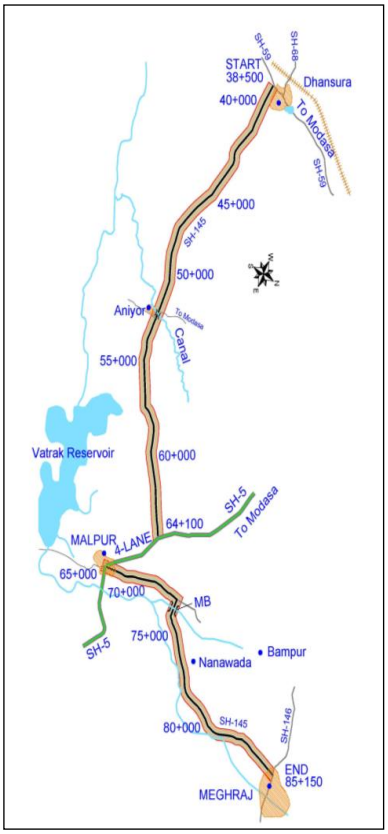

ROADS AND BUILDINGS DEPARTMENT
GOVERNMENT OF GUJARAT

GSHP-II

Project Preparatory Works Consultancy Services for Gujarat State Highway Project - II

Detailed Project Report

Executive Summary
(DHANSURA - MEGHRAJ)

January 2013

LEA Associates South Asia Pvt. Ltd.
LEAdership in engineering & planning solutions

EXECUTIVE SUMMARY

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1 INTRODUCTION

1.1 PROJECT BACKGROUND

1. Gujarat is one of the versatile and dynamic states in India. The state has established itself on stronger economic foundation. Over the last decade the name of "Gujarat" has emerged synonymous with progress and vibrancy. Government of Gujarat (GoG) through Roads and Buildings Department (R&BD) is thriving to deliver better than the best road infrastructure for the communities.

2. Gujarat roads, managed by R&BD, are known as one of the best in the country. R&BD is successfully managing its road assets through various flagship programs of GoG, besides multilateral funding and Public Private Participation. The Gujarat State Highway Project – I (GSHP-I) successfully implemented by R&BD, GoG through 2001 to 2007 with the World Bank assistance, has set many bench marks for other states to follow. The state appreciating need of sustenance of its economic growth, endorses that the infrastructure is one of the key and further its enhanced quality is a great value addition.

3. GSHP-I project umbrella before its closure itself rooted efforts towards second highway project for the state. The Updated Strategic Options Study (USOS) for the Core Road Network of the Gujarat State was carried out in 2005-06 to this respect and the same was duly revalidated in 2010. This study has prioritised road sections on strategic parameters to arrive at about 1,600 km road length. R&BD, GoG with in-principal agreement with the World Bank (WB) has finalised project budget as Rs. 2,100 crore. As a pre-requisite for loan appraisal process with the WB, R&BD, GoG selected about 397.9/460 km of road length for project preparatory works.

4. R&BD, GOG has taken a step forward by selecting LEA Associates South Asia Pvt. Ltd. (LASA) as Project Preparatory Works Consultant. Project Preparatory Works Consultancy Services (PPWCS) mandates the consultant for detailed engineering project report preparation along with procurement documents for selected 397.9 km road length.

1.1.1 Project Corridors

5. The corridors are selected by R&BD across the state to have representation of various project interventions like four laning, wide two laning and maintenance. The list of project corridors at a glance is furnished through Table 1.1. The map showing project corridor is provided as Map 1.1.

Table 1.1: List of Project Corridors

Work Type	Sr. No.	Link Name	SH No.	Length (km)
Two Laning / Wide Two Laning	1	Lunawada – Khedapa (Border)	SH-02, SH-152	56.70
	2	Bayad – Lunawada	SH-69,SH-63, VR/MDR	44.56
	3	Dhansura – Meghraj	SH-145	46.65
	4	Gondal – Atkot	SH-01	35.40
	5	Dhandhuka – Dholera	SH-20	27.00
	6	Umreth- Vasad (including	SH-83,SH-188, SH-151	35.45

Work Type	Sr. No.	Link Name	SH No.	Length (km)
		Kapadvanj-Ladvel)		
	7	Dabhoi – Bodeli	SH-11	38.60
Four laning	8	Mehsana-Himmatnagar	SH-55	66.15
Rehabilitation	9	Paliyad-Dhandhuka	SH-001	46.00

Source: As provided in Terms of Reference (ToR)[1]

1.2 BROAD OBJECTIVES AND SCOPE

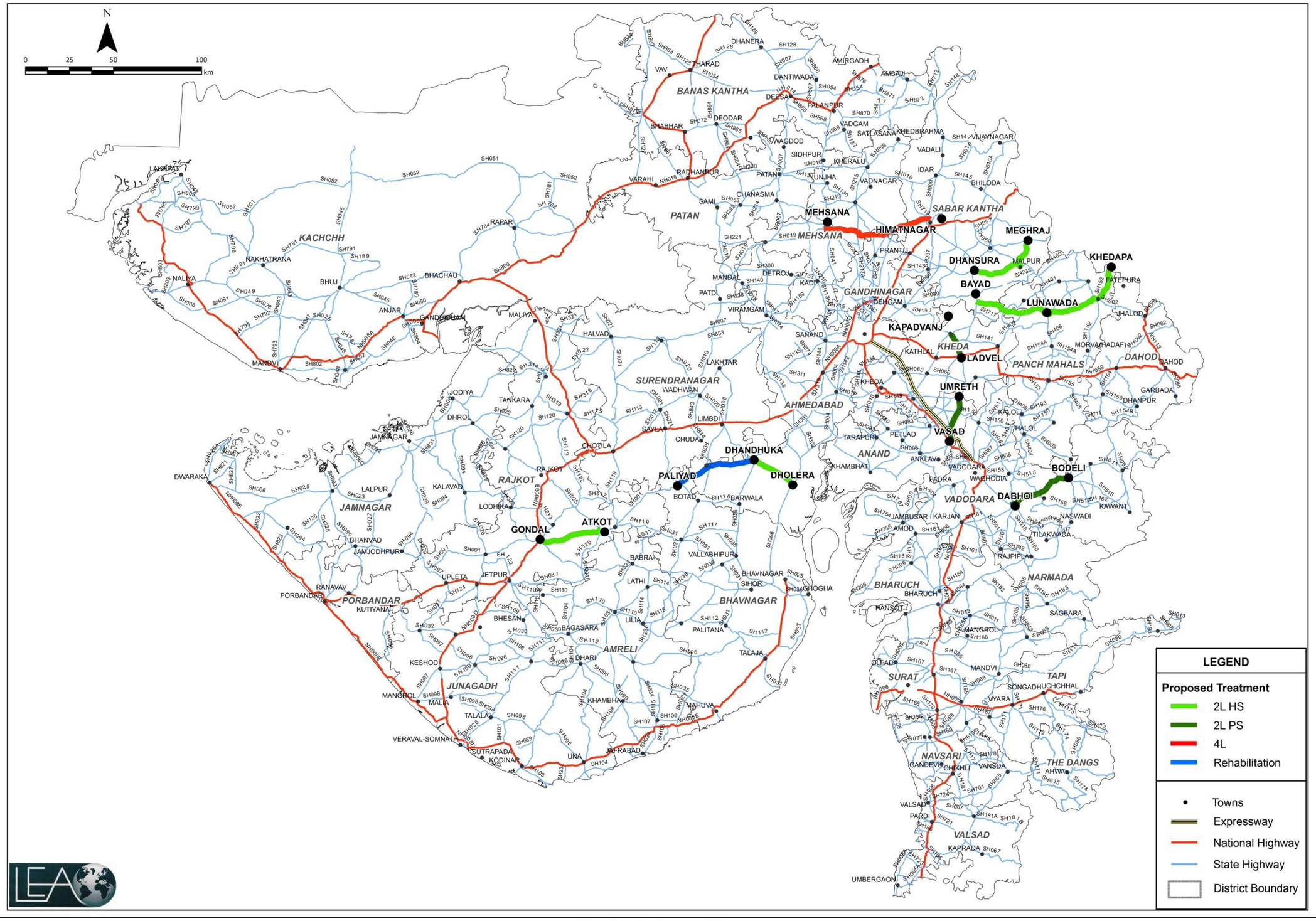
Project Intervention	Total Length (Km)
Widening to tWide 2L	286.9 km
Widening to 4L	66 km
Maintenance/Rehabilitation	45 km
Total length	**397.9 km**

6. The broad objective of the assignment is to have detailed engineering project ready for bidding. It includes economic analysis for each section, integration of road safety audit in final design, implementation and O&M along with Environmental Impact Assessment, Environmental Management Action Plan and Rehabilitation and Resettlement Studies as per World Bank Guidelines.

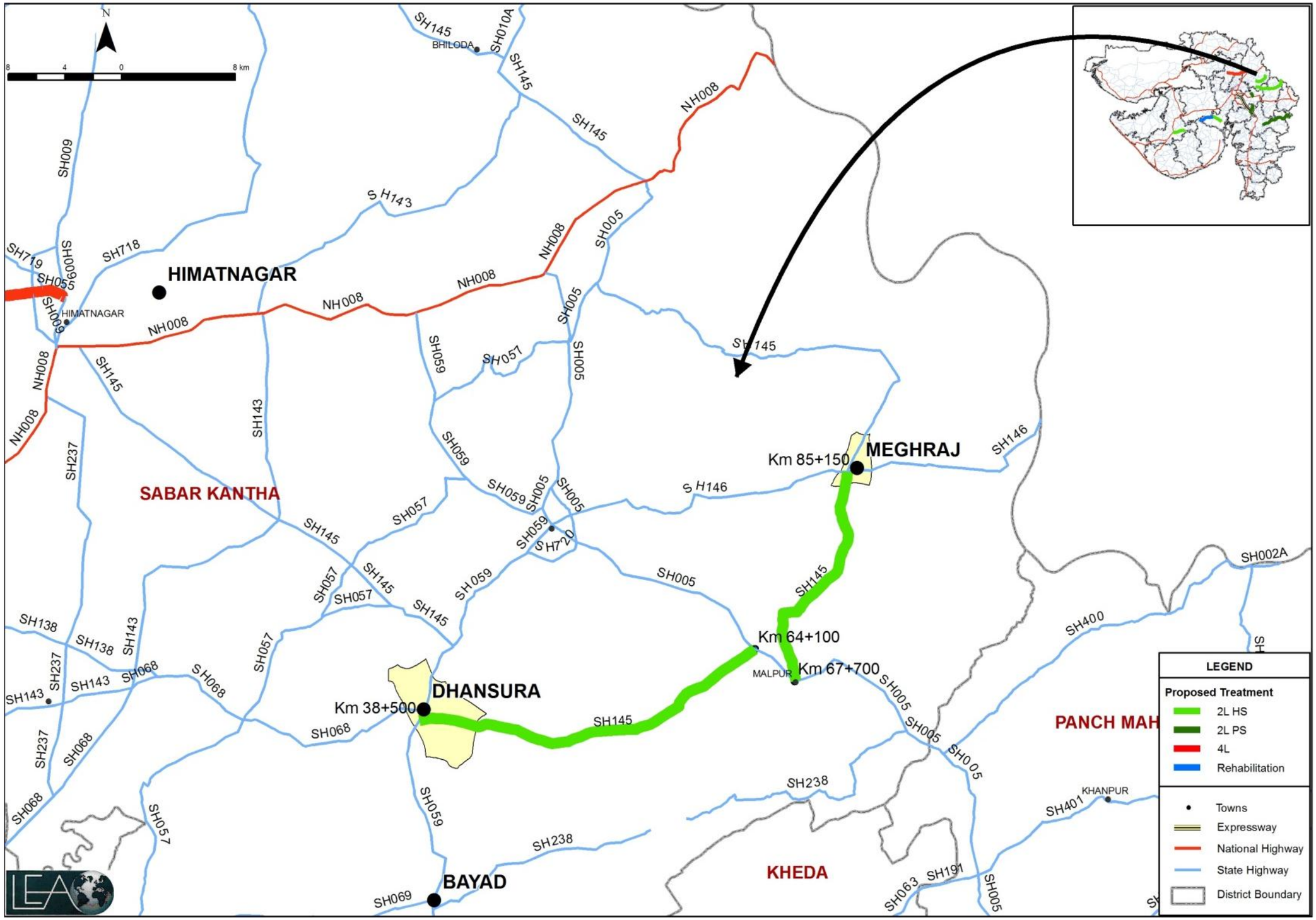
1.3 DETAILED PROJECT REPORT

7. This Executive Summary of DPR pertains to two laning with hard shoulder for the project corridor Dhansura-Meghraj. The key map showing project corridor is presented in Map 1.2.

[1] Bodeli-Alirajpur Corridor left out as part of GSHP-II as it is being declared as National Highway



Map 1.1: Project Corridors



Map 1.2: Key Map Showing Project Corridor

2 SOCIO-ECONOMIC PROFILE OF THE CORRIDOR

8. The corridor Dhansura-Meghraj is located in Dhansura, Meghraj and Malpur talukas of Sabarkantha district covering a total length of nearly 43.5 km.

9. **Population Distribution:** The project corridor traverses through 3 talukas which comprise a total population of 3.71 lakh in 2011 and 3.24 lakh during 2001. Population of these talukas grew at an Average Annual Growth Rate (AAGR) of 1.4 percent during the year 2001 to 2011[2]. There are total of 30 census villages and 2 towns (Meghraj and Malpur) which abuts the project corridor. The total population of villages and towns adjoining corridor is 58,780; which is almost 18 percent to the project talukas population (Census 2001). Settlements seen along the corridor are Dhansura, Wantada suka, Aniyor Kampa, Rasapur, Malpur, Parsoda, Idalpura and Meghraj. The total number of households along project corridor is 11,563. Average Household (HH) size along the project corridor is 5.1, which vary from 4.6 in Juna Takhatpur to 6 in Rasapur village.

10. **Age and Sex Ratio:** The overall population below 6 years age in project corridor talukas is 14 percent. The average sex ratio[3] for project corridor talukas during 2001 was 941 which increased to 950 during 2011. Meghraj taluka has shown relatively higher sex ratio of 965 followed by Malpur taluka. For the project corridor villages, the analysis for sex ratio reveals 923 females per thousand males. Bhempur village followed by Sonikpur village have shown higher sex ratio of 1193 and 1116, which is higher when compared to the average of state and talukas average. Maljina Pahadiya has shown relatively lower sex ratio of 825 than other villages abutting corridor. Similarly, looking into the juvenile sex ratio[4], it was analysed that as against the juvenile sex ratio of 897 for project corridor talukas, the project corridor villages had the lowest sex ratio of 848.

11. **Literacy Rate:** As per Provisional Census 2011, the project corridor talukas possess literacy rate of 72 percent, as against 62 percent during 2001. Male literacy ratio in project corridor taluka is 85 percent as against the female literacy rate of 59 percent in 2011. Average literacy rate in project corridor villages is 72 percent, this constitutes 84 percent male literates and 59 percent females. Amongst all the villages and settlements along corridor, urban settlements of Malpur and Meghraj have shown higher literacy rates i.e. 81 and 83 percent.

12. **Urban Rural Population:** The project corridor abuts 2 urban settlements of Meghraj and Malpur. Population of Meghraj and Malpur during the year 2001 was 9902 and 6512. These 2 towns comprise nearly 28 percent of the total population residing along the corridor.

[2] Village/ settlement wise analysis for the project corridor has been done based on 2001 Census information. Taluka level analysis is based on 2001 census information and 2011 Provisional census data base information.
[3] Sex Ratio: Number of females per thousand males
[4] Juvenile Sex Ratio is the sex ratio of population in age-group 0-6 years

13. **Occupational Structure:** Total workers according to census 2001 in project corridor taluka was 1.57 lakh, this comprised 70 percent workers classified as main workers[5] and rest 30 percent as marginal workers[6]. Taking into account the composition of workers majority of workers are cultivators (51 percent) and are working in other sectors[7] (24 percent). The total workers in project corridor settlements are 24,431. Of this, Dhansura village accounts for majority of workers i.e. 18 percent to total project corridor settlement. Workers composition along the corridor shows highest share of workers engaged in others sector (46 percent) followed by agricultural sector (38 percent). The Workforce Participation Ratio (WPR) for project corridor taluka in 2001 was 49 percent. While comparing and analysing the male WPR and female WPR, it was recorded that the female WPR is merely 28 percent as against male WPR of 54 percent. The average WPR for project corridor settlements is 42 percent which is lower than the Talukas WPR. Male WPR in project corridor settlements is 53 percent as against 30 percent for female WPR.

14. **Schedule Caste and Schedule Tribe Population:** Analysis of social groups for the project corridor has been done on the basis of concentration of Schedule Caste (SC) and Schedule Tribe (ST) population in talukas and project corridor settlements. 22 percent population in project corridor talukas comprises SC and ST community. The share of SC community in talukas is 17 percent, whereas, the SC community have a share of 5 percent. As mentioned above, Meghraj is a tribal taluka and is included as part of Fifth schedule area. The schedule tribes identified in this taluka are predominantly Bhil and Nayak. As per Census 2001, total SC and ST population along the corridor accounts for the figure of 6,582 which is nearly 11 percent of total population for settlements along the project corridor. Primarily, the predominant group amongst the social groups is that of SC community i.e. 8 percent to the entire SC and ST population of the corridor.

[5] Main workers were those who had worked for the major part of the year preceding the date of enumeration i.e., those who were engaged in any economically productive activity for 183 days (or six months) or more during the year

[6] Marginal workers were those who worked any time at all in the year preceding the enumeration but did not work for a major part of the year, i.e., those who worked for less than 183 days (or six months).

[7] Census Definition of Other Workers: All workers, i.e., those who have been engaged in some economic activity during the last one year, but are not cultivators or agricultural labourers or in Household Industry, are 'Other Workers (OW)'. The type of workers that come under this category of 'OW' include all government servants, municipal employees, teachers, factory workers, plantation workers, those engaged in trade, commerce, business, transport banking, mining, construction, political or social work, priests, entertainment artists, etc. In effect, all those workers other than cultivators or agricultural labourers or household industry workers, are 'Other Workers'

3 CORRIDOR CHARACTERISTICS

3.1 PROJECT CORRIDOR

15. The project corridor takes off from SH-059, down south by a kilometer distance from Dhansura town, while joining Malpur and overlapping eastern SH-005-4L at Malpur and further connecting Meghraj at north-eastern direction. It provides a vital tribal and interstate connectivity of Gujarat and Rajasthan. The project corridor spanning for a length of about 43 km lies in Central Gujarat. The existing corridor characteristics are presented in Table 3.1.

Table 3.1: Existing Corridor Characteristics

<table>
<tr><th>Sr. No.</th><th>Components</th><th colspan="2">Details</th></tr>
<tr><td>1</td><td>Corridor Name and SH Number</td><td colspan="2">Dhansura-Meghraj (SH-145)</td></tr>
<tr><td>2</td><td>District</td><td colspan="2">Sabarkantha</td></tr>
<tr><td>3</td><td>Sections</td><td>Dhansura to SH-005 (SH-145)</td><td>Malpur-Meghraj (SH-145)</td></tr>
<tr><td>4</td><td>Length of Corridor</td><td colspan="2"><table><tr><th>Start</th><th>End</th><th>Length (km)</th></tr><tr><td>km 38+500</td><td>km 64+100</td><td>25.60</td></tr><tr><td>km 67+700</td><td>km 85+150</td><td>17.45</td></tr><tr><td colspan="2">Total Length</td><td>43.05</td></tr></table></td></tr>
<tr><td>5</td><td>Total Length of Corridor (km)</td><td colspan="2">43.05</td></tr>
<tr><td>6</td><td>Right of Way (m)</td><td>24</td><td>24</td></tr>
<tr><td>7</td><td>Carriageway width (m)</td><td>3.75</td><td>5.5</td></tr>
<tr><td>8</td><td>Intersection/Junction</td><td colspan="2">7</td></tr>
<tr><td>9</td><td>Traffic</td><td>km 40+100</td><td>km 79+300</td></tr>
<tr><td></td><td></td><td>1,775 Vehicles (1,735 PCU)</td><td>1,400 Vehicles (1,462 PCU)</td></tr>
<tr><td>10</td><td>Terrain type</td><td colspan="2">Plain</td></tr>
<tr><td>11</td><td>Soil Classification</td><td colspan="2">Black Cotton</td></tr>
<tr><td>12</td><td>Pavement Condition</td><td colspan="2">Fair to poor</td></tr>
<tr><td>13</td><td colspan="3">CD Structures</td></tr>
<tr><td></td><td>Major Bridge</td><td colspan="2">2</td></tr>
<tr><td></td><td>Minor Bridge</td><td colspan="2">9</td></tr>
<tr><td></td><td>Pipe Culvert</td><td colspan="2">41</td></tr>
<tr><td></td><td>Slab Culvert</td><td colspan="2">10</td></tr>
<tr><td></td><td>Box Culvert</td><td colspan="2">1</td></tr>
<tr><td></td><td>Total Number of Structures</td><td colspan="2">63</td></tr>
<tr><td>14</td><td>Riding Quality- IRI (m/km)</td><td>2.76-5.62</td><td>3.63-6.98</td></tr>
<tr><td>15</td><td>Existing Crust Thickness</td><td>200-680</td><td>280-600</td></tr>
<tr><td>16</td><td>Soaked CBR</td><td>1.10-8.70</td><td>4.30-8.20</td></tr>
<tr><td>17</td><td>Vehicle Damage Factor</td><td></td><td></td></tr>
<tr><td></td><td colspan="3"><table><tr><th>Vehicle Type</th><th>VDF</th></tr><tr><td>Mini Bus</td><td>0.51</td></tr><tr><td>LCV</td><td>0.63</td></tr><tr><td>BUS</td><td>0.30</td></tr><tr><td>2-Axle Truck</td><td>5.38</td></tr><tr><td>3-Axle Truck</td><td>8.16</td></tr><tr><td>M-Axle Truck</td><td>4.60</td></tr></table></td></tr>
</table>

4 TRAFFIC ANALYSIS AND FORECAST

4.1 INTRODUTION

16. Road development projects are meant for achieving multi-objectives while meeting the basic needs of the road user - *Mobility and Accessibility*. Key functionalities and upcoming utilization of the project corridor in years to come is the essential task for which the highway facility needs to be upgraded or improved. All proposed solutions from traffic point of view have appropriately been incorporated with respect to issues related to geometry, environmental and social.

4.2 EXISTING TRAFFIC CHARACTERISTICS

17. The analysis of traffic volume data indicates an ADT of 1,830 vehicles, equivalent to 1,789 PCU, at km 40+100 while 1,443 vehicles, equivalent to 1,507 PCU, are observed at km 79+300. Two-wheelers comprise the maximum share of vehicular traffic of about 55% at km 40+100, and about 49% at km 79+300. Around 8 to 8.5% of the total traffic is travelling within peak hour as observed at km 40+100 and km 79+300.

18. Travel desire pattern on the corridor indicates most of the traffic travelling within the state. Dhansura, Malpur and Meghraj are identified as major intersection/junctions at which peak hour volume observed is 914, 2,142 and 1,450 respectively. Speed and delay study indicates the existing average speed on the corridor as 37 kmph. The maximum VDF values are observed as 4.27 and 3.3 for 2-axle trucks and 3-axle trucks respectively.

19. The passenger and goods traffic characteristics indicate that most of the trips are made for shorter distances and accordingly shorter durations. The analysis indicates around 40% and 20% of the passenger and goods trips, respectively, to be made daily.

20. The major commodity being carried on the corridor is building materials. Dhansura – Kapadvanj (SH-059) and Dhansura-Prantij (SH-068) are identifies influencing corridors on which 5,771 vehicles (5,553 PCU) and 6,433 vehicles (9,384 PCU) are observed respectively.

4.3 TRAFFIC FORECAST

21. Traffic forecast is done using both – Trend Based and Econometric Method. In addition, incorporating Client and World Bank view points, appropriate options are worked out. The growth of registration vehicles in state as well as flat 5% growth of vehicles each year is worked out to better ensure the realistic assessment of traffic forecast. Growth rates estimated from Trend Based Method is adopted. The forecasted traffic using Trend Based, Econometric and Flat 5% growth rates are presented in Table 4.1.

Table 4.1: Total Forecasted Traffic

Traffic/ Year	km 40+100, Near Shaktinagar							km 79+300, Kambharoda						
	2011	2015	2020	2025	2030	2035	2040	2011	2015	2020	2025	2030	2035	2040
Traffic Forecast by Econometric Method														
Vehicle	1,775	2,235	3,011	3,910	4,981	6,245	7,853	1,400	1,729	2,283	2,915	3,658	4,516	5,587
PCU	1,735	2,165	2,932	3,870	5,055	6,548	8,533	1,462	1,746	2,243	2,829	3,541	4,397	5,489

Traffic Forecast by Trend Based Method														
Vehicle	1,775	2,164	2,731	3,453	4,295	5,069	5,666	1,400	1,682	2,095	2,615	3,212	3,757	4,175
PCU	1,735	2,105	2,650	3,344	4,176	4,947	5,547	1,462	1,716	2,086	2,551	3,088	3,578	3,955
Traffic Forecast by Flat 5% Growth Rate														
Vehicle	1,775	2,157	2,753	3,514	4,485	5,724	7,305	1,400	1,701	2,170	2,770	3,535	4,512	5,758
PCU	1,735	2,109	2,691	3,435	4,384	5,595	7,141	1,462	1,776	2,267	2,893	3,690	4,710	6,011

4.4 IMPROVEMENT OPTION

22. The improvement option proposed is SL/IL to 2LHS and is further reconfirmed with concerns related to geometry, safety, land acquisition, environmental and social aspects, before incorporation in the final design of the corridor.

5 ROAD SAFETY AUDIT

5.1 PROJECT BRIEF

23. Dhansura-Meghraj is proposed to be improved with better riding quality and enhanced safety. Road Safety Audit addresses identification of safety related deficiencies as well as behavioral safety issues while subsequently recommending countermeasures in approaching towards sustainable design solution. All sections of the project corridor are visited and studied. Review and audit of safety measures of the corridor are followed with the prevailing best practices. With proposed improvement option of two lane with granular shoulders, the objective of the exercise focuses on abating road accidents and their severity while improving riding quality.

5.2 ACCIDENTS STATISTICS

24. First Information Report (FIR) details relating to the accidents, fatalities and injuries in the project corridor and its immediate influence area are collected and studied. Though such information is recorded by police stations, there is a potential scope of other minor injury and property damage accidents to not have reported. However, efforts are extended in preparing safety improvement options beyond available accident data and the same is incorporated in final improvement proposals. 17 fatalities and 34 injuries reported in a span of 6 years (2006 – 2011). The data indicates most accidents concentrated at Aniyor, Aniyor kampa and Dhansura.

5.3 SAFETY ISSUES FOR PROJECT CORRIDOR

5.3.1 Carriageway

25. It is observed that carriageway and shoulders are inadequate in width. It is essential to increase the carriageway width in this entire stretch at least up to 7.0 meters + edge strips 1.0 m on either side for improved safety.

5.3.2 Geometric design

26. During the audit, it is identified that sight distance at sharp curves lack in standards and needs to be improved with geometric design. Curve passing through villages needs proper signage. Appropriate control measures are essential.

5.3.3 Intersections/Junctions

27. There are seven major junctions/intersections observed on the project corridor. It is observed that considerable habitants gather near these junctions; thereby generating local trips. It is audited that the existing junction/intersection design lacks in incorporating local travel behaviour and influence of habitations in proximity, which makes them potential accident prone spots. It is identified that careful attention needs to be given in developing appropriate designs for these junctions/intersections. In addition, provision of suitable location of bus stops near junction/intersection needs to be considered.

5.3.4 CD Structures

28. The cross drainage works, especially culverts/Canals, are narrow in width and the parapets of the culverts are potential hazards.

5.3.5 Wayside amenities

29. It is observed that Intermediate Public Transport (IPT) modes operating on this corridor are popular as well as in demand due to their services in providing local accessibility and mobility at affordable price to the habitants. They usually travel with over occupancy and their stoppages and parking are uncertain, creating chaotic and unsafe conditions to the other traffic utilizing corridor.

5.3.6 Traffic Management and Control Issues

30. It is identified that traffic signs needs to be provided at many places. Existing signages are in a poor condition. It is identified that provision of pavement markings lack at many places on the project corridor.

5.4 IDENTIFIED ISSUES AND SUGGENTIONS

31. Suggestions, recommendation as well as issues identified from safety audit are incorporated into final improvement options which include, but not limited to,

a. Deficient 36 horizontal curves;
b. Identified 115 major/minor intersections (including access roads);
c. Identified 12 highway sections near habitations and;
d. Identified deficient 63 structures.

32. The details of the recommended interventions are presented in Volume III Road Safety Audit.

6 DESIGN OF CORRIDOR

6.1 INTRODUCTION

33. This chapter deals with detailed analysis of road geometrics, development aspects, safety and road furniture requirements, to provide pleasant and aesthetic highway for road users. This chapter also discusses about pavement design, design and rehabilitation proposals of CD structures and bridges.

6.2 IMPROVEMENT OPTION

34. The existing carriageway width of the project corridor is 3.5-3.75m, i.e. Single Lane (SL) configuration for Dhansura-Malpur section, thereafter from Malpur-Meghraj project section is having carriageway of 5.5m (intermediate lane) and with 10m wide carriageway at Malpur and Meghraj. Project scope is for widening of existing road from SL/IL to 2L++HS configuration.

35. The project corridor has right of way of 24 m. The improvement option for project corridor is seen with respect to traffic, safety, speed and mobility. World Bank advises and shared iRAP[8] reports are also taken into consideration.

36. The project section, Dhansura-Malpur is carrying 1775 vehicles on the project road in 2011-2012 projecting to 3,344 PCUs in 2025 and 5,547 PCUs in 2040. Looking to traffic figures project road calls for higher order up gradation from the year 2013-2014. The emerging traffic scenario and feasibility of improvement option can be simulated through Table 6.1.

Table 6.1: Emerging Traffic Scenario and Improvement Needs

Project Section	Traffic /Year	2011	2015	2020	2025	2030	2035	2040
Dhansura-Malpur	Vehicle	1,775	2,164	2731	3,453	4295	5,069	5,666
	PCU	1,735	2,105	2,650	3,344	4,176	4,947	5,547
	Configuration	SL	2LHS					
Malpur-Meghraj	Vehicle	1,400	1,682	2,095	2,615	3,212	3,757	4,175
	PCU	1,462	1,716	2,086	2,551	3,088	3,578	3,955
	Configuration	IL	2LHS					

37. The project section Malpur-Meghraj is carrying 1,400 vehicles on the project road, in 2011-2012 projecting to 2,551 PCUs in 2025 and 3955 PCUs in 2040. Not traffic numbers but importantly bridging the tribal villages and talukas supports up gradation to standard two lanes. The project section does not call for up gradation before 2040. Based on World Bank's

[8] iRAP: International Road Assessment Programme, Gujarat is also covered under the Programme with selected corridors. Findings of IRAP and recommendations at particular stage are shared.

advice of provisioning of wide hard shoulders irrespective of the capacity needs but on the pretext of the safety aspects.

38. The project corridor is proposed to be widened and strengthened to two lanes and wide hard shoulder (2L+HS). The cross-section depicting placement of existing carriageway and proposed improvement is presented through Figure 6.1.

39. Cross sectional elements are based on the adopted design standards. The adopted lane width is 3.5 m, hard shoulder is 1.0 m wide in general, based on safety it is proposed for 2.5 m wide hard shoulders with 12.0 m wide formation width.

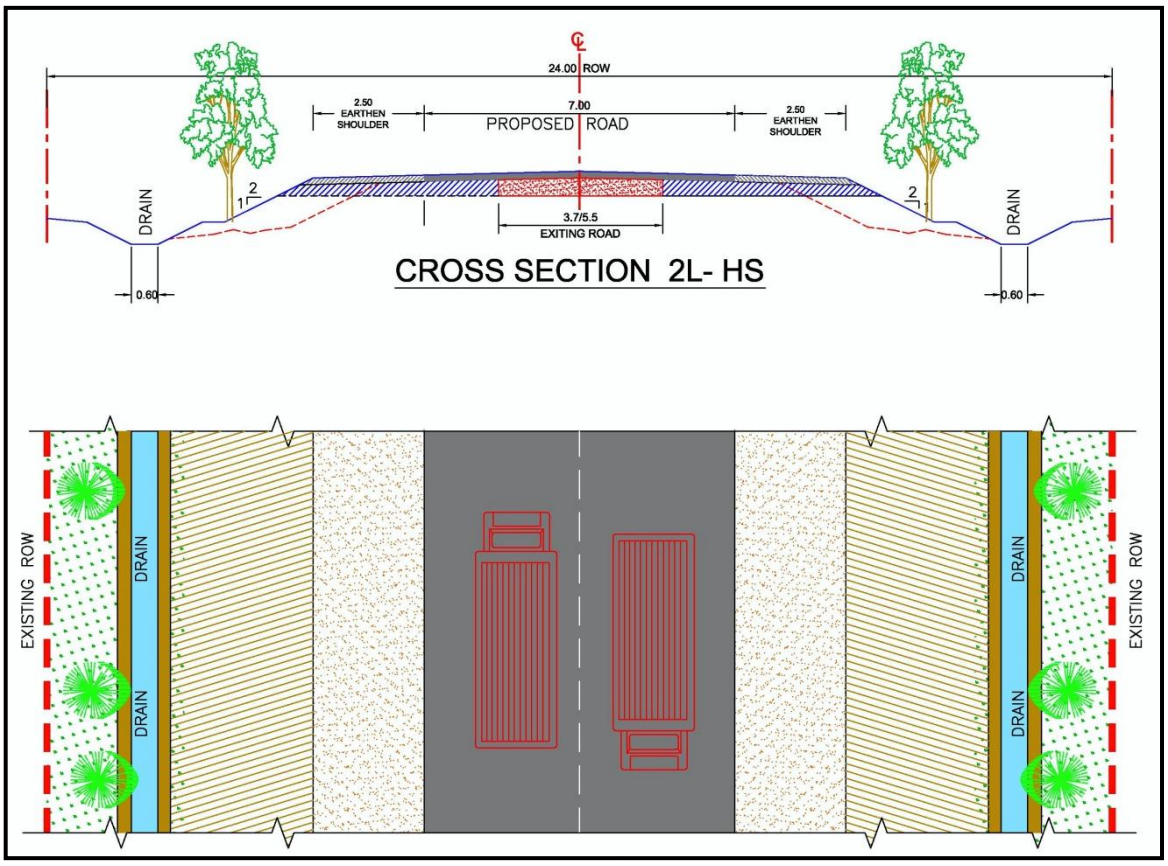


Figure 6.1: Proposed Improvement Option (SL/IL to 2L+HS)

40. The project corridor predominantly traverses through agriculture land. Existing environmental and social aspects are duly integrated in improvement scheme within available right of way width.

6.2.1 WIDENING SCHEME

41. Existing road is placed concentrically within available ROW of 24m, in general. The condition of the existing pavement is fair along the project corridor.

42. The project corridor Dhansura-Meghraj is proposed for overlay and widening along with improvement in geometry. The concentric option is worked out with consideration of available RoW, least disturbance to utilities along the project road including social impacts on the project corridor.

43. The factors considered for widening preferences are:

- Availability of land;
- Geometric improvement;
- Utility Lines;
- Ribbon developments and settlements; and
- Environmental and Social concerns.

44. The proposed widening scheme is presented in Table 6.2.

Table 6.2: Proposed Widening Scheme

From (km)	To (km)	Length (m)	Existing Carriageway Width in (m)	Proposed Carriageway in Width (m)	Hard Shoulder in m	Remarks
Dhansura-Meghraj						
38.502	38.558	56	3.7	7.0+1.5+7.0	2.5	Junction Imp.
38.558	42.6	4042	3.7	7	2.5	
42.6	42.9	300	3.7	7	2.5	
42.9	44.375	1475	3.7	7	2.5	
44.375	44.475	100	3.7	7.5	2.5	
44.475	48.05	3575	3.7	7	2.5	
48.05	48.325	275	3.7	7	2.5	
48.325	48.975	650	3.7	7	2.5	
48.975	49.8	825	3.7	7	2.5	
49.8	50.7	900	3.7	7	2.5	
50.7	51.55	850	3.7	7.5	2.5	
51.55	54.825	3275	3.7/7.0	7	2.5	Approaches to bridges are 7.0m wide
54.825	55.425	600	3.7	7.5	2.5	
55.425	56.785	1360	3.7	7	2.5	
56.785	56.925	140	3.7	7.5	2.5	
56.925	57.55	625	3.7	7	2.5	
57.55	57.85	300	3.7	7	2.5	
57.85	58.6	750	3.7	7	2.5	
58.6	58.9	300	3.7	7.5	2.5	
58.9	60.075	1175	3.7	7	2.5	
60.075	60.275	200	3.7	7	2.5	
60.275	62.575	2300	3.7	7	2.5	
62.575	62.825	250	3.7	7.5	2.5	
62.825	63.125	300	3.7	7	2.5	
63.125	63.25	125	3.7	7.5	2.5	
63.25	64.505	1255	3.7	7	2.5	
64.505	64.584	79	3.7	7.0+1.5+7.0	2.5	Junction Imp
Malpur-Meghraj						
67.711	67.784	73	10	7.0+1.5+7.0	1.5	Junction Imp
67.784	67.975	191	10	10	1	Foot Path /Drain
67.975	68.45	475	10	10	1	
68.45	70.065	1615	5.5	7	2.5	
70.065	71.175	1110	5.5	7	2.5	
71.175	71.4	225	5.5	7	2.5	
71.4	71.8	400	5.5	10	-	Footpath cum Drain
71.8	73.5	1700	5.5	7	2.5	
73.5	74.425	925	5.5	7	2.5	
74.425	83.9	9475	5.5	7	2.5	
83.9	84.65	750	10	10	1	
84.65	84.907	257	10	10	1.5	Foot Path /Drain
84.907	84.986	0.08	10	7.0+1.5+7.0	1.5	Foot Path/Drain

6.2.2 DESIGN INTERVENTIONS

45. The process involved in design intervention is depicted in Figure 6.2.

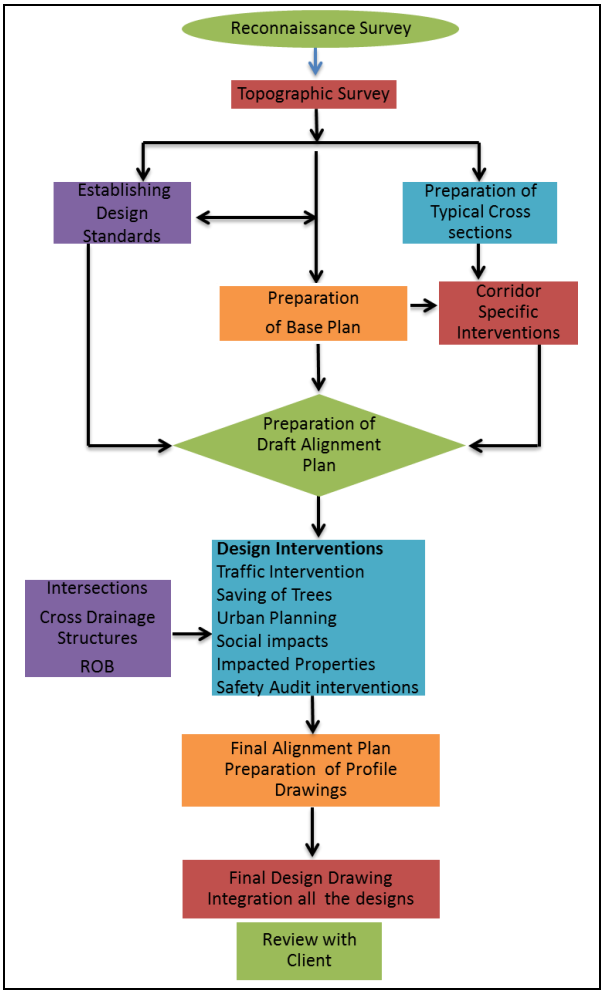


Figure 6.2: Design Interventions

Speed

46. The horizontal geometry with speeds less than 65 kmph in rural sections is improved. Largely following the mandate improvements are proposed within available RoW. Efforts are also made to provide safe designs in settlements considering speeds 40-65 kmph.

Intervention on Saving of Trees

47. No significant of impact on existing plantation is observed along the project corridor. Alignment improvement/modifications evaluated lesser impact on tree cutting.

Social Impact

48. Special efforts have been made to minimize the social &environment impacts by shifting the alignment along the project corridor at sensitive receptors. Two wells along project corridor within corridor of impact at km 53+760 and km 78+490 are saved by adjusting the alignment. The land acquisition is avoided in tribal area of Meghraj taluka which is part of Fifth Schedule Area. The alignment is adjusted to eliminate impacts on temple at km 55+750 and km 78+495.

49. For the sections through settlements specific care has been taken to safe guard cultural properties, existing permanent structures and kiosks towards reducing the social impacts. In total 72 socially impacted structures are identified in the initial stages of design, the same is reduced to 26 after design interventions coupled with road furniture and safety measures along the project corridor.

Safety

50. The safety is very much incorporated in design process; interventions include provision of speed humps at exit and entry of settlements, foot paths, improved junction layouts, advanced warning signs, rumble strips, provision of guard rails etc. The detailed interventions on safety are provided through Volume III of this DPR.

6.3 GEOMETRIC DESIGN INTERVENTIOINS

51. Base plan of the corridor showing all existing natural and manmade features has been prepared using the topographical survey data. All the features within a band width of 60m have been captured with an unique "description code" during the survey along with the details of existing carriageway centreline, edge of pavement, edge of shoulder, toe line of the embankment etc. Survey data is formatted to suit the requirements of Civil 3D environment. The steps followed for preparation of base plan are:

- Data is imported into software;
- Main corridor features are defined by joining the points of centerline, edge of pavement, embankment toe line;
- The points with same description codes for all physical features like rivers, buildings, religious structures, shops, telephone poles, electric poles, cross roads etc. within the above specified limits are joined;
- Break lines for features such as edge of the road, shoulder, nallahs, top and bottom of ditches, etc. are established;
- Details of existing cross drainage structures such as bridge number, span arrangement etc. are inserted;
- Details of utility services collected are inserted;
- The prepared base plans are verified and updated by "walkover" surveys and
- Additional survey data where necessary is gathered and the base plans is finalized.

6.3.1 Horizontal Alignment Design

52. Design of the horizontal alignment has been carried out in CIVIL 3D environment as per the finalised widening scheme. Extensive field checks to verify the feasibility of the proposed alignment have been carried out and suitable modifications to the alignment have been effected wherever considered essential to safeguard sensitive elements.

53. The design chainage is given Table 6.3.

Table 6.3: Design Chainage

Project Section	Start Chainage (km)	End Chainage (km)	Length (km)
Dhansura-Malpur	38+501.28	64+583.61	26.082
Malpur-Meghraj	67+711.75	84+986.94	17.275

54. Geometric design of project corridor has been conceptualized for a design speed of 80/100kmph in rural sections and 40-60 kmph in village/urban sections as per the design standards formulated for the project. The project corridor has fair horizontal geometrics but several locations of horizontal curves (40 Curves), low degree of curvature are identified and are improved.

55. Geometric improvement has been carried out, with due consideration of project features, social impact assessment, along with interventions due to green tunnels. Crossroads have been realigned at the junction with main carriageway to reduce the skew angle of the crossing and to ensure safety. The list of access roads with realignment is provided Volume VIII of this report. The process involved in design intervention is depicted in Figure 6.2. The

geometry is improved within available RoW, except at following locations where Land Acquisition (LA) is inevitable for improvement. The location of LA is given in Table 6.4.

Table 6.4: Location of LA

Chainage		Side	Village	Total Area (sq.m)	Total Area (ha)
From (km)	To (km)				
57+594	57+852	LHS	Satarda	1592.873	0.1592873
70+672	70+896	RHS	Medi timba	1040.018	0.1040018
70+999	71+085	RHS	Medi timba	426.643	0.0426643
71+085	71+110		River Portion		
71+110	71+148		Nanavada		
74+095	74+290	RHS	Parsoda	2356.641	0.2356641
Total				**5416.175**	**0.5416175**

6.3.2 Vertical Alignment Design

56. The existing vertical geometry for majority of project road calls for attention. The project road is in place since long, but the proper design of project corridor has not probably taken place in recent times. The unevenness in profile calls for efforts for designing the vertical profile. The existing pavement is under fair condition.

57. The design Finished Road Levels (FRL) at the centreline of the roadway is determined from new pavement design for Dhansura-Malpur and Malpur-Meghraj. The pavement design necessitates overlay in sections as discussed in subsequent chapters.

58. For fixing the design finished road level an overlay of 25 mm SDBC and 100mm[9] of BM is proposed. Out of the 100 mm BM, 75 mm is for overlay and 25 mm is profile corrective course (PCC). During the design of vertical profile, due unevenness in existing profile, it is observed that PCC is required to keep design profile within design standards set out for project corridor.

59. Cutting of existing pavement to provide required finished road level is kept to a minimum and adopted only when cost effective or most appropriate.

6.3.3 Side Slopes

60. The average embankment height of existing project road is about 0.5-1.0 m. The side slopes of highway embankments shall be as flat as possible so that drivers accidentally leaving the roadway have better chances of survival. This has been also recommended in IRC-36, which provides a side slope of 1:4 for low embankment upto1.5m height, although due to limited RoW and accommodating the longitudinal drains the slope is kept as 1:2.0. Where required essential safe guards are proposed.

[9] Includes 75mm overlay requirement in BM, rest 25 mm considered as PCC, but modelled to have 50 mm layer first to have corrected good profile along with structural layer built-in, followed by uniform 50mm as next layer. This optimises the PCC quantity.

6.3.4 Road Side Drainage

61. Project corridor is passing through agricultural lands, call for attention on drainage. The longitudinal drain is proposed all along the project corridor. The drain width is 0.6m at bottom and 1.2:1 side slopes. The drainage analysis along the project road is provided in Volume II of this report.

62. Closed drains are proposed in location given in Table 6.10.

Table 6.5: Proposed Footpath and Closed Drains Locations

Sr. No.	Location	From (km)	To (km)	Side
Footpath with RCC drain				
1	Nanawada	71+400	71+800	Both
Footpath				
1	Shaktinagar near school	40+165	40+230	LHS
		40+260	40+310	LHS
		40+280	40+415	RHS
2	Sherdi Kampa near school	47+625	47+760	LHS
		47+710	47+760	RHS
3	Parsoda near school	74+300	74+400	Both

6.3.5 Utility Crossings

63. Utility crossings are proposed at 9 locations to avoid frequent digging of carriageway.

6.4 INTERSECTION/JUNCTION DESIGN

64. At-grade intersections/junctions, unless properly designed can be accident-prone and can reduce the overall capacity of the road. The basic requirements for the design of intersections are not only to cater safe movements of road users, but also to provide them full traffic information by way of signs and pavement markings. Simplicity and uniformity is the guiding principles for intersection design. Based upon these principles at-grade intersections/junctions have been categorized as:

1. Major Intersections/Junctions
2. Minor Intersections/Junctions
3. Access roads and Cart Tracks

65. The project corridor is having six major junctions/intersections, 12 minor junctions/intersections and 27 access roads and cart tracks. The location of intersections along the project road with various categories of roads, improvements proposed is detailed in this section.

6.4.1 Major Intersections/Junctions

66. Intersections/junctions with category of roads like NH/SH/MDR and having black top surface are presented in Table 6.6.

Table 6.6: Major Intersections/Junctions

Sr. No.	Intersection/ Junction	Type	Chainage (km)	Existing Width (m)	Improvement
1	Dhansura	3-Arm	38+501	3.75	As per MOST standards
2	Malpur	3-Arm	64+583.61	3.75	As per MOST standards
3	Malpur	4-Arm	67+711.75	10.00	As per MOST standards

Sr. No.	Intersection/ Junction	Type	Chainage (km)	Existing Width (m)	Improvement
4	Mewada	3-Arm	72+760	5.5	As per IRC
5	Meghraj	3-Arm	84+986.94	10.00	As per MOST standards

67. The start of the project corridor forms a junction with SH-59 near Dhansura, providing connectivity to Kapadvanj and Modasa. The junction design is based on type designs for T junction on NH/SH as per MOST specifications. Another two junctions is at Malpur with SH-5 providing connectivity to Northern States to south Gujarat. The Meghraj end forms T-junction for the town. The detailed junction/intersection design is provided through Volume VIII.

6.4.2 Minor Junctions

68. The project road is having 47 junctions with category of roads like MDR ODR and VR. Two typical designs (Type-I, Type-II) have been developed for these junctions types. Type-1 is for approach road having carriageway width greater than 5.0 m. Type-2 is for approach road having carriageway width less than 5m. One out of the 47 is Type-1. Design details of these intersections are provided at Volume VIII- Drawings.

6.4.3 Access Road and Cart tracks

69. The access road leading to commercial establishments, public amenities and cart tracks leading to agricultural fields are 102 in number along project road. For access road/cart tracks two types of typical designs are developed i.e. Type-I and Type-II. Type-I is for access road having carriageway width greater than 5 m. Type-2 is for access road having carriageway width less than 5 m. Design details of these intersections are provided at Volume VIII Drawings.

6.5 WAYSIDE AMENITIES AND SAFETY ASPECTS

6.5.1 Pedestrian Safety

70. Pedestrian crossing a across project road is normally major cause of concern for the accidents. iRAP study findings for Gujarat have highlighted such and other issues. To reduce the speed and subsequently to increase the pedestrian safety rumble strips are proposed at major intersections/ junctions and at entry and exit of settlements.

71. **Rumble strips** are provided at 49 locations on project corridor

72. **Pedestrian Crossings:** Raised pedestrians crossings are provided at 18 locations on project corridor

6.5.2 Crash Barrier

73. The guard rails are provided at sharp curves, approaches to canals along with signage's to provide safety for vehicles at such locations. The locations of guard rails are given in Table 6.7. The guard rails are provided with W-metal beam type barrier, the details of same are provided in design drawings.

Table 6.7: Location of Crash Barrier

Sr. No.	From (km)	To (km)	Side	Location
1	39+950	40+425	RHS	Trees
2	42+600	42+900	Both	Curve
3	43+200	43+400	Both	Curve
4	44+960	44+000	LHS	Bridge
5	48+000	48+300	Both	Curve
6	49+150	49+350	Both	Curve
7	51+750	52+050	Both	Bridge
8	52+700	52+950	Both	Bridge
9	53+755	53+790	LHS	Well
10	57+600	58+100	Both	Curve
11	68+115	68+140	LHS	Trees
12	69+790	69+900	LHS	Trees
13	71+850	71+870	RHS	Well
14	72+690	72+660	RHS	Trees
15	72+900	73+200	Both	Bridge
16	73+125	73+360	Both	Bridge
17	77+750	77+415	RHS	Trees
18	78+195	78+215	LHS	Well
19	78+460	78+490	LHS	Well
20	82+000	82+500	both	Curve
21	82+700	82+900	RHS	Bridge
22	83+150	83+250	Both	Culvert

6.5.3 Signage

74. The detailed signage plan is provided in Volume VIII of this report. The same is checked for compliance to the safety audit report.

6.5.4 Bus Shelter and Busy bays

75. There are existing bus stops along project road. Generally these stops are associated with a settlement area or an intersection with a crossroad. It is proposed to provide bus stops and bus bays in both directions at these locations. The details of bus shelter and bus bay locations along the project corridor are given Table 6.8 and Table 6.9.

76. The typical design of bus shelter is provided in Figure 6.3.

Table 6.8: Existing Bus Shelter

Sr. No.	Chainage (km)	Side	Village	Remarks
Dhansura-Malpur				
1	40+200	RHS	Shaktinagar	Use existing bus stop
2	41+450	RHS	Adalpur	Use existing bus stop
3	44+375	RHS	Rampir kampa	Existing demolished
4	45+225	RHS	Bilvaniya	Existing demolished
5	47+775	RHS	Sherdi kampa	Existing demolished
6	55+775	RHS	Aniyor Kampa	Use existing bus stop
7	60+190	RHS	Surana pahadiya	Existing demolished
8	61+630	LHS	Laljina Pahadiya	Use existing bus stop
9	62+400	LHS	Vavdi	Use existing bus stop
10	63+680	LHS	Mahiyapur	Existing demolished
Malpur-Meghraj				
11	67+825	RHS	Malpur	Use existing bus stop
12	70+050	RHS	Meditimba/Sonik pur	Existing demolished
13	71+380	LHS	Nanawada	Use existing bus stop
14	77+650	RHS	Eploda	Existing demolished
15	79+335	RHS	Kambhroda	Use existing bus stop
16	83+390	RHS	Vasna	Existing demolished

Table 6.9: Proposed Busbay and Shelters

Sr. No	Chainage (km)	Side	Village	Remarks
Dhansura-Malpur				
1	38+630	LHS	Dhansura	New
2	40+200	RHS	Shaktinagar	Only bus bye
3	40+375	LHS		New
4	41+500	RHS	Adalpur kampa	Only bus bye
5	41+615	LHS		New
6	44+320	RHS	Rampir Kampa	New
7	44+450	LHS		New
8	45+125	RHS	Bilvaniya	New
9	45+310	LHS		New
10	47+660	RHS	Sherdi kampa	New
11	49+330	RHS	Kamaliya Kampa	New
12	49+475	LHS		New
13	53+025	RHS	Aniyor	New
14	53+160	LHS		New
15	55+760	RHS	Aniyor Kampa	Only bus bye
16	55+860	LHS		New
17	60+075	RHS	Surana Pahadiya	New
18	61+630	LHS	Laljina Pahadiya	Only bus bye
19	62+275	RHS	Vavdi	New
20	62+400	LHS		Only bus bye
21	63+540	RHS	Mahiyapur	New
22	63+775	LHS		New

6.5.5 Bus Shelter Design

77. Shelter at both side of the main road within settlement areas as per Table 6.8.Bus shelter is designed with inbuilt aspect for maintenance free considering rural/ urban lifestyle.

78. In the bus shelter necessary seating arrangement and support facilities are provided. Planting of low height large foliage flowering trees near by bus shelter, makes pleasant situation for the road users.

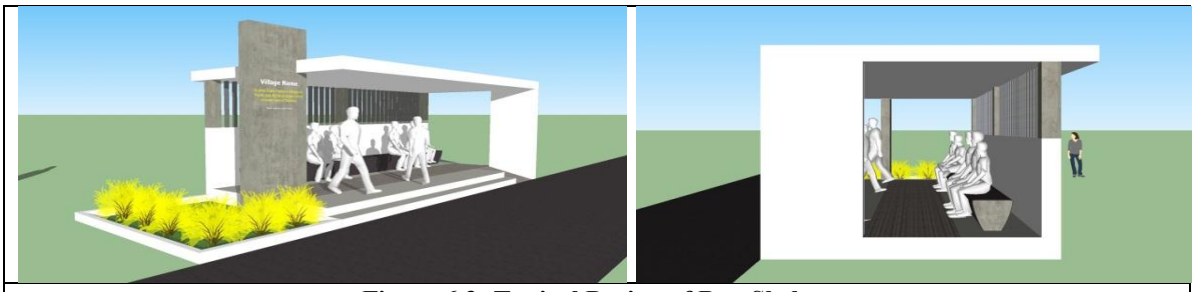


Figure 6.3: Typical Design of Bus-Shelter

6.5.6 Foot Paths and Closed Drains

79. Foot paths and along with closed drains are proposed in location given in Table 6.10.

Table 6.10: Proposed Footpath and Closed Drains Locations

Sr. No.	Location	From (km)	To (km)	Side
Footpath with RCC drain				
1	Nanawada	71+400	71+800	Both
Footpath				
1	Shaktinagar near school	40+165	40+230	LHS
		40+260	40+310	LHS
		40+280	40+415	RHS

Sr. No.	Location	From (km)	To (km)	Side
2	Sherdi Kampa near school	47+625	47+760	LHS
		47+710	47+760	RHS
3	Parsoda near school	74+300	74+400	Both

6.5.7 Integration of Way Side Facilities

80. The integration of bus shelter, foot path and pedestrian crossing is done and the typical plan is depicted in Figure 6.4.

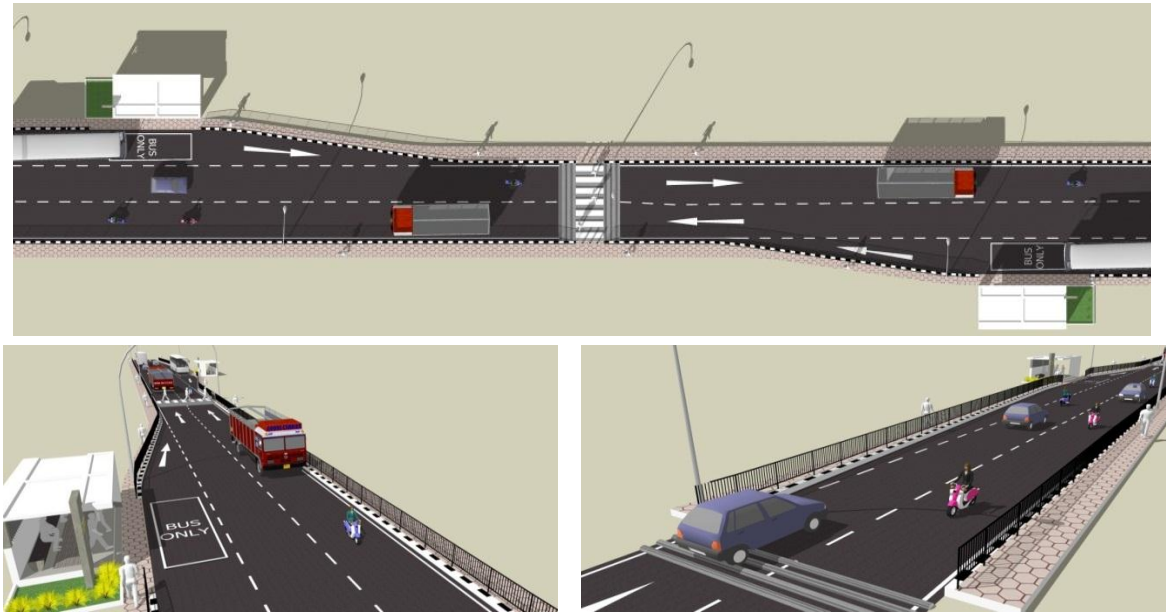


Figure 6.4: Integration of Wayside Facilities

6.5.8 Information on Infrastructure Development

81. The entry and exit point is treated with welcome signage's with due information regarding the project corridors. The same is shown up in Figure 6.5. The detailing is provided in Volume-VIII of this report. The signs are provided at four locations near exit and entry of project sections.

Figure 6.5: Typical View of Welcome Sign

6.5.9 Truck laybys

82. The truck laybys are proposed one each at Dhansura-Malpur and Malpur-Meghraj sections. The truck laybys are provided at locations where additional land acquisition is proposed i.e. km 57+650 and km 70+700.

6.6 PAVEMENT DESIGN

6.6.1 General

83. Pavement design forms an integral part of highway design. Pavement performance under prevailing and projected traffic and environmental conditions is considered to be

crucial as it has an implication on the economic returns from the project. Present section of the report deals with pavement design and strengthening of the existing pavement crust. Detailed description of pavement evaluation and pavement design has been included in Volume-II under pavement design chapter.

6.6.2 PROPOSED ROAD STRENGTHENING AND RECONSTRUCTION NEEDS

6.6.2.1 General

84. Distresses other than ravelling on the pavement of the entire corridor covering 43.05 km of road are not severe, however the ride quality is not up to mark. The IRI in most of the cases is more than 3. The characteristic deflection is high, the traffic loading is moderate. However, in order to control further deterioration of pavement and improve the riding quality strengthening of pavement is necessary. All 43.05 kilometres of road are considered most suitable candidate for strengthening of pavement by providing bituminous overlays on the existing pavement. The strengthening of pavement option envisages that the candidate preventive treatments will focus primarily on medium thick overlay, shape correction, pavement preparatory works, shoulder repairs and drainage.

85. The lane configuration of existing road is single lane and short intermediate lane. It is proposed to widen the existing road pavement to standard two lane configuration along with hard shoulders.

86. Pavement design for widening of carriageway to standard two-lane and paved shoulder is carried out as new pavement design based on the concept of repetitions of million standard axles during the design life and design CBR of subgrade and in accordance with IRC Publication No.IRC;37-2001.

Table 6.11: Summary of Pavement Condition and Treatment Option

Section	Length (km)	Carriageway Width (m)	Status of pavement condition	Proposed treatment
Dhansura-Malpur section	25.60	3.75	Fair with High Ravelling, High IRI	Strengthening the existing pavement and widening to standard two lane CW
Malpur- Meghraj section	17.45	5.5 to 10		

6.6.2.2 Design Life of Pavement

87. The design life of new pavement is considered 10 years for bituminous courses and 15 years for graular base and sub base courses. The overlays (strengthening course) have been designed for 7 year design life from the year of completion of construction.

6.6.2.3 Pavement strengthening (overlay) strategy

88. Pavement strengthening strategy adopted in this project envisages that after attending to the rectification of defects like cracking, potholes, deep depressions, and rutting etc. the overlay will be laid over the existing bituminous surface.

89. The design of the overlay has been carried out to determine the strengthening requirement for a forecast period of 7 year's traffic demand.

90. The requirement of overlay have been deduced from the design curves relating characteristic deflection to the cumulative number of standard axles to be carried over the

design life given in IRC 81;1997. The thickness deduced from these is the overlay thickness in terms of bituminous macadam construction. The equivalent overlay thickness in terms of The equivalent overlay thickness in terms of BC/DBM to be provided shall be determined using appropriate equivalency factor given in IRC:81-1997, which are reproduced below:

- 1 cm of Bituminous macadam = 1.5 cm of WBM/WMM/BUSG
- 1 cm of Bituminous macadam =0.7 cm of DBM/AC/SDC

91. The annual rainfall in project area is >2000 mm and the design traffic (msa) is less than 10, the proposed wearing course shall be 30 mm SDBC and the binder course of BM of required thickness.

92. The designed overlay thickness for section under strengthening is given in Table 6.12.

6.6.2.4 Pavement Composition

93. Pavement composition for strengthening and widening of pavement of various sections is indicated in Table 6.12. Pavement design module is presented in Part I of Volume II of this DPR.

Table 6.12: Proposed Pavement Composition

Section	Overlay	New construction for widening
Dhansura-Malpur section- length-26.082 Km		
Section-1 Km 38.700 to 45.000 (Length- 6.3 Km)	SDBC- 25 mm BM- 100 mm in two layers (50+50)	SDBC-25 mm BM – 50mm WMM- 250mm GSBC-150 mm Subgrade 8 CBR-500mm
Section 2 Km 45.000 to57.000 (Length- 12 Km)	SDBC- 25 mm BM- 100 mm in two layers (50+50)	SDBC-25 mm BM – 50mm WMM- 250mm GSBC-150 mm Subgrade 8% CBR-500mm
Section 3 Km 57.000 to 64.100 (Length – 7.1 Km)	SDBC- 25 mm BM- 100mm in two layers (50+50)	SDBC-25 mm BM – 50mm WMM- 250mm GSBC-150 mm Subgrade 8% CBR-500mm
Malpur- Meghraj section- Length-17.275 Km		
Km 67.700 to 85.000 (Length- 17.3 Km)	SDBC-25mm BM- 100 mm in two layers (50+50)	SDBC-25 mm BM - 50mm WMM- 250mm GSBC-150 mm Subgrade 8% CBR-500mm

94. Although variation BM overlay in different sections of Dhansura-Malpur, the uniform BM thickness of 100 mm is considered, out of the same 50 mm is for Overlay and 50 mm is profile corrective course (PCC). The profile corrective in some of the sections is more than 50mm requirement due unevenness in the existing surface. The addition quantity of BM is worked out comparing the profiles.

6.6.3 Widening Scheme

95. The pavement widening scheme is provided in Table 6.13 and Table 6.14. Pavement sections are prepared with respect to type of treatment, varying widths, improvement options and road furniture in line with existing site condition on situation to situation, the typical cross-section are presented in Volume VIII of this DPR.

Dhansura-Malpur	
Type A:	Widening and Overlay, widening to 7.0 m carriageway 2.5 m wide shoulders.
Type B:	Widening and Overlay, widening to 7.0 m carriageway 2.5 m wide shoulders.
Type C:	Widening with extra width of 0.5 at locations of Geometric Improvement
Type D:	Four Lane Reconstruction for Junction improvement with formation width of 20.5
Malpur-Meghraj	
Type A1:	Widening and Overlay, widening to 7.0 m carriageway 2.5 m wide shoulders.
Type B1:	Widening and Overlay, widening to 7.0 m carriageway 2.5 m wide shoulders.
Type C1&C2:	Overlay only over 10m wide carriageway
Type D1:	Four Lane Reconstruction for Junction improvement with formation width of 20.5

Table 6.13: Pavement Widening Scheme Dhansura-Malpur

From km	To km	Length km	Type	Existing Carriageway (m)	Proposed Carriageway (m)	Hard Shoulder (m)	Formation Width (m)	Remarks
38.502	38.558	0.056	Type D	3.7	7.0+1.5+7.0	2.5	20.5	Junction improvement
38.558	42.600	4.042	Type A	3.7	7	2.5	12	
42.600	42.900	0.300	Type B	3.7	7	2.5	12	
42.900	44.375	1.475	Type A	3.7	7	2.5	12	
44.375	44.475	0.100	Type C	3.7	7.5	2.5	12.5	
44.475	48.050	3.575	Type A	3.7	7	2.5	12	
48.050	48.325	0.275	Type B	3.7	7	2.5	12	
48.325	48.975	0.650	Type A	3.7	7	2.5	12	
48.975	49.800	0.825	Type B	3.7	7	2.5	12	
49.800	50.700	0.900	Type A	3.7	7	2.5	12	
50.700	51.550	0.850	Type C	3.7	7.5	2.5	12.5	
51.550	54.825	3.275	Type A	3.7/7.0	7	2.5	12	Approaches to Bridges are 7.0m wide
54.825	55.425	0.600	Type C	3.7	7.5	2.5	12.5	
55.425	56.785	1.360	Type A	3.7	7	2.5	12	
56.785	56.925	0.140	Type C	3.7	7.5	2.5	12.5	
56.925	57.550	0.625	Type A	3.7	7	2.5	12	
57.550	57.850	0.300	Type B	3.7	7	2.5	12	
57.850	58.600	0.750	Type A	3.7	7	2.5	12	
58.600	58.900	0.300	Type C	3.7	7.5	2.5	12.5	
58.900	60.075	1.175	Type A	3.7	7	2.5	12	
60.075	60.275	0.200	Type B	3.7	7	2.5	12	
60.275	62.575	2.300	Type A	3.7	7	2.5	12	
62.575	62.825	0.250	Type C	3.7	7.5	2.5	12.5	
62.825	63.125	0.300	Type A	3.7	7	2.5	12	
63.125	63.250	0.125	Type C	3.7	7.5	2.5	12.5	
63.250	64.505	1.255	Type A	3.7	7	2.5	12	
64.505	64.584	0.079	Type D	3.7	7.0+1.5+7.0	2.5	20.5	Junction improvement

Table 6.14: Pavement Widening Scheme Malpur-Meghraj

From (km)	To (km)	Length (km)	Type	Existing Width (m)	Proposed CW Width (m)	Proposed Hard Shoulder (m)	Proposed Formation Width (m)	Remarks
67.711	67.784	0.073	Type D1	10	7.0+1.5+	1.5	18.5	Four Lane-Int

From (km)	To (km)	Length (km)	Type	Existing Width (m)	Proposed CW Width (m)	Proposed Hard Shoulder (m)	Proposed Formation Width (m)	Remarks
					7.0			
67.784	67.975	0.191	Type C1	10	10	1	12	Foot Path/Drain
67.975	68.450	0.475	Type C2	10	10	1	12	
68.450	70.065	1.615	Type A1	5.5	7	2.5	12	
70.065	71.175	1.110	Type B1	5.5	7	2.5	12	
71.175	73.500	2.325	Type A1	5.5	7	2.5	12	
73.500	74.425	0.925	Type B1	5.5	7	2.5	12	
74.425	83.900	9.475	Type A1	5.5	7	2.5	12	
83.900	84.650	0.750	Type C2	10	10	1	12	
84.650	84.907	0.257	Type C1	10	10	1.5	13	Foot Path/Drain
84.907	84.987	0.080	Type D1	10	7.0+1.5+ 7.0	1.5	18.5	Four lane Foot Path/Drain

Table 6.15: Type design in Widening Scheme (Dhansura-Malpur)

Type	Overlay		New Construction and Widening				
	SDBC	BM	SDBC	BM	WMM	GSBC	Subgrade 8 CBR
A,C	25	50+50	25	50	250	150	500
B,D			25	50	250	150	500

Table 6.16: Type design in Widening Scheme (Malpur-Meghraj)

Type	Overlay		Widening/Reconstruction				
	SDBC	BM	SDBC	BM	WMM	GSBC	Subgrade 8 CBR
A1	25	100	25	50	250	150	500
B1,D1			25	50	250	150	500
C1, C2	25	100					

6.7 IMPROVEMENT PROPOSAL FOR STRUCTURES

6.7.1 Proposal

96. **Major and Minor Bridges:** The major bridges at SH-145, km 52+600 and km 73+050 are in good condition, hence this bridges are retained. Out of 9 minor bridges 8 needs repair and only 1 needs widening and repair. The details of proposed treatments for bridges are provided in Table 6.17.

Table 6.17: Proposed Treatment: Dhansura-Meghraj (SH-145)

Sr. No.	Design Chainage (km)	Type of Bridge	Nos. of Span	Span length (m).	Total Length of Bridge	Total Width of Bridge	Carriageway Width (m)	Overall Structure Condition	Proposal
1	44+255	Minor	2	5.10	10.20	7.80	3.80	Condition: 3 1. Spall in slab 2. Loose Joints and Vegetation 3. Parapet damaged	Repair
2	47+335	Minor	4	6.80	27.20	8.00	7.10	Condition: 3 1. Loose Joints and Vegetation 2. Parapet damaged 3. Spall in slab 4. Scour	Repair
3	51+895	Minor	4	12.10	48.40	8.20	7.40	Condition: 4 1. Minor Spall 2. Vegetation	Repair
4	52+850	Major	5	12.20	61.00	8.30	7.50	Condition: 3 1. Minor Spall in Girder 2. Vegetation 3. Possibility of	Repair

Sr. No.	Design Chainage (km)	Type of Bridge	Nos. of Span	Span length (m).	Total Length of Bridge	Total Width of Bridge	Carriageway Width (m)	Overall Structure Condition	Proposal
								water pipe in LHS which is causing deterioration of pier 4. Scour	
5	58+361	Minor	2	7.00	14.00	8.30	6.90	Condition: 5 1. Horizontal members of railing missing	Repair
6	68+165	Minor	3	3.00	9.00	9.50	8.60	Condition: 3 1. Scour 2. Minor Spall 3. Poor quality of Coarse aggregates (pebbles) are used	Repair
7	71+305	Minor	3	6.20	18.60	8.40	7.60	Condition: 5 1. Minor Scour	Repair
8	72+500	Minor	1	7.60	7.60	7.60	5.00	Condition: 2 1. Heavy Scour needs immediate attention 2. Loose joints in railing, needs to be repaired 3. Loose joints in substructure 4. Vegetation	Repair and widening
9	73+080	Major	7	12.40	86.80	8.00	5.60	Condition: 3 1. Spall in slab 2. Vegetation 3. Requires Hydraulic Analysis	Repair
10	81+820	Minor	3	6.00	18.00	8.40	5.00	Condition: 4 1. Poor quality coarse aggregates (Pebbles)	Repair
11	84+530	Minor	2	6.35	12.70	8.40	7.30	Condition: 4	Repair

97. **Culverts:** The condition of some culverts along this corridor are bad, more over these are very old structures with loose joints, blockage of pipes, scour and growth of vegetation. Head walls of some culverts are damaged. Hence reconstruction is suggested of such highly damaged culverts.

98. The summary of proposed treatment for culverts is presented in Table 6.18.

Table 6.18: Summary of Proposed Treatment

Treatment	Numbers
Repair	40
Replace with new	10
Head wall reconstruction	2
Total	**52**

7 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

7.1 ENVIRONMENTAL IMPACT ASSESSMENT

99. The proposed upgradation (strengthening and widening) of Dhansura-Meghraj Corridor is designed within the available RoW. The environmental and social screening and the subsequent consultations with the stakeholders confirmed that there are no sensitive environmental features that are present along the corridor. In addition to the construction related impacts, the key issues of concern were (i) those arising from safety issues with respect to geometric / curve improvement and provision of road safety furniture's at settlement / urban areas and temples, schools and cultural properties and (ii) provision for sufficient drain facility including upgrading the bridges and culverts and provision of additional culverts at water logging areas.

100. As per the Government of Gujarat Gazette dated 5th July, 1973, the project corridor from Dhansura-Meghraj (SH-145) is notified as "Protected Forest" and warrants forest clearance for diversion of 36.76ha of forest land for non-forest purpose. Proposals have been submitted to the forest department for necessary action for the purpose of obtaining forest clearance and for seeking permission for tree felling.

101. The environmental impacts associated with the proposed widening and upgradation activities are construction related impacts pertaining to the road widening projects. These are proposed to be addressed through good engineering practices and adoption of environmental management measures proposed in the Environmental Management Plan (EMP) for the corridor. The EMP budget of INR 2.39 million comprises of the funds necessary for the implementation of management measures as well as includes the provision for environmental monitoring, HIV/ AIDS prevention measures and for the cultural / community enhancements.

7.2 LAND ACQUISITION AND RESETTLEMENT IMPACTS

102. A total of 1.02 ha land will be acquired for the geometric improvements, of this 0.89 ha is private agricultural land and remaining 0.14 ha is government land. Geometric improvements of curves trigger land acquisition at four locations (57+594 km to 57+852 km on LHS at Satarda village, 70+672 km to 70+896 km on RHS and 70+999 km to 71+085 km on RHS at Medi Timba, 71+110 km on RHS to 71+148 on RHS at Nanavada village, 74+095 km to 74+290 km on RHS at Parsoda village) in Malpur taluka of Sabarkantha district. Land acquisition and resettlement of the affected persons shall be carried out in accordance with the provisions of RPF of the project.

103. Apart from the impact on agricultural land of 10 households, 10 commercial structures (kiosks) which are of non-titleholders and boundary wall of 4 residential structures will be affected due to project intervention. No private structures and land are affected in

tribal area along the corridor. The project will affect 2 community assets (1 hand pump and 1 seating area around tree). Cultural properties will not be affected due to the project.

104. Five public consultation meetings were held along the project corridor with road side communities to obtain their views and suggestions regarding the proposed project interventions. The consultations have provided inputs towards mitigation of impacts, improvement in designs, and preparation of resettlement plan and its implementation. Based on the suggestions design modifications including curve improvement, shifting of alignment to protect mainly structures of religious importance, provision of road safety measures such as pedestrian crossings, warning signs, markings, etc has been carried out.

105. A resettlement budget of INR 1.5 million including compensation for the affected land and structures, assets within the affected properties and rehabilitation and resettlement assistance has been estimated. Any unforeseen impacts on resettlement during implementation will be taken up in accordance with the Resettlement Policy Framework (RPF) of the project.

8 ACCESSIBILITY AND MOBILITY TO TRANSPORT FACILITIES IN VILLAGES: SUMMARY

8.1 INTRODUCTION

106. Baseline socio-economic information related to accessibility and mobility to transport facilities in the villages along the proposed corridor has been collected and analyzed. The study intended to assess the travel pattern of villagers, which includes, travel time to major markets, educational and health institutions, frequency of trips to nearby places, perception of villagers on travel situation, etc. The findings of the present study shall form basis for measuring impacts after the proposed roads are improved. There are 82 villages located within 2 km bandwidth of the proposed corridor, of which 41 villages are chosen for the survey. Altogether 205 households are surveyed.

8.2 PROFILE OF SAMPLE POPULATION

107. **Gender and Age** D**istribution:** Age distribution shows that 52 percent of the population belongs to the age group of 26-60 and 11 percent of the population is in the age group of 6-14.

108. **Education profile:** Female population has a lower level of education compared to male population. 35 percent of the population has secondary levels of education and 14 percent are having graduation or higher qualifications.

109. **Income Profile and Dependency Ratio:** 75 percent of the sample households have a monthly income of less than Rs.3000; of which33 percent have a monthly income less than Rs.2000. The dependency ratio is 2.4:1

110. **Occupation Profile:** major percentage of sample population is engaged in agriculture.

8.3 MAJOR FINDINGS

111. **Trip Information:** Analysis of trip information of villagers is based on 549 cases of usual trip information of 205 surveyed households. Analysis based on chi-square test shows that trip information does not vary significantly between income-groups.

112. **Mode of Travel:** Amongst the 549 usual trip information, 185 (34 percent) travel on foot and 364 trips (66 percent) are by bicycle, auto-rickshaw, bus or *chakda*.

113. **Frequency of Travel:** 10 percent of the 549 usual trips are on daily basis; 16 percent of the trips are for 3-4 times in a week and 26 percent trips are on monthly basis. Among all vehicles *chakda* and bus are the most used modes for usual trip. Bus is used for 51 percent of usual trips. Of the total trips using vehicles, 10 percent trips are on daily basis.

114. **Perception about Present Transport Situation:** Villagers opined about the requirement of good quality roads, more number of buses and requirement of road widening, etc.

9 PROJECT COSTING

115. The project corridor is divided in two sections as Dhansura-Malpur and Malpur-Meghraj. The project corridor is designed involving widening, reconstruction and maintenance of both pavement and cross-drainage structures. Based on the estimated quantities and extensive rate analysis, combined project cost including environmental is Rs 62.55 crore. The total cost is presented in two subheads as Civil Construction Cost and Social Cost. Environmental Management Plan (EMP) related cost is factored in construction cost itself. The total cost under two sub heads is given in Table 9.1.

Table 9.1: Project Cost

Sr. No.	Description	Amount (INR)
1	Civil Construction Cost	62,39,03,465
2	Social Cost	15,70,127
Grand Total		**62,54,73,592**

10 ECONOMIC ANALYSIS

10.1 RESULTS OF ECONOMIC ANALYSIS

10.1.1 Base Analysis

116. The economic analysis has been undertaken for the project road by using RUCS equations. The results obtained are in terms of the Economic Internal Rate of Return (EIRR), Net Present Value (NPV), as presented below for project corridor as a whole.

Table 10.1: Result of Economic Analysis

Scenarios	Description	EIRR					
		Without Time		With Time		With Accidents	
		20 years	30 years	20 years	30 years	20 years	30 years
I	Base Costs + Base Benefits	7.31%	11.27%	16.25%	18.30%	19.94%	21.40%
		NPV (in million Rupees)					
I	Base Costs + Base Benefits	-155	-38	173	387	339	589

117. The project is economically viable, even in case of only savings in the VOCs. With VOT and accident cost savings, it becomes a very desirable project from the perspective of the society.

10.1.2 Sensitivity Analysis

118. Any investment is subject to risks and uncertainties. All risks culminate into either increase in project cost, reduction in benefits or both put together. In order to cover the above stated risks, a detailed sensitivity analysis, with respect to the sensitive parameters, has been undertaken. The various sensitivity scenarios considered are as follows:

- Sensitivity 1: Base Costs plus 15% and Base Benefits (15% Increase in cost);
- Sensitivity 2: Base Costs and Base Benefits minus15% (15% reduction in benefits); and
- Sensitivity 3: Base Costs plus 15% and Base Benefits minus 15% (15% Increase in costs and 15% reduction in benefits).

119. The results of the sensitivity analysis have been presented in Table 10.2.

Table 10.2: Results of Sensitivity Analysis

Scenarios	Description	EIRR					
		Without Time		With Time		With Accidents	
		20 years	30 years	20 years	30 years	20 years	30 years
I	Base Costs plus 15% and Base Benefits (15% Increase in cost)	5.82%	10.11%	14.23%	16.60%	17.62%	19.38%
II	Base Costs and Base Benefits minus 15% (15% reduction in benefits)	5.55%	9.95%	14.00%	16.41%	17.38%	19.17%
III	Base Costs plus 15% and Base Benefits minus 15% (15% Increase in costs and 15% reduction in benefits)	4.13%	8.86%	12.11%	14.86%	15.24%	17.34%
		NPV (in million Rupees)					
I	Base Costs + 15% and Base Benefits	-227	-110	101	314	267	516
II	Base Costs and Base Benefits minus 15%	-202	-102	77	259	218	430
III	Base Costs + 15% and Base Benefits minus 15 %	-274	-175	5	187	146	358

120. The sensitivity analysis reflects project viability in the worst scenario also, in case the VOT and/or accident cost savings are considered. If the analysis period is taken as 20 years, the project is viable in case of VOC and VOT savings (EIRR>12%). With additional benefit of accident cost savings, it tends to become more attractive.

10.2 IMPACT OF PROJECT DELAY ON ECONOMY

121. The project needs to be planned and implemented soon. The savings in travel time is precious for the economy. In case, the project implementation is delayed, the cumulative loss in value of travel time is likely to go up from Rs 34.6 million in 2015 to about Rs 2575.5 million in the year 2040. Therefore, the state should get the project initiated soon. (Refer Figure 10.1).

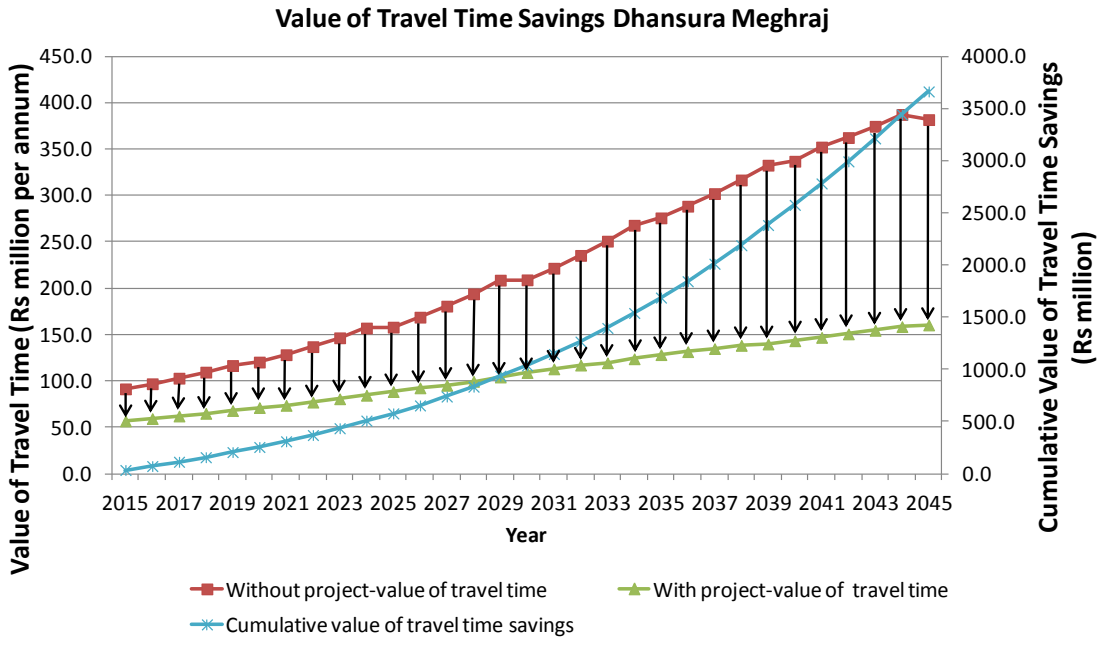


Figure 10.1: Value of Travel Time Savings

10.3 CONCLUSION

122. The road project ***is desirable from the society's point of view.*** The project corridor as a whole is found to be economically viable with positive net present values and EIRR greater than 12%, even in the worst scenario of drop in benefits coupled with increase in cost. Hence, based on the above results, the project is recommended for implementation.

123. Since the accident benefits are high, it is further recommended that due consideration should be given to the measures suggested from safety point of view. This would make Dhansura-Meghraj corridor a safe highway.