1.2 National Development Plans

After independence from British rule in 1947, India adopted a system to formulate development plan with each period covering a span of Five Years. The First Five Year Plan began in 1951. The Eighth Five Year Plan (1992-1997) has terminated last fiscal year and the plan period of the Ninth Five Year Plan (1997-2002) has launched.

1.2.1 Ninth Five Year Plan (1997-2002)

The Planning Commission has released the Approach Paper for the Ninth Five Year Plan spelling out its approach, objectives and emerging issues, macro economic dimensions, development strategies and policy priorities. In this Approach Paper, the macro economic Scenarios are presented as follows :

Table 1-3 Macro Parameters

Index	VIII Plan	IX Plan	
		Base-line Scenario	Accelerated 7% Growth
1 Domestic Saving Rate (% of GDP at market price)	23.7	25.2	26.2
2 Current Account Deficit (% of GDP at market price)	1.3	1.7	2.4
3 Investment Rate (%of GDP at market price)	25.0	26.9	28.6
4 GDP Growth Rate (% per annum)	5.9	6.2	7.0
5 Export Growth Rate (%per annum)	11.4	12.0	14.5
6 Import Growth Rate (% per annum)	13.6	11.4	15.3

Source : Approach Paper to the Ninth Five Year Plan 1997-2002

Therefore, economic growth rate for the Ninth Five Year Plan period is expected in the range of 6.2% to 7.0% per annum.

Although the macro economy performed reasonably well in the Eighth Five Year Plan, some major weaknesses have also emerged. In particular, the growth pattern has not benefited the poor and under privileged. The Ninth Five Year Plan was designed to remedy the weaknesses in such a manner as to ensure that the benefits of growth reach the poor.

1.2.2 Plan Outlay and Public Investment Program

The public investment programs for the Seventh and Eighth Five Year Plans are shown in Table 1-4. The total expenditure of the central government for the Ninth Plan was increased to 2.6 times of the Eighth Plan. The allocation of plan outlay to the transport sector was at 13% of the total budget.

1.3 Transport Sector

The main transport modes in India are represented by railways and roads. Reviewing the shares of the two modes for the past 40 years, the road share in freight movement has exceeded railways share from 1985 and presently in 1995 it dominates more than 70% of freight movements. On the other hand, percentage share of roads in passenger movement had exceeded in early year 1956 and dominating now about 90% of passenger movement.

The transportation system in India is both extensive and diversified, comprising about 62,570 route km of railways lines, 2.1 million km of roads (1992), 8 major ports, and 139 intermediate and minor ports, 75 airports including four major international airports, about 14,500 km of navigable inland waterways and 9,900 km of pipelines for carrying crude oil, petroleum products. The country's transportation system provides a reasonable level of service in many respects, but there remains considerable potential for reducing transport costs and improving the quality of services through removal of capacity bottlenecks.

1.4 The Road Sub-sector

1.4.1 Road Network in India

The total road length grew from 0.4 million km in 1950 to 2.1 million km in 1992. The network is classified into three categories on a functional basis :

(1) The primary system of National Highways (34,300 km in 1996), mostly serving interstate long distance traffic;

(2) The secondary system, consisting of State Highways (128,000 km in 1992) and Major District Roads (216,000 km in 1992), carrying mainly intra-State traffic; and

(3) The tertiary system, comprising rural roads (1,375,000 km), including other district roads, village and local roads.

Nearly 20% of the National Highways, which are almost all surfaced with bituminous pavement, still have a single lane (3.7 meters wide) carriageway. Although the National Highways constitute only 1.7% of the total road

Table 1-4 Public Investment Program (Seventh & Eighth Plan)

(Rs.crore, %)

Sector	Seventh Plan (1985-90)			Eighth Plan (1992-97)		
	Plan outlay		Actual	Plan outlay		(*) Actual
	Amount	%	expenditure	Amount	%	expenditure
1 Agriculture & allied activities	10523.6	5.8	12792.6	22467.2	5.2	23080.8
2 Rural development	8906.1	4.9	15246.5	34425.4	7.9	35263.2
3 Special area programs	2803.6	1.6	3470.3	6750.1	1.6	5836.7
4 Irrigation & flood control	16978.6	9.4	16589.9	32525.3	7.5	23280.4
5 Energy	54821.3	30.5	61689.3	115561.1	26.6	130562.5
a. Power	34273.5	19.0	37895.3	79588.7	18.3	67775.4
b. Petroleum	12627.7	7.0	16008.8	24000.0	5.5	49038.0
c. Coal & lignite	7400.6	4.1	7122.3	10507.0	2.4	12008.6
d. Non-conventional sources of energy	519.5	0.3	662.9	1465.4	0.3	1740.5
6 Industry & minerals	22415.5	12.5	29220.3	46921.7	10.8	51403.4
a. Village & small scale industries	2752.7	1.5	3249.3	6334.2	1.5	6228.4
b. Other industries	19662.8	10.9	25971.1	40587.7	9.3	45175.0
7 Transport	22644.9	12.6	29548.1	55925.6	12.9	69744.7
a. Railways	12334.5	6.9	16549.2	27202.0	6.3	34582.0
b. Roads & bridges			6330.0	13210.0	3.0	
c. Others			6668.9	15513.6	3.6	
8 Communications	4474.5	2.5	8425.5	25110.0	5.8	38381.9
9 Science, technology & environment	2463.1	1.4	3023.9	9041.7	2.1	6875.3
10 General economic services	1395.6	0.8	2249.6	4549.5	1.0	7079.9
11 Social services	31545.2	17.5	34959.6	79011.9	18.2	79505.3
a. Education	6382.6	3.5	7685.5	19599.7	4.5	19559.0
b. Medical & public health	3392.6	1.9	3688.6	7575.9	1.7	7048.0
c. Family welfare	3256.3	1.8	3120.8	6500.0	1.5	6791.7
d. Housing	2428.2	1.3	2722.8	5273.0	1.2	7016.6
e. Urban development	1801.3	1.0	2113.4	5277.0	1.2	4826.9
f. Other social services	14283.9	7.9	15628.5	34786.3	8.0	34263.1
12 General services	1028.0	0.6	1513.8	1810.5	0.4	3107.2
TOTAL (1 to 12)	180000.0	100.0	218729.4	434100.0	100.0	474121.2
(a) Central Government Plan	95534.0	53.1	127519.6	247865.0	57.1	328905.7
(b) State Plans	80698.0	44.8	87492.4	179985.0	41.5	(**)
(c) Union Territory Plans	3768.0	2.1	3717.7	6250.0	1.4	(**)

Source: "Economic Survey 1996-97", Original source = Planning Commission.

Note : (*) Including revised and budget estimates.

(**) Central plan only since figures for States/UT of 1996-97 are not yet available.

network in the country, they carry about 40% of the total passenger and freight traffic.

1.4.2 Growth of National Highway Network

National Highway System is the main arterial transport system of the country. The requirements of its expansion in terms of both capacity and length have been attached high priority in every Five Year Plan in order to cope with a rapid traffic growth. However, due to constraint of financial resources, no significant growth in the National Highway Network could take place after the Seventh Five Year Plan period. During the Eighth Plan, only a length of 609 km could be added to the National Highway Network. Table 1-5 presents the situation regarding additions to National Highway Network in past Five Year Plans. The total length added since the Pre-First Plan (1947-1951) until the Eighth Five Year Plan (up to March 1996) was a 12,858 km length of which 80% portion was added by the end of the Sixth Plan (1980-85). The Seventh Plan and Eighth Plan could contribute only a 20% of addition achieved in the past 49 years.

Table 1-5 Planwise Adding to the National Highway System

Sl.No.	Period	Length added during the period (km)	Total length at the end period (km)
1	As on 1.4.1947	-	21,440
2	Pre-first Plan (1947-51)	815	22,255
3	First Plan (1951-56)	-	22,255
4	Second Plan (1956-61)	1,514	23,769
5	Third Plan (1961-66)	179	23,948
6	Interregnum Period (1966-69)	52	24,000
7	Fourth Plan (1969-74)	4,819	28,819
8	Fifth Plan (1974-78)	158	28,977
9	Interregnum Period (1978-80)	46	29,023
10	Sixth Plan (1980-85)	2,687	31,710
11	Seventh Plan (1985-90)	1,902	33,612
12	Interregnum Period (1990-92)	77	33,689
13	Eighth Plan (1992-97) (Upto 3/96)	609	34,298
	Total additions since 1947	12,858	

Source: Report of the Working Group on Roads for the Ninth Five Year Plan 1997-2002, MOST (Road Wing), August 1996

1.4.3 Road Development Plans (the Ninth Five Year Plan)

(1) Road Development Plans for Five Year Plan

The Ministry of Surface Transport has prepared the "Report of the Working Group on Roads for the Ninth Five Year Plan 1997-2002, August 1996". The road development policies, strategies and necessary measures are presented in the report and summarised as below :

(2) Policy Framework for Development of National Highways

・ Widening 2-lane to 4-lane

High Density Corridor (more than 35000 PCUs/day) = 7000 km
Medium Density Corridor (20000-35000 PCUs/DAY) =11000 km
Low Density Corridor (15000 - 20000 PCUs/day) = 5000 km
Total = 23000 km

However, due to the resource constraints, four lane widening is to be restricted to a length of 7000 km of HDC. Out of 7000 km of four laning, about 1500 km may be with partially controlled access and remaining 5500 km with normal four laning along with paved shoulders with a view to convert these four lane sections into Expressways later on.

・ Expressways

For high density corridors, expressways could be planned. However, because of severe resource constraints, it may be difficult to construct new Expressways during the Ninth Five Year Plan.

・ Quadrilateral and Diagonal Connecting Corridors

Development of National Highways in high density corridors need to be concentrated broadly on the quadrilateral with diagonals connecting the major cities of Delhi, Bombay, Calcutta and Madras.

・ Strengthening of Pavement including paved shoulder

For Medium Density Corridors where traffic volume would be the range of 20000 PCUs to 35000 PCUs, the strategy of improvement could be strengthening of the existing pavement with paved shoulders.

・ Widening of single lane to two-lane

For remaining corridors where the traffic is less than 20000 PCUs,

widening of single lane sections to two-lane, improvement of geometric and riding quality should be taken up. It is also proposed to tackle the works relating to construction of missing links.

• Composed Projects

It is proposed to sanction composed projects for a given section containing all improvement works needed so that highway user is not put to any hardship once a particular section is tackled. As regards bypasses, these may be treated as projects in itself and keeping in view the resource constraints, these may preferable be taken up under BOT scheme.

• Additions to the existing National Highway System

1981-2000 Perspective Plan lays down a target of 66000 km of National Highways by the turn of the century. However, it is generally felt that no useful purpose will be served by adding more length to National Highway System in the face of severe resource constraints for the development and maintenance of National Highways. Therefore, no provision is being recommended for addition to NH System. The priority during the Ninth Five Year Plan should be to consolidate the existing network rather than its expansion. At the same time, bypasses with service roads to be provided for all district headquarters (in order to recover or to strength the consolidation of road network).

1.5 Present Situation of the Study Areas

The followings briefly explain the present situations and background of each proposed bypass.

(1) Bareilly Bypass in Uttar Pradesh

NH24 which links Delhi and Lucknow, the State capital of Uttar Pradesh, runs through Bareilly. Bareilly locates almost the middle of Delhi and Lucknow. According to the Regional Plan 2001, National Capital Region, December 1988, Bareilly was nominated as one of the 5 Counter-magnets which were proposed to provide a pull to migrants from the less development areas, and to form a regional growth centres in the regions to achieve a balanced pattern of urbanisation. Since NH24 is one of the corridors from Delhi to Calcutta via Lucknow and Kanpur, and Bareilly itself shows remarkable development as a commercial/industrial centre of the region, the mixture of increased through traffic and intra-traffic causes the heavy traffic congestion in the city. Therefore the State Government is planning the new bypass.

(2) Patna Bypass in Bihar

Patna is the State capital of Bihar. Patna locates on the right (south) bank of Ganga and extends its area to the eastern and western directions along the river. NH30 traverses the city centre and causes the traffic congestion by the inflow of through traffic. NH30 also passes Danapur and Ara. Danapur locates west of Patna, and Ara locates far west of Patna, on the opposite bank of Son River, the tributary of Ganga. Due to the through traffic on NH30 both cities also have traffic congestion. Therefore the State Government planned a bypass running west to east at the south of Patna to ease the traffic congestion in these cities. The eastern part of the planned bypass, Phase 1 and Phase 2 sections, was already completed and opened to the public.

(3) Keonjhar Bypass in Orissa

Keonjhar locates northern inland of Orissa. Keonjhar forms itself having a junction between NH6 and the State Highway as the core. The bypass was proposed to detour the north of the city in order to ease the traffic congestion by the diversion of through traffic of heavy lorries.

(4) Balugaon Bypass in Orissa

Balugaon locates around 90 km south-west from Bhubaneshwar, the State capital of Orissa. Balugaon is next to Chilika lake which is one of the tourist resorts of Orissa. As NH5 traverses the city centre, the mixture of through traffic and intra-city traffic, such as bullock-carts, bicycles, rickshows and 3

wheeler taxies, at the shopping area causes the traffic congestion as a bottleneck of NH5. NH5 runs parallel to the railways, and runs sea side of railways at Balugaon area having at-grade railway crossings at the north and the south of the city. The traffic congestion at the railway crossing is also increasing due to longer closing time of crossing gate in recent years. The State Government proposed the bypass of NH5 which will detour the inland side of the railways to ease the congestion in city centre and at the railway crossings.

(5) Vijayawada Bypass in Andhra Pradesh

Vijayawada locates on the left bank of Krishna River at the Bay of Bengal side of Andhra Pradesh. Vijayawada is a industrial city having cement factories along the river, railway carriage manufacture of Indian Railways at the outskirts of the city, and others. The trunk National Highway No. 5 (NH5) from Calcutta to Chennai traverses the city, and, at the same time, NH9 starts form the city which links to Mumbai via Hyderabad. There is a existing bypass, dual lanes, of NH5 along the Krishna River. The bypass capacity was observed not sufficient for the traffic demand due to the narrow carriageway width without lane markers, and narrow Krishna River bridge, dual lanes, which utilise the top of river weir to cross the river of approximately 2 km wide. At present four-laning projects of NH5 from Vijayawada to Eluru, and NH9 from Vijayawada to Nandigama by ADB, and NH5 from Vijayawada to Chilakalurupet by OECF are planned. The proposed bypass of this Study will link above mentioned Eluru on NH5 and Nandigama on NH9.

(6) Kannur Bypass in Kerala

Kannur locates the coast side of northern Kerala. NH17, originates in Mumbai and link to Cochin via Mangalore, traverses the city. In order to solve the traffic congestion due to the mixture of through traffic and intra-city traffic at morning/evening peak hours, and due to the at-grade railway crossing at the southern fringe of the city, the bypass plan locates the east side—inland side—of the city was proposed. However the proposed alignment traverses the plantation area, mainly coconut plantation. The alternative study was required.

(7) Nandura Bypass in Maharashtra

Nandura locates on NH6 at the inland of north Maharashtra. NH6 originates in Dhule and reaches Calcutta, via Nagpur and Keonjhar which is one of the proposed project areas of this Study. In order to ease the traffic congestion in the city centre due to the through traffic, mainly heavy lorries, the State Government proposed 3 alternative bypass plans of 1) detour the south of the city; 2) detour the north of the city; and 3) replace the NH6 bridge which crosses Dnyanganga at the east of the city.

(8) Khamgaon Bypass in Maharashtra

Khamgaon is the next city of Nandura at the east side. NH6 runs through the city. The situation of traffic congestion is similar to Nandura. To ease the congestion by the diversion of the through traffic to the outside of the city, the bypass which detours from the west of the city to the south and return to NH6 at the east of the city was proposed. The bypass was also intended to provide a smooth access to the planned industrial estate. Therefore the alignment of the bypass needs to fit with the requirement of industrial estate plan.

(9) Bhopal Bypass in Madhya Pradesh

Bhopal is the State capital of Madhya Pradesh. NH12, which start from Jaipur to Jabalpur, runs through the city. Having other 4 state highways, Bhopal seems to radiate 6 highway legs to the outside. To solve the traffic congestion at morning/evening peak hours, which was cause by the increased traffic in recent years, is urgently required. As the huge Bara Talao lake locates closely at the west side of the city, the proposed bypass to divert the through traffic has a semi-circular alignment from the north, via east, to the south of the city.

(10) Gwalior Bypass in Madhya Pradesh

Gwalior is located about 320 km south from Delhi. Nh3 runs west side of the city and the city area spread over east side of NH3. NH 3 connects with NH 2 with high through traffic. Gwalior is nominated as one of the National Capital Regions to reduce the burden of the Capital city of Delhi. In this respect, the Gwalior Bypass is planned as an important facility to formulate the future urban development plan of Gwalior.

Pre-Feasibility Study

Chapter 1 *Socio economic Conditions of the Study Area*

Chapter 2
Traffic Survey and Analysis

Chapter 3 *Future Traffic Demand Forecast*
Chapter 4 *Design Standards*
Chapter 5 *Preliminary Design of the Bypasses*
Chapter 6 *Environmental Related Study*
Chapter 7 *Preliminary Cost Estimates*
Chapter 8 *Preliminary Economic and Financial Analysis*
Chapter 9 *Project Implementation Plan*
Chapter 10 *Priority of the Bypasses*

2 Traffic Survey and Analysis

2.1 General

In this Study, three types of traffic surveys were carried out to understand the existing traffic flow patterns in the study areas. These three types of traffic surveys are Classified Traffic Count Survey, Origin-Destination Survey and Traffic Speed-Delay Survey. All the traffic surveys were carried out between 12th May 1997 to 24th May 1997 on working days (i.e. excluding Sunday and holidays). The number of traffic survey locations for each 10 project site by type of survey is given below in Table 2-1. The location of traffic survey points for each project site is shown later in Figure 2-11 to Figure 2-20.

Road Inventory Survey was also carried out to collect the road inventory data on national highways sections on which the bypasses are proposed.

This chapter describes the methodology and results of the three traffic surveys. The results of traffic surveys will be used for future traffic demand forecast and other aspects of planning.

Table 2-1 Number of Traffic Survey Locations by Type of Survey

S.No.	Name of Bypass	Name of Roads	Traffic Count Survey	O-D Survey	Traffic Speed-Delay Survey
1	Bareilly	NH24, SH33, SH37	4	4	13
2	Patna	NH30	3	3	4
3	Keonjhar	NH6	2	2	2
4	Balugaon	NH5	2	2	4
5	Vijayawada	NH5, NH9	2	2	3
6	Kannur	NH17	2	2	2
7	Nandura	NH6	2	2	1
8	Khamgaon	NH6	2	2	1
9	Bhopal	NH12, SH18, MDR	5	5	16
10	Gwalior	NH3	2	2	5
Total			26	v	51

Note : NH24 = National Highway No. 24; SH33 = State Highway No. 33;
MDR = Major District Road
The values for Traffic Speed-Delay Survey refers to the no. of road sections.

2.2 Classified Traffic Count Survey

2.2.1 Methodology

The classified traffic count survey was carried out at all the 26 traffic survey locations for 24 hours for 3 consecutive weekdays by manual counts. Traffic counts were taken for 13 vehicle types in both directions. Traffic counts were recorded every 15 minutes in a particular format. The location of traffic count survey stations for each bypass is shown later in Figure 2-11 to Fig 2-20.

2.2.2 Results and Analysis of Traffic Count Survey

The average daily traffic volumes at the 26 survey locations are summarised in Table 2-3. Here, the average daily traffic volume refers to the average of 3 day traffic volume for both directions. As expected, the average daily traffic volume varies widely from 3,756 veh/day for Bhopal (Location No. 11) to 13,887 veh/day for Bareilly (Location No. 24). The fast moving traffic volumes were highest for Bareilly at about 10,000 veh/day and lowest for Keonjhar and Balugaon at around 4,000 veh/day. The slow moving traffic volumes were again highest for Bareilly at around 3000-4,000 veh/day and lowest for Kannur at around 150-250 veh/day. The traffic volumes were also computed in PCUs (Passenger Car Units) by using the PCU factors as shown in Table 2-2.

Although the traffic count survey was carried out for 13 vehicle types, these were aggregated into 7 vehicle types as specified in the "Traffic Studies for Planning of Bypasses around Towns", The Indian Road Congress, 1988. The traffic volumes for each bypass for 7 vehicle types and by direction is given in Table 2-5 to Table 2-14.

Traffic characteristics such as vehicle composition, peak hour traffic and day time traffic (i.e. traffic between 6:00 hrs to 18:00 hrs) was also computed for all the 26 traffic survey locations (Table 2-5). The average peak hour traffic comes to about 6.7% and the average day time traffic to 61.2%. The vehicle composition varies widely from city to city and on average the share of trucks, buses, cars, two-wheelers and slow moving vehicles was found to be 40.8%, 8.7%, 20.6%, 14.9% and 14.9% respectively. In case of Nandura and Khamgaon the share of trucks was found to be highest varying from 57% to 74%. The share of slow moving vehicles was highest for Bareilly (between 20% to 34%). In Kannur, the share of cars was highest at about 43%, and the share of slow moving vehicles was lowest at 1.4%-3.4%.

The hourly variation of traffic for each bypass was also plotted (Figure 2-1 to Figure 2-10). It was found that in case of big cities like Bareilly, Patna and Bhopal, the day-time off-peak traffic is more or less equal to that of peak period traffic. In case of small cities like Nandura, Khamgaon, Balugaon and Keonjhar, the day-time off-peak traffic is considerably lower than the peak period traffic as expected.

Table 2-2 PCU (Passenger Car Units) Factors

S.No.	Type of Vehicle	PCU Factor
1	Two Wheelers	0.5
2	Auto Rickshaw	0.75
3	Car/Jeep/Taxi	1.0
4	Van/Tempo	1.0
5	Mini Bus	1.5
6	Bus	3.0
7	LCV	1.5
8	2-Axle Truck	3.0
9	Multiple-Axle Truck	4.5
10	Agricultural Tractor Trailer	2.0
11	Animal/Hand Drawn	6.0
12	Cycle	0.5
13	Cycle Rickshaw	0.75

Table 2-3 Average Daily Traffic Volumes (26 Survey Locations)

S. No.	Name of Bypass	Survey Location No.	Average Daily Traffic Volume (in Vehicles)			Average Daily Traffic Volume (in PCU)		
			Fast	Slow	Total	Fast	Slow	Total
1	Bareilly	23	9,850	2,981	12,831	19,349	3,466	22,815
		24	9,598	4,289	13,887	15,513	7,070	22,583
		25	10,163	2,578	12,741	19,532	3,632	23,164
		26	8,298	4,209	12,507	14,717	4,897	19,614
2	Patna	3	5,729	1,302	7,031	11,663	1,152	12,815
		4	5,630	1,154	6,784	10,813	1,106	11,919
		5	8,141	1,975	10,116	14,848	1,514	16,362
3	Keonjhar	17	3,584	497	4,081	7,236	323	7,559
		18	3,782	1,780	5,562	7,941	991	8,932
4	Balugaon	19	4,330	1,272	5,602	9,913	893	10,806
		20	4,151	605	4,756	10,045	491	10,536
5	Vijayawada	1	12,032	1,540	13,572	27,147	2,327	29,474
		2	6,151	492	6,643	14,366	498	14,864
6	Kannur	6	9,462	130	9,592	15,421	73	15,494
		7	7,446	259	7,705	11,663	141	11,804
7	Nandura	13	6,341	960	7,301	14,536	1,073	15,609
		14	6,181	641	6,822	14,018	825	14,843
8	Khamgaon	15	6,225	165	6,390	15,535	320	15,855
		16	7,175	557	7,732	16,860	699	17,559
9	Bhopal	8	5,946	765	6,711	9,648	884	10,532
		9	3,779	1,671	5,450	5,689	1,604	7,293
		10	5,679	439	6,118	9,325	667	9,992
		11	3,143	613	3,756	5,001	621	5,622
		12	11,469	677	12,146	19,064	939	20,003
10	Gwalior	21	7,067	811	7,878	13,815	1,142	14,957
		22	9,769	877	10,646	22,610	1,491	24,101

Note : Average Daily Traffic Volume is the average of three day 24 hrs traffic count in both direction.

Table 2-4 Traffic Characteristics

S. No.	Name of Bypass	Survey Location No.	AADT (in Vehicles)	Vehicle Composition (%)					Peak Hour Traffic (%)	Day Time Traffic (%)
				Trucks	Buses	Cars	2-W	Slow Veh		
1	Bareilly	23	12,831	28.7%	16.0%	19.9%	12.1%	23.2%	6.6%	63.0%
		24	13,887	20.8%	12.8%	21.2%	14.3%	30.9%	8.0%	75.8%
		25	12,741	34.7%	10.4%	19.2%	15.5%	20.2%	6.4%	65.1%
		26	12,507	26.5%	5.4%	20.2%	14.2%	33.7%	7.3%	70.8%
2	Patna	3	7,031	40.1%	8.0%	21.5%	11.9%	18.5%	6.6%	60.5%
		4	6,784	37.3%	7.5%	28.3%	9.8%	17.0%	7.6%	61.2%
		5	10,116	24.9%	16.5%	18.1%	21.0%	19.5%	7.0%	68.8%
3	Keonjhar	17	4,081	51.5%	1.9%	17.6%	16.9%	12.2%	7.3%	64.1%
		18	5,562	39.3%	2.9%	11.9%	13.8%	32.0%	7.2%	61.3%
4	Balugaon	19	5,602	49.9%	3.2%	13.4%	10.8%	22.7%	7.2%	63.1%
		20	4,756	59.5%	5.0%	13.5%	9.3%	12.7%	6.5%	60.1%
5	Vijayawada	1	13,572	51.7%	9.6%	14.8%	12.6%	11.3%	5.3%	51.4%
		2	6,643	54.0%	12.5%	16.8%	9.3%	7.4%	5.3%	51.0%
6	Kannur	6	9,592	21.0%	20.2%	42.6%	14.8%	1.4%	7.0%	69.8%
		7	7,705	24.2%	13.9%	43.3%	15.2%	3.4%	7.2%	69.6%
7	Nandura	13	7,301	57.1%	6.1%	13.3%	10.3%	13.2%	6.4%	54.7%
		14	6,822	59.2%	6.2%	15.6%	9.7%	9.4%	5.9%	55.9%
8	Khamgaon	15	6,390	74.0%	6.5%	11.3%	5.6%	2.6%	5.3%	50.0%
		16	7,732	64.2%	6.2%	12.1%	10.3%	7.2%	6.4%	56.2%
9	Bhopal	8	6,711	32.0%	6.7%	25.2%	24.7%	11.4%	6.4%	62.5%
		9	5,450	18.0%	7.8%	17.9%	25.6%	30.7%	8.6%	70.6%
		10	6,118	30.4%	8.9%	32.0%	21.4%	7.2%	6.1%	57.0%
		11	3,756	28.1%	8.4%	18.7%	28.5%	16.3%	7.7%	60.7%
		12	12,146	34.5%	7.1%	27.9%	24.9%	5.6%	7.1%	64.3%
10	Gwalior	21	7,878	45.7%	7.6%	20.1%	16.3%	10.3%	5.6%	52.7%
		22	10,646	54.3%	8.3%	19.6%	9.5%	8.2%	6.1%	52.1%
Average				40.8%	8.7%	20.6%	14.9%	14.9%	6.7%	61.2%

Note : Day Time Traffic is traffic from 06:00 till 18:00 hrs.

AADT is total traffic in both directions.

Table 2-5 Traffic Count Results (Bareilly)

Survey Location No.	Chainage	Direction of Traffic	Fast Moving Vehicles				Slow Moving Vehicles			Total Vehicles			Total PCUs		
			Trucks/ Truck Trailers	Buses	Cars/Jeeps/ Vans/ Three Wheelers	Two Wheelers	Cycles/ Cycle Rickshaw	Animal Drawn Vehicles	Others (Tractor trailer)	Fast	Slow	Total	Fast	Slow	Total
23	NH 24; Km 233/0	Towards Bareilly City	1,919	1,146	1,349	872	1,111	139	149	5,286	1,398	6,684	10,311	1,716	12,027
		Away from Bareilly City	1,769	907	1,204	684	1,308	125	150	4,564	1,583	6,147	9,037	1,751	10,788
		Total (Both Directions)	3,688	2,053	2,553	1,556	2,418	264	299	9,850	2,981	12,831	19,349	3,466	22,815
24	SH 33; Km 38/0	Towards Bareilly City	1,453	891	1,445	1,096	1,368	283	342	4,885	1,993	6,878	7,842	3,103	10,945
		Away from Bareilly City	1,441	889	1,495	887	1,525	398	373	4,713	2,296	7,009	7,671	3,967	11,638
		Total (Both Directions)	2,894	1,780	2,940	1,983	2,893	681	715	9,598	4,289	13,886	15,513	7,070	22,583
25	NH 24; Km 262/0	Towards Bareilly City	2,339	675	1,222	940	960	178	170	5,176	1,309	6,485	10,048	1,894	11,943
		Away from Bareilly City	2,079	654	1,218	1,036	944	153	172	4,987	1,269	6,256	9,484	1,738	11,222
		Total (Both Directions)	4,418	1,328	2,440	1,977	1,905	332	342	10,163	2,578	12,741	19,532	3,632	23,164
26	SH 37; Km 14/0	Towards Bareilly City	1,784	376	1,313	873	1,623	215	187	4,347	2,025	6,372	7,840	2,482	10,321
		Away from Bareilly City	1,534	301	1,219	898	1,807	187	191	3,951	2,184	6,135	6,877	2,415	9,292
		Total (Both Directions)	3,318	677	2,532	1,771	3,430	402	378	8,298	4,209	12,507	14,717	4,897	19,614

Table 2-6 Traffic Count Results (Patna)

Survey Location No.	Chainage	Direction of Traffic	Fast Moving Vehicles				Slow Moving Vehicles			Total Vehicles			Total PCUs		
			Trucks/ Truck Trailers	Buses	Cars/Jeeps/ Vans/ Three Wheelers	Two Wheelers	Cycles/ Cycle Rickshaw	Animal Drawn Vehicles	Others (Tractor trailer)	Fast	Slow	Total	Fast	Slow	Total
3	NH 30; Km 135/0	Towards Patna City	1,404	283	781	416	570	24	65	2,884	659	3,543	5,822	562	6,384
		Away from Patna City	1,417	276	729	422	580	43	20	2,845	644	3,488	5,841	590	6,431
		Total (Both Directions)	2,822	559	1,511	837	1,150	67	85	5,729	1,302	7,031	11,663	1,152	12,815
4	NH 30; Km 140/0	Towards Patna City	1,402	250	1,082	365	605	33	56	3,098	694	3,792	5,938	618	6,556
		Away from Patna City	1,129	262	837	303	370	29	62	2,532	461	2,992	4,875	487	5,362
		Total (Both Directions)	2,531	512	1,919	668	975	61	118	5,630	1,154	6,784	10,813	1,106	11,918
5	NH 30; Km 182/0	Towards Patna City	1,367	860	916	960	920	22	74	4,104	1,016	5,120	7,818	769	8,587
		Away from Patna City	1,155	805	914	1,162	861	20	77	4,037	959	4,995	7,030	746	7,776
		Total (Both Directions)	2,522	1,666	1,831	2,122	1,781	42	151	8,141	1,975	10,115	14,848	1,514	16,363

Table 2-7 Traffic Count Results (Keonjhar)

Survey Location No.	Chainage	Direction of Traffic	Fast Moving Vehicles				Slow Moving Vehicles			Total Vehicles			Total PCUs		
			Trucks/ Truck Trailers	Buses	Cars/Jeeps/ Vans/ Three Wheelers	Two Wheelers	Cycles/ Cycle Rickshaw	Animal Drawn Vehicles	Others (Tractor trailer)	Fast	Slow	Total	Fast	Slow	Total
17	NH 6; Km 355/0	Towards Keonjhar	1,010	37	352	341	200	1	10	1,740	210	1,950	3,474	124	3,598
		Away from Keonjhar	1,091	40	365	348	260	3	24	1,844	287	2,131	3,762	198	3,960
		Total (Both Directions)	2,101	78	716	689	460	4	34	3,584	497	4,081	7,236	323	7,559
18	NH 6; Km 349/5	Towards Keonjhar	1,059	77	289	374	783	3	19	1,799	805	2,604	3,824	452	4,276
		Away from Keonjhar	1,127	87	375	394	953	3	18	1,982	975	2,957	4,117	540	4,657
		Total (Both Directions)	2,186	164	664	768	1,736	6	37	3,782	1,780	5,561	7,941	991	8,932

Table 2-8 Traffic Count Results (Balugaon)

Survey Location No.	Chainage	Direction of Traffic	Fast Moving Vehicles				Slow Moving Vehicles			Total Vehicles			Total PCUs		
			Trucks/ Truck Trailers	Buses	Cars/Jeeps/ Vans/ Three Wheelers	Two Wheelers	Cycles/ Cycle Rickshaw	Animal Drawn Vehicles	Others (Tractor trailer)	Fast	Slow	Total	Fast	Slow	Total
19	NH 5; Km 322/0	Towards Balugaon	1,407	98	369	296	580	18	18	2,170	616	2,786	5,035	436	5,471
		Away from Balugaon	1,386	83	383	309	618	18	20	2,160	656	2,816	4,878	458	5,335
		Total (Both Directions)	2,794	180	752	605	1,199	36	38	4,330	1,272	5,602	9,913	893	10,806
20	NH 5; Km 337/0	Towards Balugaon	1,313	112	319	213	278	12	22	1,956	311	2,267	4,663	253	4,915
		Away from Balugaon	1,518	128	321	228	261	11	22	2,196	294	2,489	5,383	239	5,621
		Total (Both Directions)	2,831	240	640	441	539	22	43	4,151	605	4,756	10,045	491	10,536

Table 2-9 Traffic Count Results (Vijayawada)

Survey Location No.	Chainage	Direction of Traffic	Fast Moving Vehicles				Slow Moving Vehicles			Total Vehicles			Total PCUs		
			Trucks/ Truck Trailers	Buses	Cars/Jeeps/ Vans/ Three Wheelers	Two Wheelers	Cycles/ Cycle Rickshaw	Animal Drawn Vehicles	Others (Tractor trailer)	Fast	Slow	Total	Fast	Slow	Total
1	NH 5; Km 57/0	Towards Vijayawada City	3,492	647	995	869	546	103	139	6,003	788	6,791	13,521	1,173	14,694
		Away from Vijayawada City	3,521	662	1,010	836	506	101	145	6,029	752	6,781	13,626	1,154	14,780
		Total (Both Directions)	7,012	1,309	2,006	1,706	1,052	204	284	12,032	1,540	13,572	27,147	2,327	29,474
2	NH 9; Km 230/0	Towards Vijayawada City	1,832	452	596	309	169	0	66	3,190	236	3,426	7,443	224	7,667
		Away from Vijayawada City	1,758	379	518	306	175	5	76	2,962	256	3,218	6,923	274	7,197
		Total (Both Directions)	3,591	832	1,114	615	345	6	142	6,151	492	6,644	14,366	498	14,865

Table 2-10 Traffic Count Results (Kannur)

Survey Location No.	Chainage	Direction of Traffic	Fast Moving Vehicles				Slow Moving Vehicles			Total Vehicles			Total PCUs		
			Trucks/ Truck Trailers	Buses	Cars/Jeeps/ Vans/ Three Wheelers	Two Wheelers	Cycles/ Cycle Rickshaw	Animal Drawn Vehicles	Others (Tractor trailer)	Fast	Slow	Total	Fast	Slow	Total
6	NH 17; Km 150/0	Towards Kannur	986	974	2,069	720	56	0	5	4,749	61	4,810	7,694	39	7,732
		Away from Kannur	1,029	967	2,017	700	69	0	0	4,713	69	4,782	7,727	34	7,762
		Total (Both Directions)	2,015	1,941	4,086	1,420	124	0	5	9,462	130	9,592	15,421	73	15,494
7	NH 17; Km 161/0	Towards Kannur	973	557	1,662	578	130	0	0	3,771	130	3,900	6,010	65	6,075
		Away from Kannur	894	512	1,676	594	123	1	5	3,676	129	3,805	5,653	76	5,729
		Total (Both Directions)	1,867	1,070	3,338	1,172	253	1	5	7,446	259	7,705	11,663	141	11,804

Table 2-11 Traffic Count Results (Nandura)

Survey Location No.	Chainage	Direction of Traffic	Fast Moving Vehicles				Slow Moving Vehicles			Total Vehicles			Total PCUs		
			Trucks/ Truck Trailers	Buses	Cars/Jeeps/ Vans/ Three Wheelers	Two Wheelers	Cycles/ Cycle Rickshaw	Animal Drawn Vehicles	Others (Tractor trailer)	Fast	Slow	Total	Fast	Slow	Total
13	NH 6; Km 319/0	Towards Nandura City	2,104	218	516	371	411	43	33	3,209	487	3,697	7,362	539	7,901
		Away from Nandura City	2,066	224	459	381	392	42	38	3,129	473	3,602	7,172	534	7,707
		Total (Both Directions)	4,170	442	974	752	803	86	71	6,339	960	7,299	14,534	1,073	15,607
14	NH 6; Km 316/0	Towards Nandura City	2,038	215	520	335	257	28	50	3,109	335	3,445	7,053	400	7,453
		Away from Nandura City	2,001	206	541	324	221	36	49	3,072	305	3,377	6,965	424	7,390
		Total (Both Directions)	4,039	421	1,062	659	478	64	99	6,181	641	6,822	14,018	825	14,843

Table 2-12 Traffic Count Results (Khamgaon)

Survey Location No.	Chainage	Direction of Traffic	Fast Moving Vehicles				Slow Moving Vehicles			Total Vehicles			Total PCUs		
			Trucks/ Truck Trailers	Buses	Cars/Jeeps/ Vans/ Three Wheelers	Two Wheelers	Cycles/ Cycle Rickshaw	Animal Drawn Vehicles	Others (Tractor trailer)	Fast	Slow	Total	Fast	Slow	Total
15	NH 6; Km 304/0	Towards Khamgaon	2,432	194	384	169	46	11	33	3,179	91	3,270	7,980	157	8,137
		Away from Khamgaon	2,298	219	341	188	35	17	23	3,046	75	3,121	7,555	163	7,718
		Total (Both Directions)	4,730	413	725	357	82	28	56	6,225	165	6,391	15,535	320	15,855
16	NH 6; Km 292/0	Towards Khamgaon	2,556	245	393	392	210	27	43	3,586	280	3,867	8,553	357	8,910
		Away from Khamgaon	2,411	235	541	402	212	26	39	3,588	277	3,865	8,306	342	8,649
		Total (Both Directions)	4,967	479	934	794	421	53	83	7,175	557	7,732	16,860	699	17,559

Table 2-13 Traffic Count Results (Bhopal)

Survey Location No.	Chainage	Direction of Traffic	Fast Moving Vehicles				Slow Moving Vehicles			Total Vehicles			Total PCUs		
			Trucks/ Truck Trailers	Buses	Cars/Jeeps/ Vans/ 3-Wheelers	Two Wheelers	Cycles/ Cycle Rickshaw	Animal Drawn Vehicles	Others (Tractor trailer)	Fast	Slow	Total	Fast	Slow	Total
8	NH 12; Km 324/0	Towards Bhopal City	1,081	248	819	832	278	15	132	2,980	425	3,405	4,885	492	5,376
		Away from Bhopal City	1,068	203	872	823	220	10	110	2,966	340	3,306	4,763	393	5,156
		Total (Both Directions)	2,150	451	1,691	1,655	498	25	242	5,946	765	6,711	9,648	884	10,532
9	SH 18; Km 7/0	Towards Bhopal City	454	179	453	698	683	14	197	1,785	894	2,679	2,612	823	3,435
		Away from Bhopal City	525	248	523	699	579	24	173	1,994	776	2,770	3,077	782	3,859
		Total (Both Directions)	979	427	976	1,397	1,262	38	371	3,779	1,671	5,449	5,689	1,604	7,293
10	SH 18; Km 18/6	Towards Bhopal City	939	265	966	605	120	25	80	2,776	225	3,001	4,627	372	4,999
		Away from Bhopal City	923	281	994	706	127	14	73	2,904	214	3,118	4,698	294	4,993
		Total (Both Directions)	1,862	546	1,960	1,311	247	39	153	5,679	439	6,119	9,325	667	9,992
11	MDR; Km 13/0	Towards Bhopal City	556	157	339	515	207	1	94	1,567	302	1,870	2,548	300	2,848
		Away from Bhopal City	498	161	364	553	206	2	102	1,576	310	1,886	2,453	322	2,774
		Total (Both Directions)	1,054	317	703	1,069	413	4	196	3,143	613	3,756	5,001	621	5,622
12	NH 12; Km 301/0	Towards Bhopal City	2,144	484	1,665	1,543	150	5	166	5,836	321	6,157	9,795	441	10,237
		Away from Bhopal City	2,046	383	1,727	1,477	167	9	179	5,633	355	5,988	9,269	498	9,767
		Total (Both Directions)	4,190	867	3,392	3,020	316	15	346	11,469	677	12,145	19,064	939	20,003

Table 2-14 Traffic Count Results (Gwalior)

Survey Location No.	Chainage	Direction of Traffic	Fast Moving Vehicles				Slow Moving Vehicles			Total Vehicles			Total PCUs		
			Trucks/ Truck Trailers	Buses	Cars/Jeeps/ Vans/ Three Wheelers	Two Wheelers	Cycles/ Cycle Rickshaw	Animal Drawn Vehicles	Others (Tractor trailer)	Fast	Slow	Total	Fast	Slow	Total
21	NH 3; Km 103/0	Towards Gwalior City	1,747	277	800	683	236	33	137	3,508	405	3,913	6,641	593	7,233
		Away from Gwalior City	1,850	323	783	603	266	33	107	3,559	406	3,965	7,174	549	7,723
		Total (Both Directions)	3,597	600	1,583	1,286	502	65	244	7,067	811	7,878	13,815	1,142	14,957
22	NH 3; Km 134/0	Towards Gwalior City	2,647	417	1,007	486	237	45	140	4,558	422	4,980	10,435	669	11,104
		Away from Gwalior City	3,134	471	1,077	529	207	56	192	5,211	455	5,666	12,174	822	12,997
		Total (Both Directions)	5,782	888	2,084	1,015	444	101	332	9,769	877	10,646	22,610	1,491	24,101

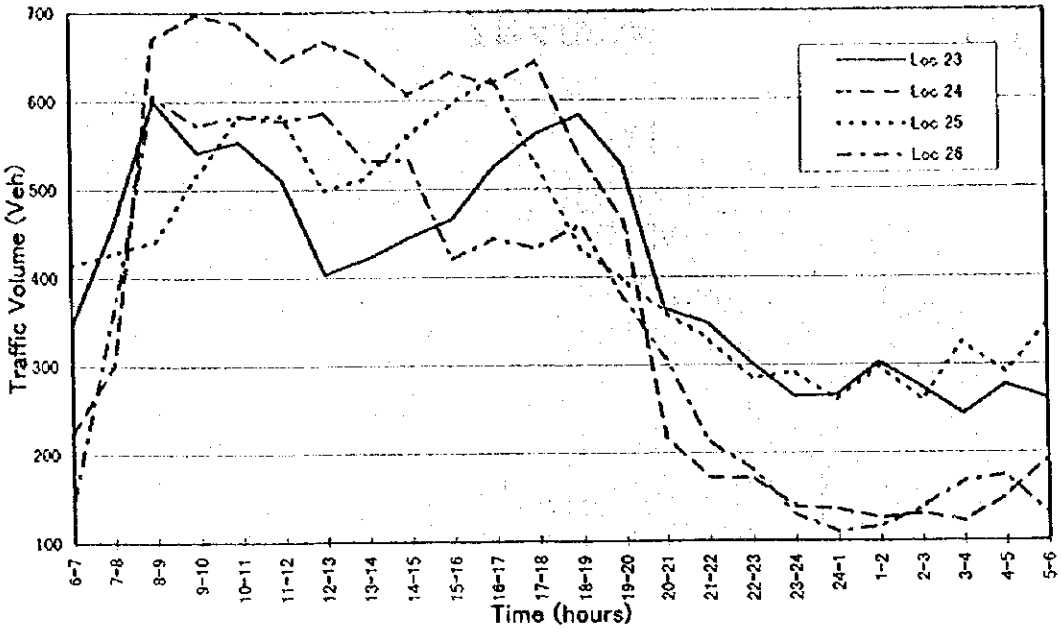


Figure 2-1 Hourly Traffic Variation (Bareilly Bypass)

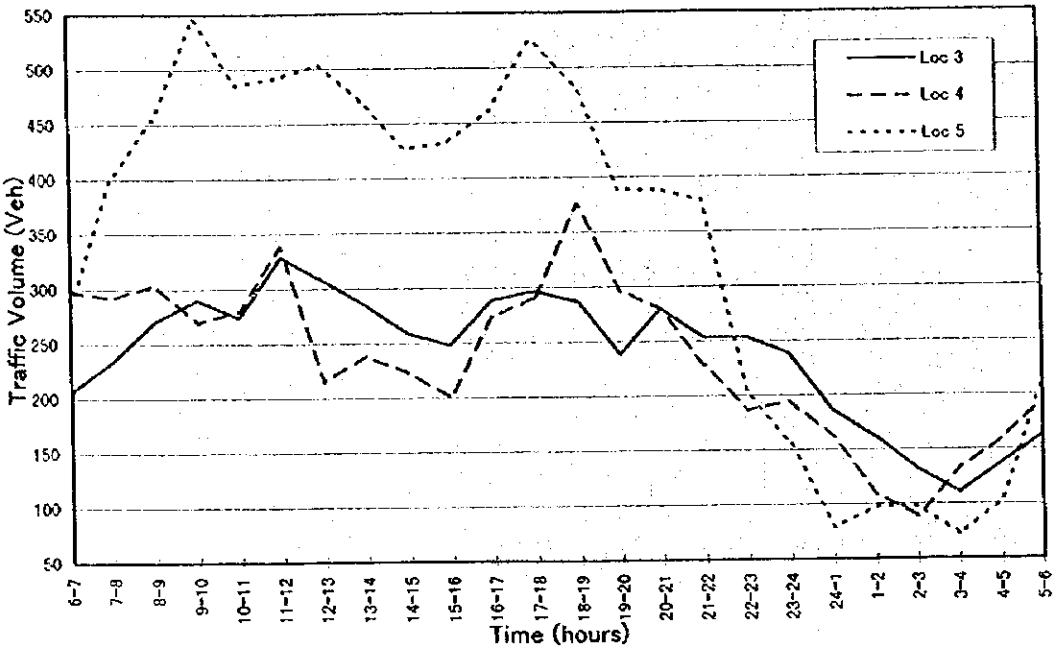


Figure 2-2 Hourly Traffic Variation (Patna Bypass)

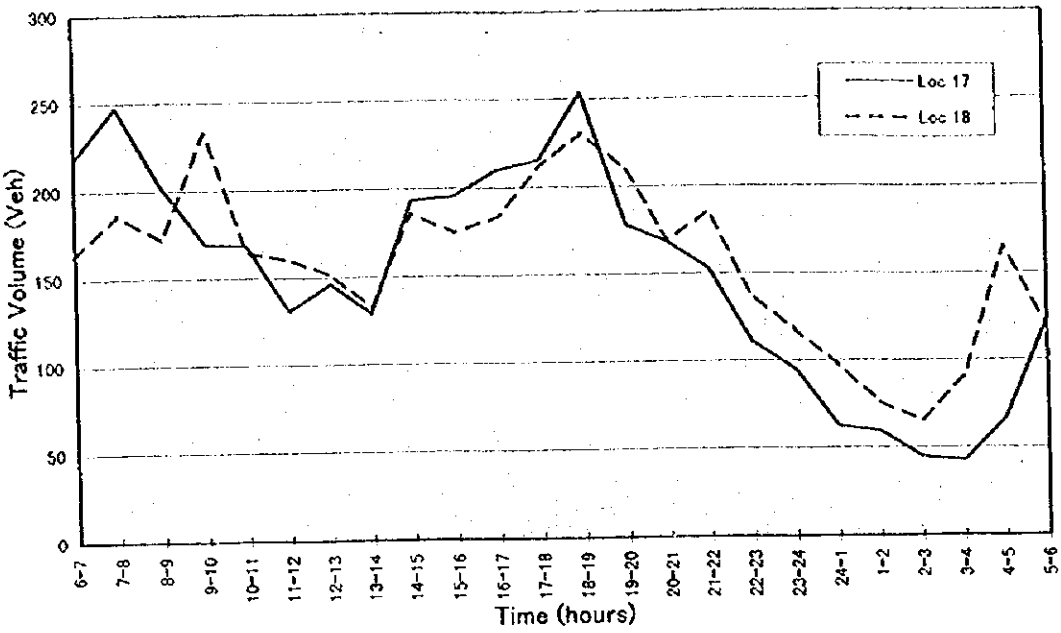


Figure 2-3 Hourly Traffic Variation (Keonjhar Bypass)

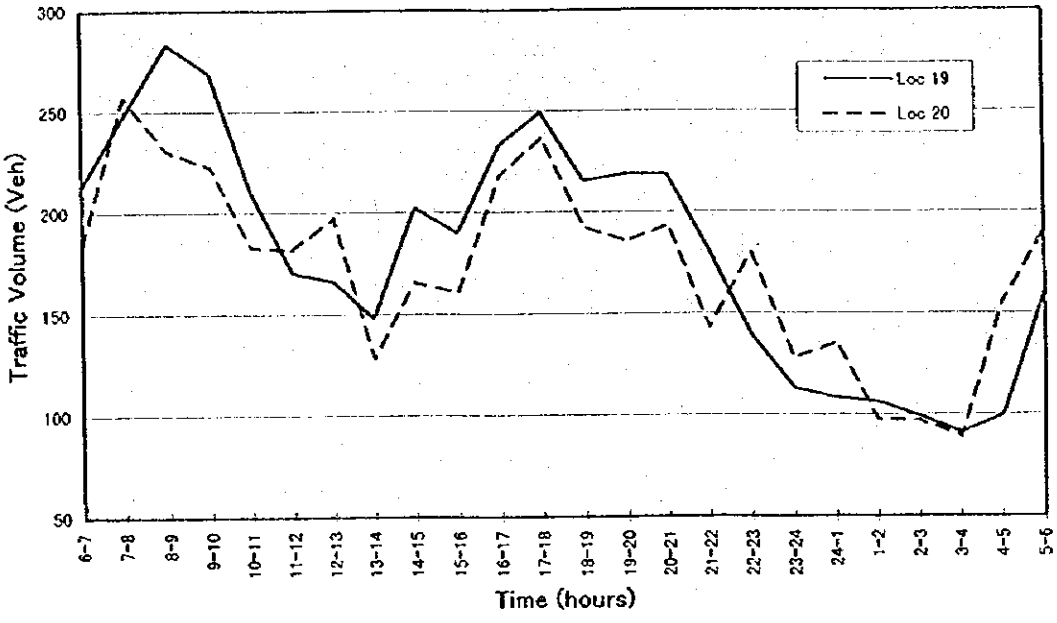


Figure 2-4 Hourly Traffic Variation (Balugaon Bypass)

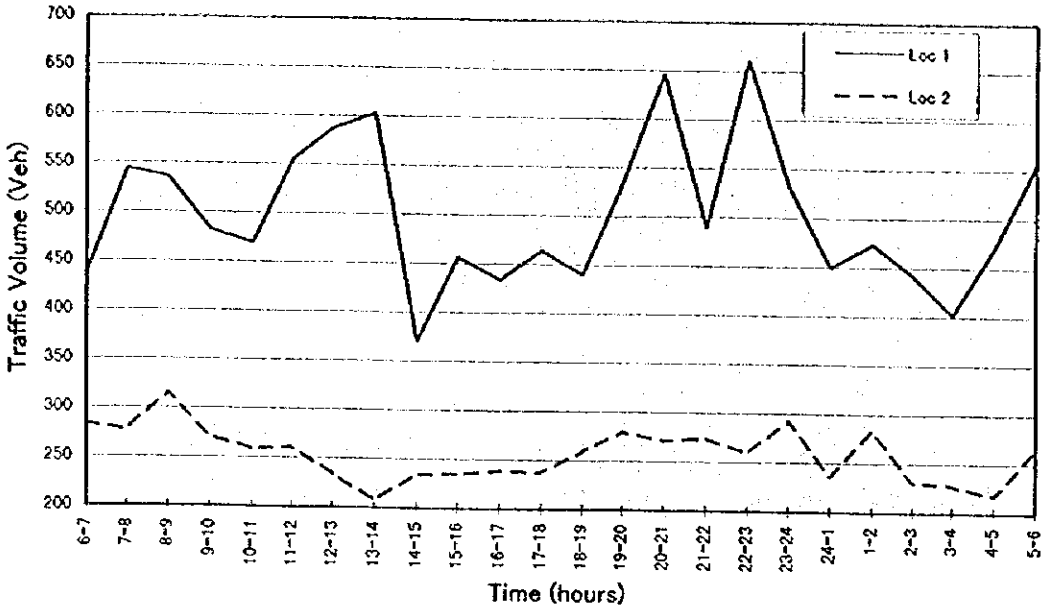


Figure 2-5 Hourly Traffic Variation (Vijayawada Bypass)

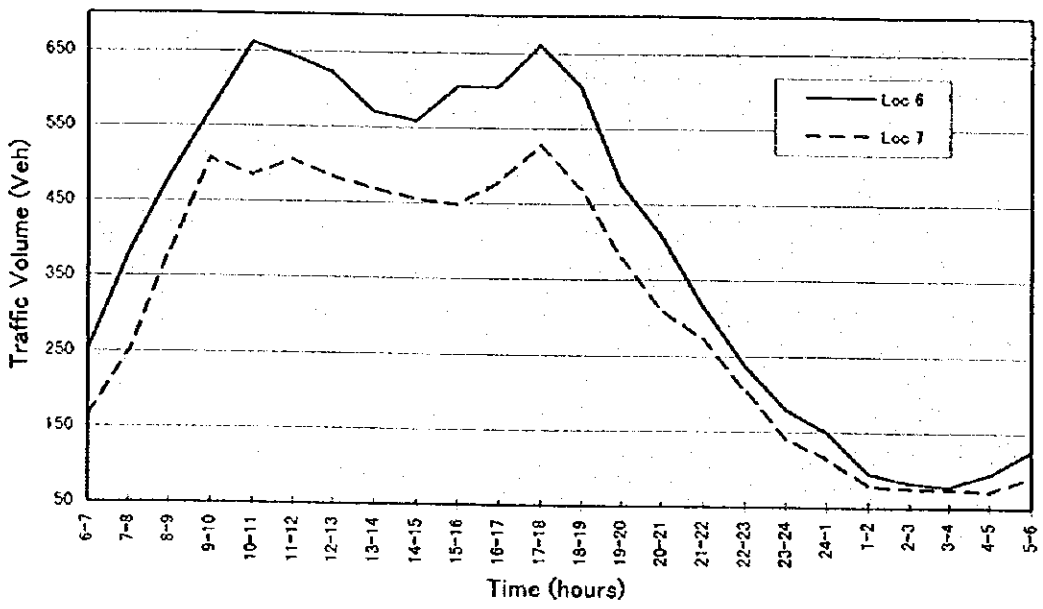


Figure 2-6 Hourly Traffic Variation (Kannur Bypass)

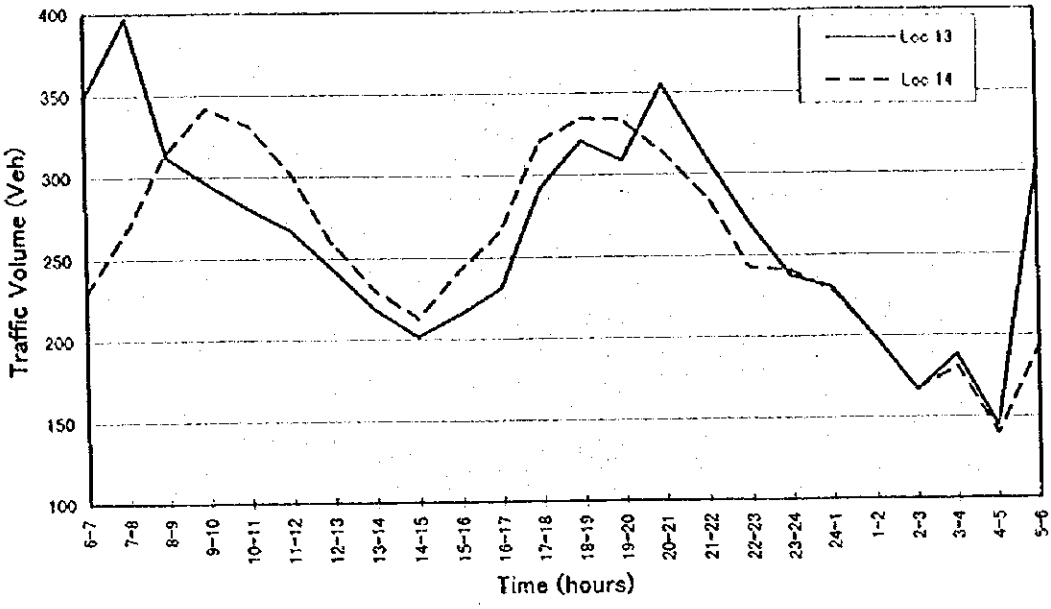


Figure 2-7 Hourly Traffic Variation (Nandura Bypass)

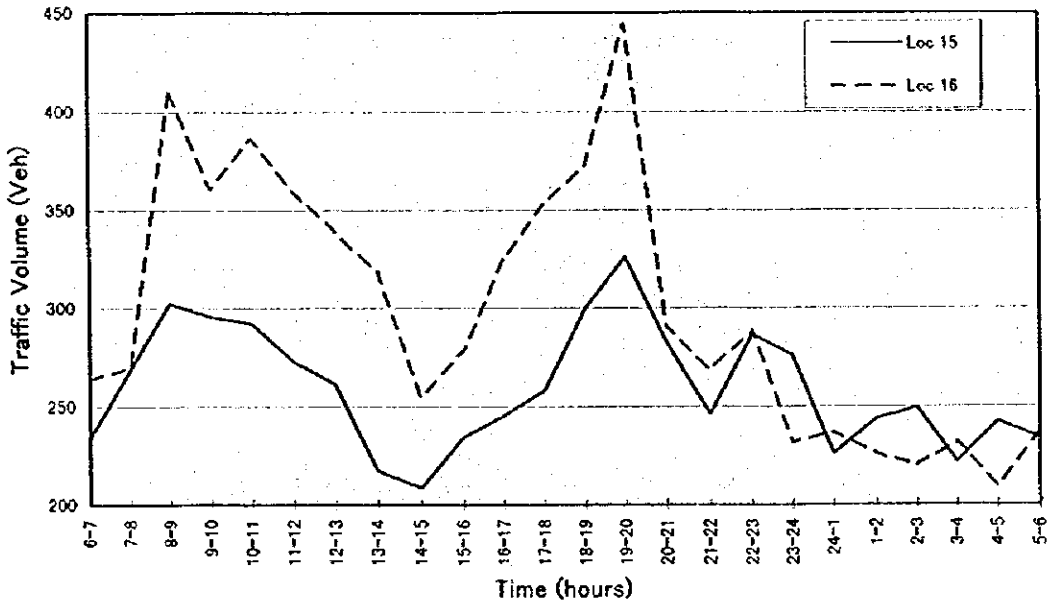


Figure 2-8 Hourly Traffic Variation (Khamgaon Bypass)

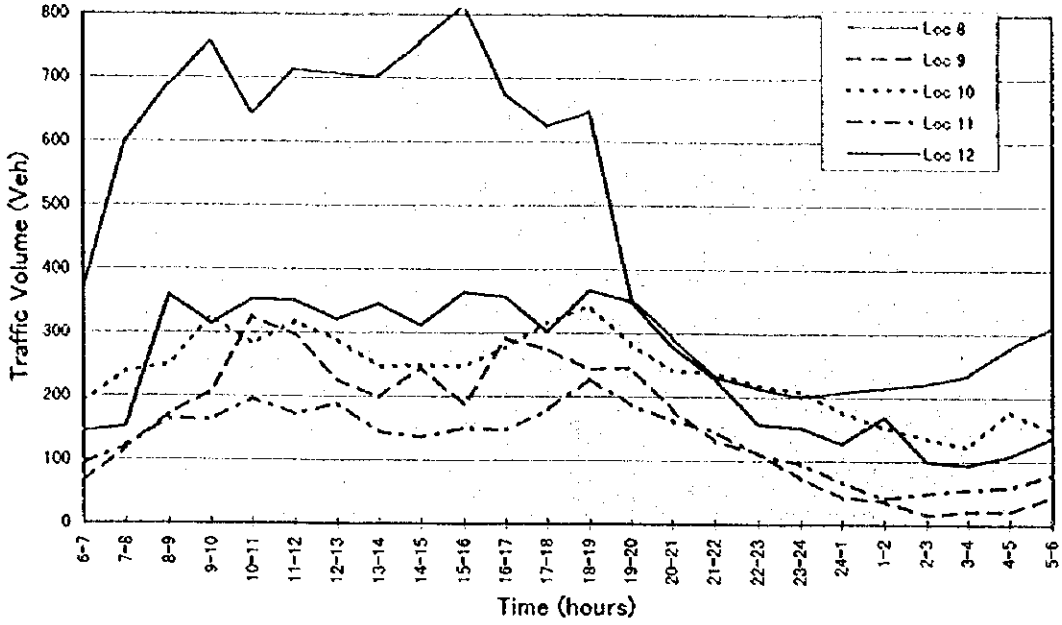


Figure 2-9 Hourly Traffic Variation (Bhopal Bypass)

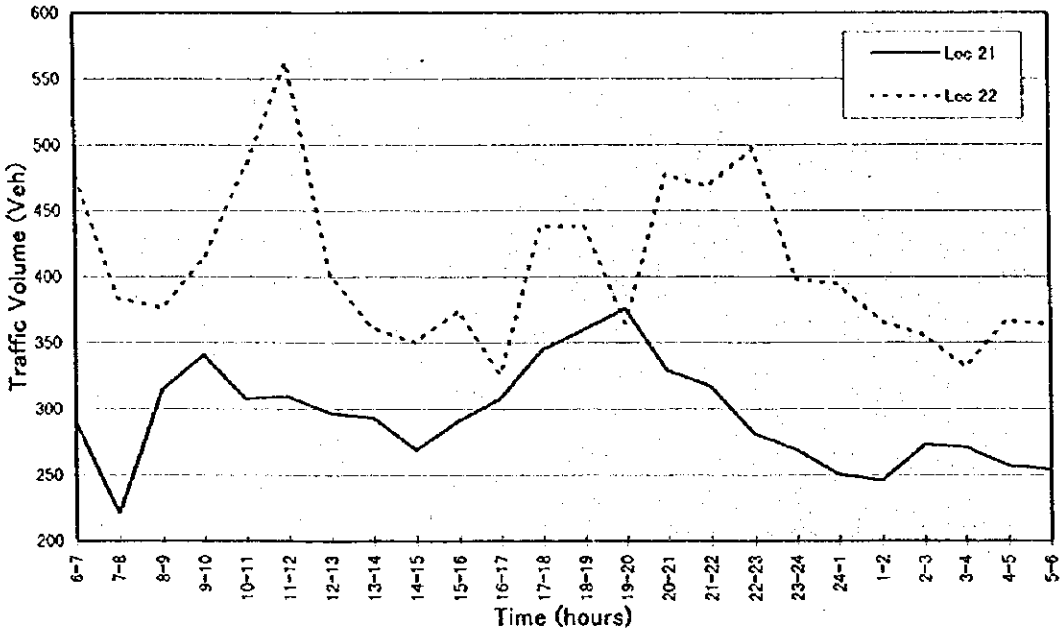


Figure 2-10 Hourly Traffic Variation (Gwalior Bypass)

2.3 Origin - Destination (O-D) Survey

2.3.1 Methodology

The origin-destination survey were conducted at all the 26 traffic survey locations where traffic count survey was conducted. The survey was conducted for 12 hours from 8 AM to 8 PM on a weekday by road-side interview method by stopping the vehicles and interviewing the driver. Police assistance was taken in stopping the vehicles. Questions like place of origin and destination, trip purpose, type and amount of freight carried etc. were asked to the driver. This information was recorded for passenger vehicles and freight vehicles separately in a particular format.

Table 2-15 shows the sampling rate of the O-D survey. Sampling rate is the ratio of no. of vehicles interviewed to total no. of vehicles passed during the survey duration. The average sampling rate is 25.4%. In case of Patna, the sampling rate is very low at 3.1%-7.7%. This was mainly due to the difficulty in carrying out the survey because of unstable political conditions at the time of survey.

2.3.2 Zoning and Coding of O-D Survey Data

Each of the 10 project sites where bypasses are proposed were divided into zones for aggregating and coding the O-D survey data. Where ever possible, administrative boundaries such as district and state boundaries were used to demarcate zones. Each zone was assigned a zone code number and trips were coded for trip origin and destination zone codes for all vehicle types. The vehicle type considered were Passenger cars (including jeep/taxi/Van and Auto Rickshaw), Two-Wheelers, Buses (including mini buses) and Trucks (including Tractor-Trailer). Other items of the collected data such as trip purpose, vehicle occupancy, type and amount of freight carried (in case of trucks) etc. were also recorded.

The zone maps showing the zone boundaries, zone numbers and also the location of O-D survey stations is shown in Figure 2-11 to Figure 2-20.

Table 2-15 Sampling Rate of O-D Survey

S. No.	Name of Bypass	Survey Location No.	O-D Sample size (veh.)	Corresponding 12hr Traffic Volume (veh.)	Sampling Rate (%)
1	Bareilly	23	1,575	6,401	24.6%
		24	1,389	7,797	17.8%
		25	1,483	6,156	24.1%
		26	1,231	6,613	18.6%
2	Patna	3	156	3,346	4.7%
		4	247	3,198	7.7%
		5	172	5,548	3.1%
3	Keonjhar	17	1,255	1,993	63.0%
		18	1,007	2,230	45.2%
4	Baluqaon	19	525	2,581	20.3%
		20	627	2,023	31.0%
5	Vijayawada	1	1,306	5,538	23.6%
		2	1,258	3,011	41.8%
6	Kannur	6	2,301	8,780	26.2%
		7	1,802	4,661	38.7%
7	Nandura	13	1,215	3,051	39.8%
		14	1,176	3,356	35.0%
8	Khamgaon	15	1,156	3,113	37.1%
		16	1,030	4,119	25.0%
9	Bhopal	8	580	4,515	12.8%
		9	321	2,966	10.8%
		10	827	3,785	21.8%
		11	344	2,204	15.6%
		12	595	8,890	6.7%
10	Gwalior	21	1,735	3,827	45.3%
		22	1,086	5,352	20.3%
				Average	25.4%

2.3.3 Results and Analysis of O-D Survey Data

Using the collected data, O-D matrices by type of vehicle were prepared for all the 26 survey locations. These O-D matrices were referred to as sample O-Ds, because they were prepared using the sample data collected for 12 hours, the duration for which the O-D survey was carried out. The sample O-Ds were expanded to daily (24hrs) O-Ds by multiplying them by expansion factors. Expansion factor for a particular survey location is the ratio of average daily traffic volume by the sample size of the O-D survey at that location. Expansion factors were computed separately for each vehicle type for each survey location.

For each city, the expanded O-D matrices of all the survey locations in that city were used to produce a final O-D for the city. The final O-D matrixes were prepared

separately for each vehicle type and then added together to produce the O-D Matrix (all vehicles).

Table 2-18 to Table 2-37 shows the final O-D matrices (all vehicles) and corresponding zone tables for each of the 10 project sites.

The final O-D matrix of each city was plotted on the zone map to produce desire line diagrams. Figure 2-11 to Figure 2-20 shows the desire line diagrams for each of the 10 cities. In maintain clarity of the desire line diagrams, the O-D pairs having traffic of less than 5% of the traffic of maximum O-D pair were not plotted.

Table 2-16 and Table 2-17 shows the traffic characteristics for passenger and goods vehicles respectively. The average vehicle occupancy for cars, buses and two-wheelers is 4.47, 35.75 and 1.8 respectively. On average 36% trips are work-related. The average tonnage for LCV, 2-axle trucks, MAV and agricultural tractors is 3.01, 8.02, 10.21 and 3.89 tonnes respectively.

The volumes of through traffic by each study area are summarised as below. Bareilly has the maximum number of through traffic with 7,217 trips/day and followed by Khamgaon (6,363 trips) and Gwalior (6,278 trips).

Total Traffic and Through Traffic

No.	Name of Bypass	(1) Total Vehicle Trips per day	(2) Through Traffic	(2)/(1) %
1	Bareilly	36,253	7,217	19.9
2	Patna	14,200	4,955	34.9
3	Keonjhar	5,464	3,742	68.5
4	Balugaon	5,887	3,529	59.9
5	Vijayawada	17,884	5,417	30.3
6	Kannur	14,813	3,124	21.1
7	Nandura	7,574	5,112	67.5
8	Khamgaon	9,095	6,363	70.0
9	Bhopal	26,384	2,378	9.0
10	Gwalior	15,898	6,278	39.5

Table 2-16 Passenger Vehicle Characteristics (O-D Survey)

S. No.	Name of Bypass	Survey Location No.	Vehicle Occupancy			Trip Length (km)			Trip Purpose (%)		
			Car	Buses	2-W	Car	Bus	2-W	Work	Non-Work	Return
1	Bareilly	23	4.73	52.10	1.96	147.73	219.54	21.27	25.87%	29.72%	44.41%
		24	6.50	37.65	1.85	28.78	79.29	24.56	52.83%	13.00%	34.17%
		25	4.97	41.72	1.76	127.46	319.42	80.05	36.06%	27.71%	36.23%
		26	5.67	43.93	1.77	39.09	94.60	20.64	58.10%	17.96%	23.94%
2	Patna	3	4.31	43.04	1.20	141.12	119.75	27.60	26.87%	31.34%	41.79%
		4	5.06	55.86	1.45	148.44	150.30	45.86	33.88%	31.40%	34.71%
		5	3.97	47.80	2.00	166.90	250.29	34.11	48.25%	23.68%	28.07%
3	Keonjhar	17	4.08	21.86	1.78	64.71	77.74	16.00	71.65%	6.40%	21.95%
		18	5.93	39.07	1.86	239.24	135.36	19.14	64.24%	6.98%	28.78%
4	Balugaon	19	4.05	43.52	1.63	80.21	212.38	42.67	38.63%	31.41%	29.96%
		20	5.19	40.31	1.77	120.74	165.00	59.01	23.24%	35.59%	41.18%
5	Vijayawada	1	4.35	37.09	1.77	130.10	117.48	57.50	26.30%	58.96%	14.74%
		2	4.88	43.96	2.62	172.37	194.16	92.22	51.83%	39.02%	9.15%
6	Kannur	6	2.56	39.12	1.48	80.43	66.26	25.21	17.62%	31.04%	51.34%
		7	3.62	37.41	1.51	115.76	89.57	43.54	24.46%	46.23%	29.31%
7	Nandura	13	6.27	19.04	1.89	253.17	233.82	134.54	15.17%	43.44%	41.39%
		14	5.75	33.54	1.85	278.88	182.69	113.05	15.12%	47.67%	37.21%
8	Khamgaon	15	6.16	30.23	1.75	348.72	187.97	72.50	11.28%	43.92%	44.81%
		16	4.27	32.90	1.92	481.02	262.41	137.19	17.43%	44.95%	37.61%
9	Bhopal	8	3.48	6.67	1.71	105.87	126.94	68.57	40.29%	41.39%	18.32%
		9	5.10	26.32	1.91	60.53	112.79	78.76	38.46%	8.39%	53.15%
		10	4.15	22.70	1.88	119.21	159.42	47.37	48.86%	9.89%	41.25%
		11	4.18	17.17	1.88	84.07	251.06	43.53	20.56%	23.89%	55.56%
		12	3.09	36.72	1.78	90.42	88.80	38.11	40.12%	10.18%	49.70%
10	Gwalior	21	5.50	43.74	1.80	207.53	125.93	37.18	49.92%	19.10%	30.99%
		22	5.44	36.09	2.00	246.12	207.41	83.51	40.40%	29.80%	29.80%
Average			4.74	35.75	1.80	156.87	162.71	56.30	36.05%	28.96%	34.98%

Note : Car includes passenger cars, jeep, vans, and three-wheelers.
Bus includes mini-buses also.
Work trips includes business trips also.
Non-Work trips includes education, tourism, religious and shopping trips.

Table 2-17 Goods Vehicle Characteristics (O-D Survey)

S. No.	Name of Bypass	Survey Location No.	Average Tonnage (t)				Trip Length (km)			
			LCV	2-Axle	MAV	Tractor	LCV	2-Axle	MAV	Tractor
1	Bareilly	23	2.95	7.50	10.97	4.09	204.20	415.71	325.32	73.17
		24	1.42	5.73	8.23	4.73	50.71	68.76	223.08	21.80
		25	2.94	10.06	14.61	2.21	334.03	578.79	708.12	328.15
		26	3.34	5.46	11.61	1.88	47.00	74.32	100.99	35.05
2	Patna	3	1.15	11.50	17.00	1.33	44.20	589.87	556.40	27.17
		4	6.63	15.06	19.25	3.57	111.60	531.38	1202.50	42.57
		5	5.50	10.08	25.00	3.75	187.50	698.53	930.00	17.00
3	Keonjhar	17	4.17	7.77	8.27	0.73	626.82	1089.45	1170.00	619.08
		18	2.77	8.13	9.33	2.25	1239.10	1275.53	1358.33	14.75
4	Balugaon	19	1.92	8.10	10.62	1.00	273.17	1062.59	1431.75	25.50
		20	2.99	8.06	10.69	3.00	266.78	1079.15	1463.26	110.63
5	Vijayawada	1	3.39	7.71	17.71	2.46	232.18	494.39	635.88	357.69
		2	2.30	6.43	13.16	3.00	291.54	402.07	433.51	122.00
6	Kannur	6	1.30	5.21	4.81	11.57	166.53	393.84	840.58	584.29
		7	1.07	5.84	3.15	10.67	219.04	438.72	394.75	336.00
7	Nandura	13	4.62	7.83	4.27	2.13	316.65	988.22	529.89	50.65
		14	2.75	8.79	8.07	3.37	274.40	917.69	993.89	123.90
8	Khamgaon	15	4.40	9.11	10.42	5.81	340.03	1054.39	1366.67	43.97
		16	3.00	8.93	8.95	5.25	465.47	1003.70	1386.25	45.36
9	Bhopal	8	1.33	5.14	7.94	0.58	201.97	589.51	749.91	26.58
		9	3.83	9.26	9.31	8.81	90.42	121.08	195.92	62.22
		10	2.31	8.15	8.65	1.00	276.03	662.86	464.53	50.42
		11	2.93	8.59	0.00	9.12	68.00	700.24	37.50	245.62
		12	2.20	6.02	6.30	2.94	91.64	374.61	687.90	209.00
10	Gwalior	21	3.41	6.84	10.05	4.15	212.45	362.03	448.98	111.74
		22	3.62	7.23	7.08	1.78	438.49	823.57	898.27	84.62
Average			3.01	8.02	10.21	3.89	271.92	645.81	751.31	144.96

Note : LCV : Light Commercial Vehicle
2-Axle : 2-Axle Trucks
MAV : Multiple-Axle Trucks
Tractor : Agricultural Tractors (with or without trailers)

Table 2-18 Zone Table for Bareilly Bypass

Zone No.	Zone Name/Description
1	Bareilly City
2	West Bareilly Tahsil
3	East Bareilly Tahsil
4	Baheri and Shergarh Tahsils Nainital, Chamoli, Pithoragarh, Almora Districts
5	Nawabganj Tahsil; Pilibit and Kheri District
6	Mirganj, Fatehpur West Tahsils
7	Anola Tahsil
8	Faridpur Tahsil
9	North and North West U.P.
10	Budaun, Aligarh, Agra, Mathura, Etah, Firozabad, Mainipuri Districts
11	Other Districts In U.P.
12	North India
13	South/West/East India, Nepal

Table 2-19 Origin - Destination Matrix for Bareilly Bypass

Destn Origin	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
1	58	11	0	3,688	4,372	1,484	0	635	1,064	10	661	510	43	12,536
2	7	0	0	0	7	160	4	0	56	0	9	18	0	261
3	32	0	0	0	0	0	0	0	0	0	0	0	0	32
4	3,767	21	0	36	40	43	15	17	124	26	259	36	20	4,404
5	4,636	46	0	12	34	10	13	17	173	20	104	38	19	5,122
6	1,781	23	0	163	77	120	6	20	56	11	123	67	11	2,458
7	7	5	0	24	7	0	0	0	0	0	0	0	0	43
8	2,482	13	0	44	13	83	19	12	72	6	13	29	7	2,793
9	1,166	19	0	61	82	45	0	61	30	2	1,002	29	65	2,562
10	58	0	0	229	68	2	0	23	6	0	347	13	35	781
11	1,185	0	0	235	20	60	74	21	522	32	26	479	43	2,697
12	388	20	0	37	168	30	0	15	30	20	864	68	285	1,925
13	282	0	0	26	6	10	6	6	115	16	2	145	25	639
Total	15,849	158	0	4,555	4,894	2,047	137	827	2,248	143	3,410	1,432	553	36,253

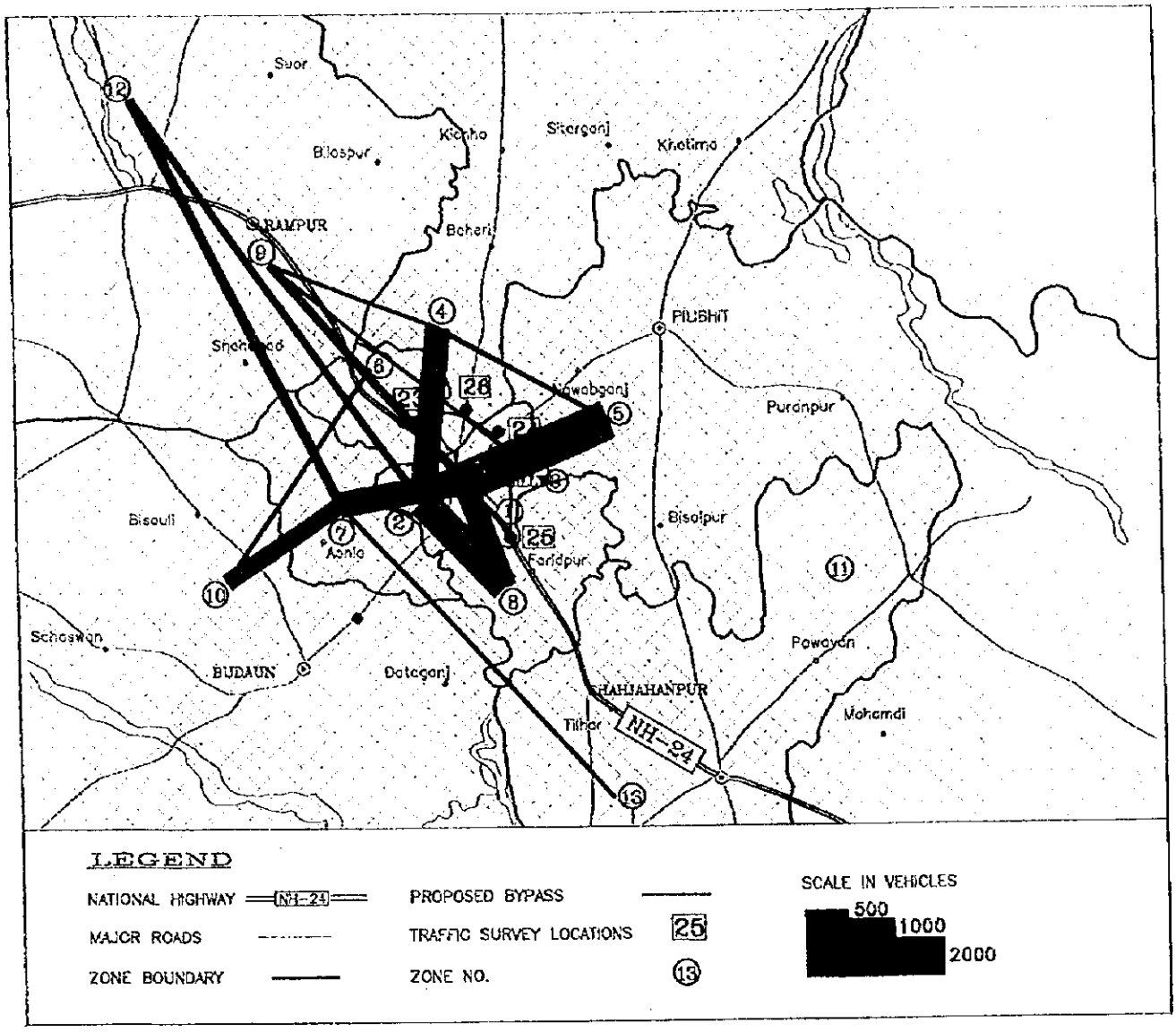


Figure 2-11 Desire-Line Diagram for Bareilly Bypass (Year 1997)

Table 2-20 Zone Table for Patna Bypass

Zone No.	Zone Name/Description
1	Patna City
2	North-West Patna District
3	South-West Patna District
4	South Patna, East Jehanabad, Nalanda Districts
5	Aurangabad, Palamu Districts
6	Bhojpur, Rohtas Districts
7	Southern Bihar, South Eastern Bihar, West Bengal and N.E. States
8	North Bihar and Nepal
9	North and South Western India
10	South India

Table 2-21 Origin - Destination Matrix for Patna Bypass

Destn Origin	1	2	3	4	5	6	7	8	9	10	Total
1	75	0	0	165	90	1,393	1,427	1,288	279	13	4,730
2	60	0	0	0	0	510	0	0	0	0	570
3	0	0	0	0	0	0	0	0	0	0	0
4	67	0	0	0	0	254	0	0	198	0	519
5	109	0	0	0	0	0	0	0	0	0	109
6	1,093	334	0	433	0	0	710	437	0	0	3,007
7	1,377	0	0	0	0	277	0	37	670	0	2,361
8	1,124	0	0	0	0	246	0	0	97	0	1,467
9	552	103	0	165	0	0	411	30	0	0	1,261
10	50	0	0	50	0	43	33	0	0	0	176
Total	4,507	437	0	813	90	2,723	2,581	1,792	1,244	13	14,200

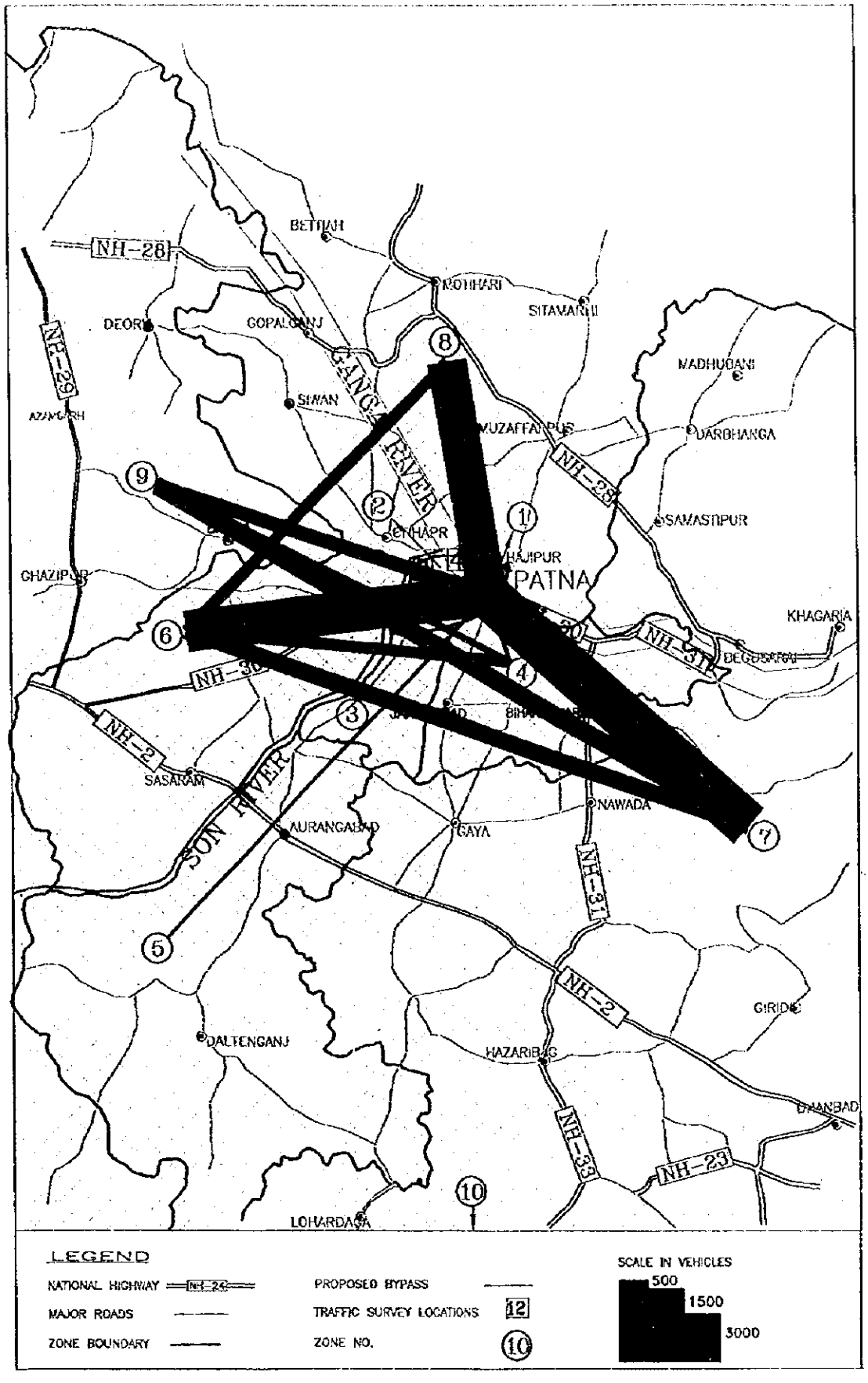


Figure 2-12 Desire-Line Diagram for Patna Bypass (Year 1997)

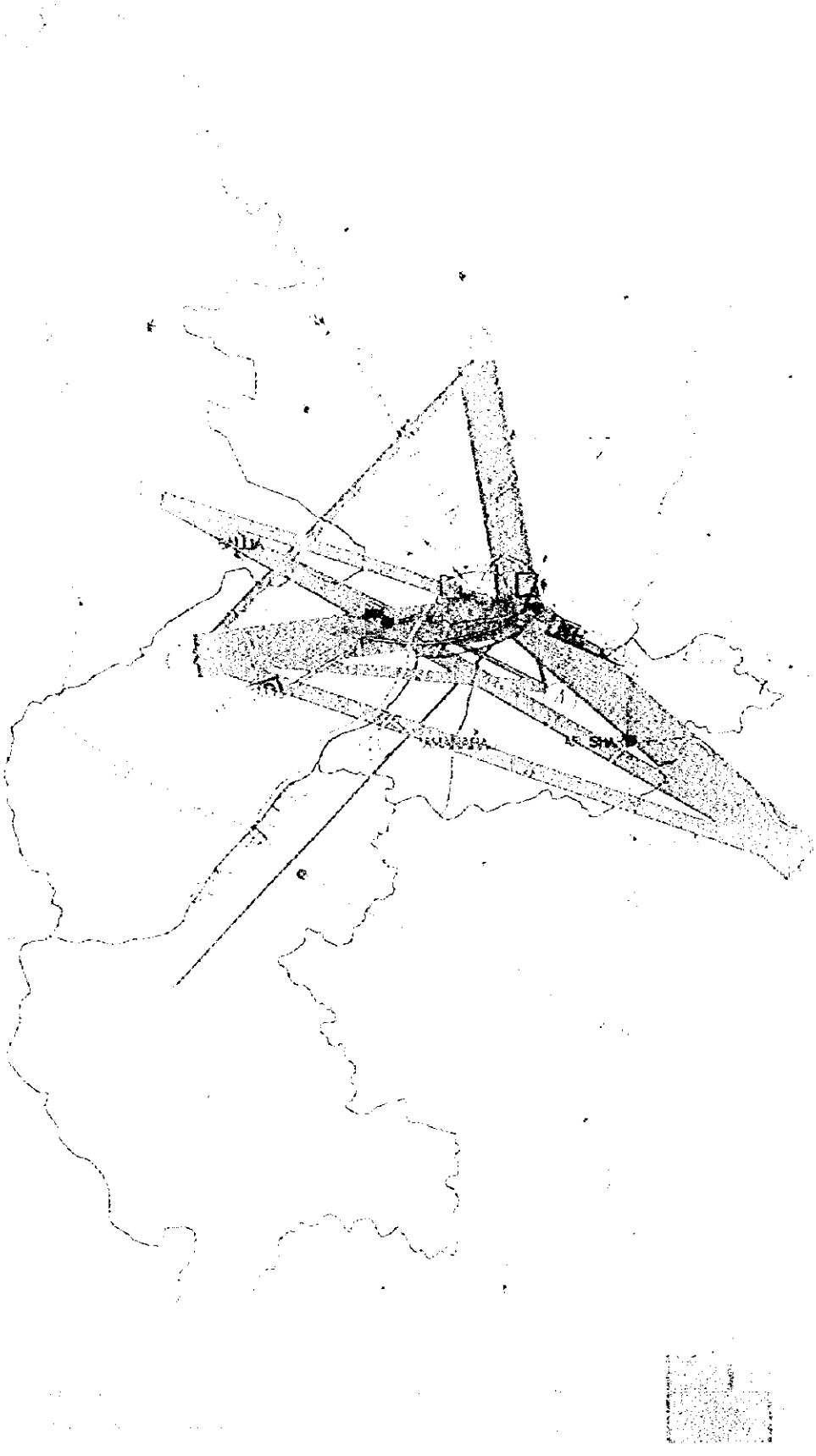


Figure 2-12 Desire-Line Diagram for Patna Bypass (Year 1997)

Table 2-22 Zone Table for Keonjhar Bypass

Zone No.	Zone Name/Description
1	Keonjhar city
2	North Keonjhar District
3	North-East Keonjhar District
4	South-West Keonjhar District
5	South-East Keonjhar District
6	Mayurbanj District
7	Baleswar Northern Cuttack Districts
8	Sudergarh, Sambalpur Districts
9	Rest of Orissa, South India
10	Madhya Pradesh, North India
11	Bihar, West Bengal, N.E. States

Table 2-23 Origin - Destination Matrix for Keonjhar Bypass

Destn Origin	1	2	3	4	5	6	7	8	9	10	11	Total
1	59	54	261	283	41	79	8	29	35	6	31	886
2	13	2	163	9	0	39	5	18	19	237	29	534
3	436	4	4	97	5	0	2	12	13	11	2	586
4	6	23	639	2	26	45	3	0	2	3	22	771
5	2	0	0	2	0	2	0	2	5	2	0	15
6	156	12	4	21	0	3	0	42	18	30	3	289
7	34	3	0	4	0	0	0	29	0	6	0	76
8	9	6	65	3	4	54	65	0	6	3	129	344
9	0	20	12	6	0	15	4	33	2	10	23	125
10	6	0	13	0	3	49	45	4	6	3	707	836
11	51	66	21	16	0	6	0	136	22	632	52	1,002
Total	772	190	1,182	443	79	292	132	305	128	943	998	5,464

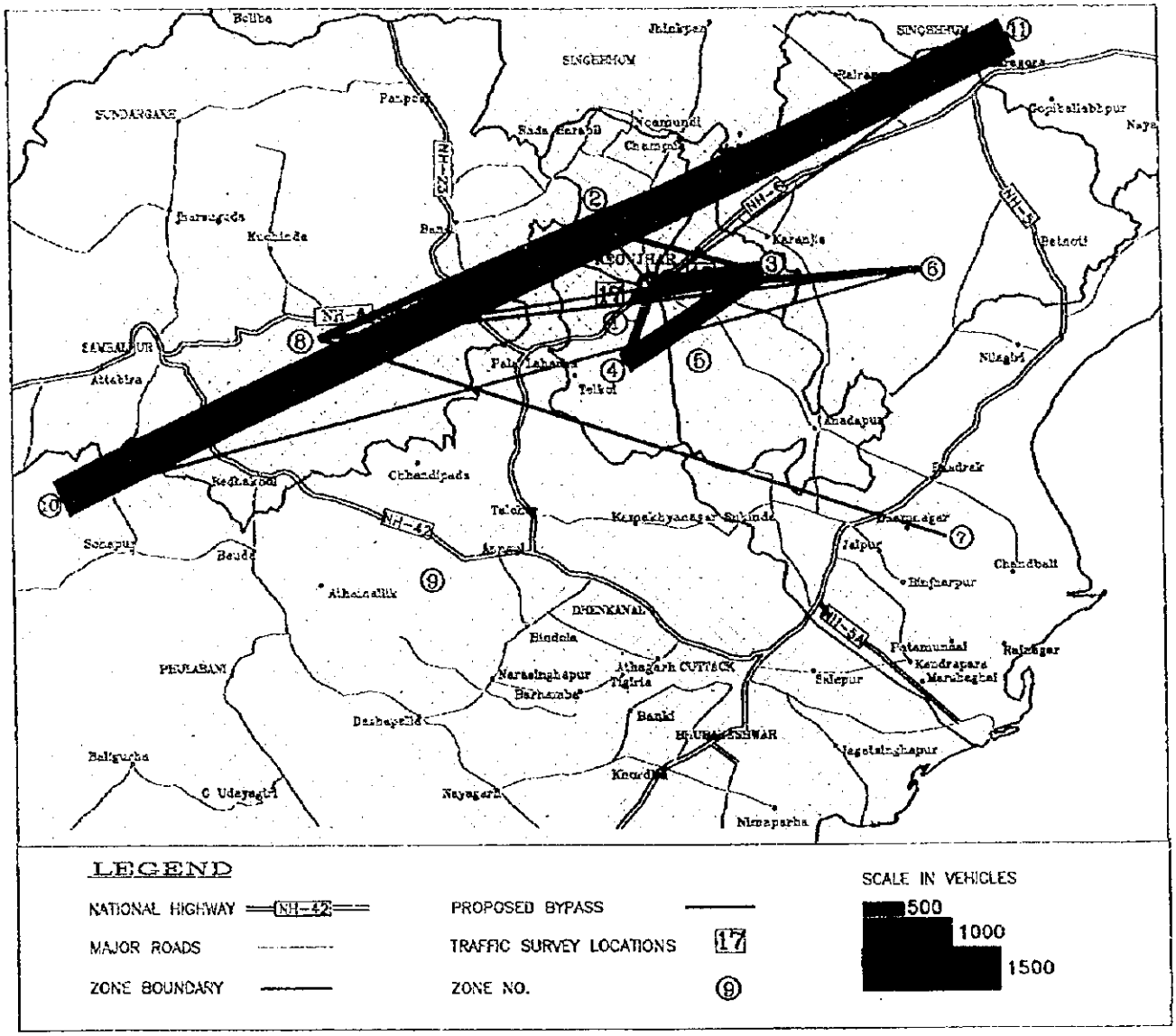


Figure 2-13 Desire-Line Diagram for Keonjhar Bypass (Year 1997)

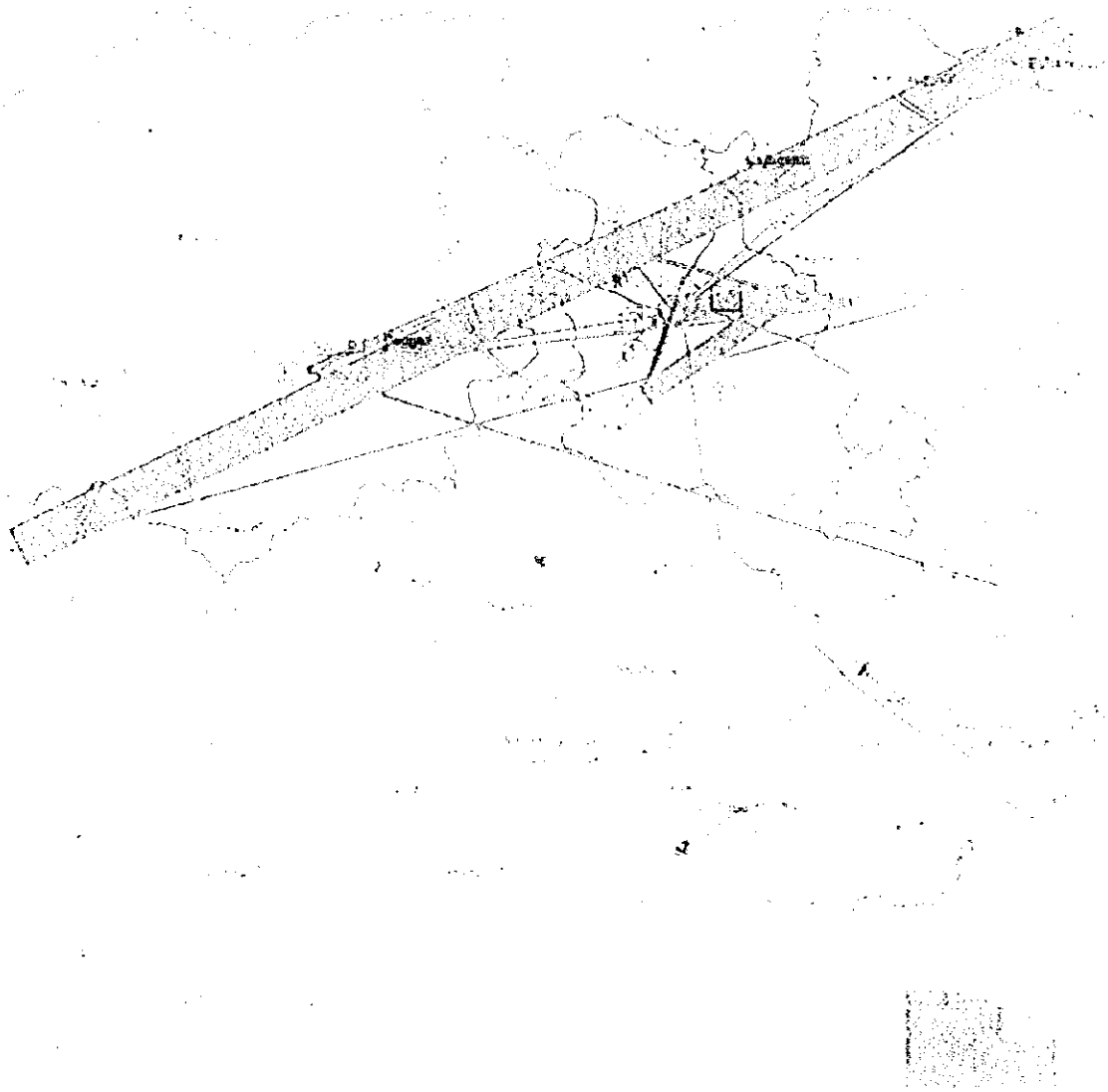


Table 2-24 Zone Table for Balugaon Bypass

Zone No.	Zone Name/Description
1	Balugaon town
2	South Puri District
3	North-East Puri District
4	North-West Puri District
5	Ganjam District
6	Kalahandi, Koraput Districts
7	North Orissa (Sambalpur, Balangir, Phulbani, Cuttack)
8	West Bengal, Bihar, M.P. and North India
9	South India

Table 2-25 Origin - Destination Matrix for Balugaon Bypass

Destn Origin	1	2	3	4	5	6	7	8	9	Total
1	605	15	345	1	299	0	48	15	11	1,339
2	5	11	26	0	0	0	6	0	11	59
3	388	23	105	0	288	23	6	0	31	864
4	15	0	10	0	0	0	0	0	0	25
5	230	21	293	5	11	0	120	68	10	758
6	0	0	11	0	11	10	41	0	10	83
7	51	0	2	0	173	29	10	0	269	534
8	1	0	31	0	89	0	0	20	679	820
9	10	0	67	0	11	10	196	1,060	51	1,405
Total	1,305	70	890	6	882	72	427	1,163	1,072	5,887

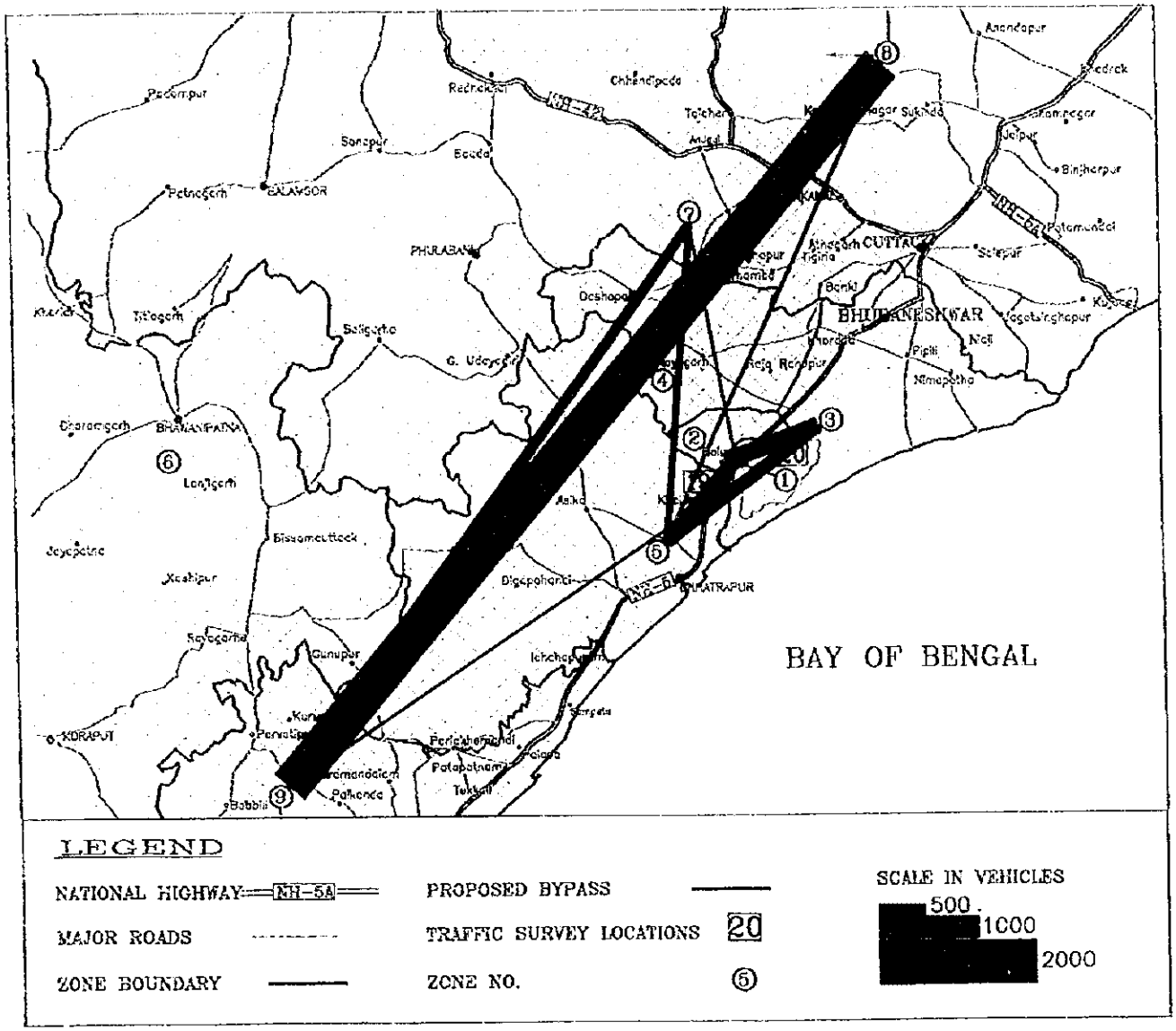


Figure 2-14 Desire-Line Diagram for Balugaon Bypass (Year 1997)

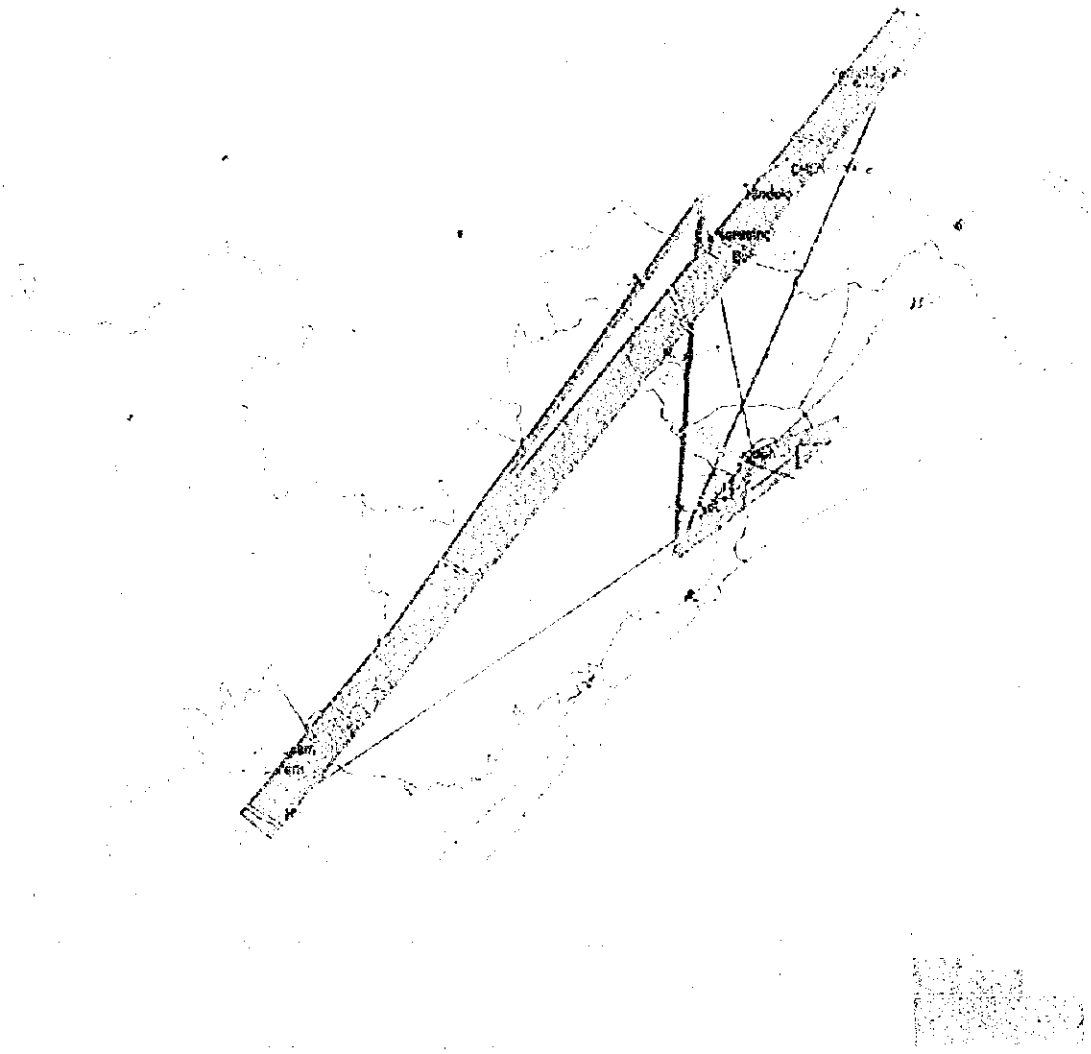


Figure 2-11 Design Frame Plan Area for Baltimore Bypass Study

Table 2-26 Zone Table for Vijayawada Bypass

Zone No.	Zone Name/Description
1	Northern Krishna District
2	Eastern Krishna District
3	West Godavari District
4	East Godavari Dist and Andhra Region
5	Telangana Region
6	Nellore, Guntur, Prakasam Dist And Rayalasima Region
7	North India and (Maharashtra, Goa, Gujarat, North Karnataka)
8	South India
9	East India (Bihar, Orissa, West Bengal)
10	Western Krishna

Table 2-27 Origin - Destination Matrix for Vijayawada Bypass

Destn Origin	1	2	3	4	5	6	7	8	9	10	Total
1	0	3	30	23	27	0	0	0	10	0	93
2	0	21	1,740	948	1,470	17	207	0	215	900	5,518
3	66	3,250	43	25	87	280	10	29	10	64	3,864
4	86	1,362	24	13	315	601	81	306	10	61	2,859
5	13	871	163	252	9	127	9	145	42	23	1,654
6	0	8	267	301	143	0	37	0	104	51	911
7	0	95	31	42	0	41	0	29	0	9	247
8	0	7	82	373	76	18	13	10	365	75	1,019
9	0	70	10	0	47	52	31	253	10	0	473
10	12	902	63	31	9	76	0	0	10	143	1,246
Total	177	6,589	2,453	2,008	2,183	1,212	388	772	776	1,326	17,884

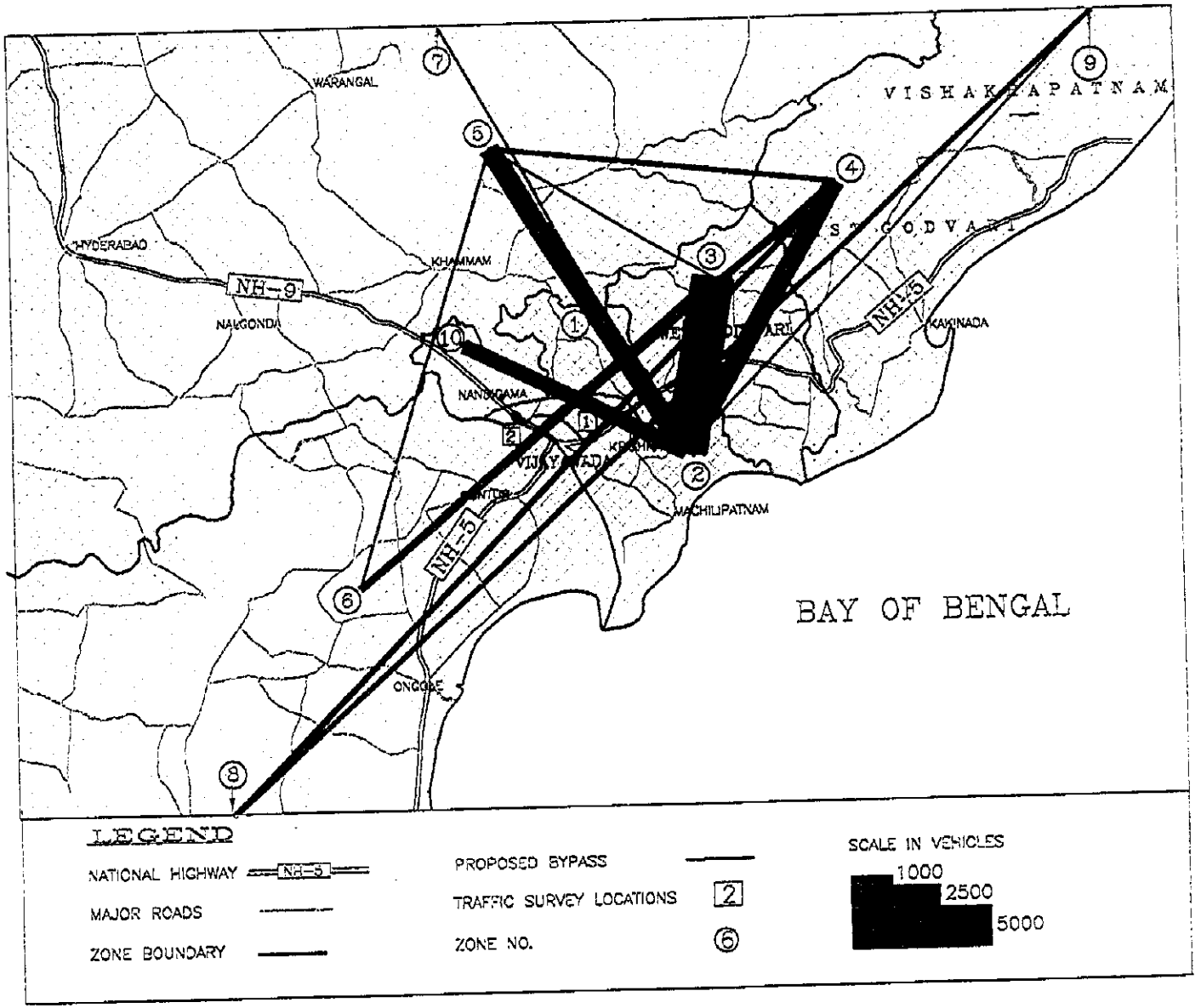


Figure 2-15 Desire-Line Diagram for Vijayawada Bypass (Year 1997)

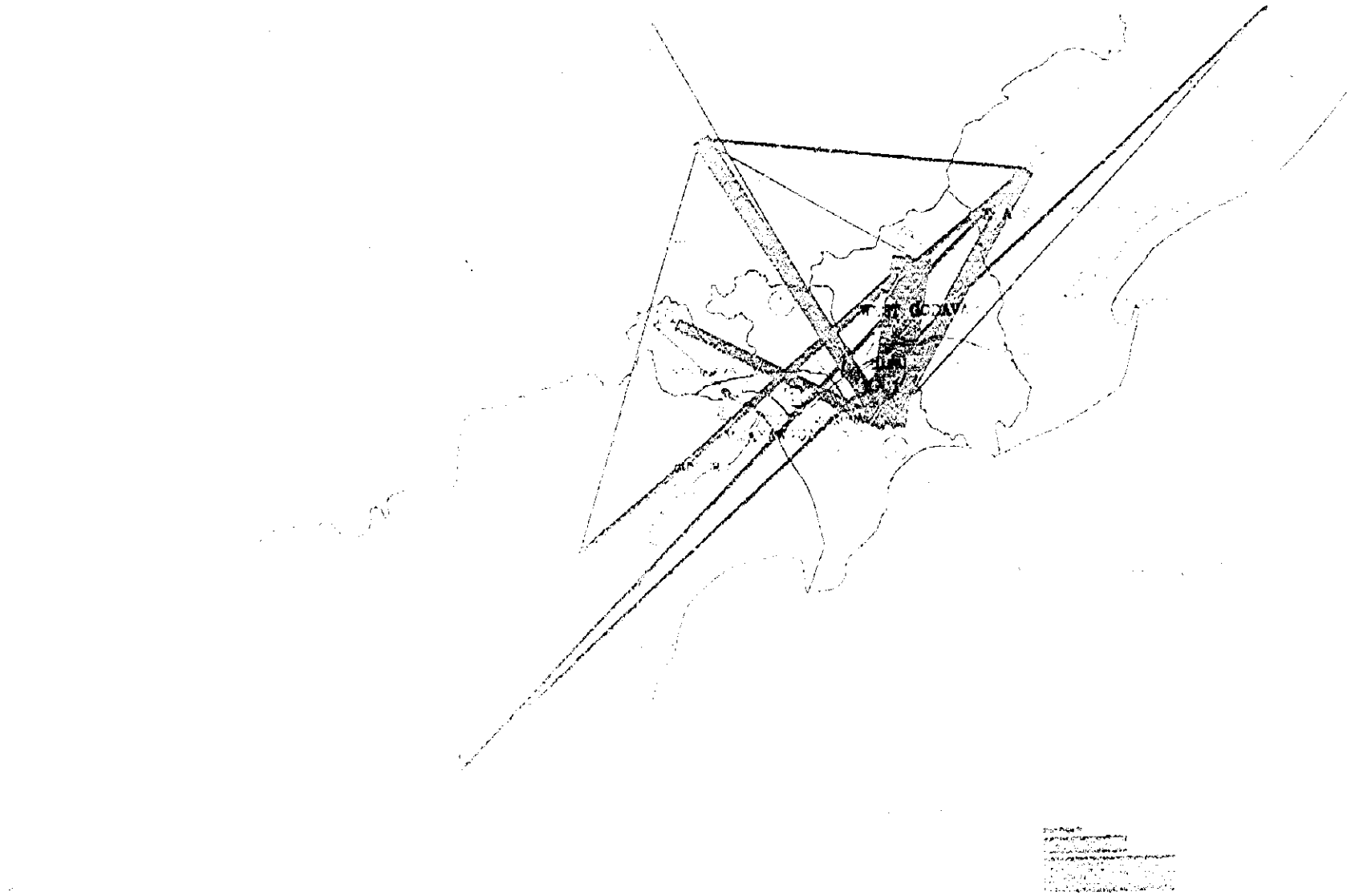


Table 2-28 Zone Table for Kannur Bypass

Zone No.	Zone Name/Description
1	Kannur West, Pallikunnu
2	Kannur East, Ayavur, Valiyannur, Purhati
3	Valapattanam, Chiakkal and Northern Kannur District
4	Edakkal, Cheloa and Southern Kannur District
5	Eastern Kannur District
6	Southern Kerala, Tamilnadu
7	Kasaragod District and North India

Table 2-29 Origin - Destination Matrix for Kannur Bypass

Destn Origin	1	2	3	4	5	6	7	Total
1	20	0	3,408	1,399	0	879	446	6,152
2	0	0	14	128	0	67	0	209
3	2,750	0	10	248	2	431	0	3,441
4	1,873	110	326	2	8	4	141	2,464
5	2	0	2	6	0	0	0	10
6	618	4	348	0	0	0	689	1,659
7	242	0	11	102	0	514	9	878
Total	5,505	114	4,119	1,885	10	1,895	1,285	14,813

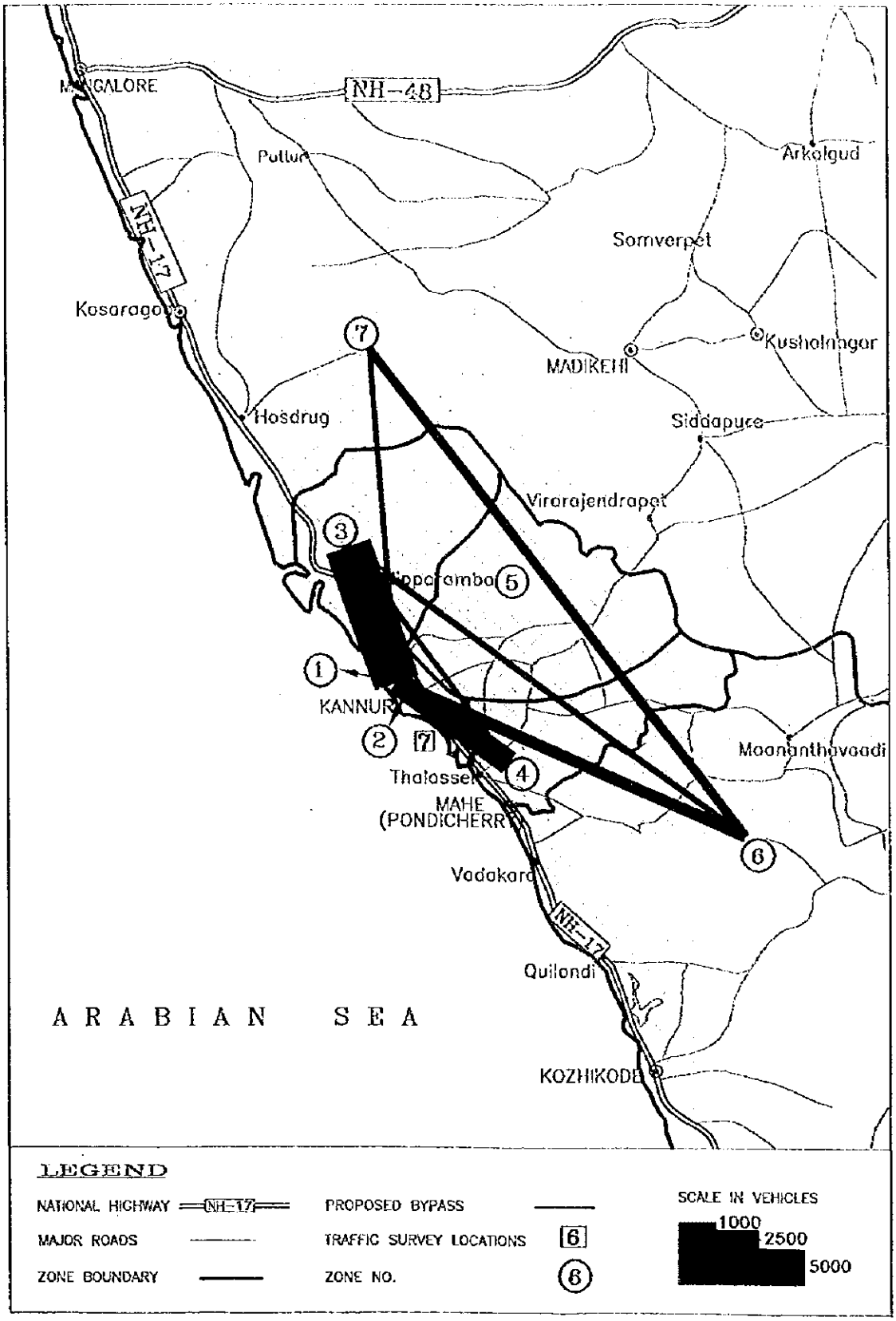


Figure 2-16 Desire-Line Diagram for Kannur Bypass (Year 1997)

Figure 2-16 Desire-Line Diagram for Kannur Bypass Year 1997

Table 2-30 Zone Table for Nandura Bypass

Zone No.	Zone Name/Description
1	Area between West side of the river and proposed bypass
2	Area between East side of the river and proposed bypass
3	Malkapur Tahsil
4	Khamgaon, Mehekar Tahsils
5	Jalgaon Tahsil
6	Chikli Tahsil
7	West Maharashtra
8	South Maharashtra
9	East Maharashtra
10	North India
11	South India
12	Madhya Pradesh, East India

Table 2-31 Origin - Destination Matrix for Nandura Bypass

Destn Origin	1	2	3	4	5	6	7	8	9	10	11	12	Total
1	20	0	178	227	2	176	90	0	31	18	0	19	761
2	0	0	0	0	0	0	0	0	0	0	0	0	0
3	158	0	5	89	0	77	11	8	185	0	9	20	562
4	117	0	125	8	6	74	115	0	21	22	0	8	496
5	0	0	8	22	0	56	2	0	8	0	0	0	96
6	270	0	64	199	0	98	105	0	99	0	6	20	861
7	106	0	11	83	4	101	94	0	796	92	28	297	1,612
8	0	0	8	0	0	7	0	0	9	0	0	0	24
9	109	0	158	35	37	135	631	15	13	156	11	89	1,389
10	23	0	0	49	0	32	106	0	228	39	200	206	883
11	0	0	0	0	0	19	39	0	6	78	6	33	181
12	0	0	14	38	0	47	382	6	30	161	20	11	709
Total	803	0	571	750	49	822	1,575	29	1,426	566	280	703	7,574

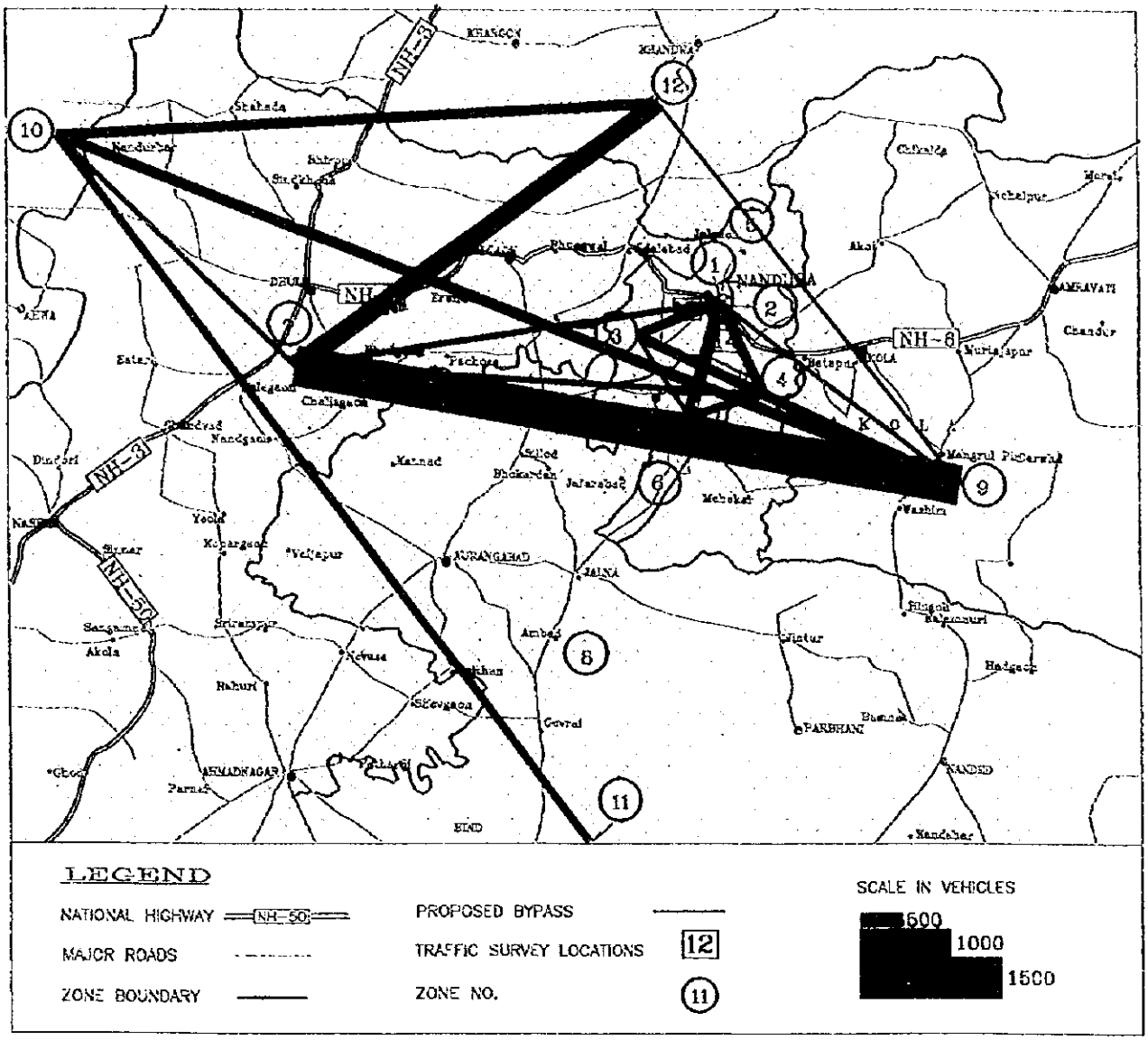


Figure 2-17 Desire-Line Diagram for Nandura Bypass (Year 1997)

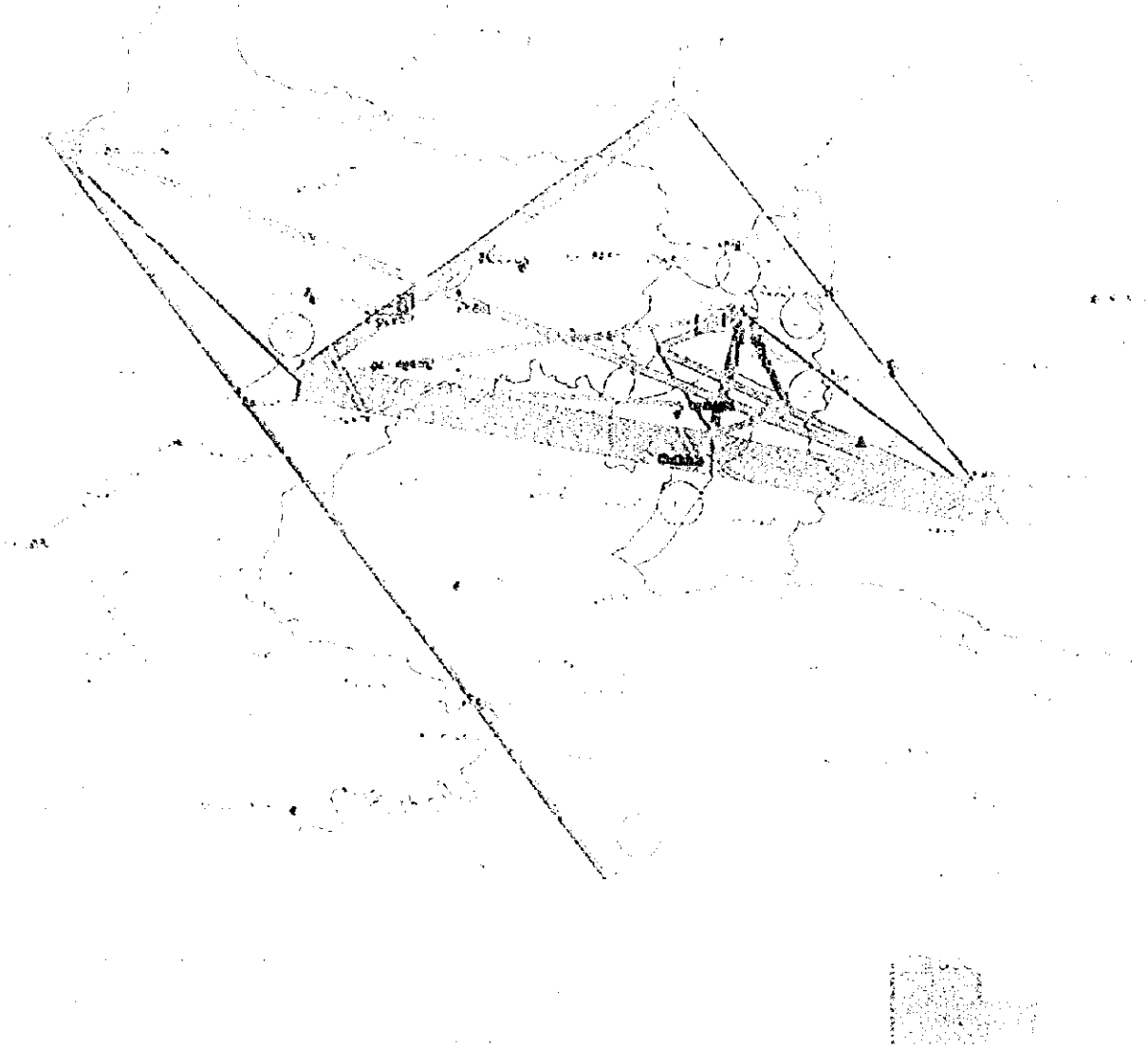


Figure 2-17 Desire-Line Diagram for Nanclare Bypass

Table 2-32 Zone Table for Khamgaon Bypass

Zone No.	Zone Name/Description
1	Khamgaon city
2	West of river Bordai and Khamgaon MIDC area
3	East Khamgaon Tahsil
4	West Khamgaon Tahsil
5	Jalgaon, Malkapur Tahsils
6	Chikli Tahsil
7	Mehekar Tahsil
8	West Maharashtra
9	East Maharashtra
10	East India
11	South India
12	North India and Gujarat

Table 2-33 Origin - Destination Matrix for Khamgaon Bypass

Destn Origin	1	2	3	4	5	6	7	8	9	10	11	12	Total
1	37	0	0	0	318	26	34	22	504	6	6	0	953
2	6	0	0	0	57	0	15	30	27	0	0	0	135
3	0	0	0	0	0	0	0	0	0	0	0	6	6
4	0	0	0	0	31	12	0	76	37	2	0	6	164
5	175	0	26	0	11	0	6	12	199	0	0	0	429
6	0	0	0	0	0	0	0	2	13	0	0	0	15
7	145	6	22	0	3	4	79	0	286	36	12	0	593
8	67	24	90	17	20	0	19	54	1,203	390	26	133	2,043
9	480	64	8	6	254	218	74	1,075	106	65	22	304	2,676
10	9	0	30	0	18	0	6	448	84	34	66	270	965
11	6	8	0	0	18	0	6	42	0	41	6	166	293
12	6	6	12	0	6	0	12	48	290	221	168	54	823
Total	931	108	188	23	736	260	251	1,809	2,749	795	306	939	9,095

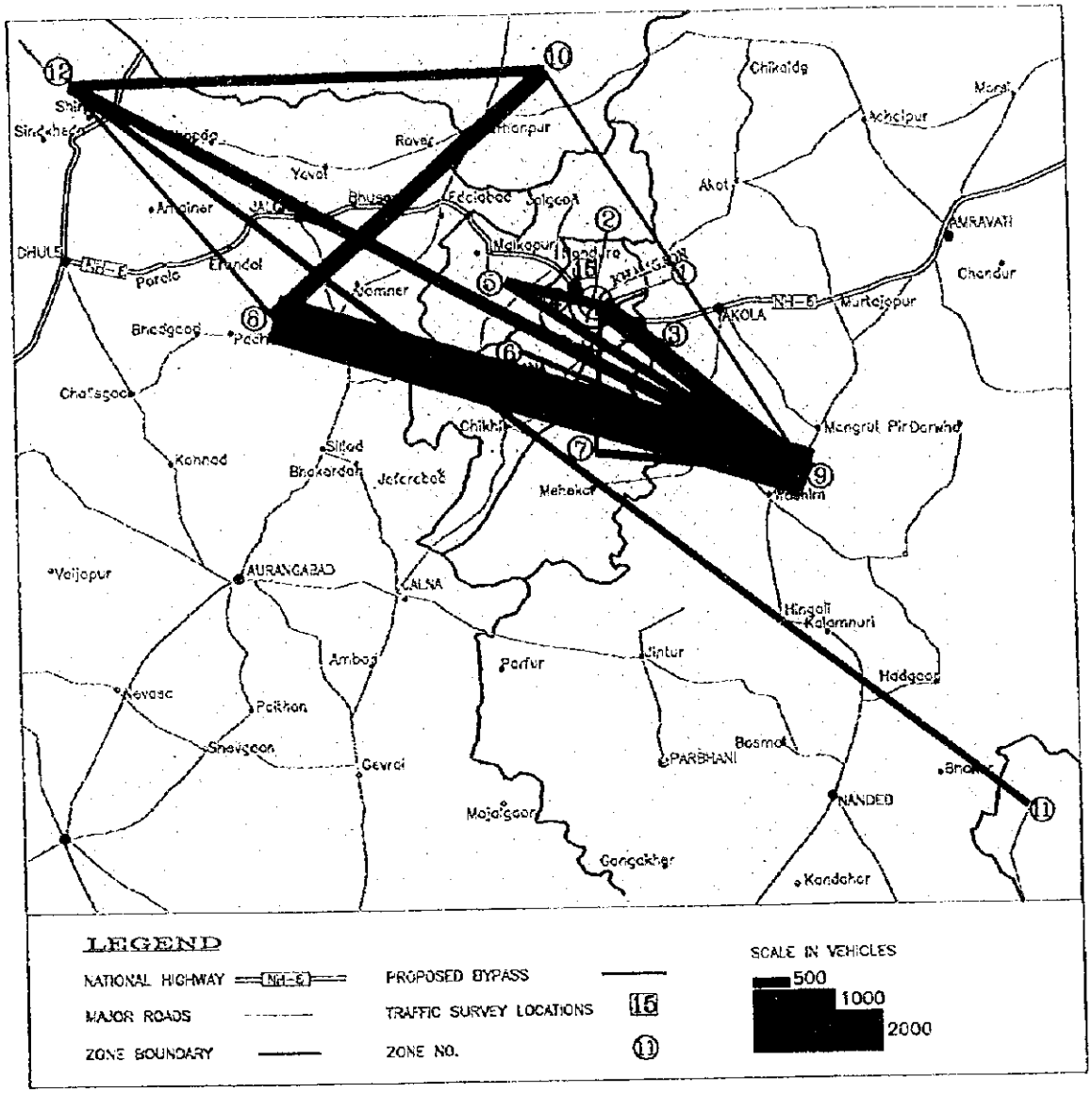


Figure 2-18 Desire-Line Diagram for Khamgaon Bypass (Year 1997)

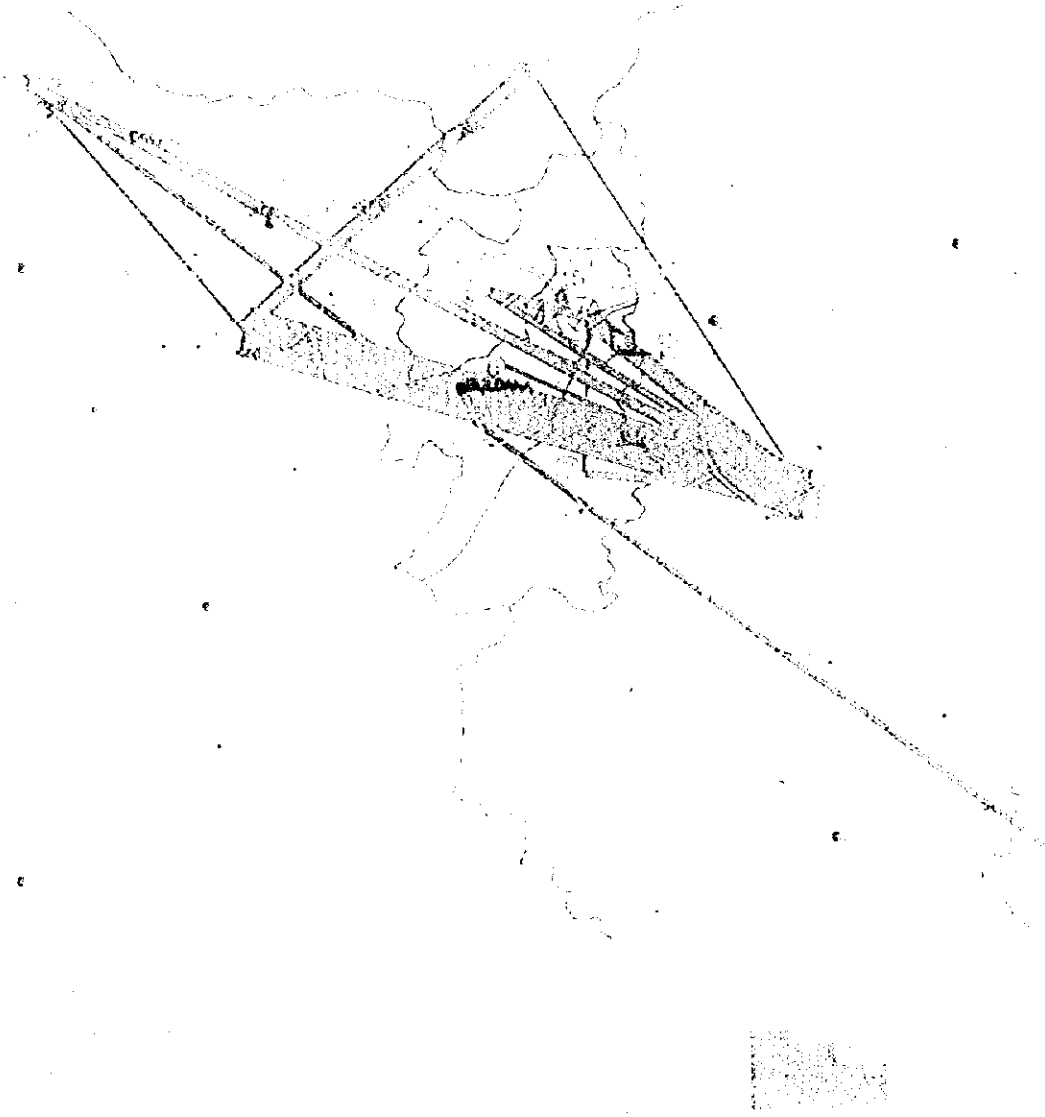


Figure 2-18 Design Line Diagram for Khampaen Bypass Year 2005

Table 2-34 Zone Table for Bhopal Bypass

Zone No.	Zone Name/Description
1	Bhopal City
2	Berasia Tahsil and a Portion of North Bhopal Tahsil
3	North-Eastern Portion of Bhopal Tahsil
4	Eastern Portion of Bhopal Tahsil
5	South-Eastern Portion of Bhopal Tahsil
6	Southern Portion of Bhopal Tahsil
7	Western Portion of Bhopal Tahsil
8	North-Western Portion of Bhopal Tahsil
9	Western Districts of M.P.
10	Northern Districts of M.P.
11	Central Districts of M.P.
12	Eastern Districts of M.P.
13	Gujarat State
14	South India
15	North India
16	East India

Table 2-35 Origin - Destination Matrix for Bhopal Bypass

Destn Origin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
1	1,189	131	371	877	3,232	0	241	1,232	2,236	511	1,154	210	23	141	268	89	11,905
2	403	0	0	0	0	0	0	0	5	21	6	0	0	0	0	0	435
3	83	0	0	0	0	0	0	0	5	0	23	0	0	0	0	0	111
4	873	0	13	0	47	0	0	0	84	12	0	0	0	0	0	0	1,029
5	5,133	0	0	40	10	0	0	0	25	27	0	0	0	20	47	20	5,322
6	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29
7	325	0	0	0	5	0	0	0	19	4	0	10	0	26	3	0	392
8	937	0	12	0	0	0	0	0	0	0	0	0	0	8	16	0	973
9	1,369	10	3	56	89	0	10	12	10	59	46	105	0	19	45	56	1,889
10	569	0	0	7	0	0	0	0	0	0	12	0	0	40	0	0	628
11	885	0	13	3	33	0	0	0	191	22	38	7	7	19	7	20	1,245
12	450	0	0	0	5	0	0	0	85	40	0	0	16	66	39	8	709
13	60	0	0	0	20	0	0	0	0	0	30	10	0	0	20	7	147
14	181	0	0	0	40	0	0	0	40	40	15	15	0	9	201	18	559
15	312	5	0	36	40	0	0	0	20	0	16	103	11	236	72	35	886
16	44	0	0	0	0	0	0	12	23	0	10	0	10	1	25	0	125
Total	12,842	146	412	1,019	3,521	0	251	1,256	2,743	736	1,350	460	67	585	743	253	26,384

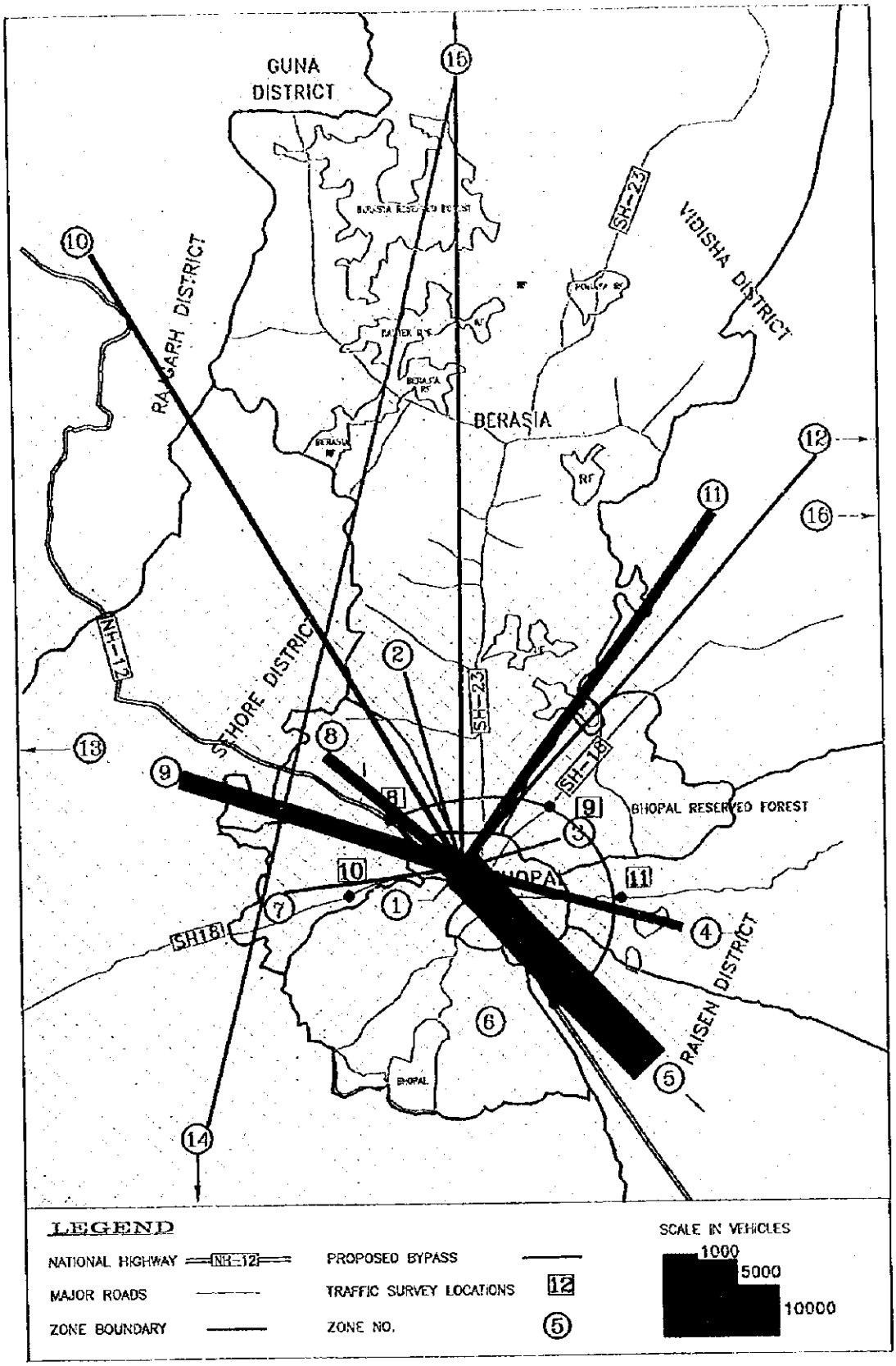


Figure 2-19 Desire-Line Diagram for Bhopal Bypass (Year 1997)

Figure 2-19 Desire-Line Diagram for Bhopal Bypass (Year 1987)

Table 2-36 Zone Table for Gwalior Bypass

Zone No.	Zone Name/Description
1	Gwalior city
2	New city area (West of NH3 & East of Prop Bypass)
3	South Gwalior District
4	North Gwalior District
5	Morena District
6	Bhind District
7	Datia District
8	Rest of the districts in M.P.
9	North India
10	South/West/Eastern India

Table 2-37 Origin - Destination Matrix for Gwalior Bypass

Destn Origin	1	2	3	4	5	6	7	8	9	10	Total
1	9	6	906	8	2,021	0	0	1,205	424	61	4,640
2	0	0	0	0	46	0	0	0	0	0	46
3	1,580	0	19	11	370	16	0	10	237	12	2,255
4	0	0	36	0	177	0	0	19	39	0	271
5	1,279	32	78	225	8	51	16	162	6	12	1,869
6	0	0	0	0	65	0	0	6	22	0	93
7	0	0	0	0	14	1	0	0	34	0	49
8	1,106	0	0	3	216	87	0	5	1,325	11	2,753
9	446	45	87	94	12	16	1	874	48	505	2,128
10	221	11	15	7	26	5	0	36	1,458	15	1,794
Total	4,641	94	1,141	348	2,955	176	17	2,317	3,593	616	15,898

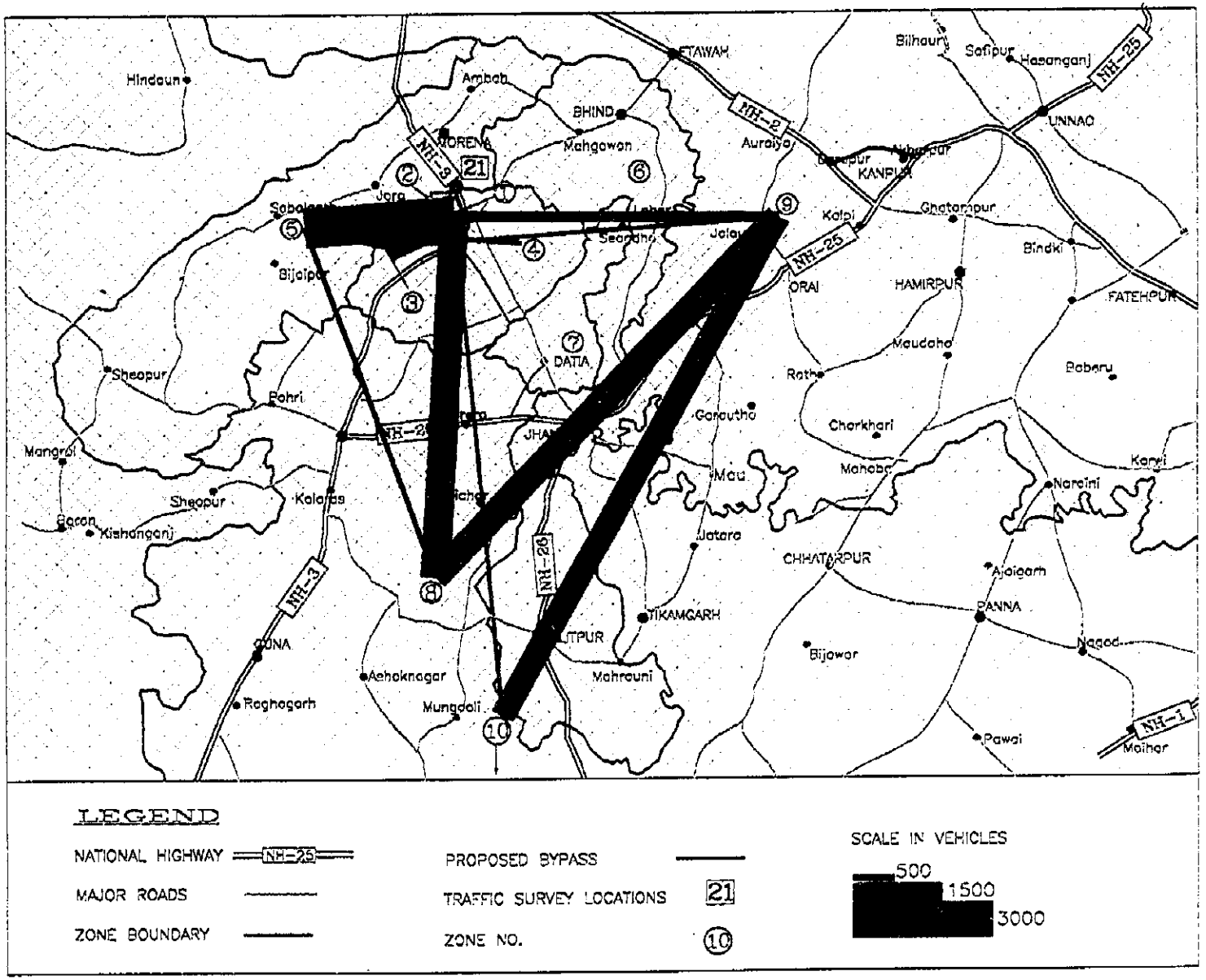
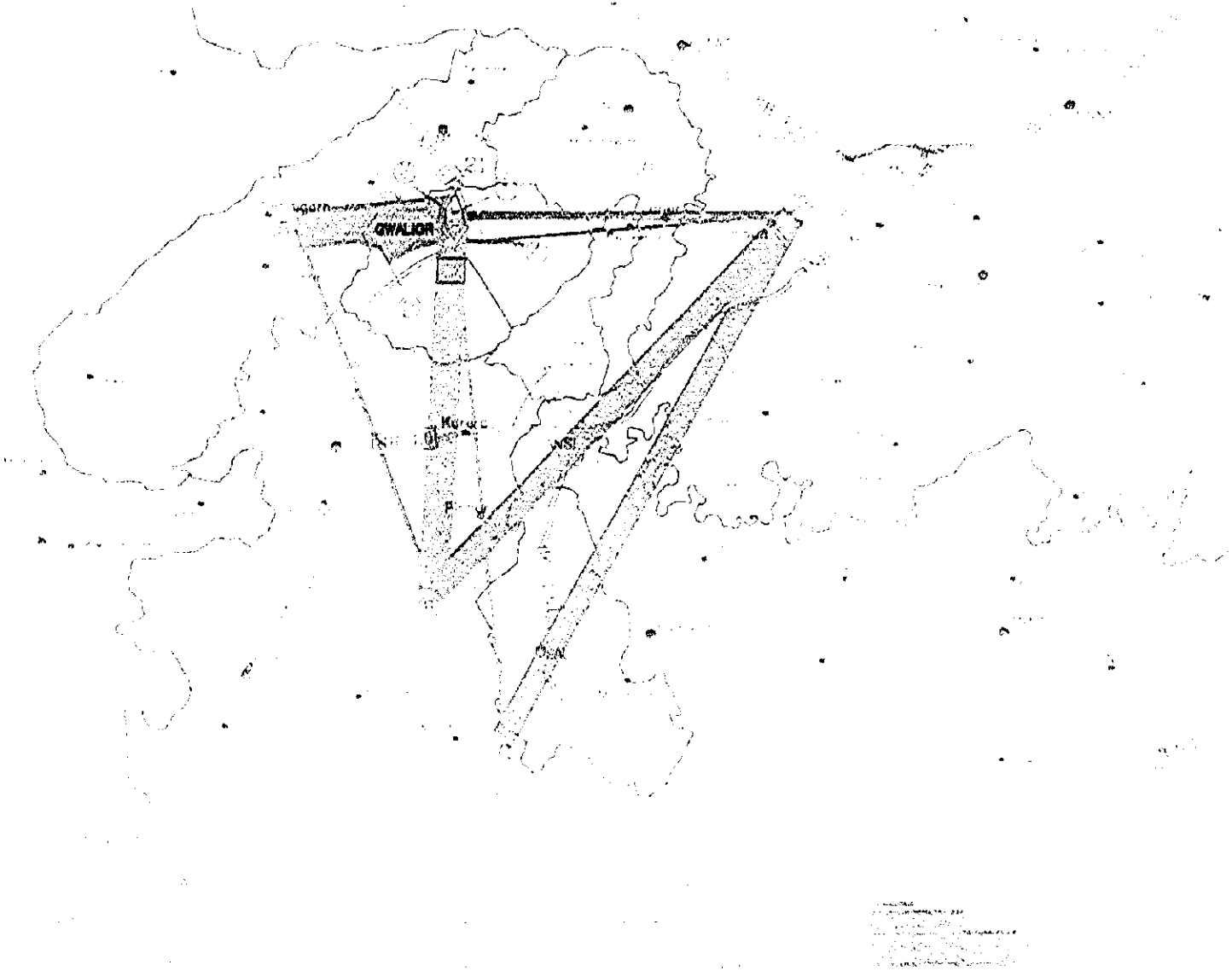


Figure 2-20 Desire-Line Diagram for Gwalior Bypass (Year 1997)


GWALIOR

2.4 Traffic Speed - Delay Survey

Traffic speed-delay survey was conducted on identified road sections of national highway (on which the bypasses are proposed) and connecting state highways or major roads (if any). The survey was conducted by moving car method for morning peak, evening peak and off-peak hours in both direction of traffic flow.

The survey was conducted by moving a car in the traffic stream along the identified road sections and recording information like length of section, journey time, number of vehicles in the opposite direction, number of vehicles overtaking the test car and number of vehicles overtaken by the test car.

Table 2-38 shows the average journey and running speeds on selected roads for all the 10 cities where bypasses are proposed.

Table 2-38 Results of Traffic Speed-Delay Survey

S. No.	Name of Bypass	Name of Road	Length (km)	Morning Peak					Off-Peak					Evening Peak				
				Journey Time (min)	Delay (sec)	Running Time (min)	Journey Speed (km/hr)	Running Speed (km/hr)	Journey Time (min)	Delay (sec)	Running Time (min)	Journey Speed (km/hr)	Running Speed (km/hr)	Journey Time (min)	Delay (sec)	Running Time (min)	Journey Speed (km/hr)	Running Speed (km/hr)
1	Bareilly	NH-24	34.0	244.08	100.00	242.41	8.36	8.42	175.28	27.00	174.83	11.64	11.67	251.48	202.50	248.09	8.11	8.22
		SH- 33	17.5	74.78	20.50	74.43	14.04	14.11	N.A.	N.A.	N.A.	N.A.	N.A.	56.91	118.00	54.94	18.45	19.11
		SH-37	8.0	50.25	1.50	50.23	9.55	9.56	N.A.	N.A.	N.A.	N.A.	N.A.	58.80	2.50	58.76	8.16	8.17
2	Patna	NH-30	52.0	165.65	61.00	164.63	18.83	18.95	136.95	14.50	136.71	22.78	22.82	171.45	51.00	170.60	18.20	18.29
3	Keonjhar	NH-6	6.0	20.31	12.67	20.09	17.73	17.92	13.52	8.17	13.38	26.63	26.90	14.81	18.00	14.51	24.32	24.82
4	Balugaon	NH-5	18.0	48.24	63.75	47.18	22.39	22.89	N.A.	N.A.	N.A.	N.A.	N.A.	67.27	469.00	59.45	16.05	18.17
5	Vijayawada	NH-5 & NH-9	104.0	166.25	772.50	153.38	37.53	40.68	164.10	7.50	163.98	38.03	38.05	183.35	930.00	167.85	34.03	37.18
6	Kannur	NH-17	11.2	23.24	24.50	22.83	28.92	29.43	16.70	0.00	16.70	40.25	40.25	21.48	21.75	21.12	31.28	31.82
7	Nandura	NH-6	5.0	17.75	180.00	14.75	16.90	20.34	17.85	90.00	16.35	16.81	18.35	27.30	132.00	25.10	10.99	11.95
8	Khamgaon	NH-6	9.0	37.70	257.50	33.41	14.32	16.16	25.30	142.50	22.93	21.34	23.56	43.00	285.00	38.25	12.56	14.12
9	Bhopal	NH-12	27.5	84.40	1044.50	66.99	19.55	24.63	54.59	44.00	53.85	30.23	30.64	73.67	668.00	62.53	22.40	26.39
		Raisen Road	12.0	28.65	15.00	28.40	25.13	25.35	26.45	0.00	26.45	27.22	27.22	26.30	6.00	26.20	27.38	27.48
		Sanchi Road	13.5	34.85	185.00	31.77	23.24	25.50	23.96	32.50	23.42	33.81	34.59	30.80	165.00	28.05	26.30	28.88
		Dewas Road	14.0	21.59	0.00	21.59	38.92	38.92	17.16	0.00	17.16	48.95	48.95	90.05	0.00	90.05	9.33	9.33
		Existing Bypass	29.0	71.35	66.50	70.24	24.39	24.77	47.41	0.00	47.41	36.70	36.70	69.40	105.00	67.65	25.07	25.72
10	Gwalior	NH-3	33.7	98.90	74.50	97.66	20.44	20.70	103.15	35.50	102.56	19.60	19.72	89.40	145.50	86.98	22.62	23.25

Pre-Feasibility Study

Chapter 3
Future Traffic Demand Forecast

3 Future Traffic Demand Forecast

3.1 Methodology

For each of the proposed bypass, future traffic demands for the target years of 2002 and 2012AD were forecast based on the results of traffic surveys, socio-economic growth and other related supplemental information.

The process for future traffic demand forecast is broadly divided into the following four steps :

- Establishment of future socio-economic framework
- Estimation of future traffic growth rate
- Forecast of future O-D (Origin and Destination) tables by vehicle type, and
- Forecast of traffic volumes on proposed ten (10) bypasses

The overall flow chart for the traffic demand forecast is presented in Figure 3-1. The above tasks were undertaken by each bypass project except for the establishment of macro economic growth target.

The forecast was based on the socio-economic information of national and State level. At the same time, the traffic zone systems established for each bypass may not be sufficiently detailed because the main purpose of the traffic survey and forecasting on the Pre-feasibility study stage is to grasp the O-D pattern of the through traffic and local traffic.

3.2 Future Socio-economic Framework

3.2.1 Macro Economic Growth

(1) Gross Domestic Product (GDP)

The economic growth rate during the Ninth Five Year Plan period (1997-2002) is estimated in the range of 6 - 7% per annum as shown in Table 3-1. In this study, the following growth rates were assumed considering the present potential of the Indian economy and future uncertainty for the long term estimation up to the year 2012.

-	1997 (base year) - 2002	6.0% p.a.
-	2002 - 2007	5.8% p.a.
-	2007 - 2012	5.6% p.a.

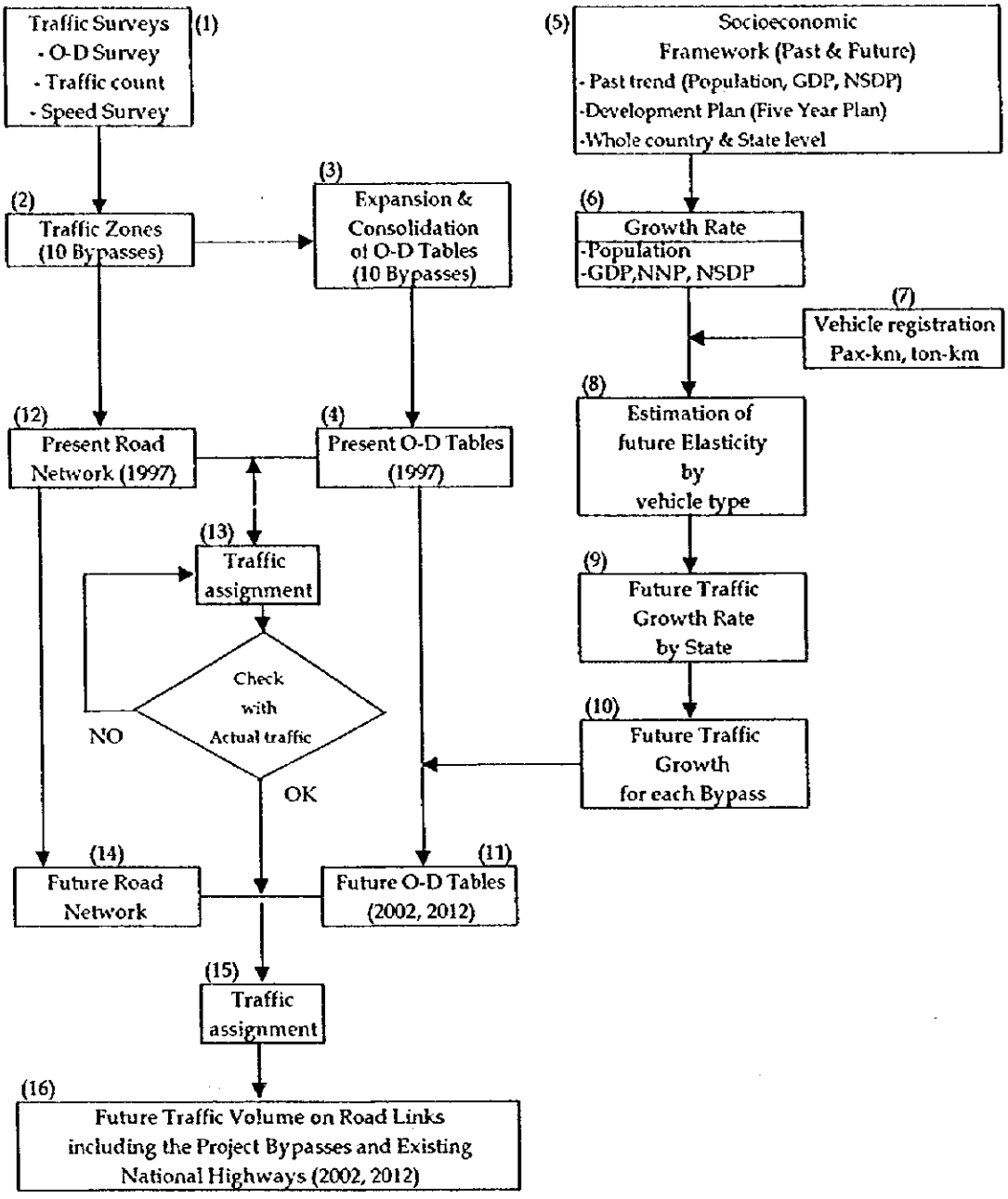


Figure 3-1 Flow Chart for Future Traffic Demand Forecast

(2) Population Growth

No population census surveys were conducted since 1991. The Planning Commission has, however, indicated a long term growth of population in the report for the Eighth Five Year Plan as shown below :

- 1992 - 1997 (Eighth Plan) 1.78% p.a.
- 1997 - 2002 (Ninth Plan) 1.68% p.a.
- 2002 - 2012 1.47% p.a.

The above growth rates were adopted in this study as well.

3.2.2 State Level Economic Growth

As the locations of the ten bypasses are planned in seven States with different growth characteristics, and as influenced areas of the long distance through traffic for each bypass spread over to other neighbouring States, it is necessary to prepare the State level future socio-economic framework not only for the direct influence areas but also for all the States/Union Territories (Uts) of the country.

The future growth at the State level was estimated keeping consistency with the pre-decided macro growth targets discussed above. The procedures adopted are explained as follows :

(1) Growth Rate of Net State Domestic Product (NSDP)

The availability of State level economic data is not sufficient to cover the whole country. Past time series data of Net State Domestic Product (NSDP at 1980/81 constant prices) is shown in Table 3-2. Some States and Union Territories are missing the latest values of 1991/92 and 1992/93. In order to keep the consistency with the macro growth rate, all States were classified into two groups : 1) Influenced areas, and 2) Other areas. (influenced areas/States by each proposed bypass are shown in Table 3-4 of next section.)

The total of each group was grown up to the present year 1997 with the past increase rate (1980/81 - 1992/93) and then adjusted by the NNP (Net National Product) in 1997 which was estimated applying the actual growth rate of GDP from 1992-97 (6.5% p.a.).

The value of NNP for the year 2002, 2007 and 2012 were forecast applying future growth targets (6.0%, 5.8% and 5.6% respectively). These pre-determined target values were used to adjust and control the individual State growth rates so as to equalise the total of influenced States with the future NNP. The results of forecast of NSDP by each influenced States are presented in the same Table 3-2.

(2) Projection of State Level Population Growth

As the population data in 1981 and 1991 are fully available for all States and Union Territories, the group wise method as above was not necessary for the estimation of future population growth rate by State. The pre-determined national level population growth rate was used to adjust the future population growth rate of all individual States and results are shown in Table 3-3.

Estimated population growth rates and growth rates of NSDP for each influence area by each bypass are summarised in Table 3-4. The influenced areas (States) were decided taking into consideration the locations of bypasses and service directions of existing National Highways.

Table 3-1 Macro Economic Target and Achievement of Five Year Plans

Five Year Plan	Period	Population Growth Rate (Average % per annum)		GDP Growth Rate (Average % per annum)		Per Capita Income Growth Rate % per annum	
		Projection/ Target	Actual	Target	Achieve-ment	Target	Achieve-ment
Seventh Plan	1985-90	1.9 (1)	2.1(2)	5.0 (4)	6.0 (5)	3.2 (7)	3.6 (7)
[Interregnum Perio	[1990-92]	-	[1.6](2)	-	[3.0] (5)	-	-
Eighth Plan	1992-97	1.78 (3)	-	5.6 (4)	(e) 6.5(5)	3.8 (7)	-
Ninth Plan	1997-2002	1.68 (3)	-	6.2 - 7.0 (6)	-	4.4 - 5.2 (8)	-
Post Plan	2002-	1.47 (3)	-	6.5 - 7.2 (6)	-	4.9 - 5.6 (8)	-

Source : (1)" EIGHTH FIVE YEAR PLAN" (page 23, Sec.2.3.1), Planning Commission.
(2) "STATISTICAL ABSTRACT, INDIA 1992", Dep.of Statistics, Ministry of Planning & Programme Implementation.
(3)" EIGHTH FIVE YEAR PLAN" (page 23,Sec.2.3.2),Planning Commission.
(4)" EIGHTH FIVE YEAR PLAN" (page 41,Sec.3.2.1),Planning Commission.
(5) "Economic Survey 1996-97" Economic Division, Ministry of Finance.
(6) "Approach Paper to the Ninth Five Year Plan 1997-2002" A NABHI Publication, April 1997. Original source : PLANNING COMMISSION.
(7) "India Economic Information Year-Book 1996"
Original source : Plan Documents; Economic Survey, 1993-94.
(8) Estimation by JICA Study Team
Note : (e) : Estimate

Table 3-2 Past Trend and Projection of Net State Domestic Product (1980/81 constant prices)

(Million Rupees)

Year / STATE	Past Trend of NSDP at constant (1980-81) prices, 1980/81 - 1992/93								1997 estimate applying growth rate of 1980-92	1997 Adjusted	2002 estimate	2002 Adjusted	97-2002 Adjusted growth rate %	2007 estimate	2007 Adjusted	2002-07 Adjusted growth rate %	2012 estimate	2012 Adjusted	2007-12 Adjusted growth rate %
	1980-81	1985-86	1988-89	1989-90	1990-91	1991-92p	1992-93q	Average Growth Rate (1980/81-92/93) %											
1 (*)Andhra Pradesh	73,210	90,468	110,284	115,434	117,234	118,573	117,767	4.0	143,540	153,532	200,158	194,959	4.9	247,565	244,539	4.6	306,728	302,954	4.4
(Yearly growth %)	-	4.3	6.8	4.7	1.6	1.1	(0.7)												
2 Arunachal Pradesh	971	1,503	1,876	2,002	2,325	2,396	2,407	7.9											
3 Assam	23,561	32,819	35,903	38,222	40,052	42,846	45,157	5.6											
4 (*)Bihar	63,492	82,929	95,234	92,307	102,385	96,091	97,610	3.6	116,766	124,895	159,806	155,655	4.5	193,992	191,621	4.2	235,898	232,996	4.0
(Yearly growth %)	-	5.5	4.7	(3.1)	10.9	(6.1)	1.6												
5 Goa	3,155	3,376	4,775	4,984	5,358	5,462	5,557	4.8											
6 Gujarat	65,851	82,447	107,788	104,080	104,939	100,840	115,552	4.8											
7 Haryana	30,320	41,811	50,976	51,776	56,493	57,478	60,395	5.9	80,482	86,084	122,701	119,514	6.8	165,925	163,897	6.5	224,763	221,998	6.3
8 Himachal Pradesh	7,228	8,313	9,698	10,858	10,908	10,834	---	3.7											
9 Jammu & Kashmir	10,495	12,298	12,528	12,354	12,721	13,191	13,730	2.3											
10 Karnataka	56,115	67,949	85,873	91,487	91,533	102,923	104,946	5.4	136,224	145,706	202,298	197,044	6.2	266,469	263,212	6.0	351,600	347,274	5.7
11 (*)Kerala	38,227	40,864	45,841	48,924	52,694	56,083	60,229	3.9	72,790	77,857	100,644	98,030	4.7	123,430	121,922	4.5	151,636	149,770	4.2
(Yearly growth %)	-	1.3	3.9	6.7	7.7	6.4	7.4												
12 (*)Madhya Pradesh	69,666	81,124	94,005	91,795	113,015	104,655	107,283	3.7	128,428	137,368	175,890	171,322	4.5	213,668	211,057	4.3	260,007	256,808	4.0
(Yearly growth %)	-	3.1	5.0	0.8	19.2	(7.4)	2.5												
13 (*)Maharashtra	151,134	187,027	220,590	255,339	268,976	259,416	282,451	5.3	366,524	392,038	544,143	530,010	6.2	716,540	707,783	6.0	945,182	933,554	5.7
(Yearly growth %)	-	4.4	5.7	15.8	5.3	(3.6)	8.9												
14 Manipur	2,009	2,588	2,945	3,075	3,300	3,643	---												
15 Meghalaya	1,796	2,143	2,422	2,768	3,094	3,447	3,704	6.2											
16 Mizoram																			
17 Nagaland	1,098	1,542	2,061	2,142	2,119	2,192	---												
18 (*)Orissa	32,253	39,808	45,085	48,480	43,447	48,970	48,137	3.4	56,878	60,837	76,888	74,891	4.2	92,191	91,064	4.0	110,730	109,368	3.7
(Yearly growth %)	-	4.3	4.2	7.5	(10.4)	12.7	(1.7)												
19 Punjab	44,493	59,237	67,923	73,645	74,949	78,642	81,856	5.2											
20 Rajasthan	41,257	51,873	74,771	73,237	84,751	77,249	86,403	6.4	117,569	125,753	183,024	178,270	7.2	252,720	249,631	7.0	349,557	345,257	6.7
21 Sikkim	490	756	1,149	1,229	1,353	---	---												
22 Tamil Nadu	72,182	93,910	107,328	114,679	123,220	130,462	133,358	5.2											
23 Tripura	2,678	3,123	4,004	4,295	4,528	---	---												
24 (*)Uttar Pradesh	140,118	169,705	205,409	210,446	222,258	225,345	227,686	4.1	278,732	298,135	390,383	380,244	5.0	484,965	479,038	4.7	603,501	596,076	4.5
(Yearly growth %)	-	3.9	6.6	2.5	5.6	1.4	1.0												
25 West Bengal	87,195	102,221	121,458	127,547	131,256	138,935	144,967	4.3	179,168	191,640	253,340	246,760	5.2	317,733	313,850	4.9	399,181	394,270	4.7
UNION TERRITORY																			
26 A.&N. Islands	493	630	766	767	753	687	785	4.0											
27 Chandigargh																			
28 D.&N. Haveli																			
29 Daman & Diu																			
30 Delhi	22,972	32,712	38,946	42,529	44,821	48,076	51,586	7.0	72,263	77,293	115,812	112,804	7.9	164,631	162,619	7.6	234,431	231,547	7.3
31 Lakshadweep																			
32 Pondicherry	1,862	2,286	2,566	2,698	2,781	2,876	2,934	3.9											
Influenced States	805,989	988,491	1,188,472	1,252,301	1,328,863	1,333,794	1,389,460	4.6	1,743,390	1,871,139	2,519,800	2,459,503	5.6	3,232,874	3,200,232	5.4	4,164,047	4,121,872	5.2
Other States	297,411	413,769	501,388	556,929	565,687	570,626	587,680	5.8	780,521	837,715	1,194,128	1,165,554	6.8	1,621,692	1,605,318	6.6	2,211,006	2,188,613	6.4
Whole country	1,103,400	1,402,260	1,689,860	1,809,230	1,894,550	1,904,420	1,977,140	5.0	2,523,911	2,708,853	3,713,928	3,625,057	6.0	4,854,566	4,805,550	5.8	6,375,053	6,310,485	5.6
(Yearly growth %)	-	4.9	6.4	7.1	4.7	0.5	3.8			(6.5 % p.a.)		(6.0 % p.a.)			(5.80 % p.a.)			(5.6 % p.a.)	
									1,749,362	1,871,139	2,525,086	2,459,503		3,239,829	3,200,232		4,173,214	4,121,872	

Source : 1980/81-1992/93 :"INDIA ECONOMIC INFORMATION YEAR-BOOK 1996",
Original source = Directorates of Economics & Statistics of respective State Governments.

Table 3-3 State Level Population Projection

(Unit : 1,000 persons)

STATE / UNION TERRITORY	Area in sq. kms.	Census Data						Population Projection									
		1981 CENSUS	Estimated Mid Year Population 1986	1991 CENSUS	Persons /sq kms (1991)	Growth Rate % per annum (1981-86)	Growth Rate % per annum (1981-91)	Estimated Growth Rate (1991-97)	Estimated Population (1997)	Adjusted Population (1997)	Estimated Growth Rate (97 - 2002)	Estimated Population (2002)	Adjusted Population (2002)	Adjusted Growth Rate (97-2002)	Estimated Growth Rate (2002-2012)	Estimated Population (2012)	Adjusted Population (2012)	Adjusted Growth Rate (2002-2012)
Whole Country	3,287,263	683,329	766,468	846,303	257	2.32	2.16	1.80	941,370	941,370	1.68	1,023,147	1,023,147	1.68	1.47	1,183,899	1,183,899	1.47
									942,082			1,023,374				1,184,144		
STATE	3,276,290	675,643	756,153	834,862	254.8	2.28	2.14	1.78	928,113	927,412	1.66	1,007,072	1,006,848	1.66	1.45	1,162,754	1,162,514	1.45
1 (*)Andhra Pradesh	275,045	53,551	60,046	66,508	241.8	2.32	2.19	1.82	74,125	74,069	1.70	80,591	80,574	1.70	1.49	93,375	93,355	1.48
2 Arunachal Pradesh	83,743	632	743	865	10.3	3.29	3.19	2.65	1,012	1,011	2.48	1,143	1,143	2.47	2.16	1,416	1,415	2.16
3 Assam	78,438	18,041	20,092	22,414	285.8	2.18	2.19	1.83	24,986	24,967	1.70	27,169	27,163	1.70	1.49	31,486	31,479	1.49
4 (*)Bihar	173,877	69,915	78,456	86,374	496.8	2.33	2.14	1.78	96,012	95,940	1.66	104,173	104,149	1.66	1.45	120,260	120,236	1.45
5 Goa	3,702	1,008	1,104	1,170	316.0	1.84	1.50	1.25	1,261	1,260	1.17	1,335	1,335	1.16	1.02	1,477	1,476	1.01
6 Gujarat	196,024	34,086	38,084	41,310	210.7	2.24	1.94	1.62	45,480	45,446	1.51	48,977	48,967	1.50	1.32	55,804	55,792	1.31
7 Haryana	44,212	12,922	14,674	16,464	372.4	2.58	2.45	2.04	18,586	18,572	1.91	20,410	20,406	1.90	1.66	24,065	24,060	1.66
8 Himachal Pradesh	55,673	4,281	4,741	5,171	92.9	2.06	1.91	1.59	5,683	5,679	1.48	6,113	6,111	1.48	1.29	6,949	6,947	1.29
9 Jammu & Kashmir	222,236	5,987	6,844	7,719	34.7	2.71	2.57	2.14	8,766	8,759	2.00	9,671	9,669	2.00	1.75	11,496	11,493	1.74
10 Karnataka	191,791	37,136	40,715	44,977	234.5	1.86	1.93	1.61	49,501	49,464	1.50	53,291	53,282	1.50	1.31	60,695	60,682	1.31
11 (*)Kerala	38,863	25,454	27,441	29,099	748.8	1.51	1.35	1.12	31,113	31,090	1.05	32,751	32,744	1.04	0.91	35,856	35,849	0.91
12 (*)Madhya Pradesh	443,446	52,179	59,020	66,181	149.2	2.49	2.41	2.00	74,543	74,486	1.87	81,713	81,695	1.86	1.63	96,047	96,028	1.63
13 (*)Maharashtra	307,713	62,783	70,684	78,938	256.5	2.40	2.32	1.93	88,523	88,456	1.80	96,708	96,686	1.80	1.57	112,994	112,971	1.57
14 Manipur	22,327	1,421	1,631	1,837	82.3	2.79	2.60	2.17	2,089	2,087	2.02	2,307	2,307	2.02	1.76	2,747	2,747	1.76
15 Meghalaya	22,429	1,336	1,550	1,775	79.1	3.02	2.88	2.40	2,046	2,045	2.24	2,284	2,284	2.23	1.96	2,772	2,771	1.95
16 Mizoram	21,081	494	603	690	32.7	4.07	3.40	2.83	816	815	2.64	929	928	2.64	2.31	1,166	1,166	2.30
17 Nagaland	16,579	775	982	1,210	73.0	4.85	4.56	3.79	1,513	1,512	3.54	1,799	1,798	3.54	3.09	2,439	2,439	3.09
18 (*)Orissa	155,707	26,370	28,968	31,660	203.3	1.90	1.85	1.54	34,692	34,666	1.43	37,224	37,215	1.43	1.25	42,140	42,131	1.25
19 Punjab	50,362	16,789	18,659	20,282	402.7	2.13	1.91	1.59	22,294	22,277	1.48	23,978	23,973	1.48	1.29	27,260	27,254	1.29
20 Rajasthan	342,239	34,262	39,493	44,006	128.6	2.88	2.53	2.11	49,880	49,842	1.97	54,947	54,935	1.96	1.72	65,145	65,131	1.72
21 Sikkim	7,096	316	375	406	57.2	3.48	2.54	2.11	460	460	1.97	507	507	1.97	1.72	601	601	1.72
22 Tamil Nadu	130,058	48,408	52,250	55,859	429.5	1.54	1.44	1.20	60,005	59,960	1.12	63,395	63,381	1.12	0.98	69,849	69,835	0.97
23 Tripura	10,486	2,053	2,388	2,757	262.9	3.07	2.99	2.49	3,196	3,193	2.33	3,582	3,581	2.32	2.03	4,379	4,378	2.03
24 (*)Uttar Pradesh	294,411	110,863	125,450	139,112	472.5	2.50	2.30	1.91	155,848	155,730	1.78	170,125	170,087	1.78	1.56	198,504	198,463	1.55
25 West Bengal	88,752	54,581	61,160	68,078	767.1	2.30	2.23	1.86	76,038	75,981	1.74	82,809	82,791	1.73	1.52	96,226	96,206	1.51
UNION TERRITORY	10,973	7,688	9,519	11,444	1,042.9	4.37	4.06	3.38	13,969	13,958	3.15	16,302	16,299	3.15	2.76	21,389	21,385	2.75
26 A.&N. Islands	8,249	189	236	281	34.1	4.54	4.05	3.37	343	343	3.14	400	400	3.14	2.75	524	524	2.74
27 Chandigargh	114	452	560	642	5,631.6	4.38	3.57	2.97	765	765	2.78	877	877	2.77	2.42	1,114	1,114	2.42
28 D.&N. Haveli	491	104	123	138	281.1	3.41	2.87	2.39	159	159	2.23	177	177	2.22	1.95	215	215	1.94
29 Daman & Diu	112	79	88	102	910.7	2.18	2.59	2.15	116	116	2.01	128	128	2.01	1.76	152	152	1.75
30 Delhi	1,483	6,220	7,771	9,421	6,352.7	4.55	4.24	3.53	11,600	11,592	3.29	13,631	13,628	3.29	2.88	18,099	18,095	2.88
31 Lakshadweep	32	40	46	52	1,625.0	2.83	2.66	2.21	59	59	2.07	66	66	2.06	1.80	78	78	1.80
32 Pondicherry	492	604	695	808	1,642.3	2.85	2.95	2.46	935	934	2.29	1,046	1,046	2.29	2.00	1,275	1,275	2.00

Source :1981,1986 & 1991 = "STATISTICAL ABSTRACT, INDIA 1992" Central Statistical Organisation,
Original source : Registrar General India, Ministry of Home Affairs.
Note (*) : Study areas for proposed Bypasses

Table 3-4 Future Population and NSDP Growth by Influence Area

No.	Bypass	Influence Area (States)	Population Projection (thousand)			Growth rate p.a. (%)		Forecast of NSDP (million Rupees)				Growth rate of NSDP p.a. (%)		
			1997	2002	2012	1997-2002	2002-2012	1997	2002	2007	2012	97-2002	2002-07	2007-12
1	Bareilly (NH-24)	Uttar Pradesh	155,730	170,087	198,463	1.78	1.55	298,135	380,244	479,038	596,076	4.99	4.73	4.47
		Haryana	18,572	20,406	24,060	1.90	1.66	86,084	119,514	163,897	221,998	6.78	6.52	6.26
		Delhi	11,592	13,628	18,095	3.29	2.88	77,293	112,804	162,619	231,547	7.85	7.59	7.32
		Total	185,894	204,121	240,618	1.89	1.66	461,512	612,562	805,554	1,049,621	5.83	5.63	5.44
2	Patna (NH-30)	Bihar	95,940	104,149	120,236	1.66	1.45	124,895	155,655	191,621	232,996	4.50	4.25	3.99
		Uttar Pradesh	155,730	170,087	198,463	1.78	1.55	298,135	380,244	479,038	596,076	4.99	4.73	4.47
		Total	251,670	274,236	318,699	1.73	1.51	423,030	535,899	670,659	829,072	4.84	4.59	4.33
3	Keonjhar (NH-6)	Orissa	34,666	37,215	42,131	1.43	1.25	60,837	74,891	91,064	109,368	4.24	3.99	3.73
		West Bengal	75,981	82,791	96,206	1.73	1.51	191,640	246,760	313,850	394,270	5.19	4.93	4.67
		Madhya Pradesh	74,486	81,695	96,028	1.86	1.63	137,368	171,322	211,057	256,808	4.52	4.26	4.00
		Total	185,133	201,701	234,365	1.73	1.51	389,845	492,973	615,971	760,446	4.81	4.56	4.30
4	Balugaon (NH-5)	Orissa	34,666	37,215	42,131	1.43	1.25	60,837	74,891	91,064	109,368	4.24	3.99	3.73
		Andhra Pradesh	74,069	80,574	93,355	1.70	1.48	153,532	194,959	244,539	302,954	4.89	4.64	4.38
		West Bengal	75,981	82,791	96,206	1.73	1.51	191,640	246,760	313,850	394,270	5.19	4.93	4.67
		Total	184,716	200,580	231,692	1.66	1.45	406,009	516,610	649,453	806,592	4.94	4.68	4.43
5	Vijayawada (NH-5) (NH-9)	Andhra Pradesh	74,069	80,574	93,355	1.70	1.48	153,532	194,959	244,539	302,954	4.89	4.64	4.38
		Maharashtra	88,456	96,686	112,971	1.80	1.57	392,038	530,010	707,783	933,554	6.22	5.96	5.69
		Orissa	34,666	37,215	42,131	1.43	1.25	60,837	74,891	91,064	109,368	4.24	3.99	3.73
		Total	197,191	214,475	248,457	1.69	1.48	606,407	799,860	1,043,386	1,345,876	5.69	5.46	5.22
6	Kannur (NH-1)	Kerala	31,090	32,744	35,849	1.04	0.91	77,857	98,030	121,922	149,770	4.72	4.46	4.20
		Karnataka	49,464	53,282	60,682	1.50	1.31	145,706	197,044	263,212	347,274	6.22	5.96	5.70
		Total	80,554	86,026	96,531	1.32	1.16	223,563	295,074	385,134	497,044	5.71	5.47	5.23
7	Nandura (NH-6)	Maharashtra	88,456	96,686	112,971	1.80	1.57	392,038	530,010	707,783	933,554	6.22	5.96	5.69
		Madhya Pradesh	74,486	81,695	96,028	1.86	1.63	137,368	171,322	211,057	256,808	4.52	4.26	4.00
8	Khamgaon (NH-6)	Orissa	34,666	37,215	42,131	1.43	1.25	60,837	74,891	91,064	109,368	4.24	3.99	3.73
		Total	197,608	215,596	251,130	1.76	1.54	590,243	776,223	1,009,904	1,299,730	5.63	5.40	5.18
9	Bhopal (NH-12)	Madhya Pradesh	74,486	81,695	96,028	1.86	1.63	137,368	171,322	211,057	256,808	4.52	4.26	4.00
		Rajasthan	49,842	54,935	65,131	1.96	1.72	125,753	178,270	249,631	345,257	7.23	6.97	6.70
		Total	124,328	136,630	161,159	1.90	1.66	263,121	349,592	460,688	602,065	5.85	5.67	5.50
10	Gwalior (NH-3)	Madhya Pradesh	74,486	81,695	96,028	1.86	1.63	137,368	171,322	211,057	256,808	4.52	4.26	4.00
		Rajasthan	49,842	54,935	65,131	1.96	1.72	125,753	178,270	249,631	345,257	7.23	6.97	6.70
		Haryana	18,572	20,406	24,060	1.90	1.66	86,084	119,514	163,897	221,998	6.78	6.52	6.26
		Delhi	11,592	13,628	18,095	3.29	2.88	77,293	112,804	162,619	231,547	7.85	7.59	7.32
		Total	154,492	170,664	203,314	2.01	1.77	426,498	581,910	787,204	1,055,610	6.41	6.23	6.04

3.3 Future Traffic Growth

3.3.1 Traffic Growth Model

(1) Basic Model

The traffic growth model which has been applied frequently and conventionally in road sector of India is a formula as shown below :

$$GRi = [\ (1 + p\ /100) \times (1 + n\ /100) - 1\ ] \times Ei \times 100$$

Where, GRi : growth rate per annum of vehicle type i (%)
p : growth rate per annum of population of State (%)
n : growth rate per annum of per capita NSDP (%)
Ei : elasticity of traffic growth rate for vehicle type i

In the above formula, the content in the bracket [ ] is easily rewritten into the expression of [growth rate per annum of NSDP] by the following definition :

$$n = [(1 + \text{growth rate of NSDP}/100) / (1 + p/100)] - 1$$

As it is difficult to collect the future sector wise information of the influence areas (States) and in order to estimate the values of Elasticity empirically at the national level, the relationship between vehicle traffic and Net National Product (NNP) was examined applying the number of vehicle registrations, passenger-km and freight-km.

(2) Estimation of Future Elasticity

The basic data of past trend for vehicle population by vehicle type, passenger-km and freight-km on roads were provided by the MOST and presented in Table 3-5. The regression analyses were undertaken applying the last 20 year traffic data and actual NNP. The results are as shown below :

a) Vehicle registration

- Car, Three Wheeler = - 2555.0 + 0.03434 NNP (R = 0.995)
- Bus = - 137.22 + 0.0026 NNP (R = 0.996)
- Truck = - 739.82 + 0.01161 NNP (R = 0.995)
- Two Wheeler = - 15103 + 0.15892 NNP (R = 0.993)

b) Passenger-km on road = - 1096 + 0.01532 NNP (R = 0.995)

c) Freight-km on road = - 363.9 + 0.00489 NNP (R = 0.988)

R : Correlation Coefficient

Table 3-5 Past Trend of Vehicle Population, Passenger-km and Freight-km

YEAR	Vehicle Population (1976-96)						Passenger km Billion km	Freight km Billion km	NNP (1980-81 prices) (Rs.crore)
	Passenger (1,000s)				Goods (1,000s)				
	Car	Bus	Two Wheeler	Three Wheeler	LCV	HCV			
1976	779	115	1195	71	70	280	371.98	95.14	95433
77	878	119	1407	83	78	305	401.52	107.27	96253
78	919	124	1657	94	91	312	484.98	114.97	103670
79	996	133	1951	110	95	349	491.64	132.31	109466
1980	1059	140	2297	122	103	369	523.52	145.35	102937
81	1160	154	2704	143	114	440	664.84	178.36	110685
82	1207	164	3184	162	125	488	726.09	202.13	117140
83	1385	178	3749	182	143	532	746.22	226.04	119704
84	1455	196	4414	229	161	581	852.96	253.68	129392
85	1607	219	5197	267	182	640	922.11	286.18	133808
86	1780	223	6119	313	193	670	1038.56	307.03	139025
87	2007	241	7204	386	214	770	1140.53	360.21	144242
88	2295	266	8483	427	233	881	1265.80	419.80	149787
89	2486	278	9987	476	253	926	1296.98	453.18	165750
1990	2736	313	11759	542	281	1001	1581.37	503.16	177315
91	3013	331	14200	610	310	1101	1615.20	566.66	186446
92	3205	358	15661	800	352	1162	1802.50	610.10	186191
93	3344	380	17060	935	389	1203	1958.40	646.20	195630
94	3617	419	18338	1093	431	1219	2153.80	672.20	207264
95	3919	444	20433	1197	492	1290	2348.00	667.00	221406
96	4334	471	22977	1338	560	1383	2515.00	720.00	236738

Source: "Draft Report of the Sub-Group on Traffic Forecasts and Fleet Requirement in the Ninth Plan" Ministry of Surface Transport (Transport Wing)

The future values of Elasticity by each category were calculated by input future NNP (which was forecast applying future macro economic growth rate) to the above equations and according to the definition of elasticity (percentage growth rate of future traffic/ percentage of growth rate of future NNP). The results are summarised below :

Future Elasticity of Traffic Growth to NNP Growth

Category	1997 - 2002	2002 - 2007	2007 - 2012
1) Car, 3 wheeler	1.38	1.25	1.18
2) Bus	1.24	1.17	1.12
3) Truck	1.31	1.21	1.15
4) Two wheeler	1.54	1.34	1.24
Pax-km	1.36	1.24	1.17
Ton-km	1.38	1.25	1.18

The above figures of 1) to 4) were adopted in this study. Although the base data for calculation of elasticity was vehicle population and not based on number of trips of vehicles directly, it is considered to be reasonable to adopt above results if vehicles registered are used effectively and average number of trips per vehicles are stable in future.

3.3.2 Traffic Growth Rates by Influence Area

Future traffic growth rates by each influence area are calculated applying the

growth rate of NSDP and the values of elasticity by vehicle type above and are shown in Table 3-6.

In order to verify the degree of validity of the estimated future traffic growth rates, those future growth rates in Table 3-6 were compared with actual past trends of vehicle registration as shown in Table 3-7. The table indicates that the estimated future traffic growth rates are within the range of reasonable figures compared to the past trends of vehicle growth.

At the same time, the future traffic growth rates were compared with the past growth rates of vehicle registration by each influence area as shown in Table 3-8. The area-wise future traffic growth rates seem to be acceptable comparing to the recent vehicle growth by study area except for some vehicle categories such as cars in Vijayawada (1.93% per annum), Nandura, Khamgaon (1.84%), Buses in Bareilly (3.98%), Patna (2.90%) and Trucks in Patna (2.90%). Therefore, area-wise or State-wise statistical vehicle registration data may not be applicable to the future traffic forecast.

In addition, past trends of the Traffic Census Data prepared by each State PWD were also collected in order to grasp the growth trends of traffic volumes on corresponding road sections of National Highways. Table 3-9 shows the average annual growth rates of traffic volumes by each survey point. Unlike the rates in Table 3-8, the growth rates of the Census data vary in wide range and considered to be not comparable with/not applicable to the future traffic demand forecast.

The following example of future traffic projection was presented by ADB study on four-lane widening projects at Vijayawada sections of National Highway 5 (Vijayawada - Eluru) and NH 9 (Nandigama - Vijayawada). Results of comparison of traffic growth rates are given below :

Vehicle Type	ADB* (1995-2004)	This Study (1997-2002)
Car	7.7% p.a.	7.86% p.a.
Bus	7.0	7.06
Truck	6.8	7.46
Motorcycle	9.0	8.77

Both studies indicate the similar results each other.

[Source *: Report and Recommendation of the President to the Board of Directors on a Proposed Loan and Technical Assistance Grant to India for the National Highways Project, ADB, Nov. 1993.]

3.3.3 Forecast of Future O-D Tables

Future O-D Tables were forecast applying the future growth rates shown in Table 3-6.

Table 3-6 Future Traffic Growth Rate per Annum (%)

No.	Bypass	1997-2002				2002-2007				2007-2012			
		Car	Bus	Truck	2Whl.	Car	Bus	Truck	2Whl.	Car	Bus	Truck	2Whl.
1	Bareilly (NH-24)	**8.04**	**7.22**	**7.63**	**8.97**	**7.04**	**6.59**	**6.81**	**7.54**	**6.41**	**6.09**	**6.25**	**6.74**
		1.472	1.417	1.444	1.537	1.405	1.376	1.390	1.439	1.365	1.344	1.354	1.386
2	Patna (NH-30)	**6.68**	**6.01**	**6.35**	**7.46**	**5.74**	**5.37**	**5.55**	**6.15**	**5.11**	**4.85**	**4.98**	**5.37**
		1.382	1.339	1.360	1.433	1.322	1.299	1.310	1.348	1.283	1.267	1.275	1.299
3	Keonjhar (NH-6)	**6.63**	**5.96**	**6.30**	**7.40**	**5.69**	**5.33**	**5.51**	**6.10**	**5.08**	**4.82**	**4.95**	**5.34**
		1.379	1.336	1.357	1.429	1.319	1.296	1.308	1.345	1.281	1.265	1.273	1.297
4	Balugaon (NH-5)	**6.81**	**6.12**	**6.47**	**7.60**	**5.85**	**5.48**	**5.67**	**6.28**	**5.23**	**4.96**	**5.09**	**5.49**
		1.390	1.346	1.368	1.442	1.329	1.306	1.317	1.356	1.290	1.274	1.282	1.306
5	Vijayawada (NH-5) (NH-9)	**7.86**	**7.06**	**7.46**	**8.77**	**6.82**	**6.39**	**6.61**	**7.32**	**6.16**	**5.85**	**6.01**	**6.48**
		1.460	1.407	1.433	1.522	1.391	1.363	1.377	1.423	1.349	1.329	1.339	1.369
6	Kannur (NH-1)	**7.88**	**7.08**	**7.48**	**8.79**	**6.84**	**6.40**	**6.62**	**7.33**	**6.18**	**5.86**	**6.02**	**6.49**
		1.461	1.408	1.434	1.524	1.392	1.364	1.378	1.424	1.349	1.330	1.339	1.369
7	Nandura (NH-6)												
8	Khamgaon (NH-6)	**7.77**	**6.98**	**7.38**	**8.67**	**6.76**	**6.32**	**6.54**	**7.24**	**6.11**	**5.80**	**5.95**	**6.42**
		1.454	1.401	1.427	1.516	1.387	1.359	1.373	1.418	1.345	1.325	1.335	1.365
9	Bhopal (NH-12)	**8.07**	**7.25**	**7.66**	**9.01**	**7.09**	**6.64**	**6.87**	**7.60**	**6.49**	**6.16**	**6.32**	**6.82**
		1.474	1.419	1.446	1.539	1.409	1.379	1.394	1.443	1.369	1.348	1.359	1.391
10	Gwalior (NH-3)	**8.85**	**7.95**	**8.40**	**9.87**	**7.79**	**7.29**	**7.54**	**8.35**	**7.13**	**6.77**	**6.95**	**7.49**
		1.528	1.466	1.497	1.601	1.455	1.422	1.438	1.493	1.411	1.387	1.399	1.435
	Elasticity	1.38	1.24	1.31	1.54	1.25	1.17	1.21	1.34	1.18	1.12	1.15	1.24

Note : Upper : Average Annual Growth Rate (%)
Down : Growth ratio for each five year period

Table 3-7 Comparison of Recent Growth of Vehicle Registration and Estimated Future Traffic Growth Rate

	Average Annual Growth Rate of Vehicle Registration %								Growth Rate per annum (%)		
	Passenger Vehicles					Goods Vehicles (Trucks)					
	Car	Car + 3 Wheeler	Bus	Two Wheeler	Three Wheeler	LCV	HCV	LCV + HCV	Pssenger km	Freight km	NNP (1980-81 prices)
Actual Average Annual Growth Rate % (1984-88)	12.1	12.8	7.9	17.7	16.9	9.7	11.0	10.7	10.4	13.4	3.7
Actual Average Annual Growth Rate % (1988-92)	8.7	10.1	7.7	16.6	17.0	10.9	7.2	8.0	9.2	9.8	5.6
Actual Average Annual Growth Rate % (1992-96)	7.8	9.1	7.1	10.1	13.7	12.3	4.4	6.4	8.7	4.2	6.2
Future Traffic Growth Rate % (1997-2002)		6.6-8.9	6.0-8.0	7.4-9.9				6.3-8.4			6.0
Future Traffic Growth Rate % (2002-2007)		5.7-7.8	5.3-7.3	6.1-8.4				5.5-7.5			5.8
Future Traffic Growth Rate % (2007-2012)		5.1-7.1	4.8-6.8	5.3-7.5				5.0-7.0			5.6

Source : Actual past growth rate based on Table 3-5

Table 3-8 Average Annual Growth Rate of Number of Registered Vehicles By Study Area (1991-1994 : %)

No.	Bypass	Cars, Jeeps, Taxis, Three-wheelers	Buses	Trucks & Trailers	Tractors	Two Wheelers	Others	All vehicles
1	Bareilly (NH-24)	9.83 (8.04)	3.98 (7.22)	8.04 (7.63)	13.56	8.69 (8.97)	-5.12	9.18
2	Patna (NH-30)	6.71 (6.68)	2.90 (6.01)	2.90 (6.35)	9.87	8.47 (7.46)	0.03	7.92
3	Keonjhar (NH-6)	5.77 (6.63)	9.73 (5.96)	7.87 (6.30)	9.51	8.77 (7.40)	4.78	8.16
4	Balugaon (NH-5)	5.80 (6.81)	6.45 (6.12)	6.55 (6.47)	5.24	5.38 (7.60)	7.06	5.60
5	Vijayawada (NH-5) (NH-9)	1.93 (7.86)	7.51 (7.06)	8.68 (7.46)	7.23	6.70 (8.77)	10.59	6.03
6	Kannur (NH-1)	9.16 (7.88)	10.12 (7.08)	8.89 (7.48)	10.23	9.05 (8.79)	2.97	9.07
7	Nandura (NH-6)							
8	Khamgaon (NH-6)	1.84 (7.77)	10.60 (6.98)	9.52 (7.38)	9.86	8.57 (8.67)	6.93	7.55
9	Bhopal (NH-12)	7.11 (8.07)	10.54 (7.25)	7.14 (7.66)	11.05	9.94 (9.01)	1.80	9.50
10	Gwalior (NH-3)	9.27 (8.85)	8.83 (7.95)	8.87 (8.40)	14.17	9.14 (9.87)	-1.45	9.47

Note : Upper : Calculated based on "Motor Transport Statistics of India 1991-1994", Transport Research Wing, MOST.
(Down) : Future Average Annual Growth Rate (1197 - 2002) in Table 3-6.

Table 3-9 Past Growth Rate of Traffic Volume on National Highways

No.	Area	Highway No.	Chainage (km)	Period		Average Annual Growth Rate of ADT (%)				
				Year	Month	(1) Car, Jeep, Van	(2) Bus	(3) Truck (HCV)	(4) MAV Trailor	(5) Motor-cycle
1	Bareilly	24	239/0	1993-96	May, June	23.1	7.0	-0.2	N.A	24.6
2	Patna	30	134/0	1987-89	January	67.0	33.4	27.2	N.A	N.A
3	Keonjhar	6	370/0	1991-96	June	5.5	10.7	13.0	N.A	N.A
4	Balugaon	5	322/6	1990-96	June	15.9	11.8	11.1	15.2	19.3
					December	16.6	6.7	16.5	-2.0	11.9
5	Vijayawada	5				N.A	N.A	N.A	N.A	N.A
		9				N.A	N.A	N.A	N.A	N.A
6	Kannur	17	154/0	1992-96	April	10.2	9.3	4.2	N.A	7.1
					October	12.3	5.5	9.5	N.A	7.2
7	Nandura	6	315/0-316/1	1992-94		28.1	19.8	-13.0	N.A	N.A
			317/0	1994-96	May	39.6	18.9	44.0	N.A	43.6
					December	25.5	56.4	10.7	N.A	9.5
8	Khamgaon	6	297/0	1991-96	May	16.4	29.0	9.2	N.A	22.2
					December	13.1	26.9	3.4	N.A	33.6
9	Bhopal	12	303/6	1991-96		5.7	11.1	5.4	14.4	3.8
			317/4-320/4	1990-96		3.6	3.1	3.2	N.A	N.A
10	Gwalior	3	135/4	1990-96	June	8.3	39.2	4.6	170.9	7.1
			122/8	1992-96	June	15.2	127.6	8.2	159.4	32.5
			105/0	1992-96	June	16.1	51.1	25.6	35.7	0.0

Source : Each State PWD and MOST