governments privatization goals
- Within this context, the GOI and/or NCRPB should aim at optimizing the simple pre-tax FIRR of individual projects while trying to minimize, where and when possible, total project investment cost.

The GOI and/or NCRPB may wish to consider positively a negotiation attitude on individual items as summarized in Figure 11.4

Reasonable risk distribution according to the principle of “risk adequacy” (the assumed risk must be fully compatible with the risk bearer’s capacity to assume such risk) becomes the overriding operational guidance, if such a strategy is to be pursued successfully.

### **(2) Recommended Implementation Plan And Timetable**

The recommended implementation plan and timetable is very tight, if the goal of opening the KG-GM Expressways in January 2006 is to be realized. The major milestones are summarized in Figure 11.5.

Subject Item	Observations, Comments & Recommended Negotiation Attitude
<p><b>Recourse or non-recourse financing</b></p>	<p>A recourse financing approach, which would imply the provision of GOI guarantees, would reduce the risk for financing institutions and ease the pressure on private equity investors to obtain such financing. However, if recourse financing is not possible, the project sponsors may have to guarantee a certain level of returns for private sector equity investors and provide other assurances, such as sub-ordinated loans serving as debt service guarantee and/or revenue shortfall guarantees to financing institutions. The latter would have a strong and direct impact on the project's cashflow.</p>
<p><b>Equity/Debt Structure</b></p>	<p>A credible equity to debts structure is crucial. The GOI/NCRPB should aim for a 30:70, or even better 40:60 equity to debt ratio.</p>
<p><b>Equity Structure</b></p>	<p>It is essential in case a public sector dominated PPP is established first that all "stakeholders", that is the Central and State Governments, and the NCRPB take a stake in equity without expecting a high ROE. This may be needed to guarantee the private equity holders a reasonable ROE. If a private sector dominated PPP is established, the GOI/NCRPB may need to assume measures to also safeguard the ROE for the private investor.</p>
<p><b>Debt Structure</b></p>	<p>India's financial market offers funds for up to 10 to 12 years at around 16% interest p.a. . This is expensive money at an implied 8% real interest rate. The GOI/NCRPB should consider positively to obtain concessional lending from an ODA entity. This would involve a sovereign guarantee and the assumption of exchange rate risk. However, it would have a positive impact on private sector confidence and ease the burden on the project's cashflow.</p>

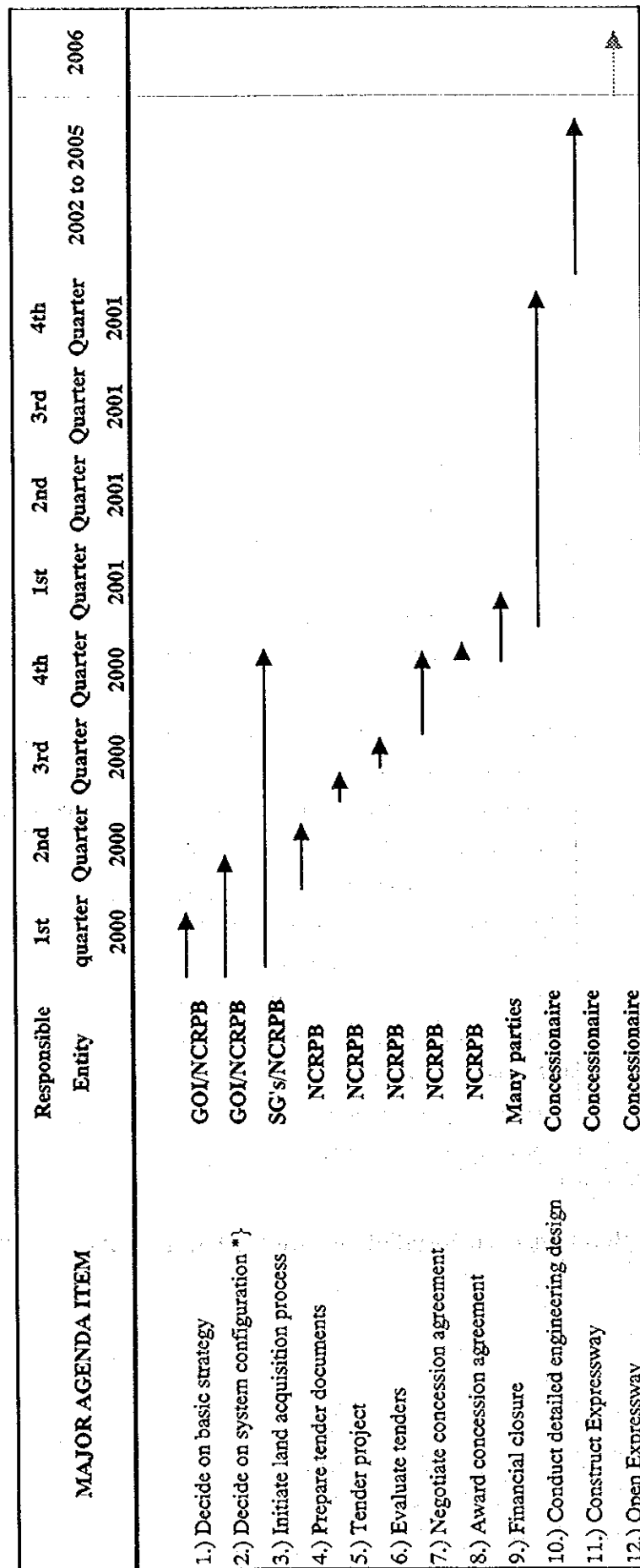
**Figure 11.4 Recommended Negotiation Attitude For The GOI/NCRPB (Part 1)**

Subject Item	Observations, Comments & Recommended Negotiation Attitude
<p align="center"><b>FIRR Considerations</b></p>	<p>The FIRR for the potential "base cases" is with 10.4% not high enough. The GOI/NCRPB may wish to consider positively in this context to enhance the FIRR through adoption of the following measures:</p> <p><b>Measure 1:</b> Secure ROW and possibly other land use rights through budget resources, so that this cost title can be treated as "sunk cost".</p> <p><b>Measure 2:</b> Grant real estate development rights automatically, if they are needed to bring the FIRR into the 20% to 25% range.</p> <p><b>Measure 3:</b> Negotiate other critical items in the concession agreement in a flexible manner (as discussed already earlier).</p>
<p align="center"><b>Toll Rate</b></p>	<p>The toll rate, established at 1.5 Rs. per km, should not exceed consumer benefits. However, the GOI/NCRPB should consider positively :</p> <p>a.) To peg the toll rate not to the unprecise WPI, but the CPI, which is more accurate;</p> <p>b.) To allow for annual toll increases, since revenues have a strong and direct impact on cashflow;</p> <p>c.) To allow for real toll rate increases, perhaps in line with real per capita income increase. Such an approach would keep tolls at the same "real price" level in terms of "willingness-to-pay."</p>
<p align="center"><b>Other vital items</b></p>	<p>1.) <b>Traffic data.</b> The GOI/NCRPB must make all historical data available to the investor at an early stage.</p> <p>2.) <b>System integration.</b> The NCR needs badly an integrated transport sector master plan. Such plan should be realized ASAP.</p> <p>3.) <b>Psychological factors.</b> It is important at the early stage of private sector led development to create a "success story". Hence, the GOI/NCRPB must do everything necessary to realize a success.</p>

Source: JICA Study Team.

**Figure 11.4: Recommended Negotiation Attitude For The GOI/NCRPB (Part 2)**

Figure 11.5 : Recommended Implementation Plan and Timetable



Source: JICA Study Team.

Notes: \*] This refers to the question of the package to be tendered. KG-GM only or in combination with the FNG.



## 12. ENVIRONMENTAL IMPACT ASSESSMENT

### 12.1 Overview

A reconnaissance survey was conducted to identify the major environmental issues. Accordingly, field surveys were undertaken to determine the ambient air quality, meteorological conditions (concurrent to the air quality studies), water quality, noise levels, soil characteristics, ecological status, and prevailing land use. The methodology adopted for this study is depicted in a flowchart as shown in Figure 12.1, which defines the input and output related to the evaluation of environmental impacts.

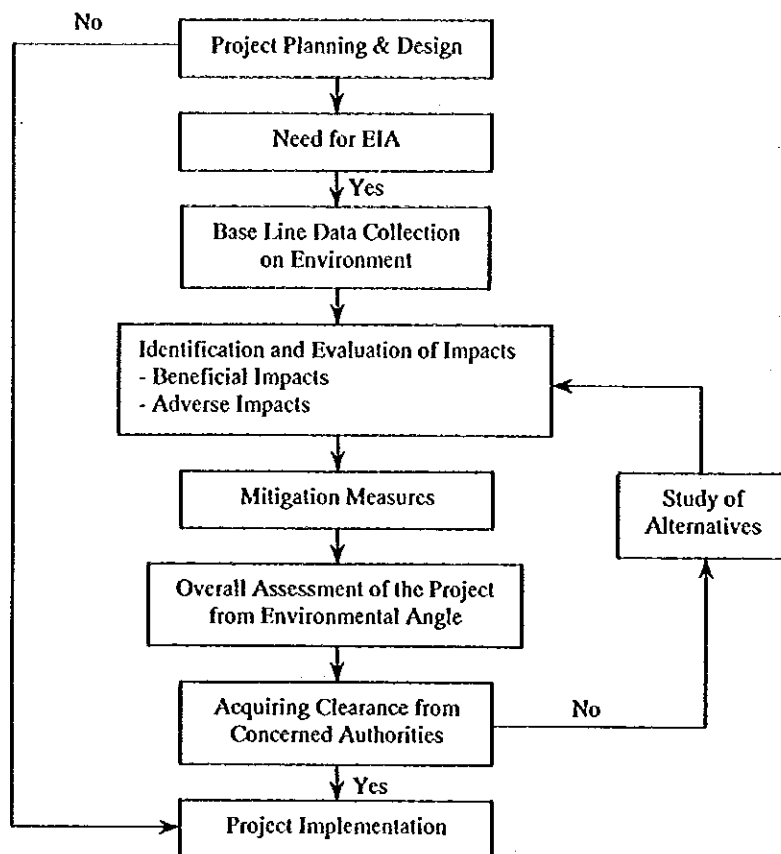
The typical environmental impact areas are categorized as shown in Table 12.1. Primary impact areas are those which are attributed directly to the project, whereas secondary impacts are those which are indirectly induced and typically include the associated investment and changing patterns of social and economic activities due to the proposed project.

**Table 12.1: Potential Environmental Impacts of Expressway Projects**

<b>POTENTIAL IMPACTS OF THE PROPOSED EXPRESSWAY</b>
<b>DIRECT IMPACTS</b>
Air Pollution
Noise
Surface and Ground Water Hydrology and Quality
Terrestrial and Aquatic Flora and Fauna
Removal of Vegetative Cover
Soil Contamination
Erosion of Lands
Sedimentation in Rivers/Ponds due to Erosion
Landscape
Hazardous Material's Spillage
Sanitation and Solid Waste Disposal
Dust and Roadside Litter
Aesthetics
Dislocation/Resettlement of People
<b>INDIRECT IMPACTS</b>
Induced Development/Land Use Patterns
Increased Transportation
Illegal/Unplanned Timber Cutting
Illegal/Unplanned Land Clearing

The impacts specific to this project are summarized considering the results of environmental impact assessment as shown in Table 12.2. Mitigatory measures to be adopted against said impacts are proposed in Table 12.3, and the cost incurred by these measures is incorporated into the project cost estimate.

**Figure 12.1: Basic Methodology Adopted for the Environmental Impact Assessment**



**Table 12.2: Potential Environmental Impacts Caused by the Proposed Expressway Projects**

Environmental Parameters	Construction Phase	Operation Phase
Air Quality	- Site clearance - Construction activities - Material transportation - Quarrying and Borrowing	- Vehicular traffic movement
Noise	- Site clearance - Construction activities - Material transportation - Quarrying and Borrowing	- Vehicular traffic movement
Vibration	- Site clearance - Construction activities - Material transportation - Quarrying and Borrowing	- Vehicular traffic movement
Water Quality	- Site clearance - Construction activities - Quarrying and Borrowing	
Ecology	- Site clearance - Construction activities - Quarrying and Borrowing	
Socio-economic	- Site clearance	

**Table 12.3: Environmental Management Plan for K-G & G-M Expressway**

No.	Environmental Issues	Actions to be Taken
<b>Construction Phase (Year 2002 - 2005)</b>		
1.	Dust contamination at site and on haul roads	Construction sites and access roads passing through residential and commercial areas and unpaved haul roads to be watered twice each day.
2.	Air pollution	24 hour monitoring at a frequency of two days a week during winter season in residential areas.
3.	Noise pollution	Provision of earplugs to heavy machinery operators. Construction of 3 m tall enclosures around generators when construction yards are within 100 m of residential areas.
4.	Disposal of construction debris	Daily inspection of the haul roads and sites for construction debris, and its collection and disposal to landfill sites.
5.	Transportation	All hauled material to be covered while being transported. Construction related transportation activity to be uniformly distributed during the night to minimize noise impacts. Routine check of vehicles used for transportation and their proper maintenance to minimize vehicular pollution.
6.	Domestic sewage and solid waste at workers' colony	Provision of water supply and washing facilities. Provision of waste disposal facilities like septic tanks at the construction workers' colony. Provision of garbage cans at site and in workers' colony for collection of domestic garbage. Provision for composing of domestic garbage at construction workers' colony.
7.	Removal of trees and landscaping	Landscaping plan to be asked with schedule of construction from contractor, it should be implemented concurrent to the road construction with a lag of few months.
8.	Resettlement	Advanced notification of enough time must be given to enable the relocatees to find a suitable place. Advance realistic payment should be available in some form for the relocatees to secure a new unit.
<b>Operation Phase (Year 2006 onwards)</b>		
1.	Air pollution	Provision of ambient air quality monitoring near the downwind direction of the expressway. Development of wide green belt all along the alignment.
2.	Noise pollution	Minimization of use of horns near sensitive locations and during nighttime with the help of signboards in proper positions.

## 12.2 Land Acquisition and Resettlement

A large scale of land acquisition requires a lot of relocation and resettlement of the people who have lived historically in the locations. The acquiring process may create various impacts to the society, and it can sometimes be a problem in the region. These impacts are such as loss of assets including lands and houses, loss of livelihood or income opportunities, and loss of common property resources of social groups.

One of the problems in the experience in India is that the policies deal with only individual owners of the lands. The loss of land, however, will have a different impact on people belonging to different ethnic and economic groups. In the event of resettlement, certain groups suffer more than others because of the difficulties they face in gaining an access to alternative sources of livelihood. The landowners will be covered by legal compensation. However, those who have no titles but depend on the land for their livelihood, tenants or sharecroppers have no rights and are often pushed aside. The current laws and regulations do not fully recognize the historically established rights of the minority people to their livelihood including access to land, natural resources and knowledge. Indigenous people, ethnic minorities and other vulnerable groups of people that may have informal customary rights to the land or other resources taken for the project should also be provided with adequate forms of compensation. The absence of a formal legal title to the land should not be grounds for denying compensation and rehabilitation.

Women in society particularly face specific difficulties in re-establishing and earning a living in the new area after resettlement. The current rehabilitation and resettlement policies do not consider women separately. The policy on land acquisition should address specifically the gender questions and enunciate the rights of women to treat the resettlement as an opportunity, a mandate for raising standard of living, restoring community and their relations, and minimizing conflict with the host community.

## 13. CONCLUSIONS AND RECOMMENDATIONS

### 13.1 Implementation of the Project

The results of the Study indicate that the projects are technically sound (no serious technical difficulty is anticipated for construction) and economically highly feasible. Taking into account the direct and enormous indirect benefits towards regional development in addition to the quantified savings in travel costs, the projects should be implemented at the earliest opportunity.

However, when the estimated constant pre-tax FIRR is compared with the prevailing interest rates and financial environment in India or even with possible off-shore financing opportunities, the financial viability of the Projects is not satisfactory. It is necessary to consider the following measures and strategies toward implementation.

**Recourse/Non-recourse Financing:** A recourse financing approach would strengthen the confidence of private investors and considerably reduce the private sector risk. If recourse financing is not possible, however, the GOI/NCRPB should consider positively guaranteeing returns for financing institutions and private equity investors.

**Equity Structure:** If a public sector dominated PPP is established first, the shareholders of the Central and State Governments as well as NCRPB have to invest in the equity without expecting a high ROE to ensure a reasonable ROE to the private equity holders. In the case of a private sector dominated PPP, the GOI/NCRPB may also need to assume measures to safeguard the ROE for the private investors

**Debt Structure:** India's financial market offers long-term funds at a high rate around 16 % interest for up to 10 to 12 years. The GOI/NCRPB should consider obtaining ODA funds from international funding institutions. This would involve a sovereign guarantee to the lender and assumption of the exchange rate risk. It would, however, provide a positive impact on private sector confidence and ease the burden on the project's cash flow.

**Toll Rate:** The recommended toll rate of Rs.1.5/pcu-km should not exceed user benefits. However, the GOI/NCRPB should consider allowing periodic toll increase, perhaps in line with real per capita income increase, which would keep constant the toll impedance to expressway users in real prices.

## **13.2 Issues for Further Consideration**

### **(1) Making A Success Story**

It is seriously important to create a “success story” at the early stage of private sector led development. The GOI/NCRPB should do everything necessary to realize a success.

### **(2) Master Plan Formulation**

The NCR needs an integrated transport sector master plan to establish an appropriate future modal share and network plan based on reliable traffic data. It is recommended that such study be performed as soon as possible.

\*\*\*\*\*









JICA