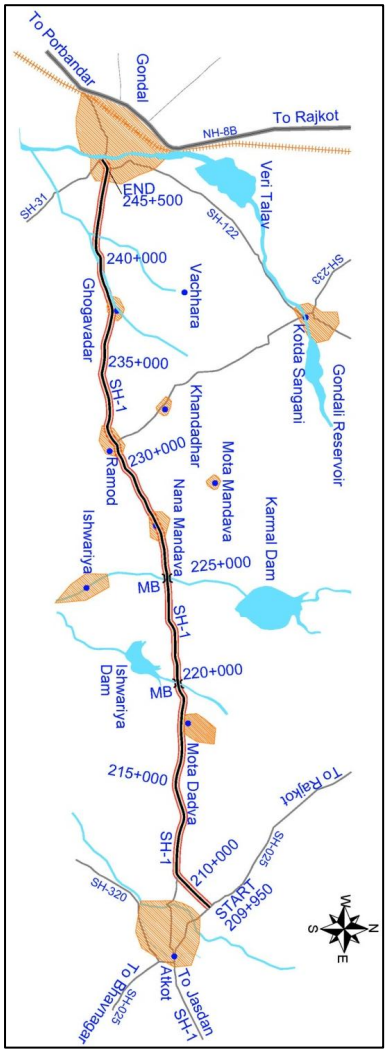
ROADS AND BUILDINGS DEPARTMENT
GOVERNMENT OF GUJARAT

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



Detailed Project Report

Executive Summary
(ATKOT – GONDAL)

December 2012

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 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 corridors is shown in Map 1.2.

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 Kapdavanj-Ladvel)	SH-83,SH-188, SH-151	35.45
	7	Dabhoi – Bodeli	SH-11	38.60

Work Type	Sr. No.	Link Name	SH No.	Length (km)
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]

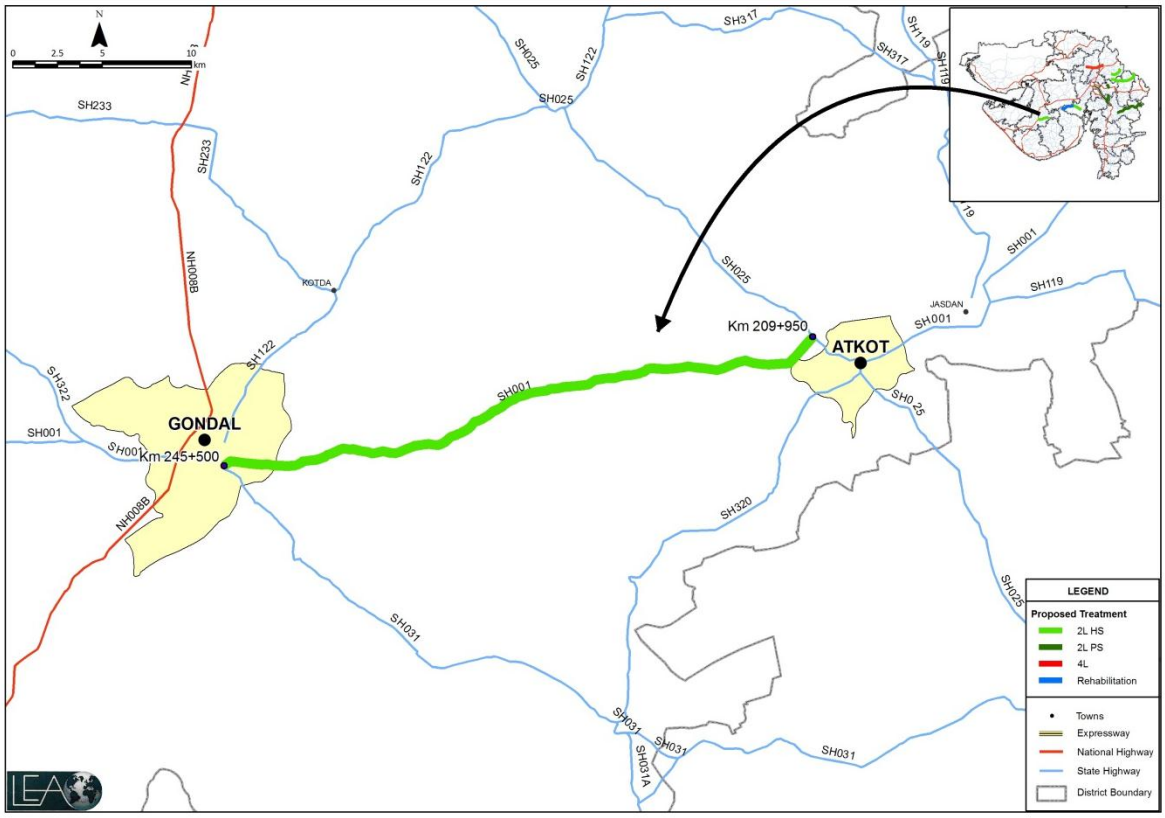
1.2 BROAD OBJECTIVES AND SCOPE

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.

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**

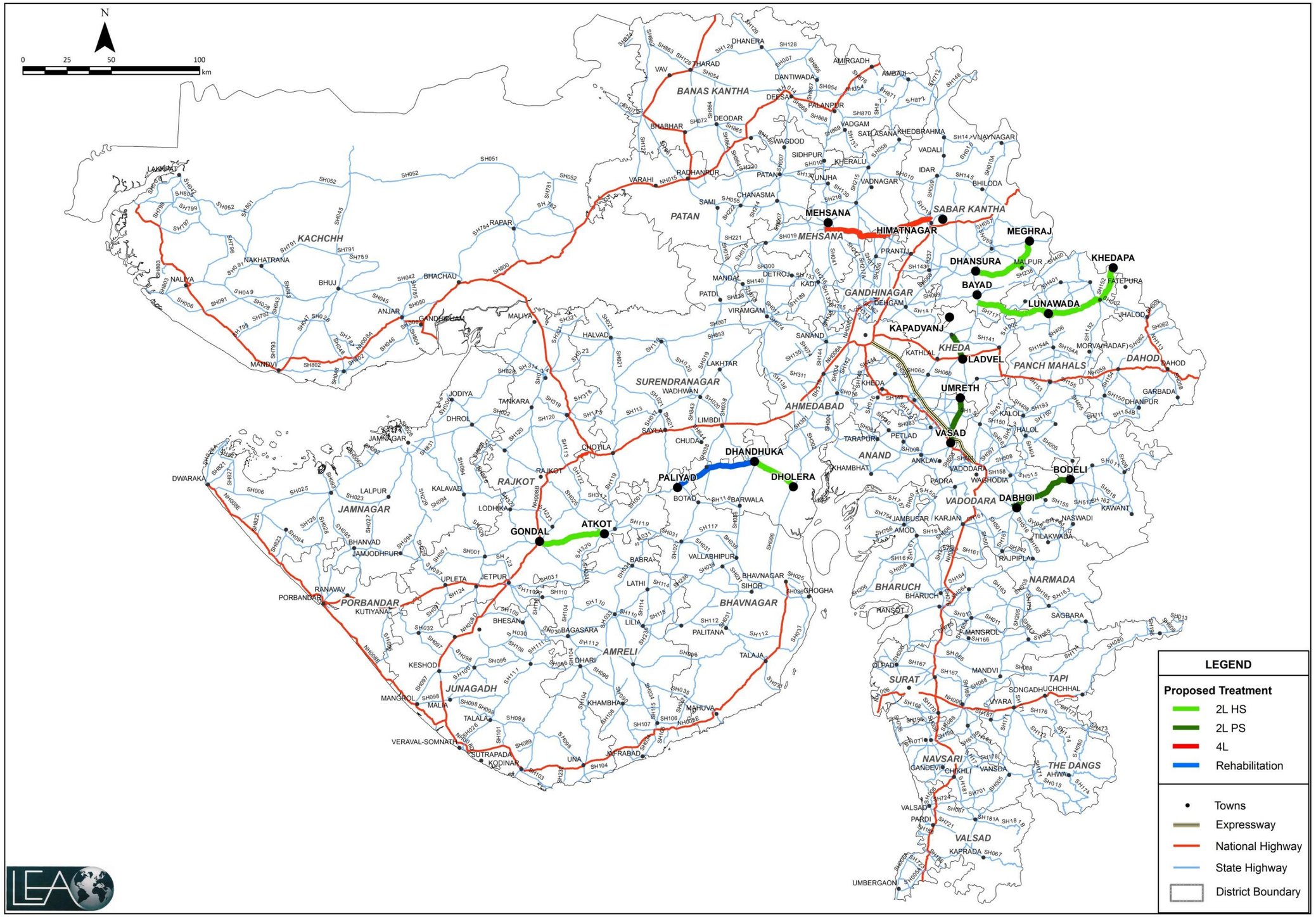
1.3 DRAFT DETAILED PROJECT REPORT

7. This Executive Summary of DPR pertains to wide two laning of the project corridor Atkot – Gondal (SH-001). The key map showing project corridor is presented in Map 1.1.



Map 1.1: Map Showing Project Corridor

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



Map 1.2: Project Corridors

2 SOCIO-ECONOMIC PROFILE OF THE CORRIDOR

2.1 GENERAL

8. Socioeconomic profile of the corridor pertains to the economic well-being of settlements for characteristics such as population profile, density, population growth, age - sex ratio, social groups, urban population and occupational structure, over last decade.

2.2 CORRIDOR PROFILE

9. The corridor Atkot-Gondal is part of Rajkot district. District has 14 talukas, including project corridor talukas i.e. Gondal, Jasdan and Kotada Sangani. Gondal is the end point of the project corridor which is approximately 40 km from Rajkot city. The population of the district was 31 million as per 2001Census, which has increased to 37 million during 2011 (Provisional Census 2011) with an Average Annual Growth Rate (AAGR) of 1.8%. Manufacturing and service sectors are the major economic sectors of the district. It is experiencing rapid development due to industrialisation and other vibrant economic activities. Majority of industries are located in Rajkot, Kotada Sangani and Gondal talukas. Prominent industries of the district are textiles, engineering and auto ancillaries which generate huge employment in the district.

10. The project corridor taluka accounts for population of 6.9 lakhs comprising 18% of the district population. Population density of three talukas is 231 persons per sq. km. as against 339 persons per sq. km of Rajkot district.

11. The project corridor passes through 11 villages having population of 1.27 lakhs. Average Population density for villages and settlements along the corridor is 644 persons per sq. km due to extension of Gondal Municipal Corporation area in the corridor.

12. The average sex ratio for project corridor villages is 919 as against the sex ratio of 940 for 3 talukas during the year 2001.

13. Average literacy rate in project corridor settlement was 79% as against 57% for the overall project corridor talukas. Majority of literate population is concentrated in Gondal settlement, rest all villages have relatively low literacy rates. Gondal is the major urban settlement abutting the project corridor amongst all other talukas.

14. The total workers in project corridor villages are 42,732, which includes 90 percent workers as main workers. The Workforce Participation Ratio (WPR) in 3 Talukas of corridor is (44 %), which is higher than the WPR of State (41 percent) and Rajkot district (40 percent) (Census 2001). Amongst the project corridor talukas, Kotda Sangani and Jasdan have higher WPR. The female WPR is as low as 12 percent compared to 53 percent for male.

15. Total SC and ST population along the corridor accounts for the figure of 6,083 which is nearly 5 percent of the total population for settlements along project corridor. (Census 2001).

3 CORRIDOR CHARACTERISTICS

3.1 PROJECT CORRIDOR

16. The corridor falls in Saurashtra region of the state and provides east-west connectivity to and from Bhavanagar, Junagadh, Porbandar and other parts of Saurashtra and Gujarat. The existing corridor characteristics are presented in the Table 3.1

Table 3.1: Existing Corridor Characteristics

Sr. No	Components	Details
1	Corridor Name and SH Number	Atkot-Gondal (SH-001)
2	District	Rajkot
3	Start Chainage (km)	209+950
4	End Chainage (km)	245+500
5	Total Length of Corridor (km)	35.55
6	Right of Way (m)	30
7	Carriageway width (m)	6.2
8	Intersection/Junction	2 -major, 6 minor
9	Traffic	
	Vehicles	5,536
	PCU	7,599
10	Terrain type	Plain
11	Soil Classification	Clayey
12	Pavement Condition	Fair
13	CD Structures	
	Major Bridge	2
	Minor Bridge	16
	Pipe	31
	Slab	9
	Canal Inverted Syphon	2
	Total No. of Structures	60
14	Riding Quality- IRI	2.4 to 8.22
15	Existing Crust Thickness	220mm to 665mm
16	Soaked CBR	3.0% to 12.6%
17	Vehicle Damage Factor	

Vehicle type	Gondal-Atkot
Mini Bus	0.28
LCV	0.30
BUS	0.95
2-Axle Truck	4.60
3-Axle Truck	7.74
M-Axle Truck	4.60

4 TRAFFIC ANALYSIS AND FORECAST

4.1 INTRODUTION

17. 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 are judiciously incorporated in issues related to geometry, environmental and social.

4.2 EXISTING TRAFFIC CHARACTERISTICS

18. The traffic about 5,536 vehicles (7,599 PCU) are plying on the corridor with 70% of passenger traffic. Travel desire pattern on the corridor indicates most of the traffic travelling mostly within state. The average speed observed on the corridor is 42 kmph.

4.3 TRAFFIC FORECAST

19. The traffic is forecasted using the trend based and econometric method. Further the forecasted traffic by trend based method is used for the estimation of the future capacities and arrive at the improvement option for entire project corridor. Projected total traffic in vehicles and PCU till the year 2045 is as below.

Table 4.1: Total Forecasted Traffic

Modes	2011	2015	2020	2025	2030	2035	2040	2045
Total Vehicles	5,536	6,535	8,272	10,707	13,673	16,480	18,700	19,935
PCU	7,599	8,977	11,421	14,767	18,983	23,028	26,260	28,070

4.4 IMPROVEMENT OPTIONS

20. Having assessed future growth and traffic scenario for each homogenous section, the next important step forward is identification and finalisation of improvement options for project corridor. An appreciation of present lane configuration, base year traffic level and corresponding projection simulates a clear picture of likely congestion levels or the utilisation level of project corridor. The improvement options are recommended for LOS B. In sections where volume exceeds half of the capacity within year 2020, a higher order improvement option is proposed.

21. The proposed improvement options are presented in Table 4.2.

Table 4.2: Proposed Improvement Option

Proposed Chainage and Length			Section	Present Config.	Proposed Config.	Traffic (Vehicle)	Traffic (PCU)
Start	End	Length (km)					
209.95	245.5	35.5	Rural	NTL	2L+PS+HS	5,536	7,599

22. The above improvement options are 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. The Project Corridor is 35.5 kms long section of the State Highway-01. This corridor is proposed to be improved to give a better riding quality and improved safety through better improvement and minimum required intervention in the form of improved profile where required, improved riding quality of the surface through strengthening of the surface course, improved design and control of intersection operations etc. 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. This chapter deals with the road safety audit findings and suggested interventions for minimising the road accidents and their severity while improving riding quality.

5.2 ACCIDENTS STATISTICS

24. To assess the traffic safety situation with respect to accidents on the project road as well as in the influence area the FIR details relating to the traffic accidents on the corridor and its immediate influence areas is collected and studied for the period from 2007 to 2011.

25. There were a total of 26 fatalities and 106 injuries reported in a span of 5 years (2007 – 2011). This is substantial figure of more than 5 deaths in a year accounting for about one fatality per 7 km in a year. In terms of injuries this figure is almost five times. The analysis further reveals that there were 27 collisions amongst vehicles. Motor cycles were involved in 29 accidents and a total of 5 pedestrians are reported to have been killed or injured.

5.3 SAFETY ISSUES

5.3.1 Intersections/Junctions

26. There are a number of road junctions in the habitations through which the project corridor is running as well as the access roads from villages located away from the corridor on either side. It is noted that these junctions have no treatment and bus stops are located on those junctions where the access road connects to remote village. These conditions are potentially accident prone spots. Therefore careful attention needs to be paid in developing appropriate designs for these junctions and suitably locating and managing the operation of the bus stops.

5.3.2 Curves

27. There are sharp curves on the corridor and the signs and control measures are inadequate and need to be improved.

5.3.3 Traffic Mobility

28. Intermediate public transport vehicles (Chhakdas) operating on this road have tendency to stop at a random place and need to regulate such stops.

5.3.4 Shoulders

29. Shoulders are inadequate in width besides being in a poor condition. Shoulder is very critical for safe operation of the vehicles.

5.3.5 CD Structures

30. The cross drainage works especially culverts are narrow in width and the parapets of the culverts are potential hazards. Wherever feasible the culverts could be expanded in width to accommodate shoulders/extended carriageway. In places where this is not feasible adequate steps must be taken for delineation of the parapets.

5.3.6 Traffic Management and Control Issues

31. Traffic signs, especially cautionary/warning signs are practically non-existent on this road. Where they exist, are in a very poor condition. This situation needs to be improved. Traffic (road) markings are practically not used at all. The presence of centerline will inculcate the discipline in driving. Delineation of the pavement edges with edge line marking will greatly improve the safety of operations by guiding the traffic both in day and night (especially at night).

5.4 IDENTIFIED ISSUES AND SUGGENTIONS

32. As a part of the road safety audit include identification of deficient parts of the highway that can cause unsafe conditions to road user. The major deficient horizontal curves are identified all major and minor intersections, major habitations and structures are identified and accordingly safety interventions at curves locations, major/minor intersections including access roads, 6 habitation stretches and 60 structures are recommended. The details of the recommended interventions are presented in Volume-III.

6 DESIGN OF CORRIDOR

6.1 IMPROVEMENT OPTION

33. The existing carriageway width of the project corridor is 6.2m, narrow two lane (NTL). The project corridor is proposed to widen to two lanes with paved shoulder and hard shoulder (2L+PS+HS) as per ToR. The cross-section with existing carriageway and proposed improvement option is presented in Figure 6.1.

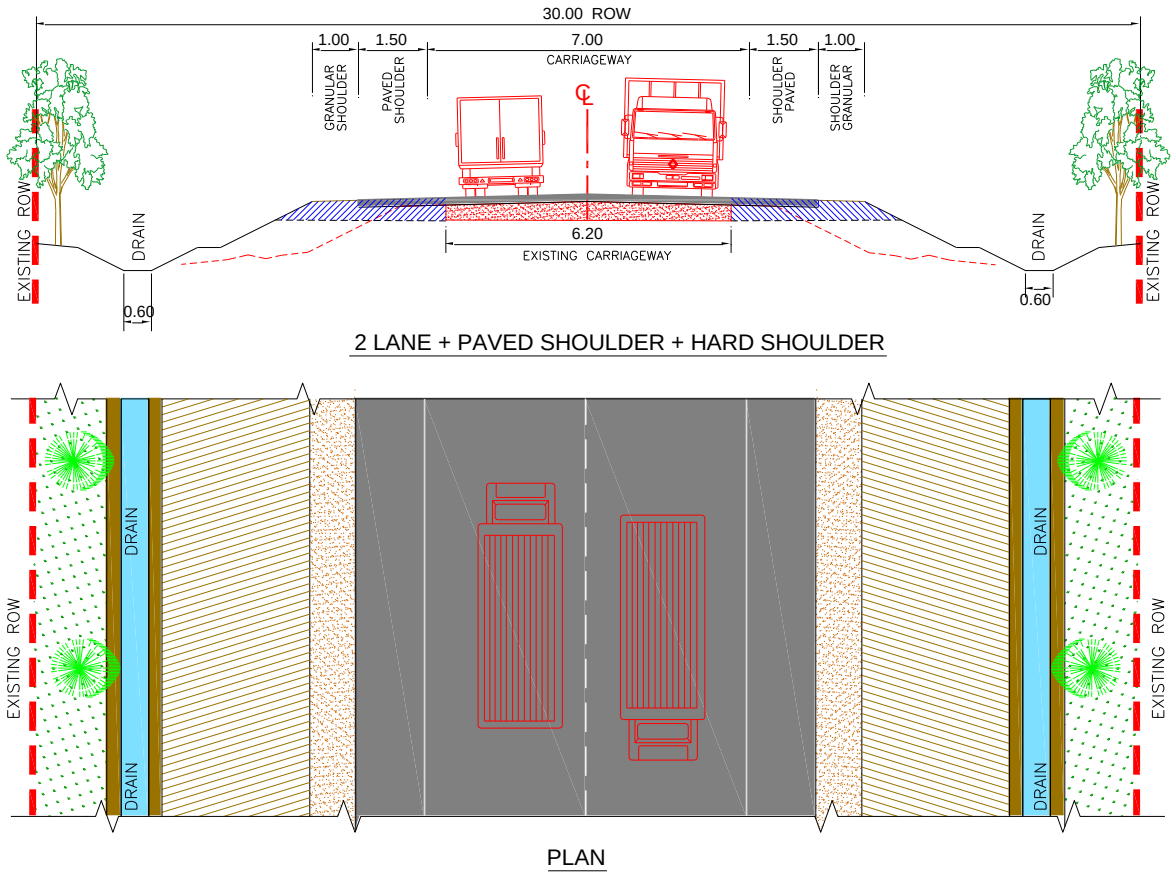


Figure 6.1: Proposed Improvement Option (NTL to 2L+PS+HS)

34. The project corridor predominantly traverses through either Agriculture land or barren lands on either sides. The project corridor has right of way of 30m except in settlements, where the part of land width is encroached or belongs to the private owners.

35. The project corridor traversing through several village settlements is proposed to widen to four lane configuration with footpath on both sides wherever possible. The cross-section also includes covered R.C.C drain all along on both sides.

36. The space for parking and settlement are adjusted to available land width causing minimal interruption to adjacent settlements. The typical four lane cross-section is depicted in Figure 6.2.

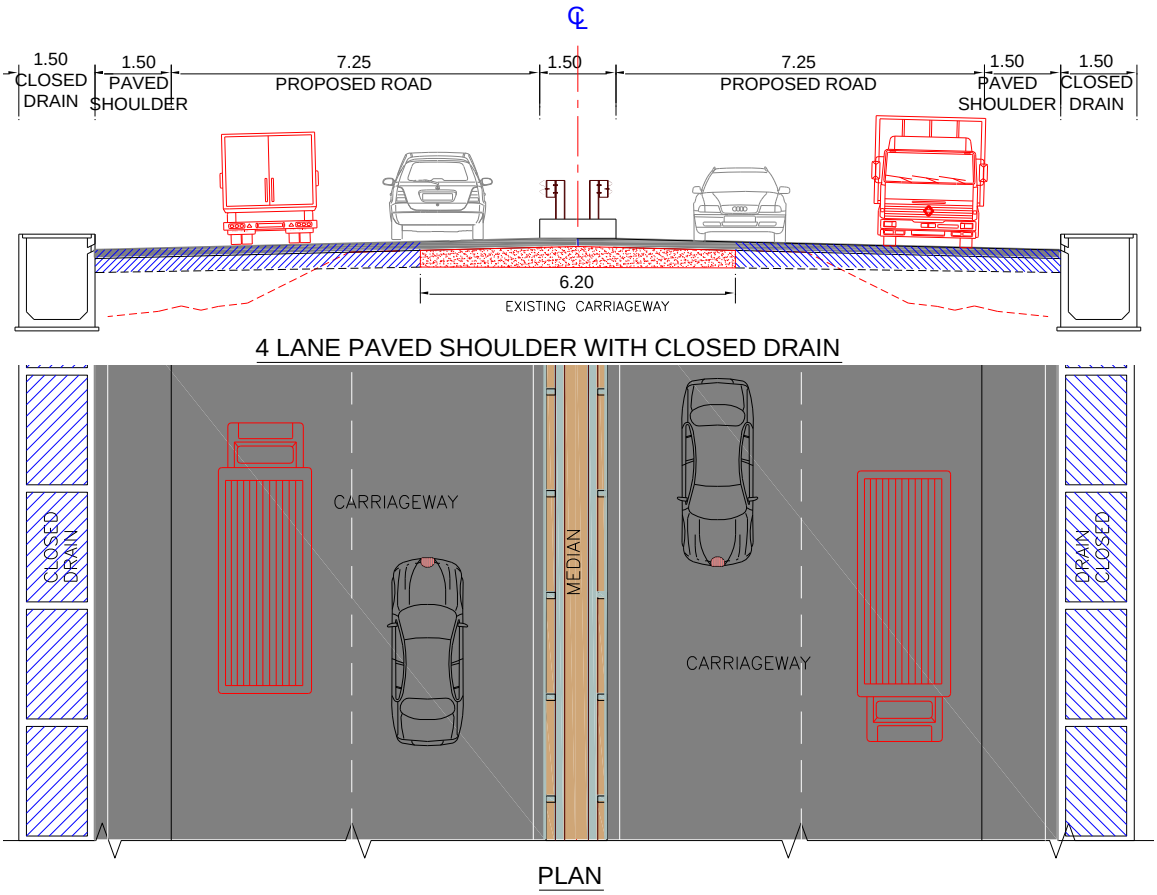


Figure 6.2: Typical Cross-section-4L+PS with Footpath and Parking Provisions

6.1.1 Widening Scheme

37. Existing project road is placed concentrically within available ROW. Concentric widening is proposed all along the project corridor by utilizing the existing pavement crust. The factors considered for widening preferences are:

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

38. The details on widening option along the project corridor are given in Table 5.1.

Table 5.1: Details of Widening Scheme

Chainage in km Column		Length in km	Existing CW in m	Proposed Widening	Remarks
From	To				
209.863	209.950	0.087	6.2-6.5	2LPSHS	Acceleration and Deceleration Lanes
209.950	211.800	1.850	6.2/10	2LPSHS	Recently Widened Section
211.800	212.600	0.800	6.2-6.6	2LPSHS	
212.600	213.600	1.000	6.2-6.5	2LPSHS	
213.600	218.200	4.600	6.2-6.5	2LPSHS	
218.200	219.000	0.800	6.2-6.5	2LPS+FP	Wide Paved Shoulder
219.000	225.000	6.000	6.2-6.5	2LPSHS	
225.000	230.300	5.300	6.2-6.5	2LPSHS	
230.300	230.500	0.200	6.2-6.5	2LPSHS	
230.500	231.780	1.280	6.2-6.5	2LPSHS	
231.780	232.800	1.020	6.2-6.5	4L	
232.800	237.920	5.120	6.2-6.5	2LPSHS	
237.920	239.221	1.301	6.2-6.5	4L	

Chainage in km Column		Length in km	Existing CW in m	Proposed Widening	Remarks
From	To				
239.221	240.700	1.479	6.2-6.5	2LPSHS	
240.700	241.200	0.500	6.2-6.5	2LPSHS	
241.200	243.000	1.800	6.2-6.5	2LPSHS	
243.000	244.835	1.835	10.0	2LPSHS+FP	Wide Paved Shoulder
244.835	245.157	0.322	10.0	2LPSHS	Acceleration and Deceleration Lanes
245.157	245.487	.330	10.0	2LPSHS+FP	Wide Paved Shoulder
Total length		35.624			

6.1.2 DESIGN INTERVENTIONS

39. The process involved in design intervention is depicted to in the following Figure 6.3.

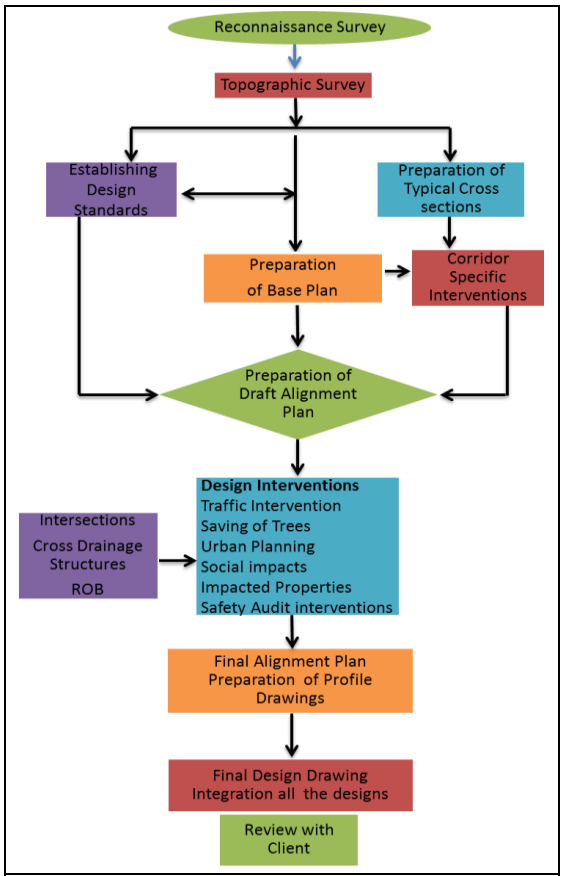


Figure 6.3: Design interventions

Speed

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

Trees

41. Special efforts have been made to minimize the impact on trees, saving them to the extent possible. At few places centre line is shifted and widening is effected as eccentric towards saving more number of trees on one side.

Social Impact

42. For the sections through settlements specific care has been taken to safe guard cultural properties, existing permanent structures towards reducing the social impacts. After incorporation of mitigation measures into the design, a total of 45 road side structures are likely to be affected out of the total 240 structures identified as getting impacted. The major structures along road comprise residential, commercial and mixed (residential and commercial) structures.

Safety

43. The safety is very much incorporated in the design process; interventions include provision of speed humps at exit and entry of settlements, Raised pedestrian crossings, foot paths, improved junction layouts, advanced warning signs, Rumble strips, Provision of Guard rails etc.

6.1.3 Proposed Improvements

44. An exercise has been carried out to assess the average journey speed after improvement of project corridor, and radius of curves, the Table 6.2 presents design speed on curves, radius and number of curves. It is observed that out of identified 116 curves 74% are having 80-100 kmph design speed with radius more than 2000m. While on the other hand 31% of curves are having a radius less than 360m with design speed less than 40kmph. Most of them are falling under settlement sections. Curves having design speed less than 65kmph in rural sections are considered for improvement with higher radius.

Table 6.2: Design Speed on curves, Radius and number of Curves

Design Speed (kmph)	Number of Curves	Existing Radius (m)	Number of Curves
80-100	86	>2000	27
65-80	3	900-2000	13
40-65	5	360-900	39
<40	22	<360	37

45. The design improvements included 12 curve improvements and whose details are given in design report (Volume II). The horizontal alignment report is provided in Volume-VIII.

6.1.4 Realignment

46. Alignment of the existing carriageway has been improved at the locations of sharp geometry in existing alignment. The locations given in

47. Table 6.3 are with major realignment and LAQ, to avoid the sharpness in alignment geometry. Further, efforts have been made to realign centre line to accommodate the four lanning with minimal impact on adjacent properties.

48. Crossroads have been realigned at the junction with main carriageway to reduce the skew angle of the crossings and to ensure the safety.

Table 6.3: Details of Land Acquisition

Sl. No	Start Chainage (km)	End Chainage (km)	Side	Village	Taluka	Total Area (Sq.m)	Total Area (ha)
1	222+950	223+140	LHS	Dadva-Hamirpur	Gondal	528.128	0.0528128
2	223+288	223+500	LHS	Ramod	Gondal	549.147	0.0549147
3	230+277	230+510	LHS	Ramod	Gondal	1287.618	0.1287618
4	240+675	241+105	LHS	Ghogavadar	Gondal	7708.337	0.7708337
					Total	10073.23	1.007323

6.1.5 Vertical Alignment Design

49. The existing vertical alignment for the majority of the road calls for attention.

50. The design finished road level (FRL) at the centreline is determined from new pavement design from km 209+863 to 225+000 and km225+00 to km 245+487 the overlay thicknesses required for pavement strengthening and is based on the existing vertical alignment.

51. The design finished road level (FRL) at the centreline is determined from new pavement design from km 209+863 to km 225+000 and km 225+00 to km 245+487 the overlay thicknesses required for pavement strengthening and is based on the existing vertical alignment.

From km 209+863 to km 225+000 is proposed for reconstruction, as per condition assessment during the November and December 2011[2].

The major maintenance (Strengthening) is attended by R&BD in the months of March 2012, with following overlay:

- SDBC 25mm
- BM 50mm
- BUSG 75mm

The major strengthening work is under guarantee period of 3 years. The condition shall be examined during the guarantee period, if found in good condition overlay is to be provided accordingly.

52. The existing road level will generally be raised by:

- An amount equal to the design overlay thickness.
- An amount required for cross section shaping and correction to surface irregularities.
- An amount for provision of a smooth vertical alignment within design standards.

53. The amount required for profile correction both longitudinally and over the cross section is significant in some cases, where the vertical alignment has to be in accordance with Standards. The profile correction course (PCC) is composed of DBM and, due to its functional aspect correcting layer varies in thickness. The thickness of DBM varies from 50mm to over 100mm in certain locations for designing safe profile.

54. Cutting of existing pavement to provide the required profile is kept to a minimum and adopted only when cost effective or most appropriate.

55. The present road is generally on embankment of sufficient height to alleviate flooding and need not be raised other than through the provision of the overlay thickness (typically 130mm). Isolated and short sections, specifically at causeway, low level bridges and their approaches, and where the road have experienced flooding in the past; the proposed road level (FRL) has been raised as per the requirements at particular cross drainage structures.

6.1.6 Side slopes

56. The average embankment height of the project road is around 1.0-1.5m. 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

[2] As described in subsequent section on Pavement Design.

IRC-36, which provides a side slope of 1:4 for low embankment upto1.5m high, although due to limited RoW and accommodating the longitudinal drains the slope is kept as 1:2. Where required essential safe guards are proposed.

6.1.7 Road Side Drainage

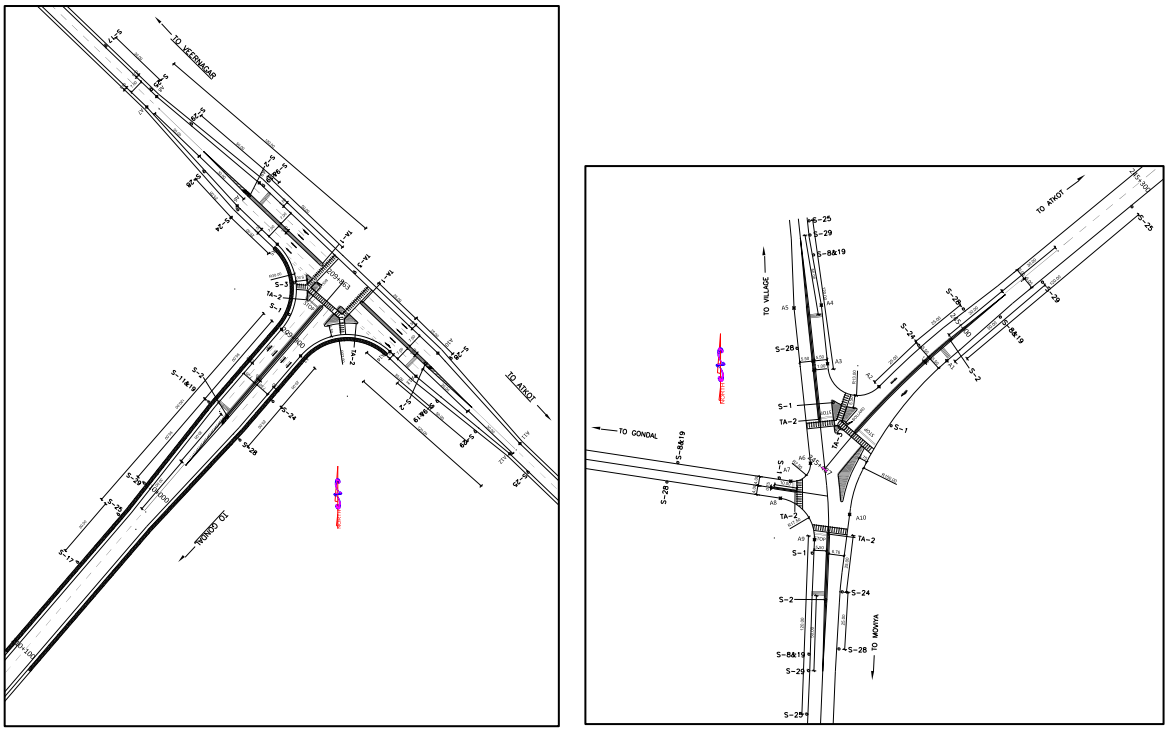
57. The presence of natural streams running parallel to corridor is taken into consideration. Accordingly it is recommended not to have open longitudinal drains in these sections. At present also these side streams are accommodating the surface runoff. Such identified sections of natural stream are used as side drain along with longitudinal covered drain shown in settlement locations. The drainage analysis along the project road is provided in Part 2 of this Volume-II on Design Report.

6.1.8 Utility Crossings

58. Utility crossing are proposed at 12 locations avoid frequent digging of carriageway.

6.2 INTERSECTION/JUNCTION DESIGN

59. The project corridor is having two major junctions and one intersection, 23 minor junctions/intersections and 208 Access roads and Cart tracks. The Major and Minor



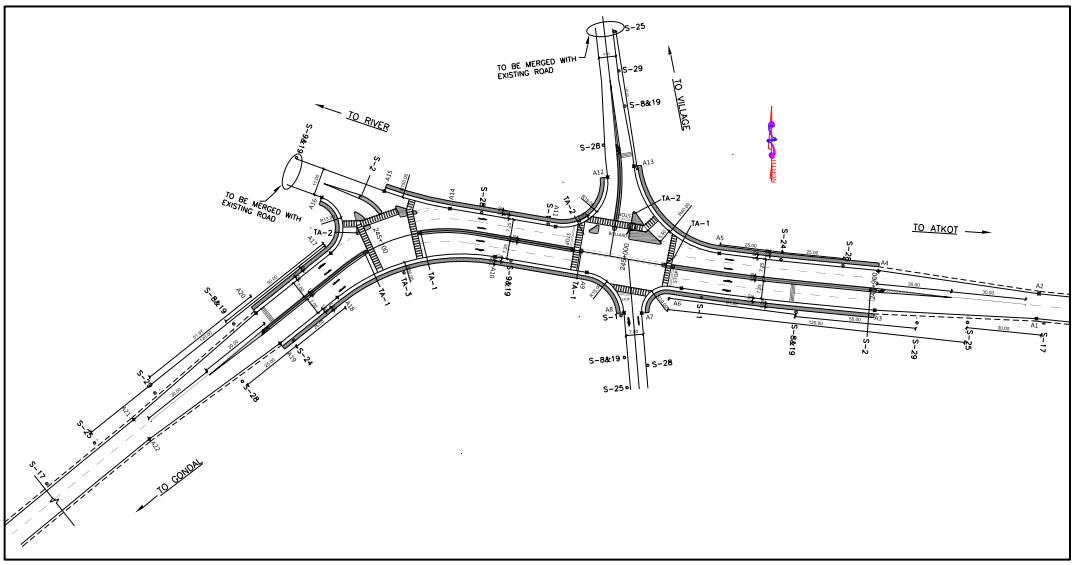
Near Atkot (km 209+800) **Near Gondal End (km 245+500)**

Figure 6.4: Junction Improvement

intersections are designed according standards with all safety precautions.

60. The start of the project corridor forms a junction with SH-25 near Atkot. The junction is designed considering the future expansion of SH-25 (Rajkot-Bhavnagar) as four lane divided highway. The junction design is based on type designs for T junction on NH/SH

as per MOST specifications (Figure 6.5). Two intersection near end of the project corridor near Gondal are also developed. (Figure 6.5)



Near Gondal (km 245+100)

Figure 6.5: Intersection Improvement

6.2.1 WAY SIDE AMENITIES AND SAFETY ASPECTS

6.2.2 Pedestrian Safety

61. Pedestrian crossing across the project highway is major cause for accidents. To reduce the speed and subsequently to increase the pedestrian safety, speed humps and raised pedestrian crossing are provided along the project corridor.

62. **Speed Humps**: are provided at 12 locations at settlements. Apart from settlements, speed humps are also provided on all the access roads leading to project highway and minor intersections.

63. **Raised Pedestrian Crossing:** are provided at 11 locations near bus shelters

64. **Rumble Strip**: are provided at 24 locations in settlement area.

6.2.3 Median Openings

65. The project road is provided the four lane sections along village settlements as discussed above, at same time median openings are also provide to facilitate for easy access to nearest development.

Table 6.4: Location of Median Openings

Sr. No	Start Chainage (km)	End Chainage (km)
1	231+940.00	231+965.000
2	232+092.00	232+117.00
3	232+234.00	232+259.00
4	232+442.60	232+467.60
5	232+590.40	232+615.40
6	238+082.35	238+107.35
7	238+326.40	238+351.40
8	238+571.20	238+596.20

6.2.4 Guard Rails

66. The guard rails are provided at sharp curves along with signage's to provide safety for vehicles on such curves. The locations of Guard rails are given Table 6.5. The guard rails are provided with W-metal beam type barrier, the details of the same are provided in design drawings.

Table 6.5: Location of Guard Rails

Sl.No.	Start Chainage (km)	End Chainage (km)	Side
1	211+800	212+000	Both Sides
2	219+800	220+050	Both Sides
3	220+200	220+350	Both Sides

6.2.5 Bus Shelter

67. The existing bus shelters along the project corridor are generally associated with settlement area or at an intersection. It is proposed to provide bus stops and bus bays in both directions at these locations. The details of bus shelters and bus bay locations along the project corridor are given in Table 6.6; the typical design of Bus Stop is given in Figure 6.6

Table 6.6: Proposed Bus Stops and Bus bays

Sl. No	Chainge	Side	Village	Location
1	212+912	RHS	Kharachiya	Proposed Bus Stop and BusBay, Existing Location
2	212+921	LHS	Kharachiya	Proposed Bus Stop and Busbay, New Location
3	218+011	RHS	Mota Dadva	Proposed Bus Stop and Busbay New Location
4	218+450	LHS	Mota Dadva	Proposed Bus Stop and Busbay New Location
5	224+885	LHS	Ishwariya	Proposed Bus Stop and Busbay, New Location
6	228+225	LHS	Nana Mandva	Existing Bus Stop and Busbay Retained
7	228+383	RHS	Nana Mandva	Proposed Bus Stop and Busbay, New Location
8	232+330	RHS	Ramod	Proposed Bus Stop and Busbay, New Location
9	232+518	LHS	Ramod	Proposed Bus Stop and Busbay, Existing Location
10	238+555	RHS	Ghogavadar	Proposed Bus Stop and Busbay, New Location
11	238+665	LHS	Ghogavadar	Proposed Bus Stop and Busbay, Existing Location

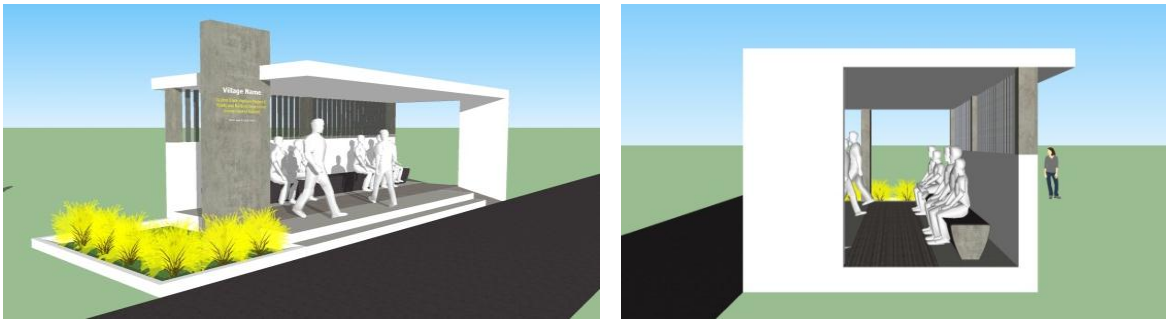


Figure 6.6: Typical Design of Bus-Shelter

6.2.6 Pedestrian Pathway

68. Pedestrian pathways are provided all along the village settlements en-routing the project corridor. The details are given in Table 6.7.

Table 6.7: Location of Footpaths

Sr No	From	To	Length (m)
1	209+863	209+950	87
2	218+200	219.000	800
3	231+780	232+800	1020
4	237+880	239+221	1341
5	243+200	244+835	1635

6.2.7 Truck Parking

69. Due to geometric improvements at two locations, incidental spaces are created. The same is used for development of Truck Laybys at km 230+275 to 230+500 and km 240+675 to 241+100. Appropriately, truck parking is proposed as per details provided in Volume VIII.

6.2.8 Integration of Way Side Facilities

70. The integration of bus shelter, foot path and pedestrian crossing is done and the typical plan is depicted in Figure 6.8.

6.2.9 Information on Infrastructure Development

71. 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 6.7. The detailing is provided in Volume VIII. These signs are provided at two locations near entry and exit of project sections.

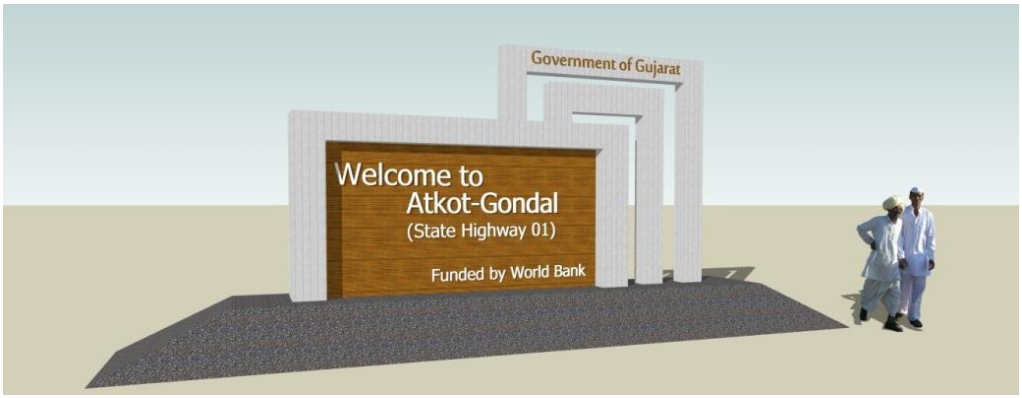


Figure 6.7: Typical View of Welcome Sign

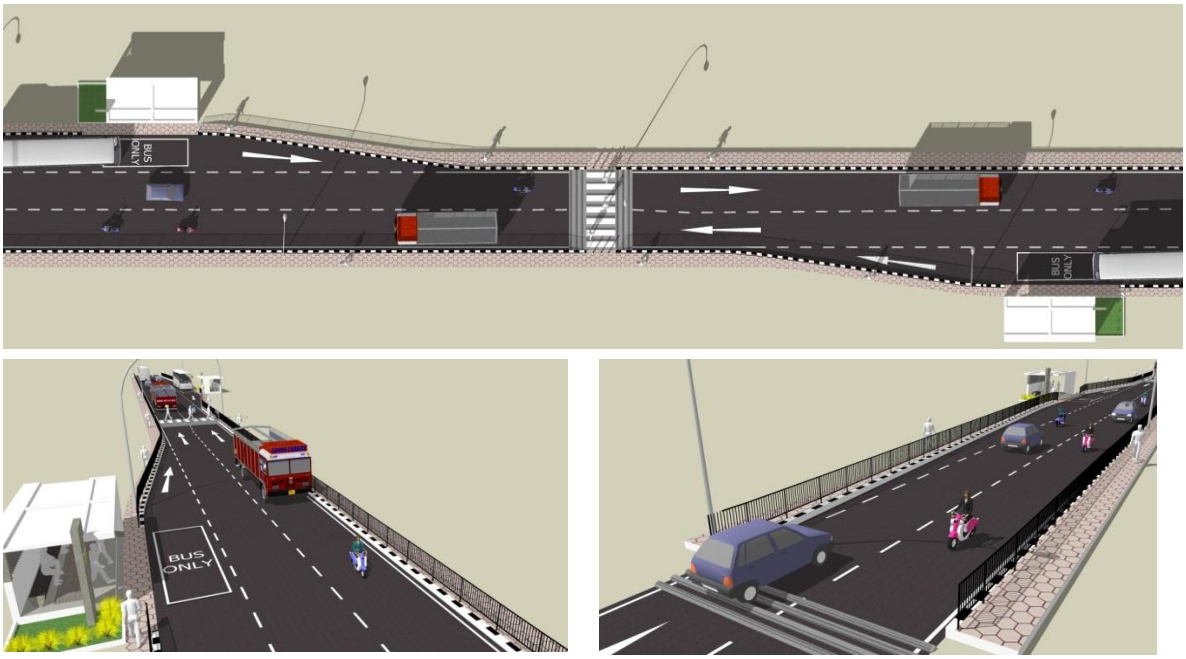


Figure 6.8: Integration of Wayside Facilities

6.3 PAVEMENT DESIGN

72. 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 a implications on the economic returns from the project. Present section of the report deals with pavement design and strengthening of the existing pavement crust

73. Proposed strengthening and reconstruction needs have been indicated in Table 6.8

Table 6.8: Abstract of Treatment Option

From (km)	To (km)	Length (km)	Treatment Option	Remarks
209+950	225+000	15.05	Strengthening and Widening	Recent Periodic Maintenance by R&BD
225+000	243+000	18	Strengthening and Widening	CRF work overlay
243+000	245+500	2.5	Reconstruction	Cracking in the range of 10 to 20% hence Reconstruction

6.3.1 Pavement Strategy

74. The following pavement strategies have been adopted.

Type A1	New Construction (Reconstruction) with two lane carriageway +paved shoulder +granular shoulders.
Type A2	Reconstruction with two lane carriageway +paved shoulder + Foot Path cum Drain
Type B1	Widening (existing carriageway to two lane with paved shoulder and granular shoulders) and Strengthening (overlay) of the existing flexible pavement with Hard Shoulder on either Side.
Type B2	Widening (existing carriageway to two lane with paved shoulder and granular shoulders) and Strengthening (overlay) of the existing flexible pavement with foot path cum drain on either side.
Type C1	Reconstruction with new Four lane having, two lanes on either side with foot path cum drains.
Type C2	New Pavement with four Lane Paved Shoulder with drain cum foot path
Type D	New Pavement with two Lane Paved Shoulder with drain cum foot path

6.3.2 Pavement strengthening (overlay) strategy

75. Pavement strengthening strategy adopted in this project envisages that after attending to the rectification of defects like cracking, potholes, deep depressions, rutting etc a layer of profile corrective course will be laid over the existing bituminous surface

76. The design of the overlay has been carried out to determine the strengthening requirement for a forecast period of 10-year's traffic demand.

77. The designed overlay thickness as per IRC 81:1997 for section under strengthening is given in Table 6.9.

Table 6.9: Designed Overlay

Pavement Composition	for Design MSA 30
BC	40mm
DBM	60mm

6.3.3 DESIGN OF PAVEMENT FOR WIDENING AND RECONSTRUCTION

78. Flexible pavement design has been carried out using the IRC guidelines (IRC-37-2001). Design MSA considered is 30 for 10 years design life (for bituminous layers) and 50 for 15 years design life (for non-bituminous layers). Subgrade strength of soil to be

considered in the pavement design has been derived from material investigations. It has been found that most of the samples have soaked CBR more than 7% at maximum dry density more than 2 gm/cc. These borrow areas are spread throughout the length of the corridor and are adequately available. Hence a CBR of 7% has been adopted for the purpose of pavement design for new carriageway.

79. For wide two lane (2L+PS+HS) Widening and Reconstruction: The design crust thickness for a traffic loading of 30MSA (for non-bituminous layers 50MSA) with 7% CBR subgrade strength have been extracted from pavement design catalogue plate 2 from IRC 37:2001 and is presented in Table 6.10 below:

Table 6.10: Pavement composition for Two Lane Re-construction and Widening

Traffic loading in MSA	Pavement Composition	Thickness in mm
30	BC	40
	DBM	110
50	WMM	250
	GSB	230
	Subgrade (7% CBR)	500

80. For Four Lane (4LPS) Widening and Reconstruction: The design crust thickness for a traffic loading of 15MSA (for non-bituminous layers 25MSA) with 7% CBR subgrade strength have been extracted from pavement design catalogue plate 2 from IRC 37:2001 and is presented in Table 6.11 below:

Table 6.11: Pavement Composition for Four Lane Re-construction and Widening

Traffic loading in MSA	Pavement Composition	Thickness in mm
15	BC	40
	DBM	60
25	WMM	250
	GSB	230
	Subgrade (7% CBR)	500

6.3.4 Pavement Treatment Scheme

81. As per the proposed above the pavement treatment by section is given in Table 6.12

Table 6.12: Pavement Treatment by Section

Chainage in km		Length in km	Existing CW in m	Type of Section	Formation Width	Proposed Widening	Remarks
From	To						
209.863	209.950	0.087	6.2-6.5	C1	21	2LPSHS	Acceleration and Deceleration Lanes
209.950	211.800	1.850	6.2-6.5	D	12	2LPSHS	Recently Widened Section
211.800	212.600	0.800	6.2-6.6	B1	12	2LPSHS	
212.600	213.600	1.000	6.2-6.5	B1	12	2LPSHS	
213.600	218.200	4.600	6.2-6.5	B1	12	2LPSHS	
218.200	219.000	0.800	6.2-6.5	B2	14	2LPS+FP	Wide Paved Shoulder
219.000	225.000	6.000	6.2-6.5	B1	12	2LPSHS	
225.000	230.300	5.300	6.2-6.5	B1	12	2LPSHS	
230.300	230.500	0.200	6.2-6.5	A1	12	2LPSHS	
230.500	231.780	1.280	6.2-6.5	B1	12	2LPSHS	
231.780	232.800	1.020	6.2-6.5	C1	21	4L	
232.800	237.920	5.120	6.2-6.5	B1	14	2LPSHS	
237.920	239.221	1.301	6.2-6.5	C1	21	4L	

Chainage in km		Length in km	Existing CW in m	Type of Section	Formation Width	Proposed Widening	Remarks
From	To						
239.221	240.700	1.479	6.2-6.5	B1	12	2LPSHS	
240.700	241.200	0.500	6.2-6.5	A1	12	2LPSHS	
241.200	243.000	1.800	6.2-6.5	B1	12	2LPSHS	
243.000	244.835	1.835	10.0	A2	14	2LPS+FP	Wide Paved Shoulder
244.835	245.157	0.322	10.0	C1	21	2LPSHS	Acceleration and Deceleration Lanes
245.157	245.406	0.249	10.0	A2	14	2LPS+FP	Wide Paved Shoulder
245.406	245.487	0.081	10.0	C2	13	2LPS	Acceleration and Deceleration Lanes
Total length		**35.624**					

6.4 IMPROVEMENT PROPOSAL FOR STRUCTURES

82. Based on matrix treatment strategies for each structure (bridges and CD Structures) are prepared.

6.4.1 Major Bridges

83. Major bridge at design km 219+275 is having superstructure type is solid slab which is already repaired by guniting. Railing is damaged and minor vegetation is observed. Structure is proposed to be widened and repaired.

84. The other major bridge at design km 225+400 is proposed for repair and rehabilitation, as widening is not possible for the structure due to RCC T- girder and deck slab type superstructure.

6.4.2 Minor Bridges

85. The Proposed intervention for bridges is summarised below

Proposed intervention	Number of Bridges
Repair and Rehabilitation	5
Repair and Widening	1
Reconstruction with new Box Structure	4
Reconstruction with new Solid Slab Structure, PCC type substructure	6

6.4.3 Culverts

86. The Proposed intervention for culverts is summarised below

Culvert Type	Proposed intervention	Number of Culverts
Slab	Repair and Rehabilitation	1
	Reconstruction with new Box Structure	4
	Reconstruction with Pipe Culvert	4
Pipe	Retain Canal Syphon	2
	Widening	1
	Repair	13
	Replace by new pipe culverts	16
	Additional New Pipe Culverts	05

7 ENVIRONMENTAL AND SOCIAL IMPACT

7.1 ENVIRONMENTAL IMPACT ASSESSMENT

87. The proposed upgradation (strengthening and widening) for Atkot – Gondal Corridor is designed within the available RoW. The environmental and social screening and the subsequent consultations with the stakeholders confirmed that there is no sensitive environmental features that are present along the corridor. In addition to the construction related impacts, the key issues raised were (i) safety issues with respect to geometric / curve improvement and provision of road safety furniture 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.

88. As per the Gujarat Government Gazette dated 23rd May 1974 the project corridor is declared as "Notified Protected Forest". The proposed widening and strengthening is designed within 16m CoI. Based on the design, the forest land diversion is estimated to be 33.18 ha. There are 426 avenue trees that are to be felled as part of the proposed upgradation. Hence the proposed widening and strengthening activity requires forest clearance for the diversion of forest land and tree felling permission from the Forest Department, GoG.

89. 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 3.39 million comprises of the funds necessary for the implementation of management measures as well as a provision for environmental monitoring, HIV/ AIDS prevention measures and for the cultural / community enhancements.

7.2 LAND ACQUISITION AND RESETTLEMENT IMPACTS

90. A total of a total of 0.9 ha of private agricultural land will be affected due to geometric improvements in 3 villages. Land acquisition along the corridor is envisaged at village Dadva-Hamirpur (222+950 to 223+497),Ramod (230+277 to 230+510),Ghogavadar (240+675 to 241+105). Other than these three village locations, the proposed improvement will be carried out within the existing RoW of 30 m throughout the corridor.

91. According to the census survey the proposed road improvement will affect agricultural land of 4 households, 8 residential structures (1 squatter), 18 commercial structures (5 squatters), 2 industrial structures, and a residential-cum-commercial structure. Cultural properties and community assets affected due to proposed improvement include 5 religious properties (4 shrines, 1temple) and the boundary wall of a school respectively.

92. Six 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.

93. A resettlement budget of INR 1.69 million including compensation for the affected land & 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

94. 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 23 villages located within 2 km bandwidth of the proposed corridor, of which 12 villages are chosen for the survey. Altogether 60 households are surveyed.

95. **Gender and Age Distribution:** Age distribution shows that 55 percent of the population belongs to the age group of 26-60 and 16 percent of the population is in the age group of 6-14.

96. **Education profile:** Female population has a lower level of education compared to male population.

97. **Income Profile and Dependency Ratio:** 40 percent of the sample households have a monthly income of less than Rs.3000. The dependency ratio is 2.2:1.

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

8.2 MAJOR FINDINGS

99. **Trip Information:** Analysis of trip information of villagers is based on 94 cases of usual trip information of 60 surveyed households. Analysis based on chi-square test shows that trip information does not vary significantly between income-groups.

100. **Mode of Travel**: Amongst the 94 usual trip information, 4 (4 percent) travel on foot and 64 trips (68 percent) are by bicycle, auto-rickshaw, bus or *chakda*.

101. **Frequency of Travel:** 47 percent of the 94 usual trips are on daily basis, 12 percent of the trips are for 3-4 times in a week and 9 percent trips are on monthly basis. Among all vehicles *chakda* and bus are the most used modes for usual trip. Bus is used for 50 percent of usual trips. Of the total trips using vehicles, 46 percent trips are on daily basis

102. **Perception about Present Transport Situation:** Villagers opined about the requirement of good quality roads, more number of buses, improved access to health centres, etc.

9 PROJECT COSTING

103. Based on the estimated quantities and extensive rate analysis, combined project cost including environmental cost and social cost is Rs 97.83 crore. EMP related cost is factored in construction cost itself. The cost under three sub heads is presented in the ensuing sub section.

9.1.1 CONSTRUCTION COST

104. The civil construction cost under 12 bills is given in Table 9.1

Table 9.1: Civil Construction Cost

Bill No.	Description	Amount
Bill No. 1	General Items	96,30,000
Bill No. 2	Site Clearance and Dismantling	69,19,092
Bill No. 3	Earthwork	5,12,38,386
Bill No. 4	Sub-Base and Base Courses	12,63,77,775
Bill No. 5	Base and Surface Course	33,07,85,290
Bill No. 6	Structures	
	a) Culverts	1,75,12,398
	b) Bridges	11,39,53,461
	c) Repair and Rehabilitation	1,04,41,981
Bill No. 7	Drainage and Protection Work	10,77,44,772
Bill No. 8	Traffic Sign and Road Appurtenances	15,14,04,745
Bill No. 9	Safety Road Construction Zone	46,68,787
Bill No. 10	Implementation of Environmental Management Plan to be Executed	32,91,413
Bill No. 12	Total maintenance cost for 2 year	1,42,80,000
	Total Construction Cost	**94,82,48,100**
	Contingencies (3 %)	2,84,47,443
	Total Cost	**97,66,95,543**

Table 9.2: Environmental Management Budget

Sl. No.	Description	Unit	Quantity	Rate	Amount
10.01	Periodic air quality monitoring during construction stage at construction camp sites, bitumen hot mix plants, crusher plants (if specifically established for Project), at major settlement areas along project road. The parameters to be monitored are SPM, RPM, SO2, NOx and CO, Lead. Each monitoring schedule shall be over duration of 24 hours (in 8 hour shifts) for three seasons per year. (as per the Environmental monitoring plan referred in the EMP)				
a)	Construction Phase	Nr	24	7500	**1,80,000**
b)	Operation Phase	Nr	12	7500	**90,000**
10.02	Water quality monitoring during construction phase at locations . The sampling shall be carried out for three seasons per year and cover all parameters as per IS10500 including heavy metals . (as per the Environmental monitoring plan referred in the EMP).				
a)	Construction Phase	Nr	30	6000	**1,80,000**
10.03	Noise quality monitoring at specified silent receptors along Project Road, at construction camp sites, bitumen hot mix plants, crusher plants(if specifically established for Project), and at major settlement				

Sl. No.	Description	Unit	Quantity	Rate	Amount
	areas along project road. – Each monitoring schedule shall be over a duration of 12hours (6Am to 6PM) for three seasons per year. (as per the Environmental monitoring plan referred in the EMP)The monitoring shall be carried out in accordance with CPCB norms at locations given .				
a)	Construction Phase	Nr	24	3000	**72,000**
b)	Operation Phase	Nr	12	3000	**36,000**
10.04	Soil quality monitoring at construction camp sites, work shop areas, oil/lubricant handling areas, bitumen hot mix plants, at all parking lay byes, vehicle servicing stations along Project Road. Parameters shall include N, P, oil and grease, heavy metals, C/N ratio, pH, organic matter to be monitored for three seasons per year.(as per the Environmental monitoring plan referred in the EMP)				
a)	Construction Phase	Nr	6	6000	**36,000**
10.05	Enhancement of Cultural Properties				
a)	Shiva Temple	Nr.	1	347004	**3,47,004**
b)	Mahadev mandir	Nr.	1	369611	**3,69,611**
c)	Public Well	Nr.	1	158009	**1,58,009**
d)	Gayle Mata Temple	Nr.	1	97406	**97,406**
e)	Hanuman Temple	Nr.	1	273383	**2,73,383**
10.06	HIV prevention / alleviation programme comprising of conduction information, Education and communication (IEC) campaigns at least every other month, providing condoms, providing STI and HIV / AIDS screening, diagnosis and referral to dedicated national STI and HIV / AIDS programme and programme management support throughout the contract period (including the defect notification period).	LS			
a)	IEC materials - printing, publishing	Nr	24	3000	**72,000**
b)	Healthcare clinic	Nr.	8	30000	**2,40,000**
c)	Condom vending machines	Nr.	3	15000	**45,000**
d)	Condom supplies	Nr.	24	5000	**1,20,000**
e)	Testing	Nr.	500	1500	**7,50,000**
f)	Signage's and hoardings	Nr.	15	15000	**2,25,000**
	Total				**32,91,412.62**

9.1.2 SOCIAL COSTS

105. The estimated total budget for the implementation of RAP is Rs. 0.17 crore.

Table 9.3: Social Cost

Sr. No.	Category	Amount (INR)
1	Compensation for Land	2,83,216
2	Compensation for Structure	6,59,270
3	Compensation for other assets within affected property (Trees and boundary wall)	3,08,920
4	R&R Assistance	3,89,000
	Sub Total (1+2+3+4)	**16,40,406**
	Contingency (@3%)	49,212
	GRAND TOTAL (Sub Total + Contingency)	**16,89,618**

10 ECONOMIC ANALYSIS

10.1 RESULTS OF ECONOMIC ANALYSIS

10.1.1 Base analysis

106. 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 in Table 10.1 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	19.88%	21.64%	29.96%	30.64%	33.54%	34.01%
		NPV (in million Rupees)					
I	Base Costs + Base Benefits	593	1,126	1,522	2,299	1,859	2,708

107. 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

108. 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).

109. The results of the sensitivity analysis have been presented in Table 10.2 given below:

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 + 15 % and Base Benefits	17.77%	19.81%	26.98%	27.86%	30.20%	30.83%
II	Base Costs and Base Benefits minus 15%	17.52%	19.61%	26.67%	27.58%	29.86%	30.52%
III	Base Costs + 15 % and Base Benefits minus 15 %	15.56%	17.94%	23.97%	25.10%	26.84%	27.70%
		NPV (in million Rupees)					
I	Base Costs + 15 % and Base Benefits	480	1,013	1,410	2,186	1,746	2,595
II	Base Costs and Base Benefits minus 15%	393	847	1,183	1,843	1,469	2,191
III	Base Costs + 15 % and Base Benefits minus 15 %	280	734	1,070	1,730	1,357	2,078

110. The sensitivity analysis reflects project viability in the worst scenario also. If the analysis period is taken as 20 years, the project is viable in case of VOC savings alone. With additional benefits of time and accident cost savings, it tends to become more attractive.

10.1.3 CONCLUSION

111. 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.