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No. 32

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

HIS MAJESTY'S GOVERNMENT OF NEPAL
MINISTRY OF WORKS AND TRANSPORT
DEPARTMENT OF ROADS

AFTERCARE STUDY
FOR
SINDHULI ROAD CONSTRUCTION PROJECT

FINAL REPORT

VOLUME II
MAIN TEXT

JULY 1993

NIPPON KOEI CO., LTD. TOKYO

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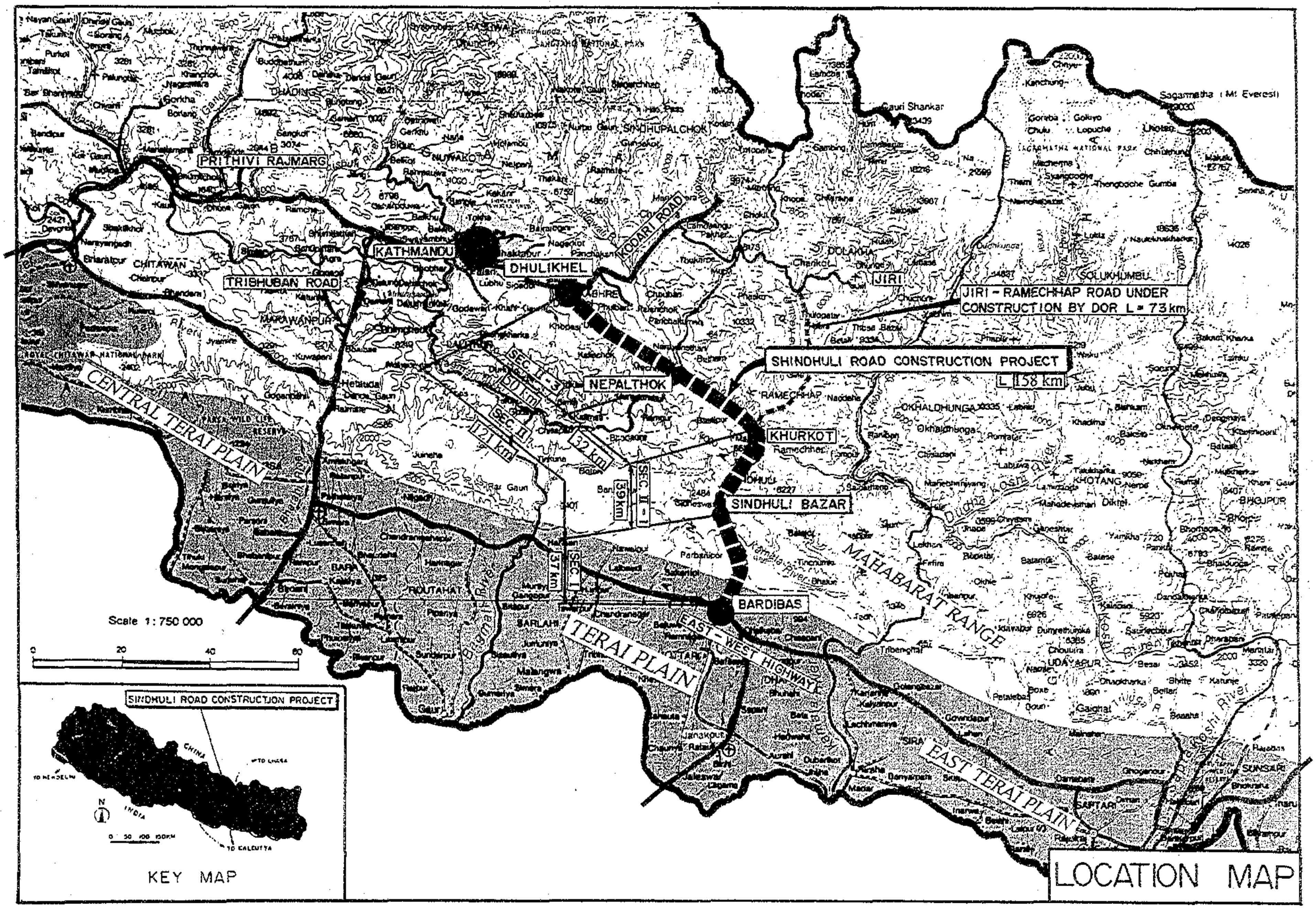
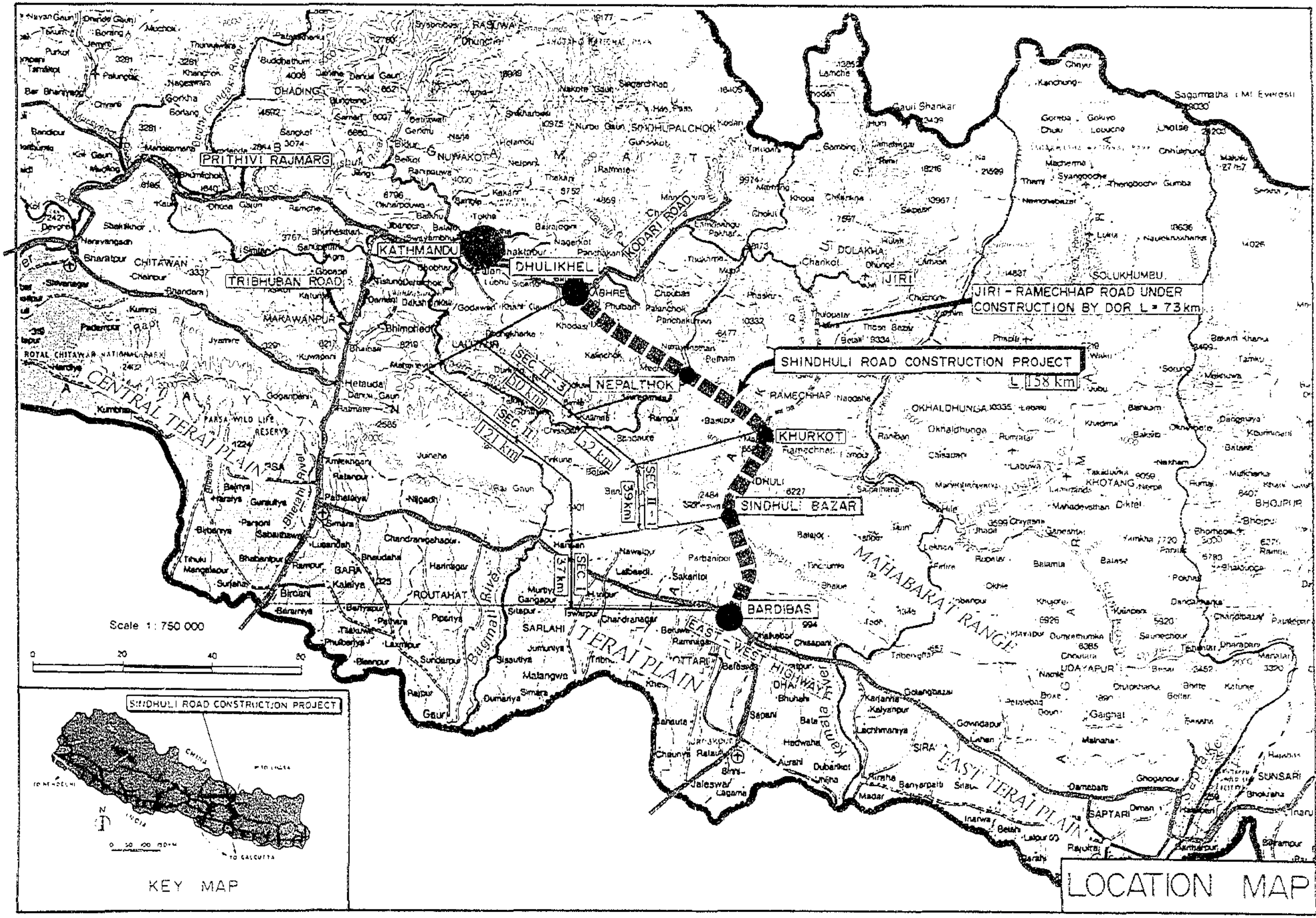
CURRENCY EQUIVALENTS
(As of March 1993)

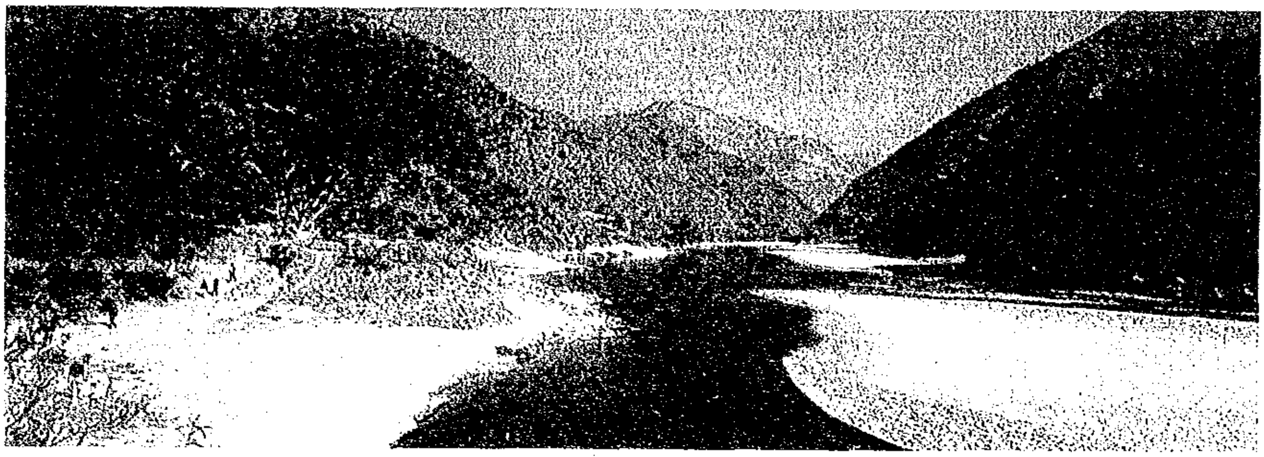
Currency Unit - Nepalese Rupees (NRs)

US $ 1.00=Yen 115.08 =NRs 45.88 (NRs 1.0=Yen 2.51)


LOCATION MAP
SHINDHULI ROAD CONSTRUCTION PROJECT
L 158 km
JIRI - RAMECHHAP ROAD UNDER
CONSTRUCTION BY DOR L = 73 km
KATHMANDU
DHULIKHEL
NEPALTHOK
KHURKOT
SINDHULI BAZAR
BARDIBAS
JIRI
KODARI ROAD
PRITHIVI RAJMARG
TRIBHUBAN ROAD
SEC. II-3
50 km
SEC. II
121 km
32 km
SEC. II-1
39 km
SEC. I
37 km
EAST - WEST HIGHWAY
CENTRAL TERAI PLAIN
TERAI PLAIN
EAST TERAI PLAIN
MAHABARAT RANGE
Sagarmatha (Mt Everest)
Gauri Shankar
SOLUKHUMBU
DOLAKHA
SINDHUPALCHOK
OKHALDHUNGA
KHOTANG
BHOJPUR
UDAYAPUR
SAPTARI
SUNSARI
SIRAHA
CHITAWAN
MAKAWANPUR
DHADING
NUWAKOT
RAUTAHAT
BARLAHI
BARA
RAMECHHAP
Scale 1 : 750 000
0 20 40 60
SINDHULI ROAD CONSTRUCTION PROJECT
CHINA
INDIA
KEY MAP



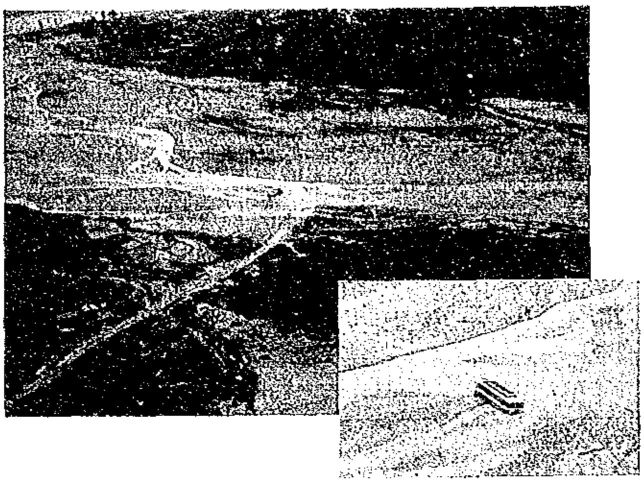
LOCATION MAP



The starting point of Section II-2, commands the view of upper reach of the Sun Kosi river.
The route is proposed on the foot of hill on the left.

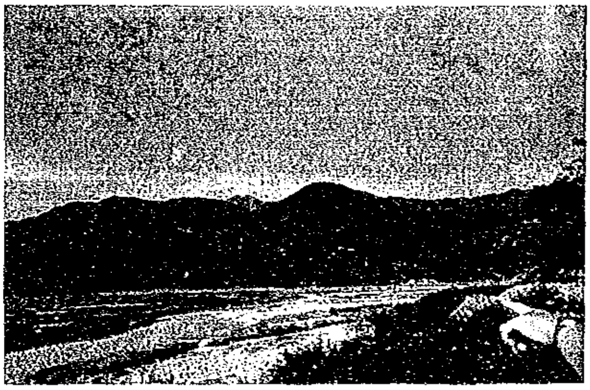
Proposed passing point of Section II-2, near the quiet mountain-village of Jhanga Jhull.
The route is proposed on the hill side above the village on the left.

View of the town of Dhulikhel, proposed end point of Section II-3, with the Himalay Mountains for the background. The route is proposed to pass on the hill on the left side of the town and to merge Kodali Road at the point in the left bottom corner of the picture.

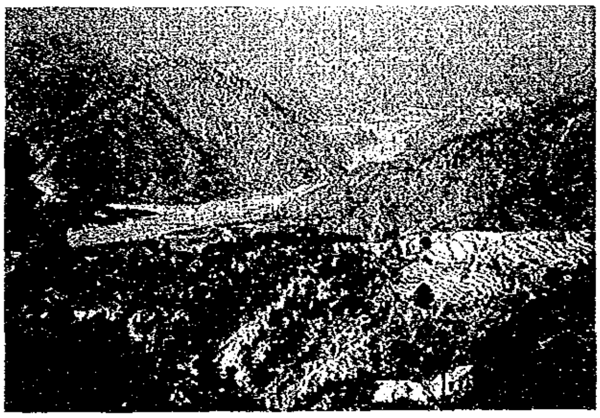


A stalled long-distant bus in the Ratu Khola during the rainy season, near the proposed crossing point of the rive.

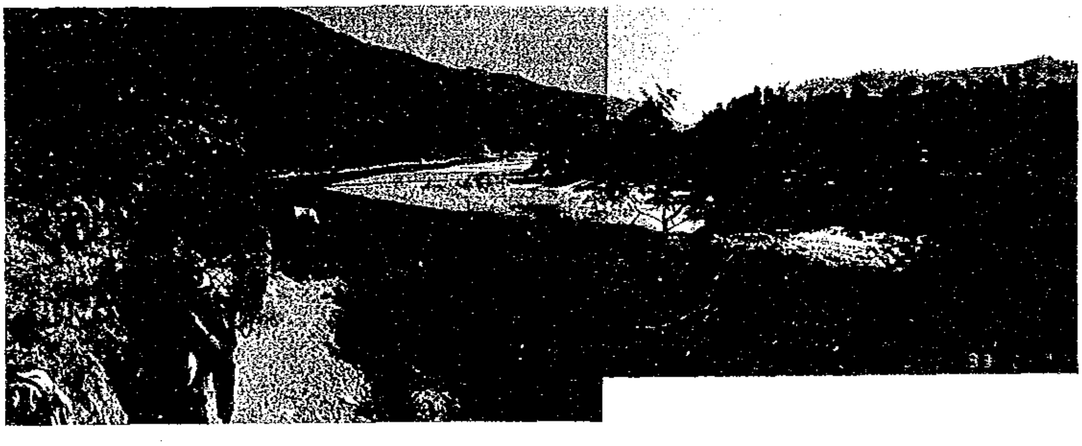
Existing road of part of Section II



The end point of Section I, command the view of the Mahabarat Mountains from Sindhuli Bazar.

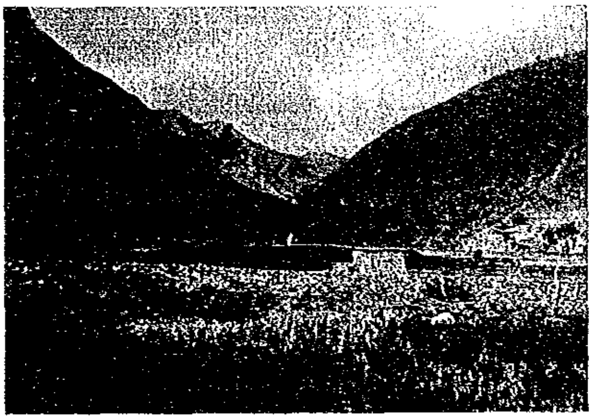


The proposed route of Section II-1 passing down to the town of Khurkot after the Mahabarat Mountains.



The end point of Section II-1 in the town of Kulukot. On the left is the Sun Kosi river. In the left bottom corner of the picture, porters carrying staffs on their backs to the town of Ramechhap from Sindhuli Bazar.

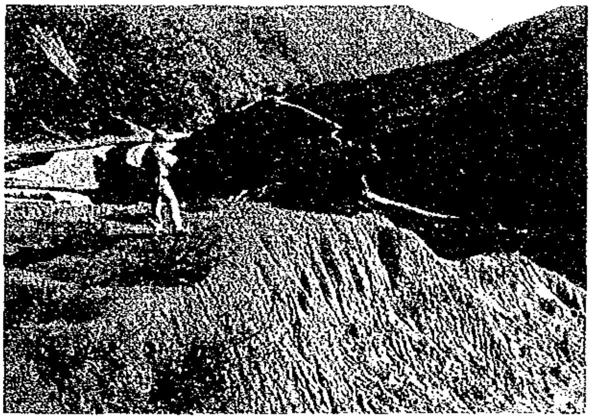
The Sun Kosi river during the rainy season. High water level is recognized compared with the picture of the same river on the right.



The junction point of Section II-2 and Section II-3 near Nepalthok. The proposed route heads for the river valley of the Roshi Khola after the Sun Kosi river.

Section II-3 passes the confluence of the Roshi Khola and the Dapcha Khola, tributary of the Roshi. The route is proposed below the mountain path seen in the picture.

Probable point of Causeway
Interview survey to villagers was carried out about the probable location of causeway.



The middle way of Section II, proposed to pass above the mountain pass on the middle part of the hill on the right.

The middle way of the Section II-3 near the Roshi Khola. The proposed route passes on the foot of the hill on the right.

The study team during the site inspection of the project road.

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ABBREVIATIONS
(In Alphabetical Order)

AC................................	Asphalt Concrete
B/C..............................	Benefit Cost Ratio
C.D.R...........................	Central Development Region
CAD.............................	Computer Aided design
DBST...........................	Double Bituminous Surface Treatment
DDG	Deputy Director General
DG	Director General
DOR............................	Department of Roads
E.D.R...........................	Eastern Development Region
EIA..............................	Environmental Impact Assessment
F.W.D.R.......................	Far-Western Development Region
F/S	The Previous Feasibility Study
GDP.............................	Gross Domestic Products
GOJ	Government of Japan
GRP.............................	Gross Regional Products
HBS.............................	Highway Bridge Standard in Japan
HMG............................	His Majesty's Government of Nepal
IRR..............................	Internal Rate of Return
JICA	Japan International Cooperation Agency
JRA	Japan Road Association
M.W.D.R.	Mid-western Development Region
MOF	Ministry of Finance
MRM...........................	Mahendra Rajmarj (East-West Highway)
NEIAG	National Environmental Impact Assessment
NPC.............................	National Planning Commission
NPV.............................	Net Present Value
NRS.............................	Nepal Road Standard
NRs	Nepal Rupees
OD...............................	Origin and Destination
PCG.............................	Prestressed Concrete Girder
pcu	Passenger car unit
PD................................	Project Director
RBLC...........................	River Bed Level Causeway
ROW............................	Right of Way
SB................................	Submersible Bridge
SC................................	Section Chief
SDT	Steel Deck Truss
SG................................	Steel Girder
STT	Steel Through Truss
US $	U.S. Dollar
VC................................	Vented Type Causeway
vpd..............................	Vehicle per day
W.D.R..........................	Western Development Region
Yen..............................	Japanese Yen

CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

1.1 The Project Background

The Kingdom of Nepal, with the total land area of about 147 thousand sq. km and the total population of about 18 million, is a land locked country located on the southern slope of the Himalaya Range. It is bordered in the South by India and in the North by People's Republic of China with the Himalayan ridges.

Kathmandu, the capital of the Kingdom as well as a center of economic and administrative activities, is located in Kathmandu Valley situated in an approximate gravity center of Nepal. Kathmandu Valley has about 1.1 million population that is equivalent to approx. 6% of the total population in Nepal.

Nepal is pre-dominantly an agricultural country. About ninety percent of the economically active population of the country is in the agriculture and allied industry. This sector contributed about 52% of the GDP in 1986/87. The main agricultural belt of Nepal is the Terai Plain situated along the Indian border with approximate mean width of 30-40 km.

Agricultural products produced in the Eastern Terai Plain in Central and Eastern-Development Regions are being transported to Kathmandu through East-West Highway (Mahendra Highway) and Prithivi Highway. This route however is a roundabout way and the transport distance, for instance, from Janakpur in Central Development Region to Kathmandu is almost 390 km by the existing highways, however, the actual straight-line distance is only 130 km. Rapid agricultural development as well as enhancement of economic activities in these Regions have led to the necessity of direct connection between Eastern Terai and Kathmandu Valley as a matter of urgency.

Presently, there are two main highways connecting Kathmandu with Tear Plain, namely Tribhuban Highway and Prithivi Highway. The former crossing the Daman Pass (EL=2,300 m above mean sea level) is, however, not used as a main trunk line because of its narrow road width and winding alignment. The latter Prithivi Highway is being used as a main transport route linking Kathmandu and Terai Plain because of two lane width and relatively acceptable alignment. A part of this highway from Mugling to Naubise has been recently improved but potential risk of interrupting the traffic flow due to land slides or bank erosion still remains in this section. The section from Naubise to Thankot is still unstable and impassable quite often, especially during the rainy season. Nevertheless, the necessity of an alternative reliable trunk road which can be called as "The Second Backbone" has been envisaged from the points of security, economic growth and expansion in the capital city of Kathmandu.

Taking into account the above mentioned necessity of a new road link directly connecting Kathmandu with Eastern Terai, HMG formulated "Sindhuli Road Construction Project", linking Bardibas on East-West Highway and Dhulikhel on Kodari Road, and gave high priority to materialize the Project.

1.2 The Project Outline

Sindhuli Road has been planned to connect Bardibas on East-West Highway with Dhulikhel nearby Banepa on Kodari Road. The route passes through such centers of rural activities on the way as Sindhuli Bazar, Khurkot and Nepalthok.

The Project Road is broadly divided into two sections, namely, Section I between Bardibas and Sindhuli Bazar with a total length of 37 km, and Section II between Sindhuli Bazar and Dhulikhel having an approximate length of 121 km.

The outline of the Project Road in each section is briefly described as follows:

Section I: Bardibas-Sindhuli Bazar (37 km)

The existing road between Bardibas on East-West Highway and Sindhuli Bazar has been constructed by DOR with the exception of bridges and pavement employing equipment granted by the Japanese Government Aid Program since 1982. The Project, therefore, aims at improvement of the existing road, construction of bridges and pavement which have remained untouched so far.

Section II: Sindhuli Bazar-Dhulikhel (121 km)

Section II is entirely new construction of the road, since there exists only a mountain trail or small track which links Sindhuli Bazar with Dhulikhel at present.

Section II of the Project Road, starting from Sindhuli Bazar, crosses over Mahabarat Range at the lowest crossing point nearby Sindhuli Garhi (EL. 1360) and reaches Khurkot. After Khurkot, the Project Road runs along the Sun Kosi River and reaches the confluence of Sun Kosi River and Rosi Khola at Nepalthok. From Nepalthok, the Project Road continues ascending along Rosi Khola and finally reaches Dhulikhel nearby Banepa on Kodari Road.

1.3 The Study Background and Objectives

In response to the request from His Majesty's Government of Nepal (HMG), the Government of Japan (GOJ) decided to conduct the feasibility study on Sindhuli Road Construction Project in 1986. The feasibility study was carried out by Japan International Cooperation Agency (JICA) during the period from November 1986 to March 1988 and the Final Report was submitted to HMG in June 1988. A summary of the conclusions and recommendations quoted from the Final Report is as follows;

- Project Feasibility
  The Project, with double-lane of paved road in a total length of 155 km, was technically and economically feasible with the highest internal rate of return of 9.88%.

- Project Cost
  The total Project cost was estimated to be NRs. 3,884 million which is equivalent to US$ 185 million or ¥ 24,040 million.
  Note: Exchange rate applied in the cost estimate was US$ 1.0=¥130.0=NRs.21.0 (As of Jan.1988)

- Implementation Schedule
  Construction period of 8 years was recommended for the implementation of the Project.

Since the construction cost derived from the feasibility study was considerably large, all the efforts taken by HMG to look for possible funding sources were not successful yet to date. However, demand for the Project has increased and HMG has given high priority to "Sindhuli Road Construction Project" as stressed in "Eighth Plan" (1992-1997) published by National Planning Commission, Nepal, July 1992

Recognizing the importance and necessity of Sindhuli Road Construction Project in Nepal, even if the minimal development scheme is applied, HMG again requested GOJ to provide technical assistance for formulating practical and realistic development scheme and implementation program of "The Project". In response to the request of HMG, GOJ decided to conduct "Aftercare Study for Sindhuli Road Construction Project" (the Study) in accordance with the relevant laws and regulations in force in Japan, and entrusted it to Japan International Cooperation Agency (JICA), the official agency responsible for implementation of the technical cooperation programs of GOJ.

Accordingly, JICA dispatched a preliminary study team headed by Dr. Yasuyuki KOGA to Nepal from 13 to 22 September 1992 for the purpose of formulating the Scope of Work for the Study. The Scope of Work was signed between the Department of Roads

(DOR) representing HMG and JICA on 22 September 1992. Points of agreement reached during the discussions held prior to the signing were officially recorded in the Minutes of Meeting also signed on 22 September 1992. A set of these documents is attached in Appendix-A.

The objective of the Study is to formulate practical and realistic development schemes as well as implementation program of the Project based on the review of the previous feasibility study report.

The Study covers the following sections:

Section I:	Preliminary design of bridges between Sindhuli Bazar and Bardibas.
Section II:	Feasibility Study of the renewed road project between Sindhuli Bazar and Dhulikhel.

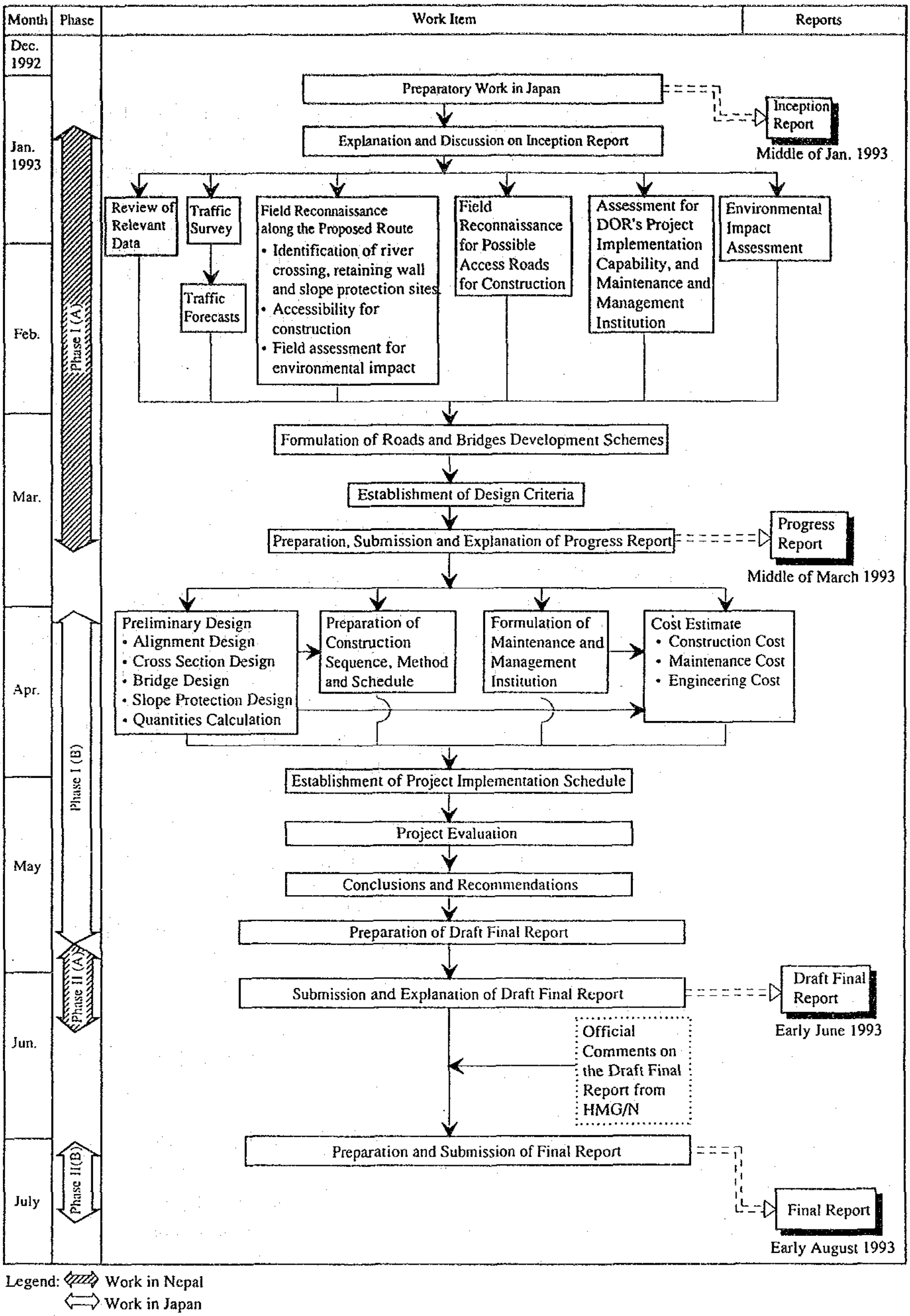
1.4 Scope of the Study

The study is broadly divided into two phases. Each phase is further subdivided into two stages involving work in Nepal and Japan, which is indicated by the suffix (A) and (B) respectively.

(1) Phase I (A) :	Work in Nepal from the middle of January to the middle of March 1993, involving field reconnaissance formulation of development scheme, and establishment of desing criteria.
(2) Phase I (B) :	Work in Japan from the end of March to the end of May 1993, including preliminary design, cost estimate and project evaluation.
(3) Phase II (A) :	Work in Nepal from the begining of June to the middle of June, including submission of Draft Final Report.
(4) Phase II (B) :	Work in Japan from early July to the middle of July 1993, including preparation and submission of Final Report.

The work flow diagram of the Study showing the interrelation of the above major study items is depicted in Figure 1-1.

Figure 1-1 Tentative Work Flow Diagram of the Study

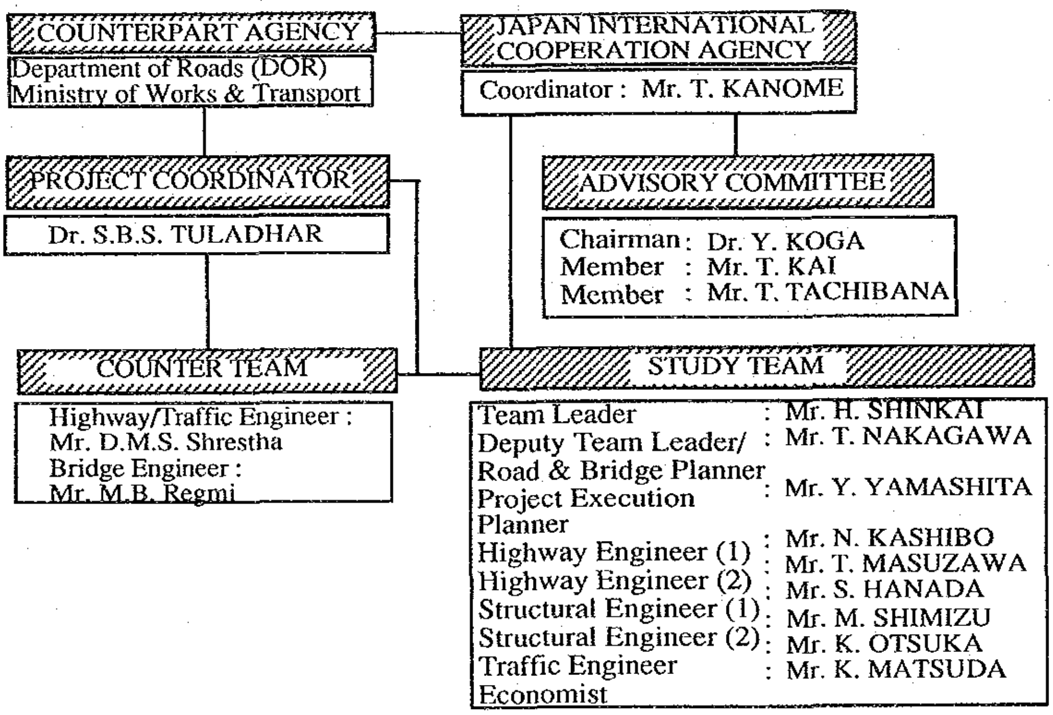


1.5 The Study Organization

To facilitate and ensure the smooth conduct of the Study, JICA organized a Advisory Committee consisting of three members who would provide advice and guidelines, and a Study Team composed of nine specialists to carry out the Study in close collaboration with Counterpart Team from DOR. On the other hand, HMG appointed the DOR as the counterpart agency to the Study Team and also as a coordination body between the Government Agencies concerned. A Counterpart Team comprising two engineers from DOR was formed in accordance with the agreement stated in Minutes of Meeting signed on 22 September 1992.

The interrelationship between the above mentioned Agency, Committee and Teams are shown in Figure 1-2.

Figure 1-2 Study Organization



1.6 Major Meetings Held

During the whole study period, the following major meetings were held in Nepal and the minutes of the respective meetings are attached in Appendix-B.

Meeting	Date	Main Subject
The First Meeting	21,26,28 January, 1993	Inception Report
The Second Meeting	5,9 March, 1993	Progress Report
The Third meeting	6 June, 1993	Draft Final Report

CHAPTER 2

TRAFFIC SURVEY AND TRAFFIC DEMAND FORECAST

CHAPTER 2

TRAFFIC SURVEY AND TRAFFIC DEMAND FORECAST

2.1 General

In order to review the outcomes of traffic demand forecast and those of economic evaluation conducted in the previous F/S, future traffic volumes corresponding to proposed road network and to road standard have been reforecasted based on updated socio-economic data and result of traffic survey exclusively designed for this purpose. Reforecasting work of traffic volumes has been proceeded based on exactly same methodology applied in the previous study which is composed of generated/attracted traffic demand forecast model, induced traffic estimation model, traffic assignment model and so on.

2.2 Traffic Survey

(1) Objective of the Survey

Roadside traffic counts have been carried out for the purpose of obtaining basic information to review the future traffic demand on the Project Road.

(2) Survey Points

Location of traffic counts are presented in Figure 2-1. These points are the same as those in the previous survey.

(3) Method of the Survey

Vehicles, passing through the survey points, were counted hourly and by vehicle type for 24 hours (6:00-6:00) of the survey day.

Survey day; February 3 (Wed.) -4 (Thu.), 1993
Vehicle type; 8 types as shown in Table 2-1

(4) Results of the Survey

Results of traffic counts are shown in Figure 2-2, Table 2-2 and Appendix-C1. Daily traffic volumes at the survey points on the major highways are more than 1,000 vpd. Traffic volume at Thankot (Point 2) on Tribhuvan Highway is the largest with

2,404 vpd. However, traffic volume on Sindhuli Road between Sindhulimadi and Bardibas (Point 7) is as small as 50.

The previous traffic survey was carried out on the same points on December 1986. Comparing these result with those of previous one, it is noticed that there has been great traffic increase during the last six (6) years on the major roads. The traffic volumes on the major roads are on the increase at the rates of 8% - 16% annually. Growth rates of truck and motorcycle are higher than those of passenger car and bus at most of the points.

Figure 2-1 Location of Traffic Counts

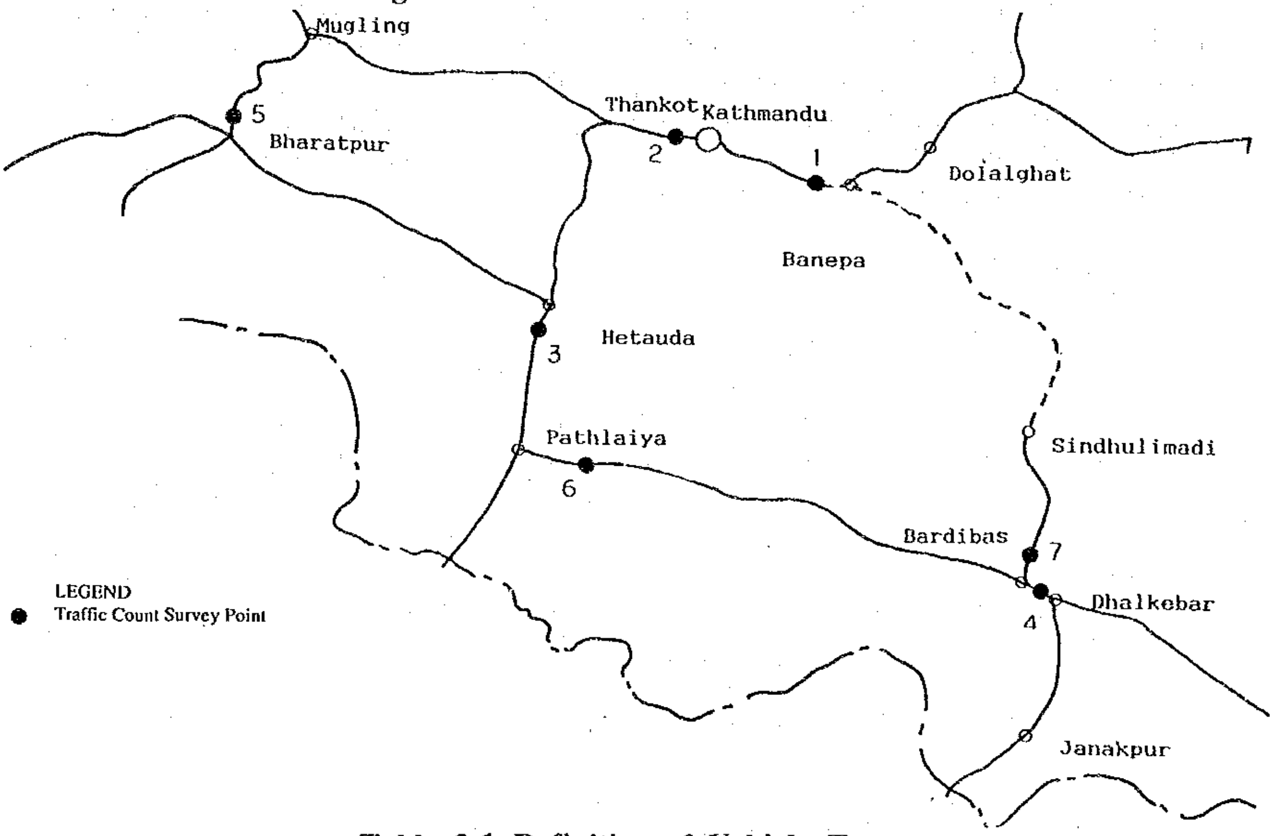


Table 2-1 Definition of Vehicle Type

Vehicle Type	Definition
Passenger Car	Including van, jeep and pick-up
Minibus	With number of seats less than 26
Bus	With number of seats 26 and over
Light Truck	Less than 2.5 ton
Medium, Heavy Truck	2.5 ton and over
Tractor	Includeght, medium and heavy tractor
Motorcycle	Include bicycles with engine
Others	Include vehicles for army, fire engine, ambulance and so on

Figure 2-2 Traffic Volume

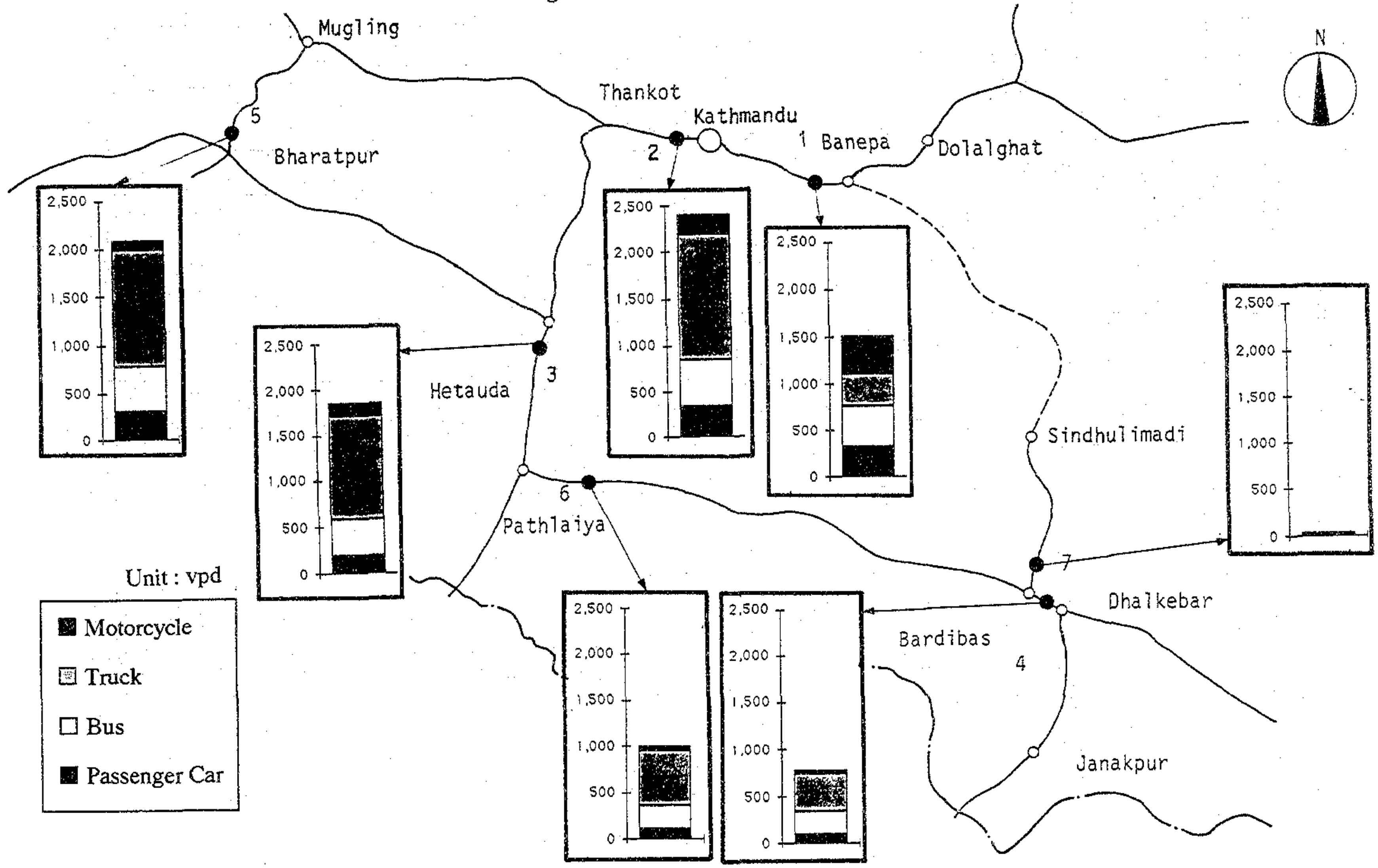


Table 2-2 Result of Traffic Counts

Unit : Vehicle

	Name of Survey Point	Duration	Motor-cycle	Car, Van, Jeep, Pick-up	Minibus	Bus	Light Truck	Medium, Heavy Truck	Tractor	Others	Total
1	Banepa	12h	339	256	229	168	69	178	34	10	1,283
		24h	402	315	270	180	90	212	38	10	1,517
2	Thankot	12h	179	259	72	224	81	917	8	17	1,757
		24h	207	339	81	435	107	1,206	10	19	2,404
3	Hetauda	12h	106	153	16	89	31	653	12	5	1,065
		24h	136	192	19	376	41	1,062	15	11	1,852
4	Dhalkebar	12h	44	71	7	94	1	236	8	0	461
		24h	48	90	9	249	8	368	12	0	784
5	Bharatpur	12h	98	244	33	134	76	505	15	42	1,147
		24h	105	296	41	436	111	1,029	18	45	2,081
6	Pathlaiya	12h	49	92	7	73	20	372	21	12	646
		24h	53	113	7	249	36	512	24	13	1,007
7	Bardibas	12h	16	4	0	10	0	9	0	0	39
		24h	20	6	0	13	0	11	0	0	50

Remark: 12h=from 6:00 to 18:00

Table 2-3 Comparison of Traffic Volume between 1986 and 1993

Unit:vpd

Year	Point	Name of the Point	Passenger Car	Bus	Truck*)	Motorcycle	Total
1986	1	Banepa	210	299	112	74	695
	2	Thankot	265	463	626	47	1,401
	3	Hetauda	99	185	505	47	836
	4	Dhalkebar	88	156	215	34	493
	5	Bharatpur	152	218	449	23	842
	6	Pathlaiya	64	153	388	34	639
	7	Bardibas	46	9	20	4	79
1993	1	Banepa	315	450	350	402	1,517
	2	Thankot	339	516	1,342	207	2,404
	3	Hetauda	192	395	1,129	136	1,852
	4	Dhalkebar	90	258	388	48	784
	5	Bharatpur	296	477	1,203	105	2,081
	6	Pathlaiya	113	256	585	53	1,007
	7	Bardibas	6	13	11	20	50
1993/1986 (Ratio)	1	Banepa	1.50	1.51	3.13	5.43	2.18
	2	Thankot	1.28	1.11	2.14	4.40	1.72
	3	Hetauda	1.94	2.14	2.24	2.89	2.22
	4	Dhalkebar	1.02	1.65	1.80	1.41	1.59
	5	Bharatpur	1.95	2.19	2.68	4.57	2.47
	6	Pathlaiya	1.77	1.67	1.51	1.56	1.58
	7	Bardibas	0.13	1.44	0.55	5.00	0.63

*); Include Others

2.3 Traffic Demand Forecast

2.3.1 Outline

The future traffic volumes have been forecasted in consideration of the following factors:

- Prospect of Eighth Plan(1992-1997)
- Prospects of regional development and transportation including on-going projects
- Updated information about population and GRP

(1) Target Year

Target years for traffic forecast have been set at 1999, the expected opening year of Sindhuli Road and at 2010, year of evaluation of middle/long-term plan.

(2) Influential Area

Influential area of the Project Road is defined along with the traffic analysis zones for the study as shown in Figure 2-3. The Central Development Region is divided into 16 zones, and the Eastern and the Western Development Regions are divided into 3 zones respectively,whereas the Mid-western and the Far-western Development Regions form one zone each. The Central Development Region is finely divided since it contains direct influenced area of the Project Road. The total number of traffic analysis zones ends up with 25.

2.3.2 Future Socio-economic Condition

(1) Population

Future population by traffic analysis zone have been forecasted based on the trend of past and projected national level population* by Central Bureau of Statistics, HMG/N. Regarding the projected national level population, medium variant has been adopted through the comparison with the other two variants: high growth variant and low growth variant. In medium variant, national level annual population growth rates are assumed 2.1% until 1996 and 1.8% thereafter. Population by traffic analysis zone have been obtained through the decomposition of national total applying the shares of each zone which are determined by the trend of the past (1981 - 1991). Regarding the populations of three districts in Kathmandu Valley, i.e., Kathmandu, Bhaktapur and Lalitpur, annual 3.0% of population growth is applied so as to keep consistency with related studies including Kathmandu Valley Urban Road Development Study by JICA. Future population by traffic analysis zone are given in Table 2-5.

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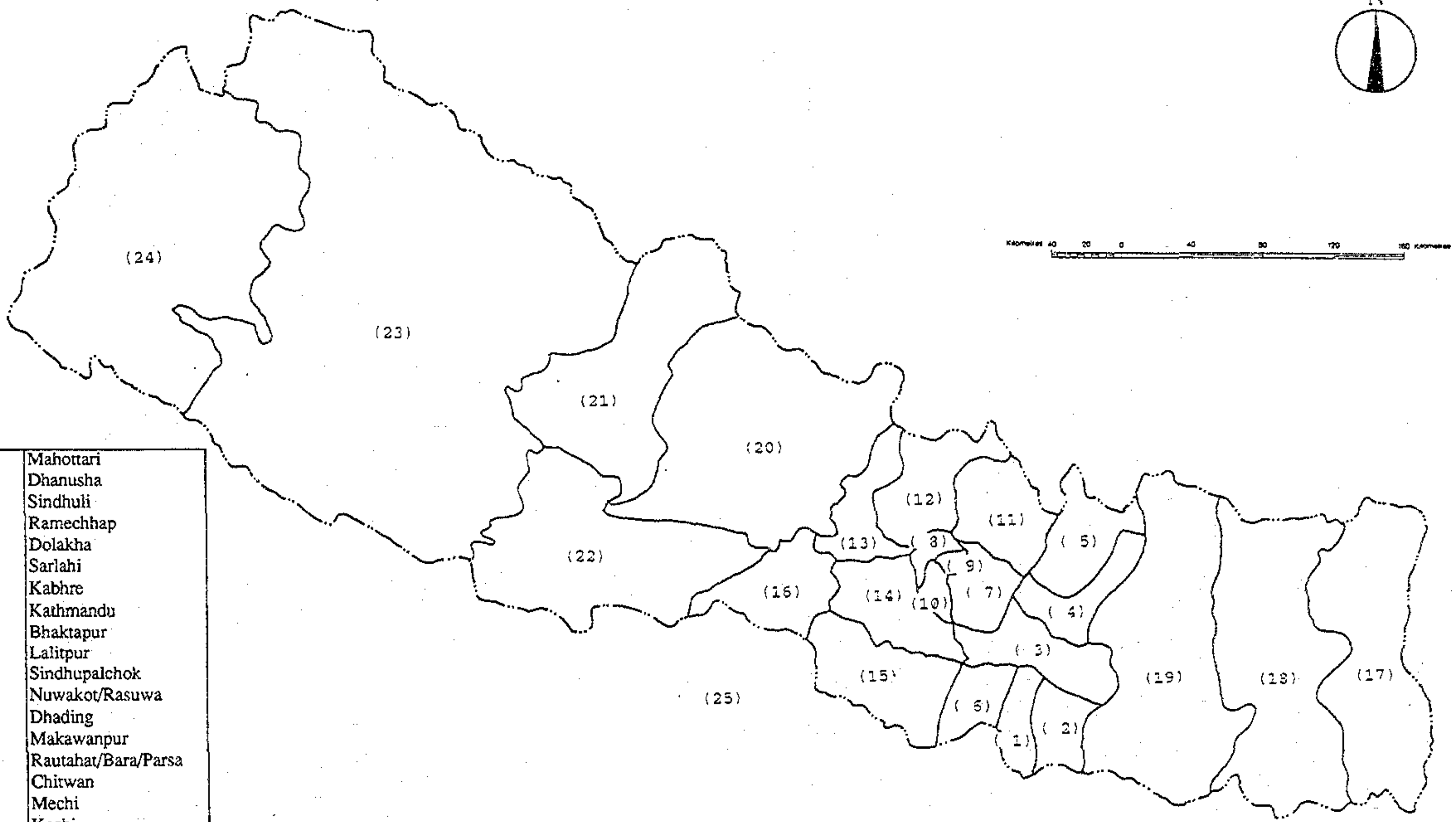
* Statistical Year Book of Nepal 1991, Central Bureau of Statistics, HMG/N.

Figure 2-3 Traffic Analysis Zone



1	Mahottari
2	Dhanusha
3	Sindhuli
4	Ramechhap
5	Dolakha
6	Sarlahi
7	Kabhre
8	Kathmandu
9	Bhaktapur
10	Lalitpur
11	Sindhupalchok
12	Nuwakot/Rasuwa
13	Dhading
14	Makawanpur
15	Rautahat/Bara/Parsa
16	Chitwan
17	Mechi
18	Koshi
19	Sagarmatha
20	Gandaki
21	Dhawalagiri
22	Lumbini
23	Mid-west Dev. R.
24	Far-west Dev. R.
25	India

Table 2-4 Population by Traffic Analysis Zone (1981 & 1991)

Unit : thousand

Zone No.	Name of Zone	Population 1981	Population 1991
1	Mahottari	361.1	440.8
2	Dhanusha	432.6	542.0
3	Sindhuli	183.7	222.9
4	Ramechhap	161.4	188.8
5	Dolakha	150.6	173.8
6	Sarlahi	398.8	490.4
7	Kabhre	307.2	324.8
8	Kathmandu	422.2	668.6
9	Bhaktapur	159.8	173.1
10	Lalitpur	184.3	258.5
11	Sindhupalchok	232.3	261.0
12	Nuwakot/Rasuwa	233.2	282.4
13	Dhading	243.4	278.5
14	Makawanpur	243.4	315.6
15	Rautahat/Bara/Parsa	935.8	1,197.7
16	Chitwan	260.0	355.3
C.D.R.Total		4,909.8	6,174.2
17	Mechi	932.6	1,119.4
18	Koshi	1,423.6	1,730.9
19	Sagarmatha	1,352.7	1,598.0
E.D.R.Total		3,708.9	4,448.4
20	Gandaki	1,107.6	1,262.7
21	Dhawalagiri	453.5	491.7
22	Lumbini	1,567.8	1,997.5
W.D.R.Total		3,128.9	3,751.9
23	Mid-west Dev. R.	1,955.6	2,406.1
M.W.D.R.Total		1,955.6	2,406.1
24	Far-west Dev. R.	1,320.1	1,681.5
F.W.D.R.Total		1,320.1	1,681.5
Nepal Total		15,023.4	18,462.1

Source : Statistical Pocket Book, 1991, 1992
Central Bureau of Statistics, HMG/N.

Table 2-5 Future Population by Traffic Analysis Zone (1999 & 2010)

Unit : thousand

Zone No.	Name of Zone	Population 1999	Population 2010
1	Mahottari	512.8	618.3
2	Dhanusha	643.9	799.4
3	Sindhuli	258.0	309.2
4	Ramechhap	212.3	244.4
5	Dolakha	193.3	219.1
6	Sarlahi	574.0	698.2
7	Kabhre	336.9	347.1
8	Kathmandu*)	847.0	1,172.4
9	Bhaktapur*)	219.3	303.5
10	Lalitpur*)	327.5	453.5
11	Sindhupalchok	284.2	312.9
12	Nuwakot/Rasuwa	326.5	390.3
13	Dhading	307.8	346.0
14	Makawanpur	385.3	496.6
15	Rautahat/Bara/Parsa	1,447.6	1,840.0
16	Chitwan	450.3	611.0
C.D.R.Total		7,326.7	9,161.9
17	Mechi	1,284.8	1,521.0
18	Koshi	2,007.1	2,409.7
19	Sagarmatha	1,811.2	2,107.6
E.D.R.Total		5,103.1	6,038.3
20	Gandaki	1,391.2	1,556.8
21	Dhawalagiri	520.3	550.8
22	Lumbini	2,404.9	3,040.4
W.D.R.Total		4,316.4	5,148.0
23	Mid-west Dev. R.	2,818.6	3,431.8
M.W.D.R.Total		2,818.6	3,431.8
24	Far-west Dev. R.	2,046.7	2,626.7
F.W.D.R.Total		2,046.7	2,626.7
Nepal Total		21,611.5	26,406.7

(2) GRP

Future GRP by traffic analysis zone has been obtained through the decomposition of region-wise GRP which has been forecasted based on the prospect of economic growth set forth in the Eighth Plan(1992-1997). Regarding the two of the components which compose GRP, say GRP by agricultural sector and that by non-agricultural sector, different methods have been applied as explained below:

<u>GRP by Agricultural Sector</u>

Regional totals have been decomposed into traffic analysis zone proportional to the sizes of present cultivated land contained in each zone.

<u>GRP by Non-agricultural Sector</u>

Regional totals have been decomposed into traffic analysis zone proportional to the sizes of future population in each zone.

Future GRP by traffic analysis zone is obtained as the sum of the above as given in Table 2-7 and 2-8.

Table 2-6 Present GRP (1993) at 1991/92 Price by Traffic Analysis Zone

Unit:Million NRs

Zone No	Name of Zone	GRP by Agricultural Sector	GRP by Non-agricultural Sector	GRP
1	Mahottari	853	788	1,640
2	Dhanusha	842	1,156	1,998
3	Sindhuli	190	585	775
4	Ramechhap	642	101	743
5	Dolakha	130	457	588
6	Sarlahi	792	1,004	1,796
7	Kabhre	762	406	1,169
8	Kathmandu	311	2,061	2,372
9	Bhaktapur	110	509	619
10	Lalitpur	190	737	927
11	Sindhupalchok	150	724	875
12	Nuwakot/Rasuwa	662	406	1,068
13	Dhading	612	419	1,031
14	Makawanpur	502	674	1,175
15	Rautahat/Bara/Parsa	2,608	1,982	4,590
16	Chitwan	672	699	1,371
C.D.R.Total		10,028	12,709	22,737
17	Mechi	2,423	939	3,361
18	Koshi	2,955	1,736	4,691
19	Sagarmatha	2,566	1,632	4,198
E.D.R.Total		7,943	4,307	12,251
20	Gandaki	2,171	1,331	3,502
21	Dhawalagiri	608	593	1,201
22	Lumbini	4,734	1,762	6,496
W.D.R.Total		7,513	3,685	11,199
23	Mid-west Dev. R.	4,633	1,963	6,596
M.W.D.R.Total		4,633	1,963	6,596
24	Far-west Dev. R.	2,978	1,268	4,247
F.W.D.R.Total		2,978	1,268	4,247
Nepal Total		33,096	23,933	57,029

Source : Study Team, based on the statistics prepared by Central Bureau of Statistics, HMG/N.

Table 2-7 Future GRP (1999) at 1991/92 Price by Traffic Analysis Zone

Unit:Million NRs

Zone No.	Name of Zone	GRP by Agricultural Sector	GRP by Non-agricultural Sector	GRP
1	Mahottari	1,207	1,099	2,306
2	Dhanusha	1,192	1,621	2,813
3	Sindhuli	270	811	1,081
4	Ramechhap	909	126	1,035
5	Dolakha	185	631	816
6	Sarlahi	1,121	1,405	2,526
7	Kabhre	1,079	486	1,565
8	Kathmandu	440	3,027	3,467
9	Bhaktapur	156	757	913
10	Lalitpur	270	1,099	1,369
11	Sindhupalchok	213	973	1,186
12	Nuwakot/Rasuwa	937	558	1,495
13	Dhading	866	540	1,406
14	Makawanpur	710	973	1,683
15	Rautahat/Bara/Parsa	3,690	2,865	6,555
16	Chitwan	951	1,045	1,996
C.D.R.Total		14,196	18,016	32,212
17	Mechi	3,430	1,331	4,761
18	Koshi	4,183	2,486	6,669
19	Sagarmatha	3,632	2,290	5,922
E.D.R.Total		11,245	6,107	17,352
20	Gandaki	3,074	1,824	4,898
21	Dhawalagiri	862	794	1,656
22	Lumbini	6,700	2,607	9,307
W.D.R.Total		10,636	5,225	15,861
23	Mid-west Dev. R.	6,559	2,782	9,341
M.W.D.R.Total		6,559	2,782	9,341
24	Far-west Dev. R.	4,217	1,798	6,015
F.W.D.R.Total		4,217	1,798	6,015
Nepal Total		46,853	33,928	80,781

Source : Study Team

Table 2-8 Future GRP (2010) at 1991/92 Price by Traffic Analysis Zone

Unit:Million NRs

Zone No.	Name of Zone	GRP by Agricultural Sector	GRP by Non-agricultural Sector	GRP
1	Mahottari	1,984	1,689	3,673
2	Dhanusha	1,961	2,637	4,598
3	Sindhuli	444	1,274	1,718
4	Ramechhap	1,494	178	1,672
5	Dolakha	303	918	1,221
6	Sarlahi	1,844	2,192	4,036
7	Kabhre	1,774	652	2,426
8	Kathmandu	724	5,363	6,087
9	Bhaktapur	257	1,392	1,649
10	Lalitpur	444	2,044	2,488
11	Sindhupalchok	350	1,363	1,713
12	Nuwakot/Rasuwa	1,541	830	2,371
13	Dhading	1,424	681	2,105
14	Makawanpur	1,167	1,689	2,856
15	Rautahat/Bara/Parsa	6,071	4,740	10,811
16	Chitwan	1,564	1,985	3,549
C.D.R.Total		23,346	29,627	52,973
17	Mechi	5,640	2,189	7,829
18	Koshi	6,879	4,178	11,057
19	Sagarmatha	5,973	3,676	9,649
E.D.R.Total		18,492	10,043	28,535
20	Gandaki	5,055	2,689	7,744
21	Dhawalagiri	1,417	1,100	2,517
22	Lumbini	11,018	4,803	15,821
W.D.R.Total		17,490	8,592	26,082
23	Mid-west Dev. R.	10,787	4,575	15,362
M.W.D.R.Total		10,787	4,575	15,362
24	Far-west Dev. R.	6,934	2,957	9,891
F.W.D.R.Total		6,934	2,957	9,891
Nepal Total		77,049	55,794	132,843

Source : Study Team

2.3.3 Road Development Plan

(1) Present Road Condition

Present road conditions in the area nearby the Project Road are shown in Figure 2-5. Most of the roads are two-laned with narrow width of carriageways and deteriorating pavement. The roads which go from north to south have a great number of curves and up-and-downs in them because of geographical condition, while the highways in the Terai Plain have more flat and straight sections. Surface condition of most sections of highways are far below the satisfactory level.

(2) Future Road Condition

Future road condition in the area nearby the Project Road are decided as shown in Figure 2-6 based on the road development plan which will be completed in 1993-1998. Road network data for the traffic demand forecast has prepared reflecting these road conditions in future.

2.3.4 Methodology of Forecast

(1) Procedure

Methodology of forecast is almost the same as the one made in the previous study. The procedure for traffic forecast is shown in Figure 2-4.

Modal split analysis has not been carried out because there is no competition of mode among means of transportation between Kathmandu Valley and Terai.

Figure 2-4 Procedure for Traffic Forecast

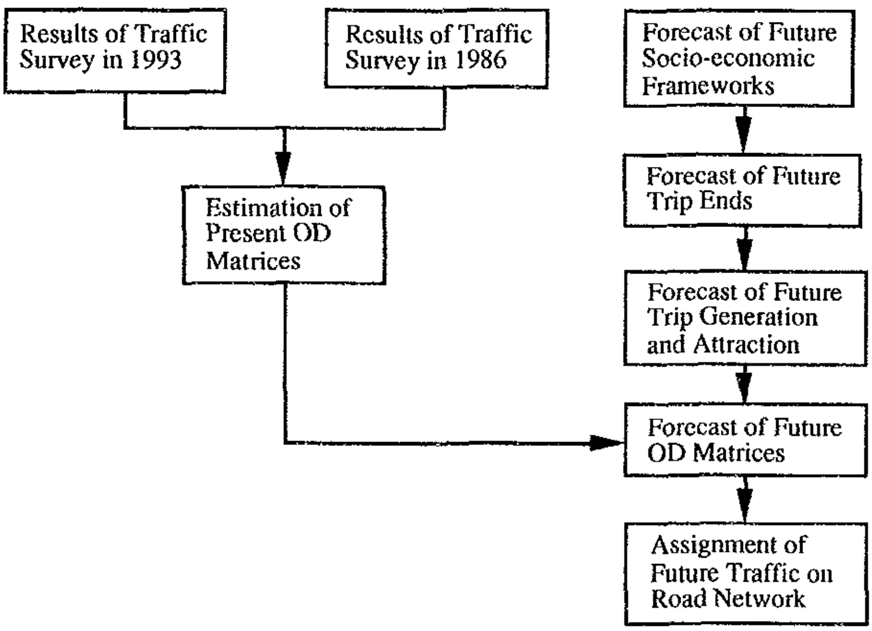
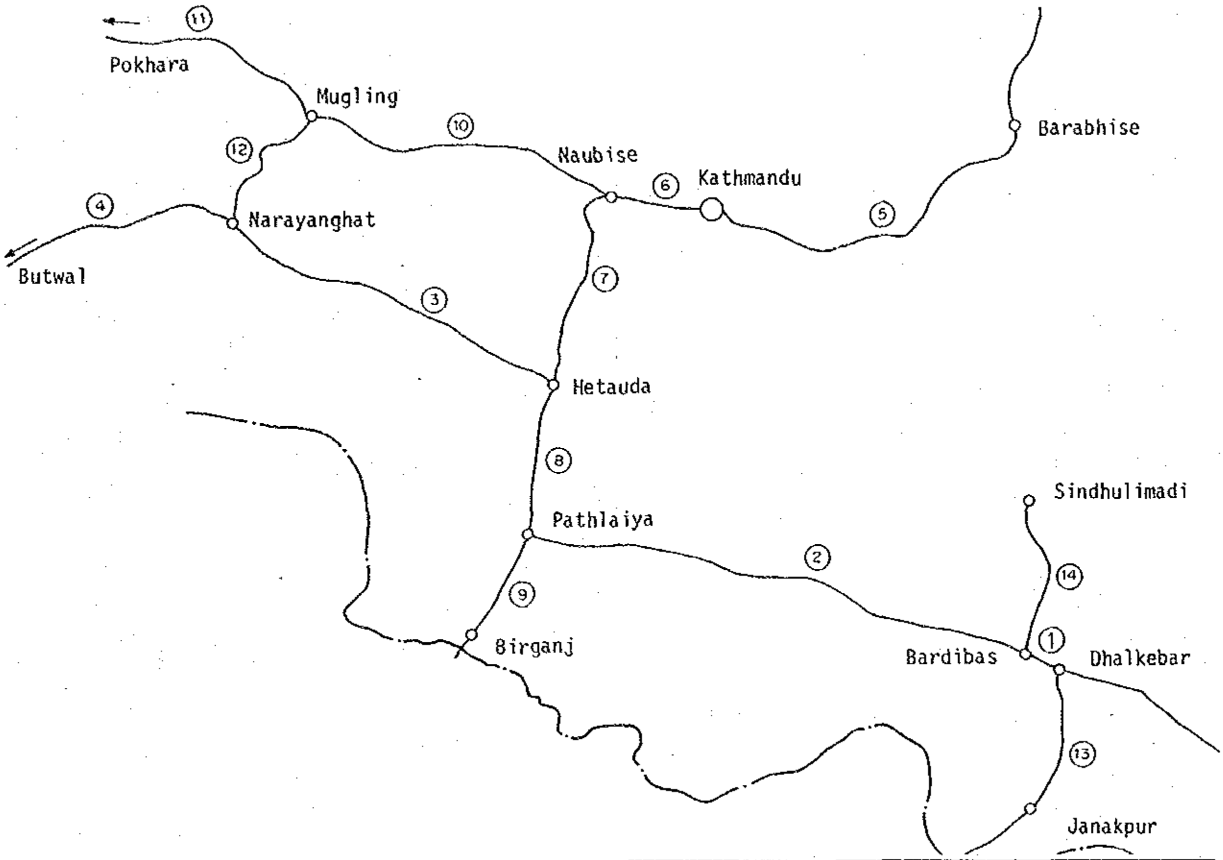


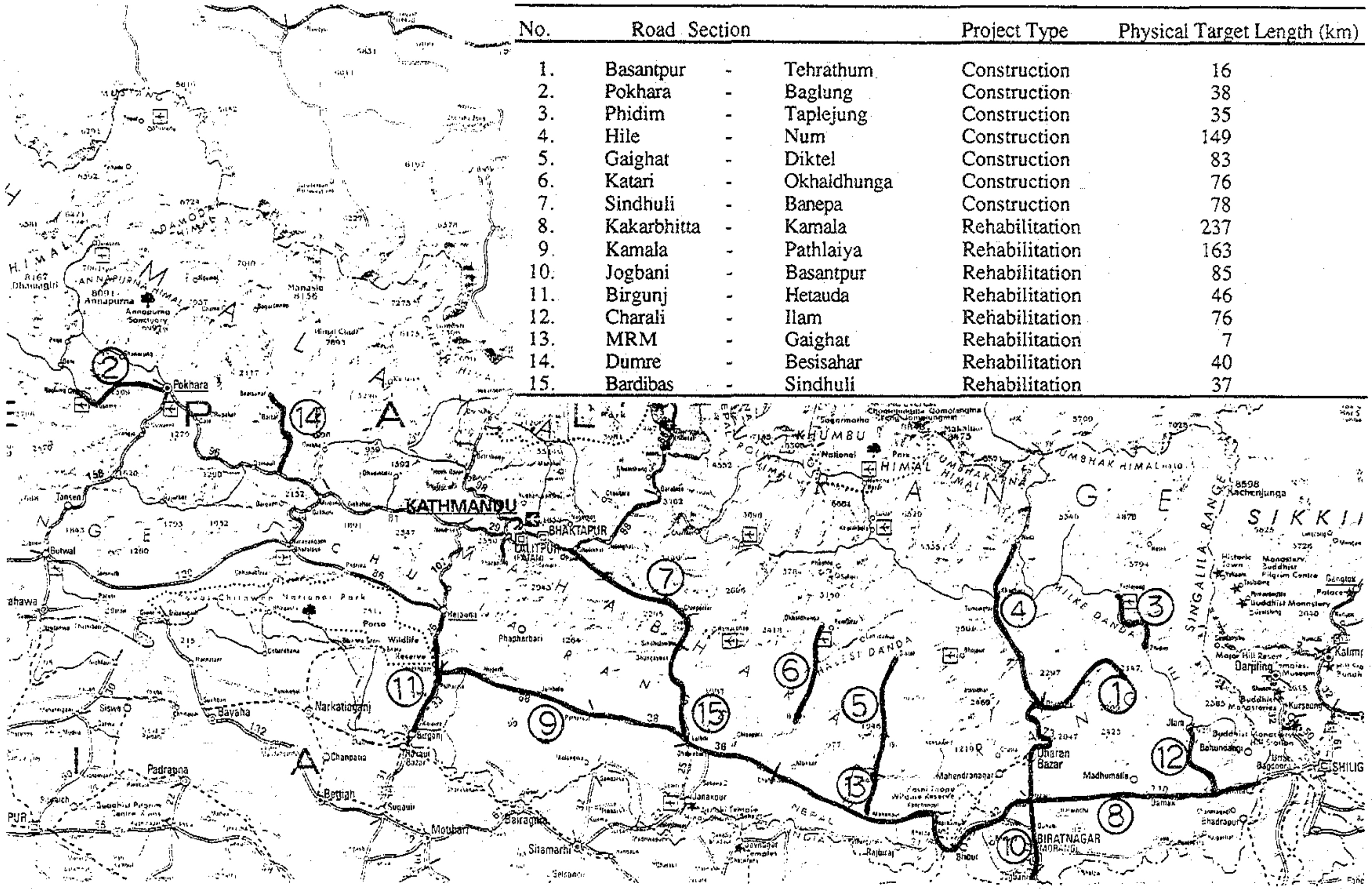
Figure 2-5 Present Road Condition



No.	Name of Road	Road Section	Number of Lanes	Pavement Condition	Surface Condition	Slope/Flat
1.	Mahendra Highway	Dhalkebar-Bardibas	2	1	3	2
2.	Mahendra Highway	Bardibas-Pathlaiya	2	1	3	2
3.	Mahendra Highway	Hetauda-Narayanghat	2	1	1	2
4.	Mahendra Highway	Narayanghat-Butwal	2	1	1	2
5.	Arniko Highway	Kathmandu-Bahrabise	2	1	3	2
6.	Tribhuvan Highway	Kathmandu-Naubise	2	1	3	2
7.	Tribhuvan Highway	Naubise-Hetauda	2	1	3	1
8.	Tribhuvan Highway	Hetauda-Pathlaiya	2	1	3	2
9.	Tribhuvan Highway	Pathlaiya-Birgunj	2	1	3	2
10.	Prithivi Highway	Naubise-Mugling	2	1	1	2
11.	Prithivi Highway	Mugling-Pokhara	2	1	4	2
12.	Prithivi Highway	Mugling-Narayanghat	2	1	1	2
13.	Janakpur-Jaleswor Road	Dhalkebar-Janakpur	2	1	2	2
14.	Sindhuli Road	Bardibas-Sindhulinadi	1	2	5	1

Pavement Condition : 1 : Paved 2 : Unpaved
Surface Condition : 1 : Good 2 : Fair 3 : Poor
4 : Bad 5 : Very Bad
Slope/Flat : 1 : Mostly Slope 2 : Mostly Flat

Figure 2-6 Highway Construction and Rehabilitation Projects in Eighth Plan



No.	Road Section			Project Type	Physical Target Length (km)
1.	Basantpur	-	Tehrathum	Construction	16
2.	Pokhara	-	Baglung	Construction	38
3.	Phidim	-	Taplejung	Construction	35
4.	Hile	-	Num	Construction	149
5.	Gaighat	-	Diktel	Construction	83
6.	Katari	-	Okhaldhunga	Construction	76
7.	Sindhuli	-	Banepa	Construction	78
8.	Kakarbhitta	-	Kamala	Rehabilitation	237
9.	Kamala	-	Pathlaiya	Rehabilitation	163
10.	Jogbani	-	Basantpur	Rehabilitation	85
11.	Birgunj	-	Hetauda	Rehabilitation	46
12.	Charali	-	Ilam	Rehabilitation	76
13.	MRM	-	Gaighat	Rehabilitation	7
14.	Dumre	-	Besisahar	Rehabilitation	40
15.	Bardibas	-	Sindhuli	Rehabilitation	37

(2) Estimation of Present OD Matrices

Present OD matrices have been estimated based on available OD matrices in 1986 applying expansion factor between 1986 and 1993. Expansion factor applied are given in Table 2-3.

(3) Forecast of Future Socio-economic Frameworks

In order to forecast the future traffic by type of traffic, i.e., normal traffic and induced traffic on the Project Road, two types of future socio-economic frameworks as explained below have been introduced:

Trend Type Socio-economic Framework

This is a socio-economic framework established based on the trend of the past and prospect of future economy envisaged in the Eighth Plan. Future traffic volume corresponding to this framework is deemed what is called "Normal Traffic" or traffic independent of the influence of the Project Road.

Impact Type Socio-economic Framework

This is a socio-economic framework established taking the socio-economic impact from the Project Road into account. It is expected that the Road would bring about many sorts of socio-economic impacts on its surrounding areas which are unable to be traced by the trend of the past.

Impact type socio-economic framework here has been obtained applying an Accessibility Model which reflects the changes in inter-regional accessibility due to opening of the Project Road. Corresponding traffic volume to this framework explains "Induced Traffic" or traffic induced by the Project Road. The relation between the above two socio-economic frameworks is illustrated in Figure 2-7.

The model applied here has following form:

$$Ei = \alpha \, Pi^{\beta} \, Ai^{\gamma}$$

$$Ai = \frac{1}{\sum_{j} tij}$$

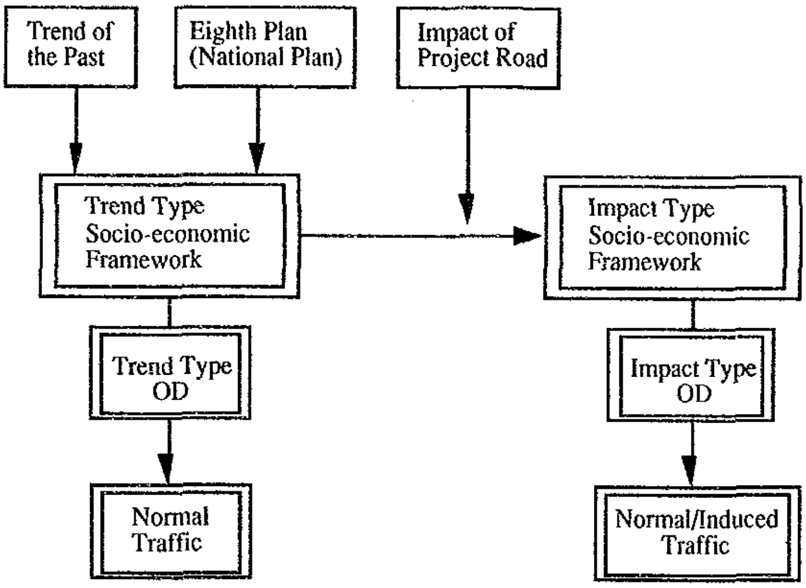
where

Ei	:	GRP in zone (i)
Pi	:	Population in zone (i)
Ai	:	Accessibility of zone (i)
tij	:	Required travel time from zone (i) to zone (j) by road
α,β,γ	:	Parameters

The parameters and correlation coefficient of the above model have been estimated by the regression analysis as shown below:

α	β	γ	Correlation Coefficient
21.501	0.876	0.217	0.993

Figure 2-7 Relation between Trend Type and Impact Type Socio-economic Frameworks



(4) Forecast of Future Trip Ends

Future total trip ends were forecasted by regression model built up on the relation between the number of vehicle registered and the level of GDP as explained below:

$$V_1 = -11{,}262 + 558.2\ G$$
$$V_2 = -6{,}921 + 231.1\ G$$
$$V_3 = -28{,}902 + 951.5\ G$$

where

V_1 : Number of Passenger Cars and Motorcycles
V_2 : Number of Buses
V_3 : Number of Trucks
G : GDP (billion NRs)

(5) Forecast of Future Trip Generation and Attraction

First, the tentative volumes of generated and attracted traffic of each zone were obtained, applying zone-wise GRP growth rates to the present values of zone-wise generated and attracted traffic. Second, the tentative values obtained in the first step were adjusted proportionally so that both the sums of generated and attracted traffic could become equal to the number of total trip-ends.

(6) Forecast of Future OD Matrices

For the different handling of normal traffic and induced traffic, two types of OD matrices, viz. trend type OD matrices and impact type OD matrices were prepared as explained below:

Trend Type OD Matrices

Future trend type OD matrices are deemed consist solely of "normal traffic", which is independent of impact from the Project Road, and explained by trend type socio-economic framework. Future OD matrices were obtained by "present pattern method", applying the Frator Method.

Impact Type OD Matrices

Future impact type OD matrices include both normal and induced traffic and explained by socio-economic framework. Impact type OD matrices were forecasted applying conversion factor to the trend type OD matrices. The conversion factor was calculated through the following procedure:

$$rij = \frac{Itij}{Ntij}$$

$$Itij = \frac{a(GIi\ GIj)^b}{Idij^c}$$

$$Ntij = \frac{a\ (GNi\ GNj)^b}{Ndij^c}$$

where

rij	:	Conversion Factor
Itij	:	Theoretical traffic volume from zone i to j calculated by Gravity Model, applying impact type socio-economic framework and travel time on the future road network which includes the Project Road.

Table 2-9 Impact Type GRP by Traffic Analysis Zone (1999)

Unit : Million NRs

Zone No.	Name of Zone	Trend Type GRP	Impact Type GRP	Amount of Impact
1	Mahottari	2,306	2,405	99
2	Dhanusha	2,813	2,950	137
3	Sindhuli	1,081	1,188	107
4	Ramechhap	1,035	1,122	87
5	Dolakha	816	849	33
6	Sarlahi	2,526	2,585	59
7	Kabhre	1,565	1,669	104
8	Kathmandu	3,467	3,652	185
9	Bhaktapur	913	967	54
10	Lalitpur	1,369	1,441	72
11	Sindhupalchok	1,186	1,254	68
12	Nuwakot/Rasuwa	1,495	1,556	61
13	Dhading	1,406	1,429	23
14	Makawanpur	1,683	1,690	7
15	Rautahat/Bara/Parsa	6,555	6,582	27
16	Chitwan	1,996	2,005	9
C.D.R.Total		32,212	33,345	1,133
17	Mechi	4,761	4,902	141
18	Koshi	6,669	6,862	193
19	Sagarmatha	5,922	6,148	226
E.D.R.Total		17,352	17,911	559

Table 2-10 Impact Type GRP by Traffic Analysis Zone (2010)

Unit : Million NRs

Zone No.	Name of Zone	Trend Type GRP	Impact Type GRP	Amount of Impact
1	Mahottari	3,673	3,831	158
2	Dhanusha	4,598	4,822	224
3	Sindhuli	1,718	1,888	170
4	Ramechhap	1,672	1,813	141
5	Dolakha	1,221	1,270	49
6	Sarlahi	4,036	4,131	95
7	Kabhre	2,426	2,588	162
8	Kathmandu	6,087	6,411	324
9	Bhaktapur	1,649	1,747	98
10	Lalitpur	2,488	2,619	131
11	Sindhupalchok	1,713	1,811	98
12	Nuwakot/Rasuwa	2,371	2,468	97
13	Dhading	2,105	2,139	34
14	Makawanpur	2,856	2,868	12
15	Rautahat/Bara/Parsa	10,811	10,855	44
16	Chitwan	3,549	3,565	16
C.D.R.Total		52,973	54,827	1,854
17	Mechi	7,829	8,060	231
18	Koshi	11,057	11,377	320
19	Sagarmatha	9,649	10,017	368
E.D.R.Total		28,535	29,454	919

N t i j	:	Theoretical traffic volume from zone i to j calculated by Gravity Model, applying trend type socio-economic framework and travel time on the future road network which does not include the Project Road.
G I i	:	GRP in zone i by impact type socio-economic framework
G N i	:	GRP in zone i by trend type socio-economic framework
I d i j	:	Travel time from zone i to j on the network which includes the Project Road
N d i j	:	Travel time from zone i to j on the network which does not include the Project Road
a, b, c	:	Parameters

In this study, the following values were applied to each parameter, which were the same as the study in 1987.

$a = 0.00970$
$b = 0.931$
$c = 1.170$

(7) Assignment of Future Traffic on Road Network

Traffic assignment was done by "all-or-nothing method" in which all vehicles for a certain pair of zones were assigned to the shortest route among the possible alternatives of routes. Traffic volume by OD pair and vehicle type (motorcycle, passenger car, bus and truck) was assigned on each of the road networks of 1999 and 2010. Conditions for traffic assignment are almost the same as those in 1987 study as there is no remarkable road development and resultant change in driving condition took place thereafter.

2.3.5 Future Traffic Volume

(1) Total Trip Ends

Total traffic volumes in 1999 and 2010 were forecasted by traffic type applying the methodology explained in the previous section. Total volume of normal traffic in 1999 is 19,276, which is about 1.8 times as large as the present. Total volume including induced traffic is 21,418, which is about 2.0 times.

Table 2-11 Future Traffic Volume

Traffic Type	1993	1999	2010
Normal	10,644	19,276	38,294
Induced	-	2,142	4,568
Total	10,644	21,418	42,862

(2) OD Matrices

Present and future OD matrices are presented in Appendix-C3. Traffic interdependence among the regions would be strengthened mainly because of generation of induced traffic. Especially, in such OD pairs as Kathmandu Valley (traffic analysis zones (8) - (10)) – Narayani (zones (14) - (16)), Kathmandu Valley – Hilly area in C.D.R. (zones (3), (4) and (7)), Kathmandu Valley – Eastern Terai (zones (1), (2) and (6)) and Kathmandu Valley – E.D.R. (zones (17) - (19)), relatively large traffic volume will be seen.

(3) Assigned Traffic

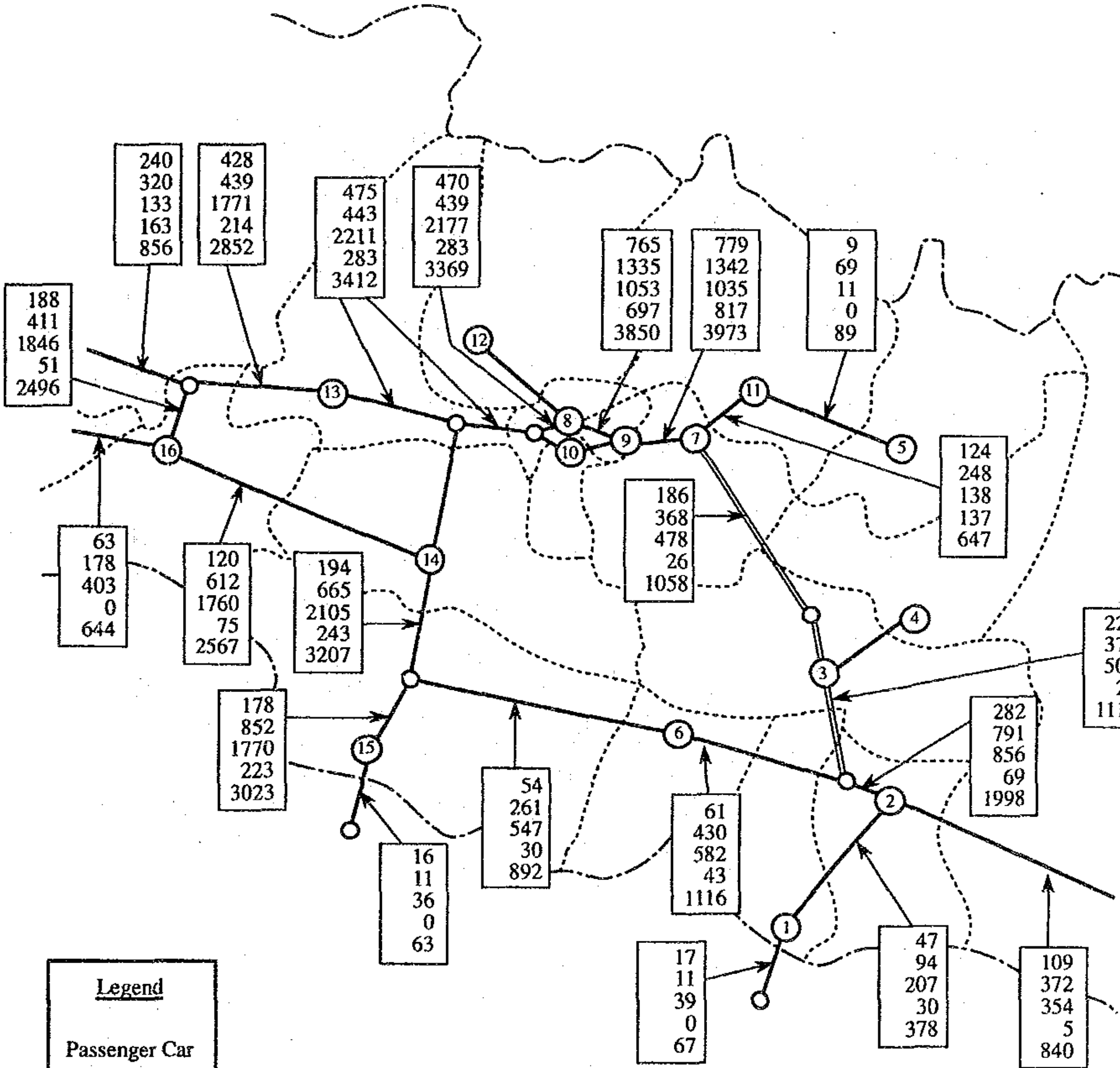
The forecasted traffic volumes on the Project Road are 1,058 in 1999 and 2,561 in 2010 as shown in Figure 2-8, 2-9 and Table 2-12. In terms of pcu, the above traffic volumes are equivalent to 2,750 and 6,613 passenger cars respectively.

Table 2-12 Traffic Volume on Sindhuli Road

	Passenger Car	Bus	Truck	Motorcycle	Total	pcu
1999	186	368	478	26	1,058	2,750
2010	452	963	1,063	83	2,561	6,613

Remark :	Passenger Car	1 vpd	=	1 pcu
	Bus	1 vpd	=	3 pcu
	Truck	1 vpd	=	3 pcu
	Motorcycle	1 vpd	=	1 pcu

Figure 2-8 Assigned Traffic - 1999

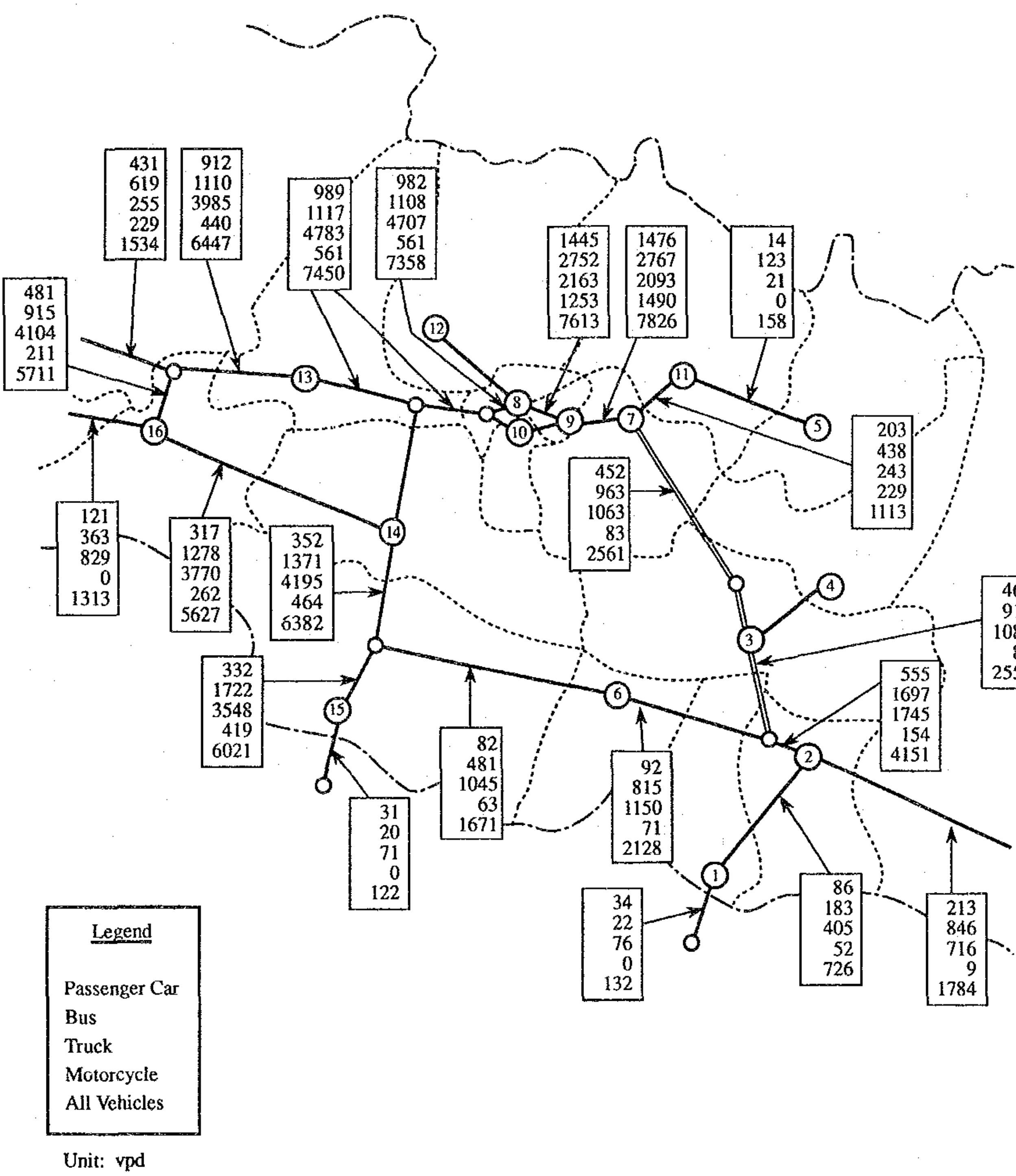


Legend

Passenger Car
Bus
Truck
Motorcycle
All Vehicles

Unit: vpd

Figure 2-9 Assigned Traffic - 2010



CHAPTER 3

FIELD RECONNAISSANCE AND FINDINGS

CHAPTER 3

FIELD RECONNAISSANCE AND FINDINGS

3.1 General

Field reconnaissance carried out in Phase I (A) are broadly divided into two: The first is field reconnaissance (1) along the proposed route with the aim of collecting updated technical information/data and confirming adaptability of counter plans prepared in Japan, and the second is field reconnaissance (2) for the purpose of confirming accessibility of all the conceivable access roads which could be used for the construction. These study results were reflected in formulating the alternatives development schemes, preliminary design, and construction planning.

3.2 Field Reconnaissance (1) Along the Proposed Route

Prior to the commencement of the reconnaissance, two reconnaissance teams were organized one each for highway and bridge. Each team consisted of 3-JICA Study Team members and 1-counterpart engineer from DOR. The main purposes of field reconnaissance are as follows:

- To confirm adaptability of the countermeasure plans prepared in Japan by applying possible route realignment, modification of river crossing structures and other structures.
- To collect the local information such as availability of the construction materials, the river and forest conditions, etc.
- To identify landslide and falling rocks area in progress
- To carry out the field environmental impact assessment

The field reconnaissance along route alignment was carried out by means of site observation on foot and aerial observation using helicopter. The works were carried out with the help of route alignment plan of a scale 1:4000, longitudinal profiles and cross sections prepared in the previous Feasibility Study. In the field reconnaissance, the river cross section survey were also carried out where the river crossing structures are possibly changed from the bridges to the causeways with shifting of the alignment.

3.3 Field Reconnaissance (2) for the Conceivable Access Roads

The field reconnaissance for conceivable access roads was carried out to confirm the accessibility of each of the routes by means of site observation on foot or by using jeeps, helicopter depending on the present conditions of roads, footpaths or rivers.

The Project Road is divided into four sections as shown in Figure 3-1. For Section-I, there is an access road available from Bardibas (East West highway) to Sindhuli Bazar. The end point of Section II -3 , Dhulikhel, has also an access road from the existing Kodari Road. The main problem with regard to the access is limited to Section II-1(39 Km), Section II-2 (30 Km) and Section II-3 (49 Km) which comprises of nearly 118 Km length.

With the help of existing topographical map study and available data, the following six conceivable access routes and river bed routes which could be used only during dry season have been identified for Sections II-1, II-2 II-3 of Sindhuli Road as shown in Figure 3-1.

<u>Conceivable access route 1:</u>
Jiri Road (Busti) - Ramechhap Road for Section II-2 , which is under construction by the Department of Roads.

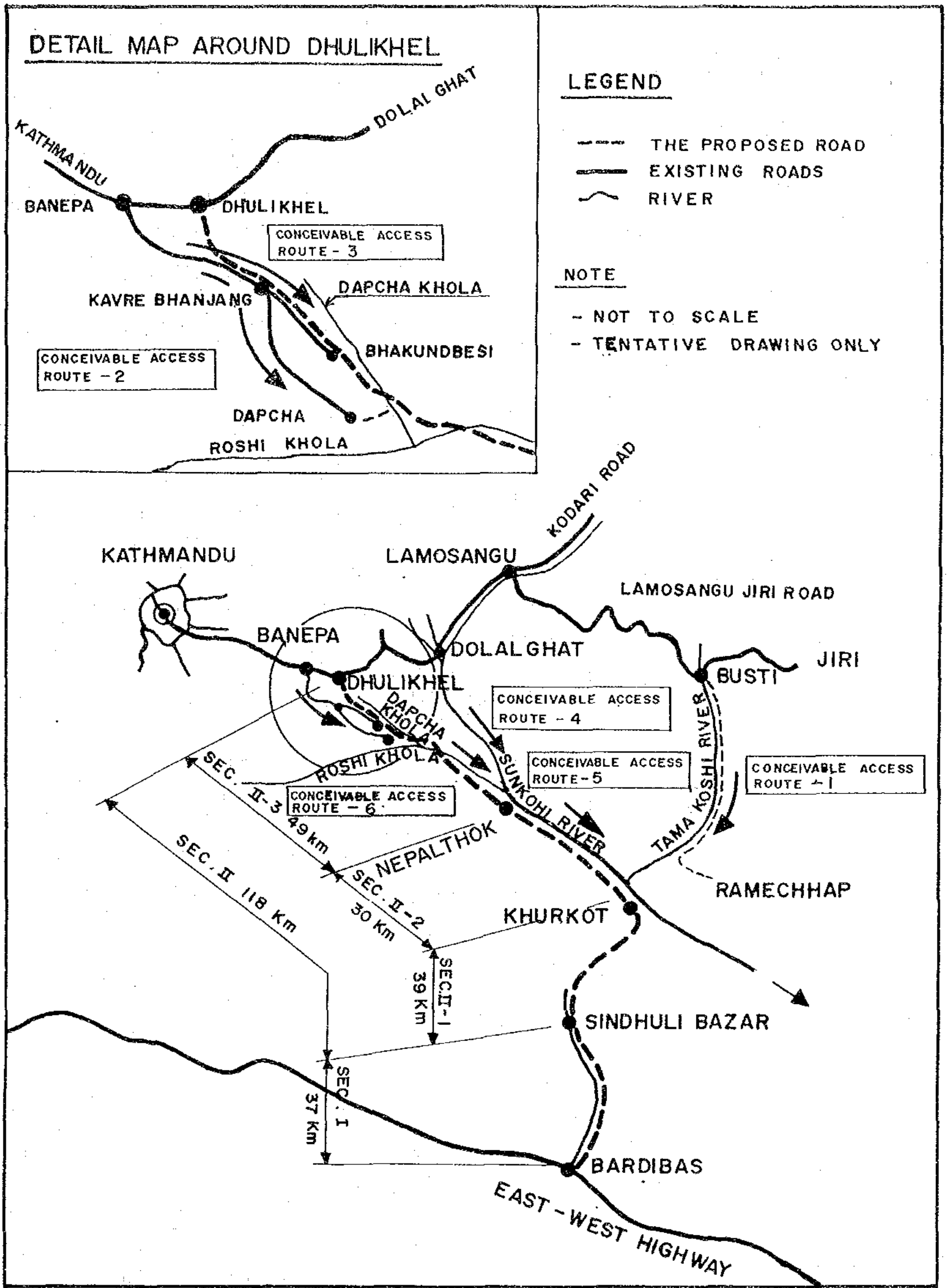
<u>Conceivable access route 2:</u>
Banepa- Shreekhandapur- Kabhrebhanjyang-Namobuddha- Dapcha for Section II-3, which is the existing roads of nearly 25 Km .

<u>Conceivable access route 3:</u>
Banepa- Shreekhandapur- Kabhrebhanjyang- Buchakot-Bhakundebesi for Section II-3 , which is the existing roads of nearly 27 Km long .

<u>Conceivable access route 4:</u>
Sunkoshi River bed route from Dolalghat (Kodari Road) to Nepalthok for Section II-2 and II-3, which is expected to use only during dry season.

<u>Conceivable access route 5:</u>
Sunkoshi River bed route from Nepalthok to Khurkot along Section II-2.

<u>Conceivable access route 6:</u>
Roshi Khola route along Section II-3, only during dry season.



AFTERCARE STUDY FOR SINDHULI ROAD CONSTRUCTION PROJECT	**Figure 3-1** LOCATION MAP OF CONCEIVABLE ACCESS ROADS

3.4 Findings of Field Reconnaissance (1)

3.4.1 Road

The road survey was conducted along the proposed route to identify the sections where possible design changes could be made in order to reduce the construction cost. The sections identified by the Team through the survey are classified into the following four groups:

(a) Sections where re-alignment of the road will be made in relation to alteration of the bridge structures.

(b) Sections where re-alignment of the road will be made so as to reduce the cut and embankment height.

(c) Sections where minimum road width will be applied due to steep topographic and poor geological conditions.

(d) Sections where re-alignments of the road will be applied in order to minimize land acquisition and compensation cost.

The following is a summary of the possible design change sections:

(a) Sections where re-alignment of road will be made in relation to alteration of the bridge structures are subdivided into the following two categories;

(i) Sections where both horizontal and vertical re-alignments will be required due to the possible alteration to causeways or submersible structures;

Table 3-1. Possible Realignment Sections Due to Alteration to Causeways

Description	Section				
	I	II-1	II-2	II-3	Total
Nos. of sections to be modified	9	1	10	5	25
Total Length(m)	4,000	2,800	8,200	4,500	19,500

Note : Total length is calculated along the original alignment and includes causeway length.

(ii) Sections where only horizontal re-alignment will be required due to the possible alteration to slab and pipe culverts

Table 3-2 Possible Realignment Sections Due to Alteration to Culverts

Description	Section				
	I	II-1	II-2	II-3	Total
Nos. of section to be modified	2	3	6	9	20
Total Length(m)	1,300	300	800	900	3,300

Note: Total length is calculated along the original alignment and includes culvert width

The locations of the above re-alignment sections are listed in Appendix-D.

(b) Sections where re-alignment will be made so as to reduce the height of cut and embankment:

Some sections where high cut or high embankment were designed in the previous F/S could be reduced by shifting alignment with applying lower geometric standards.

The following are the possible sections to be re-aligned in order to reduce the height of road cut and embankment:

Table 3-3 Possible Realignment Sections for Reducing Height of Cut and Embankment

Description	Section				
	I	II-1	II-2	II-3	Total
Nos. of section to be modified	0	4	6	4	20
Total Length(m)	0	1,889	2,250	1,310	5,440

(c) Sections where minimum road width could be applied
There are several sections where the construction work seems to be extremely difficult due to very steep terrain, unstable geological condition and land use situation. The Study Team recommends to apply minimum road width for these sections so that the construction cost and environmental effects be minimized.

The following are the possible sections identified to be applied for the minimum road width:

Table 3-4 Possible Sections where Min. Road Width could be Applied

Section II-I		Section II-2		Section II-3	
STA	length (m)	STA	length (m)	STA	length (m)
18.2-19.2	1,000	3.5-4.2	700	0.3-0.6	300
20.0-21.0	1,000	6.1-6.8	700	3.1-3.7	600
		22.0-22.5	500	5.7-6.0	300
		23.5-27.1	3,600	8.1-8.5	400
		28.7-29.66	960	12.7-13.3	600
				13.7-14.0	300
				15.7-16.1	400
Total	2,000		6,460		9,900

(d) Section where re-alignment will be applied to minimize land acquisition and compensation costs

It is noted that the section between Sta. 42 and 49 in Section II-3 was planned to follow along the existing truck with upgrading of the alignment but the vicinity of this section has already been developed to rice fields.

In order to minimize the land and house acquisition and compensation costs, the proposed road will be re-aligned to exactly follow the existing road without the alignment upgrading .

It should be noted that the above possible realignment sections will be scrutinized together with the other possible alteration in the further preliminary design.

Table 3-5 Possible Sections of Re-alignment due to Land Acquisition Problem

Section II-I		Section II-2		Section II-3	
STA	length (m)	STA	length (m)	STA	length (m)
	0		0	42.0-49.0	7,000
Total	0		0		7,000

3.4.2 Bridges

The survey was conducted to identify the possibility of reducing the bridge costs by either altering the bridge type to low cost structures, such as causeway and/or slab culverts, or changing the road alignment to shorten the bridge length.

As a result of the survey, the bridges proposed in the previous F/S were broadly classified into three categories and further subdivided into the five groups depending on the type of possible alteration as shown below:

Type of Possible Alteration

Category I: Bridges to be altered to low cost structures;

Bridges to be altered to causeways or submersible bridges G1
Bridges to be altered to slab or pipe culverts G2

Category II: Bridges to be altered to short span bridges or another type of bridges;

Bridges to be altered to the short span bridge G3
Bridges to be altered to another type of bridges G4

Category III: Bridges with no alteration; G5

A summary of the possible bridge alteration by group is presented as shown in Table 3-6.

Table 3-6 Summary of Bridge Alteration

Type of Alteration	Number of Bridges and Length in (m)				
	Sec. I	Sec. II-I	Sec.II-2	Sec.II-3	Total
G1	7(190m)	3(185m)	11(695m)	7(676m)	28(1,820m)
G2	0	17(410m)	12(315m)	12(300m)	41(971m)
G3	2(315m)	2(130m)	0	2(100m)	6(389m)
G4	0	0	0	4(170m)	4(170m)
G5	5(365m)	1 (35m)	0	0	6 (400m)
Total	15(870m)	23(760m)	23(1.010m)	25(1,240m)	86(3,880m)

The possible alteration of all the bridges in details are presented in Appendix-D.

3.4.3 Slope Protection and Retaining Walls

(1) Special Type of Slope Protections

It is desirable that special type of slope protection works such as rock shed, rock anchor bolt, rock net, concrete block wall or crib wall, gunite shooting, will be deleted from the previous design in principle taking into account the study background and policy i.e. reduction of the construction cost and maximum usage of local materials and know-how.

However, the minimum slope protections against the existing landslide and rock falls shall be provided taking into consideration the safety of traffic as well as protection of road structure itself. This work might be necessary where the proposed road is running through fragile geological sections and on the river-bank sections along Roshi Khola in order to avoid the failure risks due to the existing landslide.

Table 3-7 Existing Landslide and Rock Falls Sites Along Rosi Khola

Section II-I		Section II-2		Section II-3	
STA	length (m)	STA	length (m)	STA	length (m)
	0	28.7-29.4	700	3.3	100
				3.5	80
				3.6	120
				5.5	150
				5.7	120
				6.6	100
				7.0	200
				7.2	130
				7.3	100
				8.2	150
				12.0	180
				14.0	80
				14.45	50
				17.4	80
				26.1	60
				27.4	70
Total	0		0		1,770

(2) Retaining Walls

Retaining walls are essential for construction of roads that are running on steep slope with poor geology. The retaining walls proposed in the previous feasibility study are as follows:

- Reversed T concrete wall, H = 4 - 10 m (max, 10m)
- Gravity concrete wall, H = 3 - 5 m
- Stone Masonry wall, H = 2-10 m (2 steps) (max. 5 m)
- Gabion wall, H = 2-5 m

The type of retaining walls proposed above, however, will be altered to the low cost structures such as stone masonry and gabion walls. For instance, the proposed road where embankment may require the protection work against scouring action of river flow shall be protected with gabion walls with mass concrete block foundation, especially in the following sections:

Table 3-8 Possible Places Requiring Protection Works Against Scouring

Section II-I		Section II-2		Section II-3	
STA	length (m)	STA	length (m)	STA	length (m)
	0	1.0-1.4	400	0.3-0.6	300
		10.0-10.25	250	3.4-3.9	500
				6.6-7.4	800
				8.0-8.5	500
				11.9-12.2	300
				14.1-14.3	200
				16.9-17.5	600
				18.9-19.2	300
Total	0		650		3,500

3.4.4 Other Findings

(1) Land acquisition and compensation

It is inevitable to affect several houses and buildings due to construction of the road, even though special attention has been paid to avoid such situation in the route selection work.

In this regard, it is recommended, if possible, to acquire the land with the right-of-way width of 50 m in the sections where the proposed road is passing through village areas taking into consideration the future widening of the proposed road.

(2) Public facilities to be compensated and relocated before commencement of the construction

There are many existing irrigation channels along the river bank of Dapcha Khola, Rosi Khola and Sun Kosi River. These channels are utilized not only for irrigation but also for drinking water and may be interfered with the construction of Project Road, so that these must be protected or relocated properly during the construction and after completion of the project.

The detailed survey for the these utilities should be carried out during the detailed engineering stage to identify the possible countermeasures for these utilities.

(3) Permission of deforest

The project road in Section II-1 between Sindhuli Bazar and Khurkot runs through primeval forest in the vicinity area of Sindhuli Garhi. Though cutting these trees could not generate considerable environmental adverse effect from the view point of ecology, it is necessary to obtain permission on deforest before commencement of the construction.

3.5 Findings of Field Reconnaissance (2)

3.5.1 Present Conditions of Conceivable Access Roads

Present conditions of conceivable access routes based on the field reconnaissance (2) are as follows:

(1) Conceivable access route -1: Jiri Road (Bust:) - Ramechap Road

This road starts from the km 72 (Busti) of the Jiri Road and follows the bank of Tamakoshi River towards south direction to reach Ramechap. This proposed road to Ramechap (Manthali, new district headquarter) is located at nearly 45 km from Busti. This road project was started in near 1982 but due to lack of sufficient budget, the progress has been slow. Since 1992, the project has been stopped and do not have budget for the further construction.

The present road condition is as follows :

Km 0 to 4+200 km:	-	Earth road
	-	Road width 5.5m
	-	Jeepable up to km 0+800, from here, injeepable due to missing bridge in Gopi Khola
4+200 km to 18+700 km:	-	Earth road
	-	Road width 3-5m
	-	Inaccessible due to many damaged sections of the road and missing of bridges.
18+700 km to Khimti Khola (about 8 km)	-	No road at present
	-	Ministry of Water Resources has planned to construct the road for the use of Kirne Hydro Power Project. This plan includes construction of two (2) major bridges over Tamakoshi river.
Khimti Khola to Manthali : (about 19 km)	-	No road except Manthali area where the road have been constructed with length about 6 km.

(2) Conceivable access route -2: **Banepa- Shreekhandapur- Kabhrebhanjyang- Namobuddha- Dapcha Road.**

This is a possible access road starting from Banepa (Kodari Road, 27 km from Kathmandu) and joining Shreekhandapur village, Kabhrebhanjyang and reaching Dapcha. The total existing road length is nearly 25 Km. This route has been surveyed with the help of jeeps and present condition of the existing road is presented below:

Banepa - Shreekhandapur (about 2 km)	-	Earth road (except 1 km black top from Banepa)
	-	Road width 4-5 m
	-	Accessible
	-	Capacity of the two bridges crossing Punyamti Khola was estimated 8 to 10 ton, suitable strengthening work will be required.

Shreekhandapur - Kavrebhanjyang
(about 9 km)
- Earth road
- Road width 4-5 m
- Accessible
- The road gradient is not greater than 10%
- Mini buses are passing through the alignment

Kabhrebhanjyang - Namobuddha to Dapcha
(about 12 km)
- Earth road
- Road width 3-4 m
- The road gradient is greater than 12% and minimum radius is approx. 7.0 m at several places.

Dapcha - the Proposed Road Section II-3 (Dapcha Khola)
(about 3 km)
- Footpath only
- Footpath width 1 m
- Dapcha is located at hill top and approx. 400 m high from Dapcha Khola. The existing footpath exists along the ridge line which is steep and very sharp. It will be very difficult to construct a temporary access road along the existing footpath.

(3) **Conceivable access route -3: Banepa - Shreekhandapur - Kabhrebhanjyang - Buchakot - Bhakundebesi Road for Section II-3**

This is a possible access road to the middle of section II-3 of Sindhuli Road and follows Shreekhandapur, Kabhrebhanjyang, Buchakot and finally reaches at near Bhakundebesi, nearly 27 Km long. This existing road has been surveyed with the help of jeeps and the present conditions of road are presented as follows:

Banepa - Shreekhandapur - Kabhrebhanjyang
(about 11 km)
- Present conditions of this section are explained in the conceivable access route -2

Kabhrebhanjyang - Buchakot
(about 12 km)
- Earth road
- Road width 4-5 m
- Accessible

Buchakot - Bhakundebesi
(about 2 km)

- Earth road
- Road width 4-5 m
- Accessible
- This section of the road is under construction by local people with the help of a dozer DOR and is still in progress.

(4) <u>Conceivable access route -4:</u> **Sunkoshi River Bed Route from Dolalghat(Kodari Road) to Nepalthok:**

This river access route starting from Dolalghat (Kodari Road Km 55, from Kathmandu) to Nepalthok through the Sunkoshi river bed is an another possible access for the Section II-2 and II-3. This route is surveyed using Helicopter.

The Sunkoshi river section is wide and gentle in the starting portion at Dolaghat. But at several locations, the river section narrows in between very steep foot hills (about twenty no's of fast-flowing sections can be counted) with high river bed slopes. The river current is high and changing the direction from right side bank to left side bank at many places. Therefore it seems very difficult to use this route as an access route.

(5) <u>Conceivable access route -5:</u> **Sunkoshi river bed route from Nepalthok to Khurkot along Section II-2 :**

The field survey for this route was carried out during the field reconnaissance along the proposed route and it was found that this route could be usable during dry season, provided bulldozer work at several sections.

(6) <u>Conceivable access route-6:</u> **Roshi Khola bed route from the confluence with Dapcha khola to the confluence with the Sunkoshi river along Section II-3:**

The field survey for this route was also carried out during the field reconnaissance along the proposed route and it was found that this route could be usable only during dry season, provided temporary embankment works using bulldozers at a few sections.

3.5.2 Selection Results of Possible Access Routes

The field reconnaissance for the 6 possible access routes has given the important features of the existing roads and river access routes. From the view point of use for the construction planning of Sindhuli Road Project, the possible access roads have been selected as shown in Table 3-9.

Table 3-9 Evaluation Results of the Conceivable Access Routes

Conceivable Access Route	Evaluation Results
1. Jiri Road (Busti) - Ramechap Road	Not usable
2. Banepa - Shreekhandapur - Kabhrebhanjyang - Namobuddha - Dapcha Road	Not usable
3. Banepa - Shreekhandapur - Kavrebhanjyang Buchakot - Bhakundebesi Road	Usable but requires the maintenance works and the strengthening work of two existing bridges.
4. Sunkoshi River Bed Route from Dolalghat to Nepalthok	Not usable
5. Sunkoshi River Bed Route from Nepalthok to Khurkot	Partially usable during dry season, provided bulldozer work
6. Roshi Khola River Bed Route from the Junction with Dapcha Khola to Nepalthok	Usable only during dry season, except a few sections where temporary embankment work is required.

CHAPTER 4

ENVIRONMENTAL IMPACT ASSESSMENT

CHAPTER 4

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

4.1 General

The purposes of environmental impact assessment carried out in the Study are to identify environmental adverse effects mainly due to construction of the Sindhuli Road, and to prepare appropriate mitigation measures to minimize these effects and to formulate the further impact monitoring system as well as the recommendation from environmental view point. All the results of EIA are reflected in the further studies for formulating the development schemes,the preliminary design and environmental cost estimate.

4.2 Methodology

The environmental impact assessment is in principle carried out in accordance with "National Environmental Impact Assessment Guidelines (NEIAG) 1992" published by National Planning Commission, HMG Nepal, except where the Guideline is not clear then "Environmental Impact Assessment Guidelines for Development of Infrastructures" issued by JICA in 1992 is also referred to in this Study.

4.3 Screening and Identification of Environmental Impact

According to the screening criteria stipulated in "National Environmental Impact Assessment Guidelines (NEIAG)", the Sindhuli Road Construction Project falls into project schedule-2 including item 3 "construction of highways and feeder roads". Therefore, an evironmental impact assessment is required for the Project.

In order to identify various possible environmental impacts due to mainly construction and operation of the Project at the initial study stage, a matrix method quoted from NEIAG, which is simple and covering all the aspects and providing a complete EIA overview in a summary form, and a rating check list quoted from "JICA's Guideline", which is easy but including all the environmental parameters, are applied in EIA.

The environmental field survey was carried out referring to the above matrix and check list to confirm the present socioeconomic, natural and pollution conditions in the project area, by means of observation, interview to local residents, sampling, etc. The observation points or survey items are as follows :

- Regional development level
- Land use pattern
- Population distribution pattern
- Local transportation system
- Structure of local community
- Cultural property
- Local irrigation system
- Possible locations of spoil banks
- Topography and geology
- Topsoil depth and soil erosion condition
- Aquatic life and local fishery
- Forest condition
- Distribution of flora and fauna

Based on the results of field survey, the rating required information for each environmental parameter were filled in the matrix form and the check list form, and the results of matrix form and check list are shown in Table 4-1 and 4-2 respectively.

As revealed by Tables 4-1 and 4-2, it is substantially conclusive that no severe impacts on the environmental parameters are expected in the initial environmental assessment (IEA). However, as most of the proposed Sindhuli Road passes through steep mountainous slopes on fragile geology, the impacts on environmental parameters such as topography, geology, hazards and soil erosion are rated to be considerable, while the other parameters have slight to negligible impacts.

Table 4-1 Matrix of Environmental Parameters

NOTE ITEMS IN INTERACTION MATRIX CHECKED AS (1) INDICATE INSIGNIFICANT IMPACT: IF CHECKED BY (2) AN IEE IS ADEQUATE: IF CHECKED BY (3) A FULL SCALE EIA IS NECESSARY

SITES SELECTION

AREAS OF POTENTIAL ENVIRONMENTAL EFFECTS	IDENTIFICATION OF ACTIVTIES	ACCESS ROADS	SITE SURVEYING	SOIL TESTING	HYDROLOGICAL TESTING	ENVIRONMENTAL SURVEY	SITE CLEARING	BURNING	EXCAVATION	DRAINAGE ALTERATION	STREAM CROSSING	EQUIPMENT	WASTE DISPOSAL AND RECOVERY	PRODUCT STORAGE
PHYSICAL	WATER	1			1				2	2				1
PHYSICAL	NOISE	1						1				1		
PHYSICAL	LAND	2		1			1		2	2	1	1	2	1
PHYSICAL	ATMOSPHERE	1		1				1		1		1	2	
BIOLOGICAL	SPECIES AND POPULATIONS	2	1							2			1	
BIOLOGICAL	HABITATS AND COMMUNITIES	2								2			1	
AESTHETIC	LAND	2					1	1	2	2	1		1	1
AESTHETIC	ATMOSPHERE	1		1				1		1			1	
AESTHETIC	WATER				1					2	2			
AESTHETIC	FLORA AND FAUNA	1								1				
AESTHETIC	MAN MADE OBJECTS	1								1				
AESTHETIC	COMPOSITION	1								2				
SOCIAL	INDIVIDUALS ENV. INTERETS				2								1	
SOCIAL	INDIVIDUAL WELL-BEND	1			2								1	
SOCIAL	SOCIAL INTERACTIONS												1	

CONSTRUCTION

AREAS OF POTENTIAL ENVIRONMENTAL EFFECTS	IDENTIFICATION OF ACTIVTIES	ACCESS ROADS	SITE CLEARING (DEFORESTATION)	EXCAVATION	BLASTING AND DRILLING	DEMOLITION	BUILDING RELOCATION	CUT AND FILL	TUNNELS AND UNDERGROUND STRUCTURES	EROSION	DRAINAGE ALTERTION	STREAM CROSSING	EQUIPMENT MOVEMENTS	LABOUR FORCE	WASTE DISPOSAL	PRODUCT STORAGE	ABANDONMENT	RECLAMATION	REFORESTATION	FERTIUBATION	ANCILLARY TRANSMISSION LINES AND PIPELINES
PHYSICAL	WATER	2	1			2		2		2		2									
PHYSICAL	NOISE	1	1	2	3	2	2	2		2	1	1	2	2	2						
PHYSICAL	LAND	2	2	3	2	1		3		3			1		2						
PHYSICAL	ATMOSPHERE	1	1	2	2			1		1	1	1	1		2						
BIOLOGICAL	SPECIES AND POPULATIONS	2	2	1	2	3									2						
BIOLOGICAL	HABITATS AND COMMUNITIES	2	2	2	2	3	2				1			2	2						
AESTHETIC	LAND	2	2	2	3	3	2							2	2						
AESTHETIC	ATMOSPHERE	1	1	2	3		2	1		1	1	2			2						
AESTHETIC	WATER		1	1	2			1		2	2										
AESTHETIC	FLORA AND FAUNA	1	2	1	1			2		1	2	1			2						
AESTHETIC	MAN MADE OBJECTS	1	2	1	1																
AESTHETIC	COMPOSITION	1		2	2	2		2													
SOCIAL	INDIVIDUALS ENV. INTERETS			2				2			1				2						
SOCIAL	INDIVIDUAL WELL-BEND	1		1	1	3	2	2						2							
SOCIAL	SOCIAL INTERACTIONS			1	1			2						2							

OPERATION AND MAINTENANCE / FUTURE AND RELATED ACTIVITIES

AREAS OF POTENTIAL ENVIRONMENTAL EFFECTS	IDENTIFICATION OF ACTIVTIES	FOREST CLEARING	EXCAVATION	SPOIL AND OVERBURDEN	BLASTING AND DRILLING	DREDGING	EQUIPMENT OPERATION	OPERATIONAL FAILURES	ENERGY EQUIPMENTS	ENERGY GENERATION	AUTOMOBILE AIRCRAFT VESSEL MOVEMENT	PEDESTRAIN MOVEMENT	UTILITIES	WASTE DISPOSAL AND RECOVERY	PRODUCT STORAGE	SPILLS AND LEAKS	EXPLOSIONS	DEICING SNOW REMOVAL AND DISPOSAL	PEST CONTROL	DUST CONTROL	ABANDOMENT	URBANIGATION	FUTURE AND RELATED ACTIVITIES: INDUSTRIAL DEVELOPMENT	FUTURE AND RELATED ACTIVITIES: TRANSPORTATION	FUTURE AND RELATED ACTIVITIES: ENERGY REQUIREMENTS
PHYSICAL	WATER					1								1											
PHYSICAL	NOISE	1	2	2	2		2										2								
PHYSICAL	LAND													1			1								
PHYSICAL	ATMOSPHERE	1	2	2	1		1										1								
BIOLOGICAL	SPECIES AND POPULATIONS				2						2						1								
BIOLOGICAL	HABITATS AND COMMUNITIES	1									2									2					
AESTHETIC	LAND										2		2												
AESTHETIC	ATMOSPHERE	1	2	2			1													2					
AESTHETIC	WATER	1				1														2					
AESTHETIC	FLORA AND FAUNA																								
AESTHETIC	MAN MADE OBJECTS																								
AESTHETIC	COMPOSITION												2												
SOCIAL	INDIVIDUALS ENV. INTERETS																						2	2	3
SOCIAL	INDIVIDUAL WELL-BEND											2	2										2	2	3
SOCIAL	SOCIAL INTERACTIONS											2	2										2	2	3

Table 4-2 Environmental Rating Check List.

Environmental Parameters	Rating	Information Sources
SOCIO-ECONOMIC EFFECT		
1 Resttlement	C	The route mainly passes throught remote and less population area.
2 Economic Activities	D	No major economic activities along the route.
3 Traffic and public facilities	D	Limited traffic volume estimated and scattered public facilities.
4 Split of communities	D	The route bypasses villages and small towns in general.
5 Cultural property	D	No major cultural properties except Gadhi Fort and religious interests which were avoided in the route alignment.
6 Water rights. Right of common	C	Scattered and isolated rice field observed, but in some sections, local irrigation canals are affected dut to the road construction.
7 Sanitation	D	No effect.
8 Waste	C	The road construction in mountainous terrain resulting in waste soil materials.
9 Hazards	B	Steep/unstable slope and fragile geology.
NATURAL EFFECTS		
10 Topography and geology	B	Most of the route running through steep/unstable slope in mountainous terrain and weathered/decomposed geological formation.
11 Soil Erosion	B	Steep/unstable slope and fragile geology.
12 Ground water	D	Rich ground water
13 Hydrological situation	D	No water way and fishery.
14 Coastal zone	D	Not applicable.
15 Flora and fauna	D	The route passes less forestry and no special flora and fauna.
16 Meteorology	D	No effect.
17 Land scape	C	The project area is located in remote and less population area except Dhulikhel where a tourist spot exists.
POLLUTION		
18 Air pollution	D	Not much traffic volume estimated.
19 Water pollution	C	Possible due to waste soil during construction.
20 Soil contamination	D	Very limited fertile soil located in projcect area.
21 Noise and vibration	C	Possible during and after construction but scattered and less population.
22 Ground settlement	D	No effect.
23 Offensive odour	D	No effect.

Rating Grade

A : Severe impact

B : Considerable impact

C : Slight impact

D : Almost no impact

4.4 Possible Environmental Impact and Mitigation Measures

The environmental impact on each parameter due to construction and operation of the Project has been initially identified in the previous subsection. Thus, in this subsection, the impacts are further elaborated based on the present field conditions and the assumed development scheme of the Project, in order to formulate possible mitigation measures which are actions to reduce, avoid or offset the potential adverse environmental consequence.

Followings are the present condition and impact on each environmental parameter together with the corresponding mitigation measures.

1. RESETTLEMENT

Present Condition & Impact

Most of the proposed route pass remote mountainous area and along the rivers, where houses and other buildings are scattered and very limited. However, several permanent houses, huts and sheds are affected due to the construction.

Mitigation Measures

To minimize relocation of the houses, buildings, even huts affected, alignment design will be refined in the preliminary design. In case of some houses affected, the Government should provide an opportunity to talk with residents living in the houses affected and pay reasonable amount of compensation to the residents.

2. ECONOMIC ACTIVITIES

Present Condition & Impact

The project area is remote and mountainous except area at Dhulikhel and Sindhuli Bazar only where small economic activities are observed. Thus, possible adverse impacts are disruption of traditional self-reliant structure or rural economy, and inflation due to the increased consumption by the flow of construction workers.

Mitigation Measures

These impacts are inevitable to certain extent, but the Government should monitor these possible impacts and control the inflation and protect the rural economy, if required.

3. TRAFFIC AND PUBLIC FACILITIES

Present Condition & Impact

Because of remote area, there is no public facilities such as schools, hospitals, etc. affected by the project. On the other hand, local transport system in which consumable goods are being carried by local porters will be considerably affected.

Mitigation Measures

This negative impact is also inevitable to a certain extent, but the Government should monitor the impacts and if required should create job opportunities for these people.

4. SPLIT OF COMMUNITIES

Present Condition & Impact

The proposed route runs mainly along the rivers such as Sunkoshi, Rosi Khola, and Dabcha Khola and bypasses major towns such as Dhulikhel and Sindhuli Bazar. Thus, it is presumed that no impact is induced due to the Project.

Mitigation Measures

Small local communities may not be identified during the survey. Thus it is suggested the follow-up survey in this regard shall be carried out to identify those in the further design stage.

5. CULTURAL PROPERTY

Present Condition & Impact

Along the route, there are several places of cultural, historical & religious interests such as local bazars, shrines, temples, tombs, grave yards, cemeteries, chautara, and, Gadhi (fort), etc. Such major places have been avoided in the route selection, so that no major impact is presumed.

Mitigation Measures

Although such minor places could not be identified during the field reconnaissance, the places of cultural & religious interests shall be totally avoided in the later design stages or shall be relocated to appropriate places in consultation with the local residents during the construction stages.

6. WATER RIGHTS, RIGHTS OF COMMON

Present Condition & Impact

Road construction frequently causes interception of irrigation water flow to rice fields, which is one of the adverse effects in this regard. In some sections, especially between Bhakundebesi to Khurkot, most of the local irrigation canals (approx. 50 cm x 30 cm, naked ditchs) are affected due to the road construction. Moreover intakes of the channel also could be influenced due to construction of the check dams and the river training works. It is therefore assumed that the adverse effect is considerable to some extent.

Mitigation Measures

The existing irrigation canals shall be maintained during and after construction of the road by constructing necessary structures and the water right and flow should not be interrupted. Taking into the above principle, the mitigation measures should be designed in the further stage and implemented accordingly.

7. SANITATION

Present Condition & Impact

There could be no significant adverse effect on sanitation except a few possibilities which are sanitation problems caused by the construction camps and by rest houses which could be built during road operation period.

Mitigation Measures

The sanitation measures should be well planned in the design of construction camps, and the sanitation guideline shall be provided to the rest house owners by the Government, if required.

8. WASTE

Present Condition & Impact

As the development project is road construction in mountainous terrain, waste resulting from road excavation will cause significant adverse effects, if no proper construction management is carried out. However, small amount of other construction materials such as cement mortar, sand, asphalt bitumen, etc will not cause any significant adverse effect.

Mitigation Measures

In the further design, it is important to balance earth volume in cut and fill area. If waste soil material is arisen, locations of the spoil banks should be specified in the design. Furthermore, waste soil disposal shall be strictly supervised during the construction period.

9. HAZARDS

Present Condition & Impact

Because of the route planned mostly running on steep/unstable slope with fragile geology, natural and artificial hazards could occur during and after the construction. These hazards include land slides, surface soil erosion, flash flood etc. Use of huge amount of explosives for hard rock cutting may deteriorate the existing geology with formation of artificial cracks and fissures. High cut and embankment which are undesirable in road construction will aggravate the hazard in worse condition.

Mitigation Measures

To minimize the hazardous effect due to the construction, it is essential to apply reduced or minimal scale of the development scheme at the first stage. Nevertheless, the mitigation measures from hazardous view point such as application of inlet/outlet treatment, slope protection, etc, minimum usage of explosives, well-balanced road geometry shall be taken into account in the design and construction stages.

10. TOPOGRAPHY & GEOLOGY

Present Condition & Impact

Most of the routes proposed passes through steep slopes on the mountainous topography and on the fragile geology. It is assumed to arise considerable adverse effects on topography and geology.

Mitigation Measures

As mentioned in the previous item 9 "Hazards", it is strongly recommended to apply minimal scale of the development scheme and to provide adequate mitigation measures in order to avoid adverse effects on topography and geology.

11. SOIL EROSION

Present Condition & Impact

At several places along the route, erosive soils were observed during the reconnaissance. Moreover many gullies, eroded river banks were also found along the route. Thus, it is presumed that considerable adverse effects on soil erosion will arise due to the road construction, unless adequate mitigation measures are provided.

Mitigation Measures

Appropriate mitigation measures on soil erosion shall be incorporated in the design as much as possible to avoid the adverse impact. These measures include various types of slope protection, river and channel protection works, etc. Furthermore, waste soil disposal which will cause the future soil erosion should be strictly monitored during the construction period.

12. GROUND WATER

Present Condition & Impact

It was observed that the ground water table along the route is relatively high in general. Construction of side drain, road excavation, cross drainage works, etc. could cause it lower by small amount, but it would not have much adverse effect.

Mitigation Measures

In case that the ground water table is affected by the road construction i.e. lowering it to a certain extent, considerable adverse effects to people who are using ground water will arise accordingly. Thus the ground water table should be monitored using the existing wells during the construction period.

13. HYDROLOGICAL SITUATIONS

Present Condition & Impact

It is presumed that there will be almost no impact on hydrology. However, the natural drainage will be disturbed during and after the construction, and uncontrolled deforestation and soil erosion could cause flash water , in case that appropriate mitigation measures are not provided.

Mitigation Measures

While designing the drainage structures such as side drains, cross drains, and catch drains, the natural drainage condition should be taken into account and designed accordingly. The inlets and outlets of cross drain works should be properly protected and should be located at suitable intervals.

14. COASTAL ZONE

Present Condition & Impact

Not Applicable

Mitigation Measures

Not Applicable

15. FLORA & FAUNA

Present Condition & Impact

As the route mostly passes through less forestry and steep barren land, no special flora and fauna are observed along the route, so there will be no adverse effect on it.

Mitigation Measures

Even though no adverse effect on its flora and fauna are presumed, if such thing observed at later stages of study, it should be preserved.

16. METEOROLOGY

Present Condition & Impact

No effect on atmospheric conditions are presumed due to construction works.

Mitigation Measures

Although no adverse effect on meteorology is anticipated, the existing streams and vegetation shouldn't be disrupted, which may have the effect on atmospheric condition (rain cycle, metrological cycle).

17. LANDSCAPE

Present Condition & Impact

Most of the sections proposed runs in remote and isolated areas except Dhulikhel that is a well known tourist spot. Only adverse effects in the Dhulikhel area could be presumed unless landscape views are considered in designing the cross sections and major structures.

Mitigation Measures

The cross-section and structures should be designed considering landscape views. Major bridges should be designed with aesthetic consideration, because these could be landmarks of the road. High cuts and embankments should be avoided in the design.

18. AIR POLLUTION

Present Condition & Impact

At present, no air pollution is observed because of the remote area of the project location. During and after the construction, air pollution could be induced by dust, exhaust gas of construction equipment and vehicle traffic. The air pollution will be aggravated in case that gravel pavement is applied.

Mitigation Measures

To reduce the causes affecting air pollution, water should be sprinkled during construction and a proper type of equipment should be employed during construction. To reduce it after construction, application of bituminous pavement is strongly recommended.

19. WATER POLLUTION

Present Condition & Impact

Presently, natural soil erosion and land slide cause water pollution especially during the period of rainy season. During construction period, it is presumed that excavation and waste soil disposal will cause adverse effects on water pollution unless special care and mitigation measures are provided.

Mitigation Measures

The pollution to a certain extent, during the construction is inevitable, but the natural spring, if any, in the construction site should be preserved with an appropriate structure. Also to minimize the effect, spoil banks should be specified in the design.

20. SOIL CONTAMINATION

Present Condition & Impact

As the proposed route passes almost through the steep barren land in general, no contamination into fertile soil is anticipated with a few exceptional cases. Where the route passes through the rice field, slight adverse effect is presumed resulting from the road excavation.

Mitigation Measures

Eventhough there will be no significant soil contamination, it is recommended that unsuitable soils (materials) if encountered during construction be hauled to specific spoil banks.

21. NOISE & VIBRATION

Present Condition & Impact

Noise and vibration are anticipated during construction because of use of heavy construction equipment, and after construction because of vehicular movement. But the effects will be less as the route passes through area with less population.

Mitigation Measures

Extent of noise and vibration depends upon the method of construction. A certain extent of noise and vibration during and after construction is inevitable. It is however recommended to apply the mitigation measures such as (1) To adopt less noise and vibration equipment and method, (2) To provide regulative/restrictive traffic signs such as running speed limitation.

22. GROUND SETTLEMENT

Present Condition & Impact

No swampy area are observed along the route, so there will be no ground settlement after construction.

Mitigation Measures

There will be no adverse effect on ground settlement. However, if soft ground area such as swampy area is encountered, adequate mitigation measures should be provided.

23. OFFENSIVE ODOUR

Present Condition & Impact

There could be little offensive odor produced during the road construction period, but it depends on the type of pavement applied. If bitumen is applied for surface layer, the odour could be produced in heating and mixing. But adverse effect is very limited.

Mitigation Measures

To minimize the effect on offensive odour, the batching and melting plant should be located in isolated places far from settlement. And also, the heating and mixing in open furnace and burning of bitumen should be avoided during the construction.

4.5 Recommendations From Environmental View Point

Based on the assessment carried out in the previous subsections, recommendations from environmental view point are prepared and these are broadly divided into two categories : one is impact monitoring to be carried out in the further stages including construction period, and the other category is the recommendation for formulating development scheme of the Project.

4.5.1 Impact Monitoring

Environmental monitoring is one of the most important components of an environmental impact assessment. It is essential for (1) Ensuring that impacts do not exceed legal standards, (2) Checking the implementation of mitigation measures, and (3) Providing early warning of potential environmental damage.

For the purpose of impact monitoring, the following methods shall be employed.

- **Base Line Monitoring**

A detailed survey on the specific environmental parameters, in which considerable adverse effect is presumed, should be carried out along the proposed route before construction begins, so that subsequent monitoring can assess changes in those parameters over the time against the base line.

- **Impact Monitoring**

The environmental parameters which have slight/considerable impact as indicated in the check list and the parameters marked by 2 or 3 in the interaction matrix should be measured during the construction and operation phases to detect environmental changes which may have occurred as a result of the project implementation. Further more, implementation of the mitigation measures proposed should be monitored by the authorities concerned during and after the construction.

- **Compliance Monitoring**

During the construction and operational phases of the project, the environmental parameters such as socioeconomic effects, natural effects, and pollution shall be monitored by sampling methods at regular intervals to ensure that the impacts encountered are within the limits of specific environmental indicators or pollution levels.

It should be noted that the impact on the following evironmental parameters must be monitored in all the phases by the above mentioned monitoring methods.

- Resettlements
- Waste
- Hazards
- Topography & Geology
- Soil Erosion
- Landscape
- Water Pollution
- Noise and Vibrations

4.5.2 Environmental Recommendation For Formulating the Development Scheme

The proposed route of Sindhuli Road runs through remote and less population area, and mostly passes on steep/unstable slope in mountainous terrain and weathered, metamorphosed and decomposed geological formation. Thus it is presumed that considerable adverse effects on the environmental parameters such as hazards, topography, geology, and soil erosion could be caused by the project implementation.

Extent and magnitude of those adverse effects surely depend on a scale of the development scheme, i.e. the small scale development scheme causes relatively slight impact which could be mitigated by the appropriate measures, while a large and full scale scheme induces severe to critical adverse effects which could be beyond economic mitigation measures.

Taking into account the above mentioned relationship between extent of environmental effects and the project development scale, it is strongly recommended that (1) stage wise construction method should be introduced in formulating the project development scheme, (2) minimal development scheme meeting the initial demand forecast shall be implemented at the first phase, and (3) the succeeding development scheme shall be finalized based on the results of the environmental monitoring to be carried out after the first phase completed, and be materialized accordingly.

CHAPTER 5

ASSESSMENT OF DOR'S ROAD CONSTRUCTION, MAINTENANCE AND MANAGEMENT FORMATION

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5.1 General

The purposes of this study are to review the present DOR's organization and staffing consisting of three different levels and to assess DOR's project implementation capability from institutional, managerial and financial view points. This study also includes review of construction and maintenance from above three view points with regard to Dharan-Dhankutta Road and Lamosangu-Jiri Road which are relatively similar to the Project. These study results will be reflected in formulating implementation method, construction management system and the future maintenance formation of Sindhuli Road Project.

5.2 Present Organization and Staffing in DOR

HMG has given all the responsibility for the development of roads in Nepal to the Department of Roads (DOR) belonging to under the Ministry of Works and Transport. DOR is divided into three levels of management and organization structure that consist of Central, Regional and District levels. The present organization and staffing of each level are described herein under. It is however noted that re-organization including staffing in DOR is still in process based on the Report of Administrative Reforms Commission headed by the Prime Minister on November 1992. Therefore, the present organization and staffing presented herein are too definitive to prepare certain recommendations on this aspect.

(1) DOR, Central Office

The Central Office in DOR, which is responsible for planning, construction and maintenance of road and bridge development projects as well as formulating road standard and policies, is headed by Director General (DG). The DG is supported by 5 - Deputy Director Generals (DDG), and 3 - Section Chiefs. The present organization is shown in Figure 5-1.