Initial Environmental Examination

January 2017

IND: Karnataka State Highways Improvement Project III

Gadag to Honnali

Prepared by Project Implementation Unit, KSHIP, Government of Karnataka for the Asian Development Bank

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CURRENCY EQUIVALENTS

(as on 17 January 2017)

Currency Unit	=	Indian Rupee (INR)
INR 1.00	=	$ 0.0147
$ 1.00	=	INR 67.869

ABBREVIATIONS

AADT	:	Annual Average Daily Traffic
ADB	:	Asian Development Bank
ADT	:	Average Daily Traffic
AE	:	Assistant Engineer
AEE	:	Assistant Environmental Engineer
AIDS	:	Acquired Immune Deficiency Syndrome
AM	:	Arithmetic Mean
AP	:	Affected Person
AQ	:	Air Quality
ARAI	:	The Automotive Research Association of India
ASI	:	Archaeological Survey of India
BUA	:	Business-As-Usual
BCCI-K	:	Bangalore Climate Change Initiative – Karnataka
BDL	:	Below Detection Limit
BOD	:	Biological Oxygen Demand
BPL	:	Below Poverty Line
C/L	:	Centre Line
Ca	:	Calcium
CALINE 4	:	California Line Source Dispersion Model Version 4
CBR	:	California Bearing Ratio
CD	:	Cross Drainage
CEF	:	Composite Emission Factor
CEW	:	Corridor East-West
CGWA	:	Central Ground Water Authority
CGWB	:	Central Ground Water Board
Cl	:	Chlorine
CO	:	Carbon Monoxide
CoI	:	Corridor of Impact
CPCB	:	Central Pollution Control Board
CPO	:	Chief Project Officer
CPR	:	Common Property Resources
CRN	:	Core Road Network
CRTN	:	Calculation of Road Traffic Noise
Cu	:	Copper
CWC	:	Central Water Commission
dB	:	Decibel
DC	:	District Collector
DFO	:	Divisional Forest Officer
DGRC	:	District Grievance Redress committee
DLRO	:	District Land Revenue Officer
DO	:	Dissolved Oxygen
DO	:	Duty Officer

DPR	:	Detailed Project Report
EA	:	Executive Agency
EAC	:	Expert Appraisal Committee
EC	:	Electrical Conductivity
EHS	:	Environment Health and Safety
EIA	:	Environmental Impact Assessment
EMP	:	Environment Management plan
EO	:	Environmental Officer
EPA	:	Engineering Procurement Annuity
EPA	:	Environment (Protection) Act
EPC	:	Engineering Procurement Construction
ES	:	Environmental Specialist
Fe	:	Iron
GHGs	:	Greenhouse Gases
GIS	:	Geographical Information System
GoI	:	Government of India
GoK	:	Government of Karnataka
GRC	:	Grievance Redress Cell
GRM	:	Grievance Redress Mechanism
GW	:	Ground Water
HDPE	:	High Density Polyethylene
HFL	:	High Flood Level
Hg	:	Mercury
HIV	:	Human Immunodeficiency Virus
HS	:	Homogeneous Section
ICAP	:	Indian Clean Air Program
ICB	:	International Competitive Bidding
IE	:	Independent Engineer
IEE	:	Initial Environmental Examination
IMD	:	India Meteorological Department
IRC	:	Indian Road Congress
IS	:	Indian Standards
IUCN	:	International Union for Conservation of Nature
IVI	:	Important Value Index
KPWD	:	Karnataka Public Works Department
KRDCL	:	Karnataka Road Development Corporation Limited
KSAPCC	:	Karnataka State Action Plan on Climate Change
KSHIP	:	Karnataka State Highways Improvement Project
LA	:	Land Acquisition
LAP	:	Land Acquisition Plan
LAQ	:	Land Acquisition Officer
LHS	:	Left hand Side
LPG	:	Liquid Petroleum Gas
Mg	:	Magnesium
MI	:	Monitoring Indicators
Mn	:	Manganese
MO	:	Medical Officer
MOEF&CC	:	Ministry of Environment, Forest and Climate Change
MoRT&H	:	Ministry of Road Transport and highways
MPN	:	Most Probable Number
MSDS	:	Material Safety Data Sheet

MSL	:	Mean Sea Level
NAAQS	:	National Ambient Air Quality Standards
NABL	:	National Accreditation Board for Testing and Calibration Laboratories
NBWL	:	National Board for Wildlife
NE	:	Not Evaluated
NGO	:	Non-Government Organization
NO_2	:	Nitrogen Dioxide
NOC	:	No Objection Certificate
NPV	:	Net Present Value
NQ	:	Noise Quality
NTU	:	Nephelometric Turbidity Unit
OBC	:	Other Backward Caste
ODR	:	Other District Road
PAF	:	Project Affected Families
PAH	:	Project Affected Households
PAP	:	Project Affected Persons
Pb	:	Lead
PBDPS	:	Performance Based Deferred payment System
PCC	:	Plain Cement Concrete
PCM	:	Public Consultation Meeting
PCU	:	Passenger Car Unit
PD	:	Project Director
PHH	:	Physically Handicapped Persons
PIA	:	Project Influence Area
PIU	:	Project Implementation Unit
PM	:	Particulate Matter
PP	:	Project Proponent
PPE	:	Personal Protective Equipment
PPM	:	Parts Per Million
PPTA	:	Project Preparatory Technical Assistance
PRC	:	Public Response Centre
PT	:	Performance Target
PTV	:	Percent Time Violation
PUC	:	Pollution under Control
RAP	:	Reclaimed Asphalt Pavement
RCC	:	Roller Compacted Concrete
REA	:	Rapid Environmental Assessment
RHS	:	Right Hand Side
ROB	:	Road Over Bridge
RoW	:	Right of Way
RUB	:	Road Under Bridge
SAR	:	Sodium Absorption Ratio
SC	:	Schedule Caste
SD	:	Standard Deviation
SDO	:	Social Development Officer
SEAC	:	State Level Expert Appraisal Committee
SH	:	State Highway
SIA	:	Social Impact Assessment
SO	:	Safety Officer
SO_2	:	Sulphur Dioxide

SPCB	:	State Pollution Control Board
SPL	:	Sound Pressure Level
ST	:	Schedule Tribes
SW	:	Surface Water
TCS	:	Typical Cross Section
TDS	:	Total Dissolved Solids
TEEMP	:	The Transport Emission Evaluation Model for Projects
USEPA	:	United States Environmental Protection Agency
VDF	:	Vehicle Damage Factor
VEC	:	Valued Environment Component
WHH	:	Women Headed Household
WLPA	:	Wildlife Protection Act
WMM	:	Wet Mix Macadam

WEIGHTS AND MEASURES

Cum	:	Cubic Meter
dB(A)	:	A Weighted Decibel
gm/cm^3	:	Gram per Centimeter Cube
g/km	:	Gram Per Kilometer
ha	:	Hectare
ham	:	Hectare meter
km	:	Kilometer
Km/l	:	Kilometer Per Liter
Km^2	:	Square Kilometer
L_{eq}	:	Equivalent Continuous Noise Level
µg	:	Microgram
$µg/m^3$	:	Microgram Per Cubic Meter
m	:	Meter
mg/kg	:	Milligram per Kilogram
mg/l	:	Milligram per Liter
mg/m^3	:	Milligram Per Cubic Meter
$PM_{2.5}$	:	Particulate Matter of 2.5 Micron size
PM_{10}	:	Particulate Matter of 10 Micron size
Sqm.	:	Square Meter

EXECUTIVE SUMMARY

A. Introduction

1. The Government of Karnataka through the Government of India has received in principal approval for a loan from the Asian Development Bank (ADB) towards Karnataka State Highways Improvement Project –III (KSHIP-III) for developing State Road network adopting innovative financial models under Public Private Partnership (PPP). A pre financial feasibility has been conducted by PIU KSHIP on a Core Road Network of 4,403 km out of which 1,350 km has been selected for Detailed Project Preparation and Implementation under KSHIP-III.

2. In pursuance of the above, Intercontinental Consultants and Technocrats Pvt. Ltd. have been appointed as Consultants by KSHIP to carry out the Preparation of Detailed Project Report and provide Transaction Advisory Services for Karnataka State Highway Improvement Project-III Group II roads in the State of Karnataka to two/four lane with Paved Shoulder Configuration".

1. Objectives of the IEE

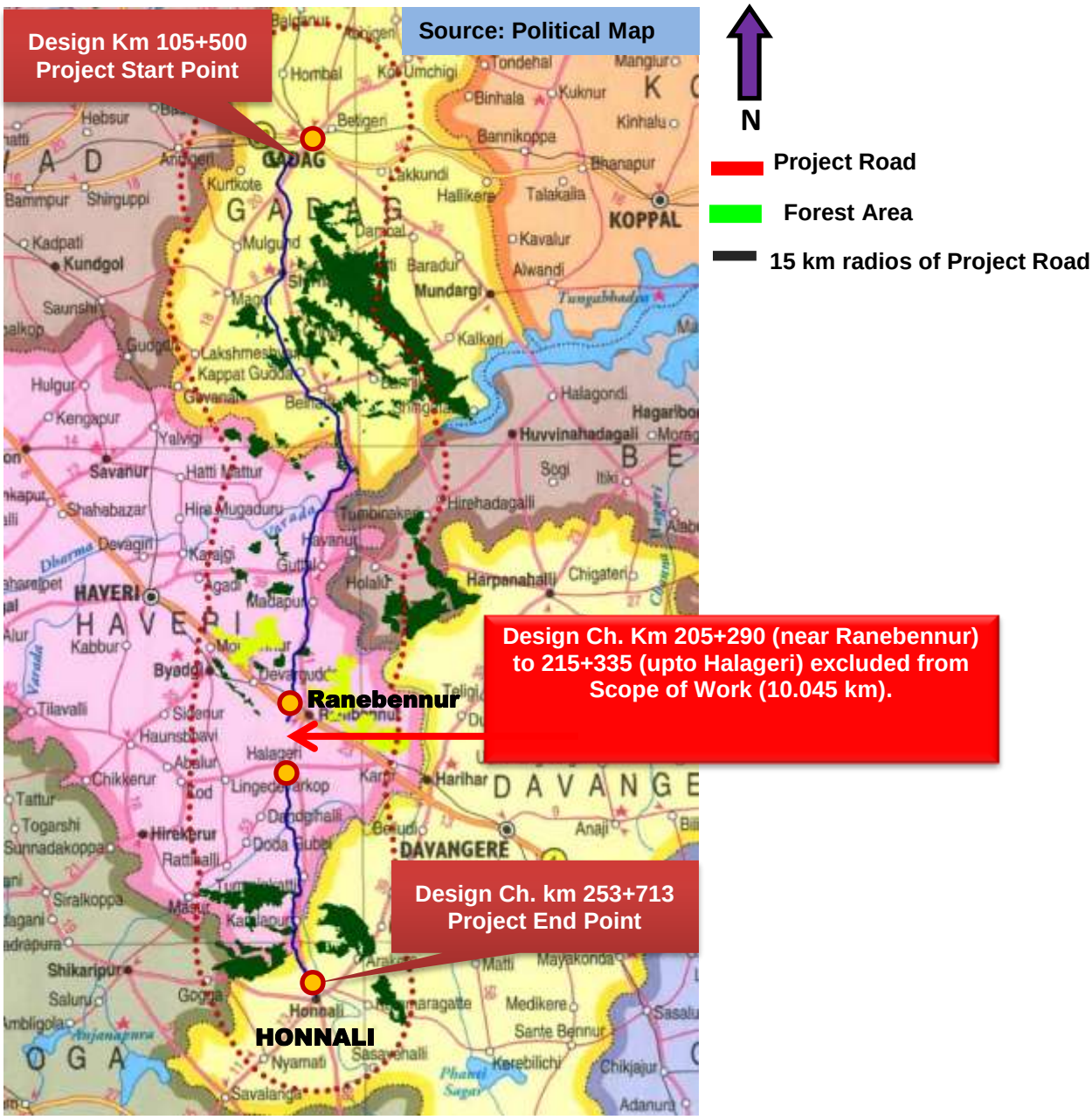
3. Following are the objectives of the Environmental Study:

- Determine the category of the project depending on improvement proposal, environmental sensitivity and magnitude of impacts, i.e. screening as per Government of India's regulations and ADB's Safeguard Policy Statement 2009;
- Determine the appropriate extent and type of EA required (IEE or EIA), i.e scoping;
- Determine the requirement of statutory clearances;
- Baseline environmental monitoring and survey;
- Prediction of impacts on relevant environmental attributes and mitigation measures to minimize the impacts; and
- Preparation of IEE Report including EMP.

B. Description of the Project

4. The Project road starts after Gadag town, from the junction of SH-57 with newly constructed SH-45 bypass and ends in Honnali settlement at a T Junction where project road SH-26 meets a city road (Figure-E.1). The Latitude & Longitude of start and end points of project road are 15°24'46.29" N & 75°37'9.88" E and 14°14′14.71″ N & 75°38′58.16″ E respectively.

5. Approx. 4.275 km (Ch. Km 205+290 to 209+565) in Ranebennur town is excluded in the improvement proposal. Approx. 5.77 km (Ch. Km 209+565 to 215+335) is also excluded from the package as the stretch is being developed by KSRDCL. Therefore, total length of the project road considered in improvement Proposal is 138.168 km.



1. Project Highlights

Table-E.1: Salient Existing Features of the Project Road

Road stretch	Gadag to Honnali
Road length	138.168 Km
Start point	After Gadag town, from the junction of SH-57 with newly constructed SH-45 bypass
End point	Ends in Honnali settlement at a T Junction where project road SH-26 meets a city road
Districts en-route	Gadag, Haveri and Davangere
Important	Soratur, Sirahatti, Bellahatti, Guttal, Honnati, Ranebennur,

settlements /villages	Tuminakatte and Honnali
Existing carriageway	The existing road is predominantly (81%) Intermediate lane carriageway of 5.5 m width, about 13.4% of the project length is single lane carriageway of 3.75 m width and about 3.8% of project length is 2-lane carriageway of varying width of 7 m to 14.5 m width. Small section of project road of about 3.4 Km length is 4 lane carriageway in the settlement areas
Terrain	Plain and rolling
Land Use	Mainly agricultural followed by built-up area and forest land
Major Bridges	2
Minor Bridges	18
Causeways	13 vented causeways
Culverts	239 culverts
ROB & RUB	Nil
Railway Crossing	one existing railway level crossing at Ch. Km 214+700
Flyover	Nil

2. Annual Average Daily Traffic (AADT)

6. Section-wise AADT obtained is shown in Table-E.2 which gives the mode-wise AADT for all the survey locations.

Table-E.2 Annual Average Daily Traffic at Various Surveyed Location

Location	Description	Survey conducted by	Total Traffic	
			Vehicles	PCUs
MCC-03	Km 113+100, Nagavi Village	iDeCK 2015	2,486	3,236
MCC-04	Km 149+000, near Bellatti Village	ICT 2015	1,531	1,451
MCC-05	Km 201+000, near Honnati Village	ICT 2015	3,457	3,293
	Km 201+000, near Honnati Village	iDeCK 2015	3,720	3,915
MCC-06	Km 223+000, Halageri Village	ICT 2015	2,822	3,382
	Km 223+000, Halageri Village	iDeCK 2015	3,111	3,246
MCC-07	Km 105+000 (NH-218)	ICT 2015	4,677	7,631

Source: Survey conducted by iDeCK & ICT

3. Identification of Homogeneous Sections

7. The project road has been divided into 4 homogeneous sections on the basis of observed mid-block traffic flows The homogeneous section wise traffic projections have been given in Table-E.3.

Table-E.3 Homogeneous Sections of the Project Road

Section No.	Sections	Start Chainage (Km)	End Chainage (Km)	Distance (Km)	Traffic Volume AADT(PCU)
HS-V	Gadag to Shirahatti	105+200	130+000	24.800	3,236
HS-VI	Shirahatti to Gutal	130+000	181+000	51.000	1,451

Section No.	Sections	Start Chainage (Km)	End Chainage (Km)	Distance (Km)	Traffic Volume AADT(PCU)
HS-VII	Gutal to Ranebennur	181+000	209+000	28.000	3,292
HS-VIII	Ranebennur to Honnali (excluding approx. 5.9 km between junction with NH-4 flyover and Junction in Halageri)	209+000	253+116	44.116	3,381

* Chainage equation (KR Pete Bypass), Previous Chainage 155+300= Forward Chainage 154+905

4. Traffic Forecast

8. The projected traffic for each of the homogeneous sections is presented in Table-E.4.

Table-E.4 Projected Annual Average Daily Traffic on Various Homogenous Sections of SH-57 & 26 (Gadag to Honnali Section)

Vehicle Type	Year								
	2015	2019	2020	2022	2025	2030	2035	2040	2050
Homogenous Section V-Gadag to Sirhatti km 105+200 to km 130+000									
Total PCUs	3,236	4,040	4,692	5,582	6,696	8,904	11,587	14,829	22,922
Total Vehicles	2,486	3,235	3,741	4,513	5,595	7,736	10,449	13,796	22,296
Homogenous Section VI-Shirhatti to Guttal km 130+000 to km 181+000									
Total PCUs	1,451	1,810	2,297	2,844	3,443	4,630	6,096	7,893	12,472
Total Vehicles	1,531	2,002	2,402	2,953	3,690	5,162	7,062	9,446	15,575
Homogenous Section VII- Guttal to Ranebennur km 181+000 to 209+000									
Total PCUs	3,292	4,254	4,970	6,010	7,411	10,172	13,658	17,859	28,396
Total Vehicles	3,458	4,593	5,250	6,340	7,975	11,230	15,447	20,704	34,156
Homogenous Section VIII- Ranebennur to Honnali km 209+000 to 253+116									
Total PCUs	3,381	4,388	5,112	6,171	7,629	10,566	14,239	18,582	29,439
Total Vehicles	2,822	3,750	4,322	5,239	6,590	9,296	12,779	17,075	28,043

5. Improvement Proposal

Table-E.5 Summary of Improvement Proposal

<table>
<tr><td>Proposed RoW</td><td>In urban / built up area: Varies from 16 m to 20 m
In rural / open country area: Varies from 26 m to 36 m depending on the height of embankment</td></tr>
<tr><td>Widening Scheme</td><td>A 2-lane section with 7 m wide carriageway and 1.5 m wide paved shoulder and 1m earthen shoulder on both sides has been proposed.

Concentric Widening : 82.828 km
Eccentric Widening : 05.925 km
Bypasses : 09.065 km
Realignment & Geometric Improvement : 40.350km</td></tr>
<tr><td>Bypass</td><td>At three locations (9.065 km):
<table>
<tr><th rowspan="2">Location</th><th colspan="2">Existing Ch. Km</th><th colspan="3">Design Chainage</th></tr>
<tr><th>Start</th><th>End</th><th>Start</th><th>End</th><th>Length</th></tr>
<tr><td>Shirahatti</td><td>128+350</td><td>132+105</td><td>127+090</td><td>130+090</td><td>3.000</td></tr>
<tr><td>Bellahati</td><td>148+500</td><td>151+422</td><td>146+150</td><td>149+365</td><td>3.215</td></tr>
</table></td></tr>
</table>

	Guttal | 188+700 | 192+140 | 178+660 | 181+510 | 2.850
Realignment	At fourteen (14) locations, total length is 23.375 km
Bridge	Existing Major Bridges Rehabilitated and Retained : 3 Proposed New Major Bridges : 4 Existing Minor Bridges to be Rehabilitated and Widened : 2 Existing Minor Bridges to be Rehabilitated and Retained : 3 Existing Minor Bridges to be Reconstructed : 6 New Minor Bridges on Realignments / Bypasses : 8 New Minor Bridges on Causeways : 6
ROB	1 new ROBs is proposed on Ranebennur Realignment at design Ch. Km 203+145
Culverts	Reconstruction of existing culverts : 95 Widening of existing culverts : 43 Construction of new culverts : 104 Existing culverts to be retained : 08
Pedestrian Subway	Nil
Road Side Drains	Roadside drains shall be provided on both sides of the embankment In Rural Section trapezoidal drain sections have been proposed on both sides. In Urban Sections, lined drains with footpath have been proposed
Bus Bays	74 bus bays at 37 locations
Truck Lay Byes	To facilitate the truck traffic, three truck lay bye on both sides of the project road have been proposed at km 148+213, 201+600 & 249+712 (Left) and Km 148+388, 201+430 & 249+837 (Right).
Toll Plaza	Considering traffic flow and homogeneous section, three toll plazas has been proposed at Ch. km 118+050, Ch. km. 187+500 and Ch. km. 228+150. However as decided during consultation with the client, construction of toll plaza will not be taken up immediately & only provision of land for the toll plaza has been made.
Design Speed	The project road is proposed to be improved to 2 lane with paved shoulder to a ruling design speed of 100 / 80 km per hour in plain / rolling terrain and with 50 km per hour as the minimum design speed in built up sections.
Road Safety Devices	Road Markings Road Signs Roadside Safety Barriers Pavement Marking and Lighting Many other safety features as prescribed in applicable codes and standards
Project Cost	Civil Cost : Rs. 577.25 Crore EMP Cost : Rs. 7.94 Crore
Project Completion Period	30 months

C. Policy, Legal and Administrative Framework

9. As per the ADB's Safeguard Policy Statement 2009, the proposed project has been classified as Category 'B' project requiring Initial Environmental Examination (IEE).

10. Environment Clearance: The proposed project is the strengthening & widening of existing State Highway. Project road is passing through plain terrain (below 1,000 m MSL) and is not passing through any ecologically sensitive area. Therefore, Environmental Clearance is not required from Government of India for improvement of SH-57 & SH-26 from Gadag to Honnali (138.168 Km) in the State of Karnataka.

11. A summary of various statutory clearances required for the project road is presented in Table-E.6.

Table-E.6 Statutory Clearances required for the Project Road

Type of Clearance	Name of the Authority	When Required
Forest Clearance	Department of Forest, GoK	Before Construction
Tree Felling Permission	Department of Forest, GoK	Before Construction

12. Apart from the clearances for the overall project work, the contractor, before starting the construction work, has to obtain required Clearances / NOCs listed in Table-E.7 for operating his equipment and carrying out construction work.

Table-E.7: Clearances Required to be obtained by the Contractor

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
	Consent for Establishment of Hot Mix Plant, WMM Plant, Stone Crushers and Batching Plant	Karnataka State Pollution Control Board	Air (Prevention and Control of Pollution) Act, 1981 Water (Prevention and Control of Pollution) Act, 1974 The Noise Pollution (Regulation and Control) Rules, 2000
	Consent for Operation of Hot Mix Plant, WMM Plant, Stone Crushers and Batching Plant		
	Permission for withdrawal of groundwater for construction	Central Ground Water Authority State Ground Water Board	Environment (Protection) Act, 1986 Ground Water Rules, 2002
	Permission for extraction of sand from river bed	Department of Mines & Geology, Government of Karnataka	Environment (Protection) Act, 1986
	Permission for extraction of sand from river bed	District Level Environment Impact Assessment Authority (DEIAA)	Environment (Protection) Act, 1986
	New Quarry and its operation	Department of Mines & Geology, Government of Karnataka Karnataka State Pollution Control Board	Environment (Protection) Act, 1986 Karnataka Minor Mineral Concession Rules, 1994 The Mines Act. 1952 Mines and Minerals (Development and Regulation) Amendment Act, 2015 The Explosive Act, 1984

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
			Air (Prevention and Control of Pollution) Act, 1981 Water (Prevention and Control of Pollution) Act, 1974
	Opening of New Borrow Areas / Quarry	MoEF&CC / SEIAA / DEIAA Karnataka State Pollution Control Board District Collector	Environment (Protection) Act, 1986 Air (Prevention and Control of Pollution) Act, 1981 Minor Mineral and Concession Rules, 2015
	Location and layout of workers camp, & equipment and storage yards	Karnataka State Pollution Control Board	Environment (Protection) Act, 1986; Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989
	Discharges from labour camp	Karnataka State Pollution Control Board	Water (Prevention and Control of Pollution) Act, 1974
	Storage, handling and transport of hazardous materials	Karnataka State Pollution Control Board	Hazardous and Other Waste (Management and Trans-boundary Movement) Rules, 2016 Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989
	Disposal of Bituminous Wastes	Intimate local civic body to use local solid waste disposal site	Hazardous and Other Waste (Management and Trans-boundary Movement) Rules, 2016
	PUC Certificate for all construction vehicles and all machineries	Transport Department of Govt. of Karnataka	The Motor Vehicle Act 1988 The Motor Vehicles (Amendment) Bill, 2015 The Central Motor Vehicles Rules, 1989
	Installation of DG Set (Consent to Establish)	Karnataka State Pollution Control Board	Air (Prevention and Control of Pollution) Act, 1981 The Noise Pollution (Regulation and Control) Rules, 2000
	Operation of DG Set (Consent to Operate)		
	Engagement of Labour Labour License	Labour Commissioner (Ministry of Labour and Employment)	The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 Contract Labour (Regulation and Abolition) Act 1970 along with Rules, 1971
	Engagement of Labour Social Security Labour Welfare Wages	Labour Commissioner (Ministry of Labour and Employment)	The Employees' Provident Fund & Miscellaneous Provisions (Amendment) Act, 1996 The Personal Injuries (Compensation Insurance) Act, 1963 The Inter-State Migrant Workmen

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
			(Regulation of Employment and Conditions of Service) Act, 1979 Equal Remuneration Act, 1976 The Payment of Wages (Amendment) Act, 2005 The Minimum Wages Act, 1948 The Minimum Wages (Central) Rules, 1950

13. In addition to the above, Contractor has to obtain:

- Insurance related to 3rd party insurance, Indemnity, Workmen Compensation etc.
- Permission / license to store explosive materials
- Permission from local Panchayat / Municipal body for setting up Construction Camp
- Change of Land Use Certificate from District Land Revenue Officer (DLRO)

D. Description of the Environment

14. The existing environmental conditions of the study area covering an area spread over 15 km on either side of the road, in general and specific environmental features of the study corridor, i.e., 50 m on either side of the existing centerline of the road, in particular, has been studied as described in the subsequent sections.

1. Seismicity

15. The project area is located in the southern India which is moderately active seismic region. The project road is situated in the Zone II (having low seismic intensity) of the Seismic Map of India (as per IS: 1893, Part I, 2002) and therefore has a low risk of potential damage due to earthquake.

2. Land Use

16. The land use pattern in most of the stretch along the project road is agricultural (80.1%) followed by residential cum commercial area (16.1%) and forest (3.8%).

3. Soil Quality

17. Three (3) sampling locations within the study area were selected for studying soil characteristics. It has been observed that the texture of soil is sandy loam with 62-65% sand content and only 12-14% clay content. The pH of the all samples varied between 7.5-7.7, which is slightly above the neutral mark of 7.0, indicating slightly alkaline soil. The organic matter was observed to sufficient and varying in the range of 2.2-2.5%. The sodium absorption ratio is low (1.2 to 1.3%), while the nitrogen content of the soil is sufficient. Thus, it can be inferred that the overall fertility status of the soils within the study area is good.

4. Climate & Meteorology

18. An automatic weather station was established at Gadag for collection of meteorological data from 9th December 2015 to 8th January 2016. Meteorological data of the study area is summarized below:

Table-E.8 Summary of Meteorological Data of the Study Area

Parameters	Dec 2015 – Jan 2016
Maximum Temperature (o C)	33
Minimum Temperature (o C)	6.1
Maximum Relative Humidity (%)	99
Minimum Relative Humidity (%)	7.6
Total Rainfall (mm)	0
Average Wind Speed (m/sec)	2.8
Calm condition	0.00
Predominant wind direction (blowing from)	South-west
Dry hours (%)	100%

Source: On-site Monitoring during Dec15-Jan16

5. Ambient Air Quality

19. For drawing up the baseline status of ambient air quality in the study corridor, ambient air quality monitoring has been conducted at 8 representative locations along the project road at a frequency of twice a week at each station for one month. 24-hourly monitoring results of PM2.5, PM10, SO2, NO2 and 1-hourly CO corresponding to air quality stations AQ1 to AQ8 are presented in Table-E.9.

20. The 24-hourly average 98-percentile values of all parameters at both the locations were observed to be within the prescribed limit for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009.

Table-E.9 Statistical Analysis of Ambient Air Quality in the Study Area

Pollutant	AAQ MS	Location	Mes	Min	Max	SD	p98	PTVIN D	PTVW B	Indian Standard
PM2.5 (μg/m3)	AQ1	Soratur	4	9.80	15.80	2.15	15.60	0.0	0.0	60
	AQ2	Chabbi	4	11.00	18.00	2.59	17.88	0.0	0.0	
	AQ3	Alagilawad	4	8.40	10.20	0.67	10.16	0.0	0.0	
	AQ4	Guttal	8	13.00	20.00	2.42	19.86	0.0	0.0	
	AQ5	Ranebennur	4	10.60	16.40	2.07	16.26	0.0	0.0	
	AQ6	Halageri	4	9.90	13.50	1.41	13.36	0.0	0.0	
	AQ7	Hallur	4	9.70	13.80	1.56	13.73	0.0	0.0	
	AQ8	Honnali	4	10.00	14.00	1.48	13.88	0.0	0.0	
	Overall 8 Locations		36	8.40	20.00	2.94	19.30	0.0	0.0	
PM10 (μg/m3)	AQ1	Soratur	4	48.00	56.00	2.96	55.88	0.0	0.0	100
	AQ2	Chabbi	4	64.00	76.00	4.58	75.64	0.0	0.0	
	AQ3	Alagilawad	4	36.00	44.00	3.16	43.88	0.0	0.0	
	AQ4	Guttal	8	62.00	74.00	3.80	73.72	0.0	0.0	
	AQ5	Ranebennur	4	58.00	68.00	3.74	67.64	0.0	0.0	
	AQ6	Halageri	4	34.00	48.00	5.48	47.88	0.0	0.0	
	AQ7	Hallur	4	43.00	59.00	6.30	58.58	0.0	0.0	

Pollutant	AAQMS	Location	Mes	Min	Max	SD	p98	PTVIND	PTVWB	Indian Standard
	AQ8	Honnali	4	44.00	57.00	4.66	56.70	0.0	0.0	
	Overall 8 Locations		36	34.00	76.00	11.59	74.60	0.0	0.0	
SO2 (μg/m3)	AQ1	Soratur	4	7.20	10.40	1.26	10.32	0.0	0.0	80
	AQ2	Chabbi	4	7.80	10.60	1.09	10.55	0.0	0.0	
	AQ3	Alagilawad	4	6.60	8.70	0.79	8.62	0.0	0.0	
	AQ4	Guttal	8	6.00	8.50	0.88	8.49	0.0	0.0	
	AQ5	Ranebennur	4	9.80	13.40	1.42	13.30	0.0	0.0	
	AQ6	Halageri	4	7.90	10.70	1.08	10.61	0.0	0.0	
	AQ7	Hallur	4	6.20	9.80	1.55	9.75	0.0	0.0	
	AQ8	Honnali	4	8.60	11.30	1.07	11.19	0.0	0.0	
	Overall 8 Locations		36	6.00	13.40	1.67	12.21	0.0	0.0	
NO2 (μg/m3)	AQ1	Soratur	4	14.00	20.00	2.24	19.88	0.0	0.0	80
	AQ2	Chabbi	4	20.00	28.00	2.96	27.76	0.0	0.0	
	AQ3	Alagilawad	4	16.00	24.00	3.32	23.76	0.0	0.0	
	AQ4	Guttal	8	16.00	28.00	3.72	27.44	0.0	0.0	
	AQ5	Ranebennur	4	24.00	32.00	3.16	31.88	0.0	0.0	
	AQ6	Halageri	4	12.00	22.00	3.84	21.88	0.0	0.0	
	AQ7	Hallur	4	11.00	20.00	3.35	19.82	0.0	0.0	
	AQ8	Honnali	4	22.00	30.00	2.96	29.76	0.0	0.0	
	Overall 8 Locations		36	11.00	32.00	5.11	30.60	0.0	0.0	
CO (mg/m3)	AQ1	Soratur	4	0.04	0.05	0.00	0.05	0.0	0.0	4
	AQ2	Chabbi	4	0.06	0.07	0.00	0.07	0.0	0.0	
	AQ3	Alagilawad	4	0.04	0.04	0.00	0.04	0.0	0.0	
	AQ4	Guttal	8	0.06	0.08	0.00	0.07	0.0	0.0	
	AQ5	Ranebennur	4	0.04	0.05	0.00	0.05	0.0	0.0	
	AQ6	Halageri	4	0.03	0.04	0.00	0.04	0.0	0.0	
	AQ7	Hallur	4	0.03	0.04	0.00	0.04	0.0	0.0	
	AQ8	Honnali	4	0.03	0.04	0.00	0.04	0.0	0.0	
	Overall 8 Locations		36	0.03	0.08	0.00	0.07	0.0	0.0	

Source: On-site Field Monitoring during Dec15 – Jan 15

AAQMS: Ambient Air Quality Monitoring Station Code, Mes: Number of Measurements, AM: Arithmetic Mean, SD: Standard Deviation, p98: 98-Percentile Value, PTV: Percent time violation with respect to the standard

6. Ambient Noise Level

21. To assess the background noise levels, ambient noise monitoring was conducted at 6 locations, two in residential areas and four at silence zone (Table-E.10).

Table E- 10 Details of Noise Monitoring Stations

Station Code	Place	Chainage (Km)	Side	Distance# (m)	Area category
NQ1	Chabbi Village (Govt. Primary School)	135+200	LHS	45	Silence
NQ2	Kerimalpur	190+850	LHS	18	Residential
NQ3	Ranebeenur	208+530	RHS	40	Residential
NQ4	Halagiri Village (Sri Sai Public School)	215+500	RHS	37	Silence

Station Code	Place	Chainage (Km)	Side	Distance# (m)	Area category
NQ5	Hallur Village (Ranganatha Swami PU College)	240+600	LHS	30	Silence
NQ6	Honnali Town (Swami Vivekananda School)	252+350	LHS	23	Silence

Source: On-site Noise Monitoring during December 2015
Distance in meter from existing centerline
Note: Noise Standard in Residential Zone: Day Time: 55 dB(A) Night Time: 45 dB(A)
Noise Standard in Silence Zone : Day Time: 50 dB(A) Night Time: 40 dB(A)

22. The daytime and night time noise equivalent levels in the residential & silence areas show that the ambient noise levels exceeds the stipulated of Noise standards. Highest equivalent noise level observed in residential and silence zone in day time is 66.2 dB(A) and 65.8 dB(A) respectively.

23. Ld10 values (highest among the monitored values) are found to be 68.4 dB(A) and 68.30 dB(A) for residential and silence zone respectively, which signifies that measured noise levels exceeded these values in only 10% of the time of measurement duration. The noise levels were recorded sufficiently away from the project road to avoid influence of traffic induced noise. Therefore, it can be inferred that the moderately high noise levels at monitoring locations originates from local activities including domestic.

7. Surface and Ground Water Quality

24. 6 surface water (Pond, River, and Canal) and 4 ground water quality monitoring stations (hand-pumps) in the study corridor were selected for the purpose of monitoring, analysis and assessment of water quality (Table-E.11).

Table E.11 Details of Surface and Ground Water Quality Monitoring Stations

SN	Station Code	Place	Chainage (Km)	Side	Distance# (m)	Usage
Surface Water						
1	SW1	Pond - Devilhal Village	144+600	RHS	10.3	Irrigation & Live Stock
2	SW2	Varada River	179+000	RHS	25	Irrigation
3	SW3	Pond - Guttal Village	190+800	LHS	5.5	Irrigation & Live Stock
4	SW4	Canal Crossing - Guddad Anveri Village	211+300	LHS	14	Irrigation
5	SW5	Kumadvati River	232+220	LHS	15	Irrigation
6	SW6	Tungabhadra River	245+900	LHS	110	Irrigation & Live Stock
Ground Water						
1	GW1	Chabbi Village	138+200	LHS	10	Drinking
2	GW2	Guttal	189+500	LHS	50	Drinking
3	GW3	Ranebennur	215+600	LHS	40	Drinking
4	GW4	Honnali	263+650	RHS	8	Drinking

Distance in meter from existing centerline
Source: On-site Water Quality Monitoring in December 2015

25. The water quality results shows the surface waters in the study area are devoid of any extraneous chemical contamination; no toxic or organic constituents are detected in samples. However, have high coliform count, high BOD levels and low dissolved oxygen indicates discharge of fecal matters and agricultural runoff in the water.

26. The ground water quality of the study area, in general, is hard in nature and the physico-chemical quality at large satisfies the permissible limit as stipulated in Drinking Water Standards of India as well as World Health Organization.

8. Ecology and Biodiversity

27. Road side Trees: The number of roadside trees existing within the row is estimated to be 3,865, out of which, 1,792 trees are located in left side and 2,073 trees are located in right side.

28. Giant Trees: Field survey was conducted to identify the location of giant trees (girth size more than 3.0 m). 104 giant trees are found along the project road, out of which 62 trees are on the left side and 42 trees are on the right side.

29. Biodiversity Study: The biodiversity study for Gadag to Honnali was carried in the month of December, 2015. Total of 10 sample plots of 100 m x 10 m were laid for the purpose of biodiversity assessment. The sample plots were laid around an interval of 10-15 km such that the plots are located on either side of the road. The GPS co-ordinates and altitude were recorded for each of the sample plots (Table-E.12)

Table-E.12 GPS Co-ordinates and Altitude for the Sample Plots

Sample Plots	Latitude	Longitude	Altitude (m)	Vegetation Type
1	14° 15'23.4''	75°38'17.8''	545	Shrubby vegetation
2	14° 25'40.9''	75°37'17.7''	540	Shrubby vegetation
3	14° 34'38.8''	75°36'57.4''	554	Vegetation along seasonal water course
4	14° 47'37.9''	75°38'06.8''	553	Shrubby vegetation
5	14° 55'10.9''	75°39'26.3''	507	Shrubby vegetation
6	15° 03'01.0''	75°40'56.0''	567	Shrubby vegetation
7	15° 11'33.9''	75°34'54.0''	654	Vegetation along seasonal water course
8	15° 16'36.3''	75°36'19.9''	717	Shrubby vegetation
9	15° 23'14.8''	75°36'3.6''	667	Shrubby vegetation
10	15° 34'06.2''	75°40'03.33''	588	Shrubby vegetation

Source: Bio-diversity Study conducted by ICT in December 2015

30. 55 floral species were identified. Out of which, 24 were tree species, 16 shrubs and 15 herb species.

31. In the present assessment, the Shannon's diversity index for tree species was 2.75, for shrubs was 2.37 and for herbs 2.42. Shannon's diversity index values obtained for different sites was found to be moderate to low when compared to reported values of 3.6 to 5.4 for tropical forests (Knight, 1975) and is nearer to the range (2.557 to 3.375) reported for Permanent Preservation Plots at Western Ghats of Karnataka (Karthik, 2009) and 2.31 to 3.30 for the Western Ghats of Southern Karnataka (Sarkar et al., 2011).

32. The calculated Simpson's index indicated that the tree diversity was more compared to shrubs and herbs.

Table-E.13 Shannon's Diversity Index and Simpson's Index

Flora	Shannon's Diversity Index	Simpson's Index
Tree	2.75	0.08
Shrub	2.37	0.11
Herb	2.42	0.12

Source: Bio-diversity Study conducted by ICT

33. Total 67 faunal species were identified out of which 43 bird species, 21 insects, 1(one) reptile and 2(two) mammals were observed.

34. Accipiter badius (Shikra) and Ictinaetus malayensis (Black Eagle) are Schedule I species as per Wildlife Protection Act, 1972.Schedule I species are provided absolute protection – offence under these are prescribed the highest penalities. According to IUCN Global Conservation status both the species are under Least Concern (LC) category in the redlist. This species have an extremely large range, and hence does not approach the thresholds for vulnerable under the range size criterion. The population trend appears to be stable; globally there are no major threats to this species. No threatened species reported as per IUCN Red list.

Table-E-14 Shannon and Simpson Index

Shannon's Diversity Index (H)	Simpson's Index (D)
3.40	0.06

Source: Bio-diversity Study conducted by ICT

35. **Protected Areas:** The project road does not traverse through any National Park, Wildlife Sanctuary or Biosphere Reserve. Ranebennur wildlife sanctuary is located within 10km radius of the project area and the nearest distance of the WLS from project road is 2.3 km.

36. **Forests:** The vegetation of project area fall under Southern Tropical Dry Deciduous and Southern Tropical Thorn Forest type of Champion and Seth's classification (1968). The distribution of the Forests in the project districts are scattered and found in patches. The major species found in forest area are Chloroxylon swietenia, Albizia amara, Cassia fistula, Diospyros melanoxylon, Wrightia tinctoria, Melia azadirachta, Acacia catechu. The species found near the banks of the rivers are Pongamia pinnata, Eugenia corymbosa, Alangium lamarckii, Terminalia arjuna, Vitex negundo, etc.

37. The project road passes through Reserved / Protected Forest Area for 4.848 Km stretch. The forests located along the project stretch are presented in Table-E.15.

Table-E.15 Location of Forest along Project Alignment

SN	Design Chainage Km		Length (Km)	Side	Existing Chainage km		Length (Km)	Forest Type
	From	To			From	To		
1	139+950	140+800	0.850	Both	142+140	142+990	0.850	RF
2	152+100	152+170	0.070	LHS	154+160	154+230	0.070	RF
3	152+900	153+115	0.215	LHS	154+970	155+185	0.215	RF
4	153+115	153+153	0.038	Both	155+185	155+223	0.038	RF
5	155+400	155+600	0.200	RHS	157+500	157+820	0.320	RF

SN	Design Chainage Km		Length (Km)	Side	Existing Chainage km		Length (Km)	Forest Type
	From	To			From	To		
6	160+500	161+100	0.600	RHS	162+935	163+535	0.600	RF
7	161+100	161+600	0.500	Both	163+535	164+035	0.500	RF
8	192+050	194+050	2.00	LHS	202+775	204+775	2.000	Gudgure RF
9	235+747	235+852	0.105	Both	21+000	21+100	0	RF1
10	236+750	236+900	0	RHS	22+100	22+300	0	RF2
11	241+667	241+830	0.163	RHS	27+025	27+200	0.175	PF
12	241+830	242+130	0	RHS	27+200	27+575	0	PF
13	242+130	242+275	0.145	RHS	27+575	27+655	0.080	PF
	Total		4.886		Total		4.848	

9. Educational, Medical and Religious Properties

38. The number of roadside educational, medical and religious / cultural properties is summarized in Table-E.16.

Table-E.16 Roadside Educational, Medical and Religious Properties

Items	Total Number
Educational Institutions	64
Medical Amenities	15
Religious Places	95

Source: Field Study conducted by ICT in December 2015

10. Archaeological Sites

39. There are no archaeological sites within 300 m on either side of the project road.

11. Demographic details of Affected Population

40. The socio-economic information of affected persons (APs) has been collected from the census survey (100%). As per census survey, 1,518 households are likely to be affected due to the up-gradation of the existing road.

41. There are a total of 7,159 APs being affected, which includes 3,859 (53.90 %) males and 3,300 (46.10 %) females. The average household size is 4.7 and the sex ratio amongst the APs is 855.

42. The majority of the PAHs belong to the Hindu religion (92.49%) and 2.50% of them are Muslims. However, nearly 5.01% of households did not respond to the question related to religion

43. Out of 1,518 affected households, 362 households (23.85 %) are from general category, 567 households (37.35 %) are from other backward caste (OBC), 134 household (8.83 %) are from scheduled caste (SC), and 82 household (5.40%) are from scheduled tribe (ST) category
150 affected households (9.88%) earn Rs. 30,000 per annum while 559 affected households (36.82%) earn above Rs.1,00,000 annually

44. 28.52% affected household are illiterate, 9.95 % are up to middle school, 15.09 % are below matric, 13.31 % APs are Matric (10th standard), 8.76 % are educated up to graduate level

45. 60.47 % households are engaged in agriculture, 2.57 % are agriculture labour, 3.10 % are daily wage earner, and 7.77% households are carrying out businesses as their main occupation

E. Analysis of Alternatives

46. The project Road SH-57 & SH-26 passes through few congested settlements having substandard horizontal geometry at few locations. Hence to minimize R&R (Rehabilitation and Resettlement) impact and to provide safety three bypasses (9.065 km) & fourteen realignments (23.375 km) have been proposed with a total length of 32.440 km. The analysis of alternatives was carried out 'with the project' and 'without the project' scenarios in terms of potential environmental impacts as well as various options of the proposed bypasses and realignments.

F. Anticipated Impacts and Mitigation Measures

1. Environmental Impacts

47. A summary of the potential environmental impacts during construction and operation phase along with recommended mitigation measures is summarized in Table-E.17:

Table-E.17 Summary of Anticipated Impacts and Recommended Mitigation Measures

Area	Impacts	Mitigation Measures
Construction Phase:		
Topography and geology	Disfiguration & change in existing profile of the land due to borrow pits & construction of realignments. Disturbance on geological setting due to quarrying. Uncontrolled digging of borrow pits resulting in water accumulation & breeding of vector disease.	▪ Borrow pits will be allowed at only pre-identified locations. ▪ Borrow pits will be restricted to 1 m depth followed by resurfacing of pits. ▪ Road building materials will be procured from approved and licensed quarries. ▪ Suitable seismic design of the road structures will be adopted to mitigate the earthquake impacts.
Soil	Disruption & loss of productive top soil from agricultural fields due to borrow pits Loosening of top soil & loss of vegetative cover along the road due to excavation & back filling which will lead to enhanced soil erosion.	▪ Adequate measures like drainage, embankment consolidation & slope stabilization will be taken along the road to avoid soil erosion. ▪ Top soils (15 cm) of borrow pit sites will be conserved and restored after excavation is over. ▪ Accidental spills of lubricants/oil and molten asphalt will be avoided by adherence to good practices.
Land use	Generation of solid waste in the form of construction spoils from construction sites. Changes in existing land use pattern of the proposed ROW for construction of the road. Proposed ROW in built up area	▪ Earth material generated from excavation of roadways & drainage will be reused during site development. ▪ Construction debris will be disposed of in suitable pre-identified dumping areas. ▪ Dumping areas will be biologically reclaimed. ▪ Construction camp will be provided to avoid

Area	Impacts	Mitigation Measures
	varies from 16 m to 20 m and in rural area it varies from 26 m to 36 m depending on the height of embankment	indiscriminate settlement of construction workers. ▪
Drainage	Change in drainage pattern of the land. Increased incidence and duration of floods due to obstruction of natural drainage courses by the road embankment. Chances of filling of existing drainage courses during earth filling.	▪ Adequate drainage facilities will be provided along the road to facilitate its long life, and to avoid soil erosion & land degradation. ▪ Adequate cross drainage works & structures will be provided for smooth passage of runoff to avoid flooding. ▪ Filling of existing drainage courses will be strictly avoided. ▪ Suitable drainage at construction site & camp will be provided to avoid water stagnation, soil erosion & mosquito breeding.
Water use	Impact on the local water sources due to use of construction water.	Maximum rainwater harvesting and minimum use of existing water sources for construction will be ensured to minimize likely impacts on other users.
Water quality	Increase of sediment load in the run off from construction sites and increase in turbidity in receiving streams/water bodies. Water pollution due to sewage from construction camps.	▪ Silt fencing will be provided to reduce sediment load ▪ Oil interceptor to stop and separate the floating oils ▪ Proper sanitation facilities will be provided in construction camp to prevent health related problems. ▪ All the construction activities will be carried out during dry seasons only. ▪ Rainwater Harvesting Structures and silt fences has been proposed at 13 locations near water bodies, river crossing, forest area and agricultural area ▪ Apart from provision of the mitigation measures, water quality shall be monitored during construction and operation phases as per environmental monitoring program to understand the effectiveness of mitigation measures suggested
Water body	14 water bodies are located within the CoI	▪ All water bodies (pond & lakes) have been saved by providing toe wall / change in engineering design or through realignment except 1 water storage area, which will be partially affected
Air quality	Deterioration of air quality due to fugitive dusts emission from construction activities and vehicular movement along unpaved roads. Deterioration of air quality due to gaseous emissions from construction equipment & vehicular traffic. Deterioration of air quality due to	▪ Construction materials will be stored in enclosed spaces to prevent fugitive emissions. ▪ Truck carrying soil, sand and stone will be duly covered to avoid spilling. ▪ Dust suppression measures such as regular water sprinkling on haul & unpaved roads particularly near habitation ▪ Asphalt and hot mix plants will be located at least 500 m away from inhabited areas & sensitive

Area	Impacts	Mitigation Measures
	emission from asphalt and hot mix plants.	receptors and 300 m from the road. ▪ Use of Recycled Asphalt Cold Mix Technology to reduce air pollution ▪ Air quality shall be monitored during construction and operation phases as per environmental monitoring program to understand the effectiveness of mitigation measures suggested
Noise level	Increase in noise level due to construction activities like operation of construction equipment & vehicular traffic.	▪ Construction camp and temporary labour sheds will be located away from the immediate vicinity of the construction sites and major road traffic. ▪ PPEs will be provided to construction personnel exposed to high noise levels as preventive measure. ▪ Low noise construction equipment will be used. ▪ Stationary construction equipment will be placed 113 m away from inhabited areas. ▪ Stationary construction equipment will be placed 200 m away from the silence zones ▪ Construction activities carried out near residential area will be scheduled to the daytime only so that minimum disturbances are caused to people. ▪ Construction of solid Noise barrier and plantation ▪ Noise level shall be monitored during construction and operation phases as per environmental monitoring program to understand the effectiveness of mitigation measures suggested
Floral & Fauna	Approximately 3,173 trees are required to be felled for the improvement of the road out of total 3,865 existing trees No threatened species of flora is falling in the ROW of the project road	▪ 24,800 trees shall be planted along the road ▪ 310 trees will be planted along the boundary of noise barrier ▪ Plantation shall be maintained for 5 years ▪ Compensatory afforestation shall be carried out in the ratio of 1:3. Compensatory Afforestation shall be provided as per the Forest Conservation Act, 1980 and amendment. The amount required for tree cutting and Net Present Value (NPV) for Forest land shall be provided by KSHIP to Forest Department ▪ Cooking fuel (LPG/ Kerosene) will be provided to construction workers to avoid cutting / felling of trees for fuel wood. ▪ Soil erosion shall be checked by adopting bio-engineering measures ▪ The Concessionaire shall ensure that no open fire is done in construction camp as it may lead to fire to surrounding forest causing injury to wildlife ▪ Noise will be kept under control by regular maintenance of equipment and vehicles. No honking board shall be placed near Forest. Noisy activity shall be prohibited during night time
Forest	Forest land is to be diverted	▪ Net Present Value will be provided to Forest

Area	Impacts	Mitigation Measures
	(3.4225 ha)	Department of Karnataka towards the cost of forest land to be diverted and cost of compensatory afforestation ▪ Construction camps shall be located away from Forest areas. ▪ No construction camp shall be allowed within the designate limits of the forest areas and within 1km from their boundaries. ▪ No earthworks or surfacing will be permitted along stretches of road passing through the reserved forest area after 6:30 p.m. ▪ No disposal of debris shall be allowed within these areas except at locations identified during project preparation.
Educational, Medical and Religious Properties	▪ None of the educational institutions along the project road will be affected ▪ None of the medical amenities will be affected ▪ Out of 95 religious structures along the project road, **15 will be fully affected**. There will be no impact on remaining 80 religious places.	▪ Affected structures will be suitably relocated ▪ Affected utilities like electrical transmission lines, telephone lines, water pipelines, petrol pumps etc. will be suitably shifted by the concerned departments
Construction camp	▪ Influx of construction work-force & suppliers who are likely to construct temporary tents in the vicinity. ▪ Likely sanitation & health hazards & other impacts on the surrounding environment due to inflow of construction labourers.	▪ Temporary construction camps with adequate potable water supply, sanitation & primary health facilities and fuel for cooking will be provided to accommodate construction workers. ▪ It will be ensured that the construction workers are provided fuel for cooking to avoid cutting of trees from the adjoining areas. ▪ Domestic as well as the sanitary wastes from construction camps will be cleared regularly.
Occupational health & safety	▪ Health & safety related problems to construction workers due to inadequate health & safety measures.	▪ Adequate safety measures complying to the occupational safety manuals will be adopted to prevent accidents/hazards to the construction workers ▪ Periodic health check-up of construction workers will be done.
Road safety	▪ Increase on incidence of road accidents due to disruptions caused in existing traffic movements.	▪ Proper traffic diversion and management will be ensured during construction at the interactions and construction areas. ▪ Reduction of speed through construction zones.
Operation Phase		
Land use and Encroachment	• Change of land use by squatter/ encroachment within ROW and induced development outside the ROW.	• Planning agencies and Collector/ Revenue Officer will be made involved for controlled development and prohibiting squatter/ encroachment within ROW.

Area	Impacts	Mitigation Measures
Drainage	• Filthy environment due to improper maintenance of drainage.	• Drainage system will be properly maintained.
Water quality	• Chances of contamination of water bodies from road surface run off containing oil spills due to traffic movement & accidents.	▪ Longitudinal roadside drains of sufficient capacity will be provided on both sides of the road to accommodate increased run-off. The out fall for these drains will be the nearby culverts / bridges or natural drainage channel. ▪ Silt fencing will be provided to sediment entering into the water courses. ▪ Contingent actions will be taken for speedy cleaning up of oil spills, fuel and toxic chemicals in the event of accidents. ▪ Regular maintenance of rainwater harvesting structures shall be done during the operation stage to prevent choking of these structures ▪ Monitoring of water quality at specified locations will be conducted at fixed interval
Air quality	▪ Air pollution due to vehicular emission from road traffic.	▪ Truck parking lay-byes and bus bays will be provided at required locations to facilitate smooth traffic flow. ▪ Monitoring of air quality at specified locations will be conducted at fixed interval
Noise level	▪ Noise pollution due to traffic noise.	▪ Monitoring of noise level at specified representative locations will be conducted at fixed interval. ▪ Roadside plantation with suitable species near sensitive receptors and inhabited areas will result in partial noise attenuation. ▪ Maintenance of noise barrier
Flora & fauna	▪ Illegal felling of road side plantation. ▪ Effect on aquatic fauna in case of accidental spill of oil, fuel & toxic chemicals into water bodies	▪ Plantation along the ROW will be maintained properly and protected from illegal felling. ▪ Contingent actions will be taken in the event accidental spill of oil, fuel & toxic chemicals.
Road safety	• Impacts on human health due to accidents. • Damage of road due to wear & tear.	▪ 74 nos. of Bus Shelters shall be provided along the project road conforming to design standards. ▪ Semi-rigid type / rigid type / flexible type safety barriers shall be provided on the high Embankment Section (where the height of embankment is more than 3.0 m) and along the horizontal curve having radius up to 450m for complete length including transition and 20m further before and after. ▪ Rigid Type such as Concrete Crash Barriers shall be provided on the bridges, isolated structures and its approaches.

2. Social Impacts

48. According to the Land Acquisition Plan (LAP) **240.4263 Ha** of land will be acquired for the project, out of which 230.7330 Ha. is private land. A summary of the impacts is provided in **Table-E.18.**

Table-E.18 Summary of Impact on Structures and Displaced Persons

Sl. No.	Type of APs	Impact category	Number
1.	Titleholders	Land only	1203
		Land & Structure	48
		Physically displaced	25
2.	Non-Titleholders	Structure	262
		Physically displaced	142
3.	Tenants	Structure only	5
4.	Employees	Structure only	0
5.	Other economically affected (excluding owners physically displaced and tenants)	Structure only	35
6.	Total number Project Affected Persons (PAPs)	Land only	6029
		Structure only	1130
7.	Total Households Affected including (Structures, Land, Tenants and Employees)	Land only	1203
		Structure	310
		Tenant	5
		Employee	0
8.	Total Vulnerable Households Affected	Land	941
		Structure	211
9.	Moderately Affected Households (Title-Holder & Non-Title Holders)	Titleholders	1226
10.	Marginally Affected Households (Tenant & Employee)	Structure Only	5
11.	Physically Displaced Households (Title-Holders)	Structure only	25
12.	Physically Displaced Households (Non-titleholders)	Structure only	142
13.	Physically Displaced Affected Families (Title-Holders)	Structure only	30
14.	Physically Displaced Affected Familes (Non-titleholders)	Structure only	206
15.	Moderately Affected Households (Title-Holders)	Structure only	23
16.	Moderately Affected Families (Title-Holders)	Structure only	37
17.	Marginally Affected Families (Tenant & Employee)	Structure only	8
18.	Households Affected by loss of income (Shop owner, Artisans Tenants & Employees)	Structure only	89
19.	Households Affected by Land Acquisition	Land only	1203
20.	Households Affected by Impact on Private Structures (Structures, Tenants & Employees)	Structure only	315
21.	CPR affected		15
22.	Religious structures affected		15
23.	Government structures affected		77

3. Public Consultatiion

49. The following are the major points of concern of the participants of PCM:

- Stakeholders are concerned about the existing traffic noise and anticipate that increase of traffic flow may lead to increased noise level after project implementation.
- Majority of the stakeholder are concerned with the existing air emission by the present traffic but their opinion in post project scenario is fragmented to a considerable extent.
- Stakeholders viewed the road as moderately accident prone and requested to take possible measures to further minimize the accidents.
- Pedestrian crossing, proper road signage and speed control measures are the most sought after road safety measures by the stakeholders.
- Accident involving wildlife and man-animal conflicts are reported to be rare and incidents of crop damage by wild boars and deer are limitedly reported.
- School authorities and citizens at large are in favour of introducing speed restriction near the schools.
- Boundary wall acting as noise barriers along the school premises are welcomed by all of the participants. The stakeholders felt construction of boundary will also provide the security to the students and should be implemented before the start of construction activity to safeguard the students from construction noise.
- Participants requested for trees with large crown areas such as Banyan (Ficus Sp.) and Neem should be planted as Avenue plantation.
- Participants at large requested for up-gradation of existing bus shelters and installation of water tank near bus shelters. The maintenance of these assets should be vested with the project implementing authorities as panchayats often does not have enough resources all the times for its up-keepment.

50. **Consultation in Religious Places:** To assess the requirement of noise barrier in the religious places along the project road, consultations with stakeholders were carried out at 3 religious places along the project road. Overall **85.7%** participants showed reservation against construction of boundary wall due to temple aesthetics and accessibility; while **14.3%** supported the concept.

4. Environmental Management Plan

51. EMP has been prepared addressing the following issues:

- Stage wise (design & pre-construction stage, construction stage & operation stage) environmental management measures;
- Environmental monitoring program during construction and operation phase including performance indicator, monitoring schedule (parameters, locations, frequency of monitoring & institutional responsibility) and reporting system;
- Institutional set up identified for implementation of the EMP including institutional capacity building and
- Various guidelines such as Top Soil Conservation and Reuse, Siting and Layout of Construction Camp, Slope Stabilization, Management of Borrow and Quarry Area, Sediment Control, Comprehensive Waste Management Plan, Traffic Management Plan, Worker's Safety during Construction, Tree Plantation Strategy, Storage, Handling, Use and Emergency Response for Hazardous Substances, Reporting Formats etc.

5. Environmental Policy of KSHIP

- Comply with all applicable environmental legislation and other requirements
- Protecting & conserving natural resources and enhancing the environmental values while preventing pollution and minimizing the impact on the natural environment
- Implement, maintain and continually improve an effective environmental management system
- Apply an approach of "avoid, minimize and mitigate", to the management of environmental impacts associated with road improvement for its Stakeholders
- Develop awareness of environmental management processes, standards and responsibilities among KSHIP employees, consultants, contractor partners etc.
- Be responsive to community and stakeholder views on environmental issues
- Set specific environmental objectives and targets relating to the key environmental aspects of KSHIP activities; measure and report progress in achieving these targets

6. Environmental Budget

52. The budgetary provision for the implementation of the environmental management plan of the project road can be categorized in to two types and is presented below:

- Environmental Management Plan Works to be implemented by the contractor under civil works contracts
- Environmental Management Plan Works to be implemented by the KHSIP

53. A capital cost provision of about **Rs. 7.94 Crore** has been kept towards implementation of environmental management plan. Summary of environmental budget is presented in **Table-E.17.**

Table-E.17 Summary of Environmental Budget

Component	Description	To be implemented by	Amount (Rs.)
A.	Mitigation / Enhancement	Contractor	24,469,900
B.	Environmental Monitoring		2,880,000
		Subtotal	***27,349,900***
C.	Forestry	KSHIP	50,928,560
D.	Training & Mobilization		1,040,000
		Subtotal	***51,968,560***
		Grand Total	**79,318,460**

G. Conclusion and Recommendations

54. Conclusion: Most of the adverse impacts of road project during construction period are short term and temporary in nature. These impacts can be minimized through specific engineering solutions. Environment friendly construction methodology has been incorporated into the project design and Environment Management Plan has been prepared to minimize the overall impact on environmental attributes by the proposed project works. Therefore, the proposed project is **unlikely to cause any significant adverse environmental impacts** and no further detailed study is required.

55. Recommendations: Environmental Management Plan has been prepared incorporating various modern technologies and guidelines to reduce the environmental impacts of highway constructions to make it a Green Highway. Therefore, it is recommended to follow the EMP and associated Guidelines during construction and operation phases of the project.

I. INTRODUCTION

A. Project Background

1. The Government of Karnataka (GoK) through the Government of India (GoI) has received in principal approval for a loan from the Asian Development Bank (ADB) towards Karnataka State Highways Improvement Project–III (KSHIP- III) for developing State Road network adopting innovative financial models under Public Private Partnership (PPP). The Executing Agency (EA), the Public Works Department, represented by the Project Director, Project Implementation Unit, Karnataka State Highway Improvement Project (PIU-KSHIP) has already completed a Pre-Financial Feasibility Study for about 4,403 km of select corridors of the Core Road Network (CRN) of the state and based on the outcome of this study, it intends to improve about 1,350 km of state highways under this ADB finance. With a view to this, the EA has engaged a consultant to prepare the Detailed Project Report and carry out Transaction Advisory Services for Karnataka State Highway Improvement Project-III (KSHIP III)", for project roads drawn under **Group II**.

2. In pursuance of the above, Intercontinental Consultants and Technocrats Pvt. Ltd. have been appointed as Consultants by KSHIP to carry out the Preparation of Detailed Project Report and provide Transaction Advisory Services for Karnataka State Highway Improvement Project-III Group II roads in the State of Karnataka to two/four lane with Paved Shoulder Configuration".

3. The project roads have been divided into packages based on the time lines required for the fulfilment of environmental safeguards as per the MOEF&CC & ADB's Safeguard Policy Statement 2009; project cost and to attract bidders of both large and small scale. Accordingly, the project roads under **Group II** have been divided into **5 packages** as presented in **Table-1**. The Project Roads are shown in the Index Map **(Figure 1).**

Table 1: Package-wise Summary of Project Roads under Group II

Package No.	Project Road	Length (Km)
1A	Kollegal to Hannur	23.8
1B	Chintamani to Andhra Pradesh Border	39.8
1C	Bengaluru to Magadi	35.7
	Magadi to Kunigal	15.3
2	Magadi to Somwarpet	165.5
3	**Gadag to Honnali**	**138.2**
	Total Length (km)	**418.3**

4. In this report, **Package-3 "Gadag to Honnali"** has been discussed.

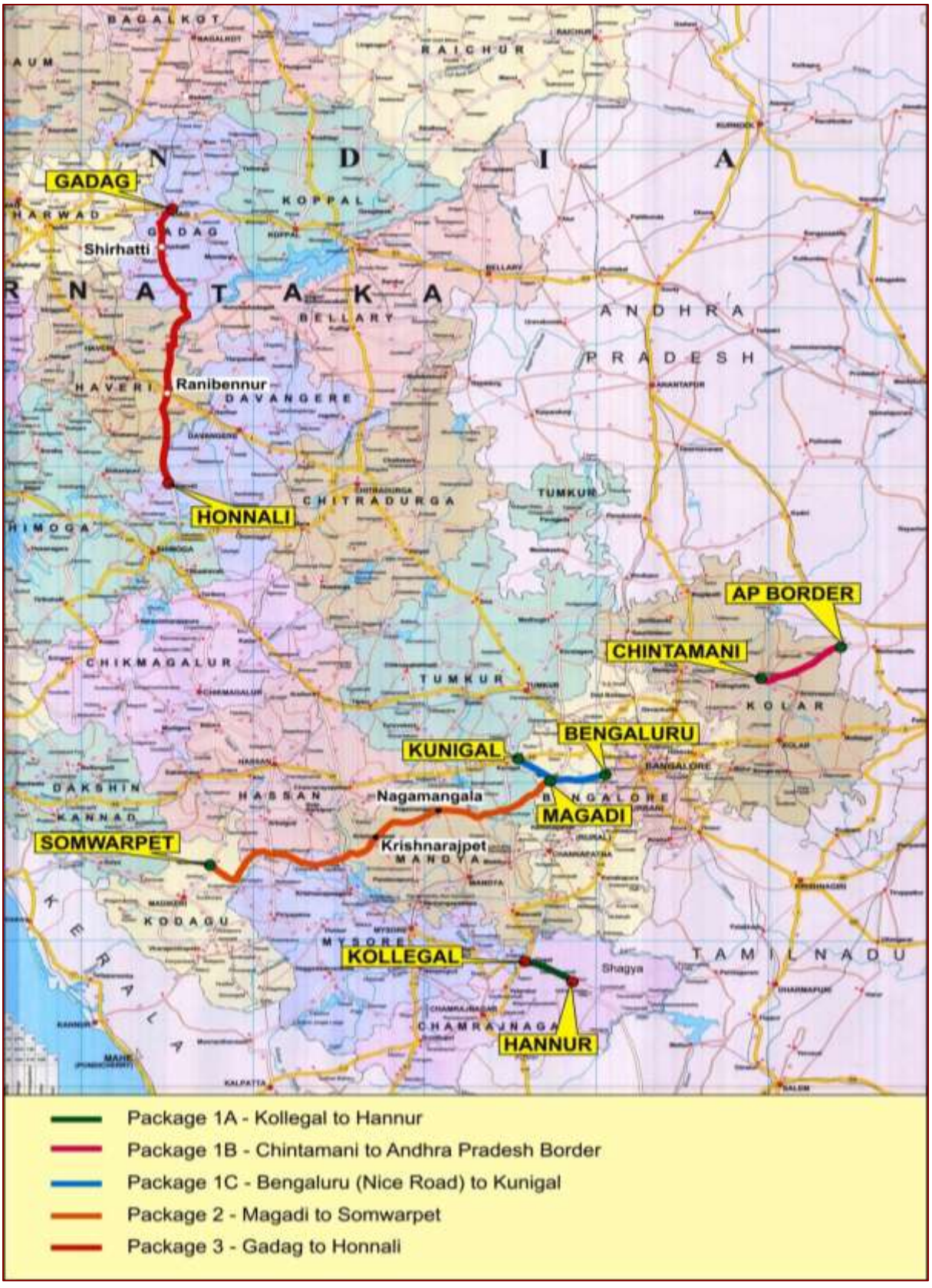


Figure 1: Index Map Showing Package Wise Project Roads

B. Objectives of the Study

5. The main objectives of the initial environmental examination (iee) study are as follows:

- To determine the category of the project depending on the length, extent of land acquisition, location, environmental sensitivity and the nature and magnitude of its potential environmental impacts, i.e. screening as per Government of India's regulations and ADB's Safeguard Policy Statement 2009;
- To determine the appropriate extent and type of Environmental Assessment (EA) required, i.e scoping;
- To determine whether the project requires environment clearance, forest clearance, wildlife clearance, consents to establish etc. depending on its type of development;
- To establish present environmental conditions of the study area through available data / information supported by field studies, wherever necessary;
- To predict the potential impacts on relevant environmental attributes due to the proposed project and to recommend adequate mitigation measures to minimize / reduce adverse impacts;
- To prepare an Initial Environmental Examination (IEE) report including Environmental Management Plan (EMP).

C. Approach and Methodology

6. The Initial Environmental Examination has been carried out within existing policy, legal and administrative framework considering the applicable environmental legislation, regulations & guidelines of ADB and MOEF&CC.

- ***Reconnaissance Survey:*** A reconnaissance study has been made for identification of Valued Environment Components (VECs) on proposed project road. Location of environmentally protected areas (National Parks, Wildlife Sanctuaries, Biosphere Reserves, Reserved / Protected Forest, Important Bird Areas, World heritage Sites, Archeological Monuments etc.); surface water bodies; environmentally sensitive receptors (educational institutions, religious structures, medical facilities etc.) along the alignment has been identified during the survey. The Consultant conducted preliminary analysis of the nature, scale and magnitude of the impacts that the project is likely to cause on the environment, especially on the identified VECs.

- ***Data Collection & Review:*** Secondary data such as Survey of India Topo Sheets, District Planning Maps, Forest Working Plans, booklet of Central Ground Water Board, details of Archaeological Monuments etc. have been collected from various secondary sources. Further, secondary data, which are relevant to understand the baseline as pertaining to physical and biological environments has been collected and reviewed. Applicable environmental legislation, regulations & guidelines of ADB and MOEF&CC has also been reviewed.

- ***Environmental Screening & Scoping:*** Screening has been conducted with specific consideration such as location of the sub-projects with respect to

environmentally sensitive areas and critical issues to be studied in detail as well as provide important feedback to the design / technical team. It helped to modify the designs at locations where impacts had to be avoided and incorporate mitigation measures wherever the impacts were unavoidable due to other constraints. Based on the screening, scope of the study of the assignment i.e. scoping has been done.

- ***Baseline Environmental Monitoring:*** To establish the baseline environmental status, monitoring was carried out for various environmental parameters such as meteorology, ambient air quality, ambient noise level, ground & surface water quality and soil quality along the proposed alignment

- ***Stakeholder Consultation:*** Consultations on environmental issues have been carried out with relevant stakeholders identified through stakeholder analysis.

- ***Analysis of Alternatives:*** The environmental analysis of alternatives mainly focuses on bypasses, if any, cross-sections, sources of materials from an environmental management perspective.

- ***Prediction of Impacts & Mitigation Measures:*** Based on the above study potential positive and negative impacts on land environment, air environment, noise environment, water environment and biological environment has been assessed for both construction and operation phase. For each impact predicted, feasible and cost effective mitigation measures has been suggested to reduce potentially significant adverse environmental impacts to acceptable levels.

- ***Environment Management Plan:*** EMP has been prepared as per the requirements of ADB safeguard policy statement. EMP includes management and redevelopment of borrow areas, quarries, construction camp; rain water harvesting, storm water management practices; enhancement plan for water bodies; requirement of noise barrier, capacity building & training; environmental supervision, monitoring & auditing requirements; bill of quantities etc.

D. Structure of the Report

7. This Initial Environmental Examination Report and Environment Management Plan (Volume-VIII) is a part of the Detailed Project Report of the **Gadag to Honnali** Project Road under the corridor CNS 5.

8. IEE Report has been structured based on ADB's Safeguard Policy Statement 2009. The structure of the IEE Report is as follows:

Volume: VIII (A) IEE Report and EMP

Executive Summary

Chapter-1	:	Introduction
Chapter-2	:	Description of the Project
Chapter-3	:	Policy, Legal and Administrative Framework

II. DESCRIPTION OF THE PROJECT

A. Project Location

9. The Project road starts after Gadag town, from the junction of SH-57 with newly constructed SH-45 bypass and ends in Honnali settlement at a T Junction where project road SH-26 meets a city road (**Figure-2**). The Latitude & Longitude of start and end points of project road are 15°24'46.29" N & 75°37'9.88" E and 14°14′14.71″ N & 75°38′58.16″ E respectively.

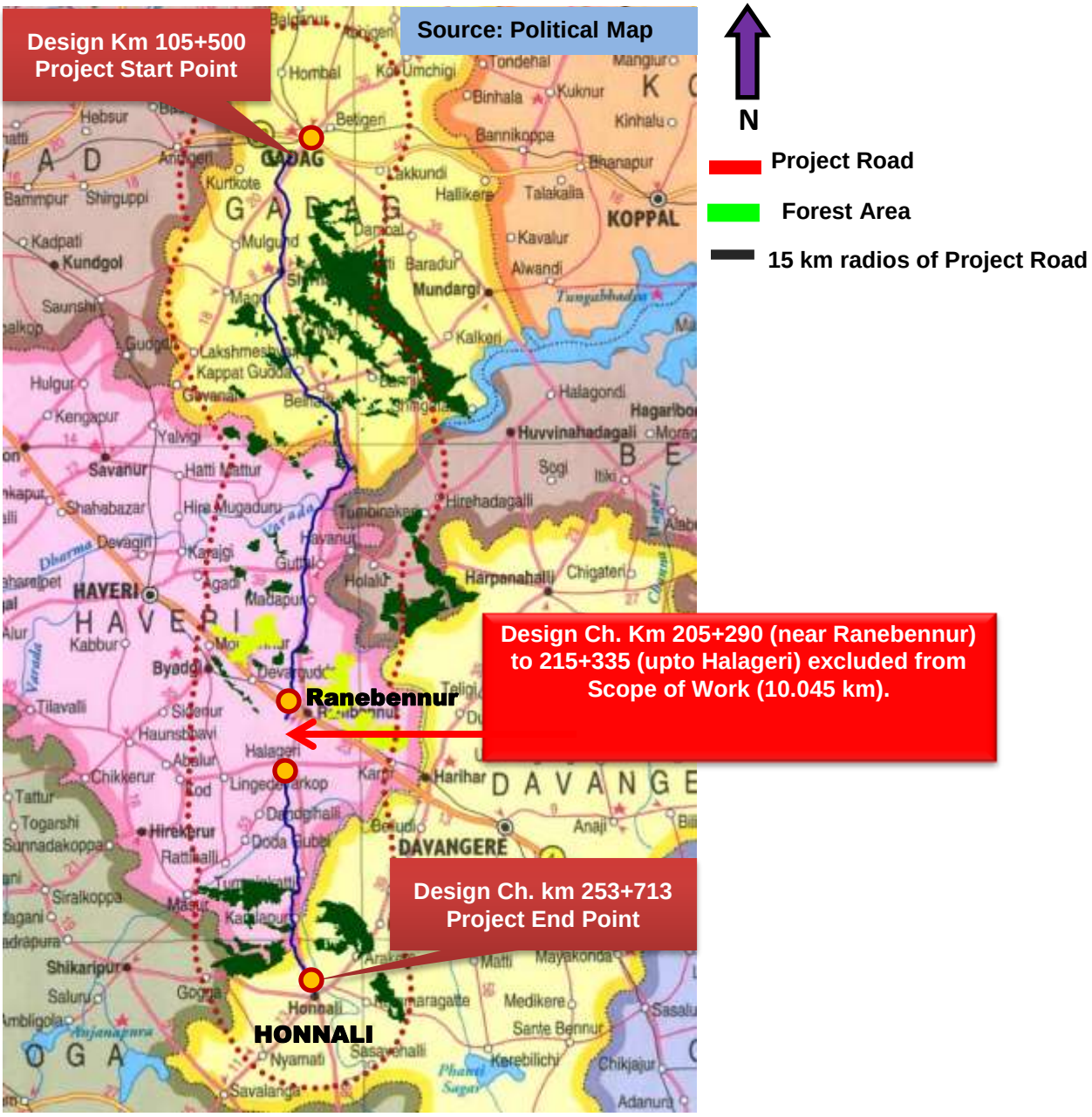


Figure 2: Map Showing location of the Project Road

10. Approx. **4.275 km** (Ch. Km 205+290 to 209+565) in Ranebennur town is excluded in the improvement proposal. Approx. **5.77 km** (Ch. Km 209+565 to 215+335) is also excluded from the package as the stretch is being developed by KSRDCL. Therefore, total length of the project road considered in improvement Proposal is **138.168 km**.

B. Description of the Project Road

11. The project road is passing through Gadag, Haveri & Davangere. Agriculture is the main land use along the project road. Commercial activities were only noted when alignment passes through settlements however no major industries are noted along project road. The project road passes through various small and big settlements such as Soratur, Sirahatti, Bellahatti, Guttal, Honnati, Ranebennur, Tuminakatte and Honnali etc.

12. **Carriageway:** The existing road is predominantly (Approx. 81% of Project length) Intermediate lane carriageway of 5.5m width, about 13.4% of the project length is single lane carriageway of 3.75m width and about 3.8% of project length is 2-lane carriageway of varying width of 7m to 14.5m width. Small section of project road of about 3.4 Km length is 4 lane carriageway in the settlement areas.

13. **Terrain:** Predominately plain except small section of project road traverse through rolling terrain.

14. **Road Intersections:** There are 13 major junctions and 183 minor junctions along the existing road alignment. All the junctions have been proposed for improvement.

15. **Pavement Condition:** The existing pavement is flexible and the composition of layer predominantly consists of bituminous layers laid over granular base / WMM and granular sub base/river material with boulders / moorum present at some locations. The bituminous surfacing varies in the range of 30 mm to 120 mm and the Granular Base/sub base layer varies from 80 to 750 mm.

16. **Existing Bridges & Culverts:** There are 2 major bridges, 18 minor bridges, 13 vented causeways, and 239 culverts (181 Pipe Culverts, 6 Box Culverts, 51 Slab Culverts and 1 BS Slab / Arch Culverts) along the existing project road.

Table 2: Location of Existing Major Bridges along the Project Road

Sl. No.	Existing Ch. (Km)	Type of Structure		Overall length (m)	Span Arrangement (m)	Overall Width (m)
		Super-structure	Sub structure			
1	160+750	RCC Solid Slab	RCC Wall Type with Open footing	70.02	10 x 7	7.95
2	178+950	RCC Solid Slab	RCC Wall Type with Open footing	120.02	10 x 12	8.00

Table 3: Location of Existing Minor Bridges along the Project Road

Sl. No	Existing Ch (Km)	Type of Structure		Overall length (m)	Span Arrangement (m)	Overall Width (m)
		Super Structure	Sub structure			
1.	105+125	Double storey three cell box structure		8.620	3 x 2.4 x 1.5	8.50
2.	114+800	Stone Slab	SM Wall type with Open footing	9.020	6 x 1.50	6.10

Sl. No	Existing Ch (Km)	Type of Structure		Overall length (m)	Span Arrangement (m)	Overall Width (m)
		Super Structure	Sub structure			
3.	126+100	RCC Solid Slab	SM Wall type with Open footing	14.020	2 x 7.00	11.70
4.	172+980	RCC Solid Slab	RCC Wall type abutment & circular pier with Open footing	38.570	3 x 12.850	12.00
5.	183+690	RCC three cell box structure		10.650	3 x 3.0 x 3.0	11.00
6.	190+750	RCC twin cell box structure		6.100	2 x 2.5 x 1.5	11.60
7.	196+950	RCC Solid Slab	RCC Wall type abutment & circular pier with Open footing	32.420	3 x 10.80	12.00
8.	205+950	RCC twin cell box structure		11.950	2 x 5.0 x 5.0	40.0
9.	209+050	RCC Solid Slab	RCC Wall type with Open footing	17.020	2 x 8.50	12.00
10.	209+640	RCC Solid Slab	SM Wall type with Open footing	19.820	3 x 6.60	8.30
11.	210+530	RCC Solid Slab / pipe	SM Wall type with Open footing	19.820 + 17.0	3 x 6.60 + 10 pipes x 1.2m dia.	8.50
12.	211+320	RCC Solid Slab	RCC Wall type with Open footing	9.440	1 x 9.40	12.00
From this point onward Chainages of SH-26 is followed						
13.	6+450	RCC Solid Slab / pipe	SM Wall type with Open footing	36.80	4 pipes x 3.5m + 2 pipes x 2.2m + 3 x 5.20	8.40
14.	7+430	RCC Girder & Slab	RCC Wall type with Open footing	48.020	4 x 12.00	12.20
15.	10+540	RCC Solid Slab	RCC Wall type with Open footing	6.620	1 x 6.60	8.40
16.	17+120	RCC Solid Slab	RCC Wall type with Open footing	15.620	2 x 7.80	12.00
17.	27+900	RCC Solid Slab	SM Wall type with Open footing	25.800	3 x 8.60	8.00
18.	33+730	RCC Solid Slab	RCC Wall type with Open footing	20.120	3 x 6.70	8.50

17. **Railway Crossing**: One existing railway level crossings at Chainage km 214+360 along the project road.

C. Traffic Study

18. During the pre-feasibility study, traffic surveys were conducted by iDeCK in 2014. As per the terms of reference of this study the Consultants were required to validate these surveys.

1. Composition of Traffic

19. The composition of traffic was worked out from the traffic volume count data. Along the project stretch, the share of passenger traffic varies from 66.9% to 83.8%, whereas goods traffic

varies from 9.7% to 32.4%. The share of trucks is varying from 1 % to 14.7% of total traffic. The share of car and taxi varies from 8% to 26.4% of total traffic along the project stretch. It is also observed that the share of non-motorized traffic which is mainly bicycles varies from 0.3% to 6.9% along the project stretch.

20. **Hourly Variation of Traffic:** During the traffic survey conducted by ICT, Peak hour traffic for all the locations on SH-57 is found to be between 7.3 % to 9.0% of the ADT, which is quite normal for rural highway connecting urban centers. Similarly, peak hour traffic data is found to be varying from 6.63% to 8.16% of the ADT by iDeCK study. On NH-218, peak hour traffic is 7.5%.

2. Annual Average Daily Traffic (AADT)

21. The Annual Average Daily Traffic (AADT) is calculated by multiplying ADT with a seasonality factor. Seasonal variation factors by vehicle types are required to account for variations in the traffic pattern on the sections of project road over different months or seasons of the year.

22. The section-wise AADT thus obtained is shown in **Table-4** which gives the mode-wise AADT for all the survey locations. It may be noted that the AADT of iDeCK has been taken for the year 2015 (as given in iDeCK report).

Table 4: Annual Average Daily Traffic at Various Surveyed Location

Location	Description	Survey conducted by	Total Traffic	
			Vehicles	PCUs
MCC-03	Km 113+100, Nagavi Village	iDeCK 2015	2,486	3,236
MCC-04	Km 149+000, near Bellatti Village	ICT 2015	1,531	1,451
MCC-05	Km 201+000, near Honnati Village	ICT 2015	3,457	3,293
	Km 201+000, near Honnati Village	iDeCK 2015	3,720	3,915
MCC-06	Km 223+000, Halageri Village	ICT 2015	2,822	3,382
	Km 223+000, Halageri Village	iDeCK 2015	3,111	3,246
MCC-07	Km 105+000 (NH-218)	ICT 2015	4,677	7,631

Source: Survey conducted by iDeCK & ICT

23. From the above table it is concluded that:

- AADT estimated during ICT study at location Km. 201+000 near Honnatti Village, is 17% less than the traffic forecast for the year 2015 in terms of vehicles given in iDeCK study. The observed volume in the two studies, represented as ADT, shows negative (-5%) growth in number of vehicles from the year 2014 to year 2015.
- AADT (iDeCK projected and ICT observed) at Km 223+000, near Halageri Village shows variation within 10% in terms of number of vehicles and PCUs. The total number of vehicles shows 9% difference between the two sets of data, while the PCUs show a difference of 4%.

24. The traffic volume count surveys conducted by iDeCK are considered as validated by ICT survey as the variation observed at all the locations is within acceptable limits as the volume of traffic is low. At common survey points, the traffic volume count conducted by ICT study has been taken as representative of the project road traffic, for the reasons cited above.

For other types of surveys like OD survey, Turning Movement Counts at intersections along the project road, number plate survey etc. iDeCK data have been considered for the purpose of traffic forecast and estimation of tollable traffic and toll lanes.

3. Identification of Homogeneous Sections

25. As per the iDeCK Traffic Report 2014, the project road CNS 05 (SH-57) from Bagalkot to Honnali has been divided into five homogeneous sections. In the current study, the project road has been divided into 8 homogeneous sections on the basis of observed mid-block traffic flows (4 homogeneous sections for Bagalkote to Gadag and **4 homogeneous sections for Gadag to Honnali**). The homogeneous section wise traffic projections for Gadag to Honnali have been given in **Table-2.4**.

Table 5: Homogeneous Sections of Project Road

Section No.	Sections	Start Chainage (Km)	End Chainage (Km)	Distance (Km)	Traffic Volume AADT(PCU)
HS-V	Gadag to Shirahatti	105+200	130+000	24.800	3,236
HS-VI	Shirahatti to Gutal	130+000	181+000	51.000	1,451
HS-VII	Gutal to Ranebennur	181+000	209+000	28.000	3,292
HS-VIII	Ranebennur to Honnali (excluding approx. 5.9 km between junction with NH-4 flyover and Junction in Halageri)	209+000	253+116	44.116	3,381

4. Turning Movement Survey

26. Turning Movement Count Surveys were carried out at 2 locations by ICT in 2015 out of which km 222+600 is three-arm and km 188+500 is a 4-arm junction. As per ICT survey at 2 locations, the daily total approach volumes vary from 5,452 PCUs (4,966 vehicles) to 12,239 PCUs (11,413 vehicles) along SH-57. While as per iDeCK study, the daily (12 hours) approach volumes vary from 2,738 PCUs (2,645 vehicles) to 9,513 PCUs (8,411 vehicles) along SH-57. The highest total approach volume along this section, in terms of PCUs has been observed at Guttal junction (km 188+500). The lowest total approach volume is found at SH-148 and SH-52 junction.

5. Axle Load Survey

27. Axle Load survey was done by ICT in 2015. The axle load survey provides data to enable the assessment of the damaging effect of the heavily loaded commercial vehicles. The survey was carried out using the electronic static axle load pad at selected 5 locations on SH-57 (Bagalkot-Badami-Gadag-Honnalli).

28. The values of VDF were calculated by dividing the sum of all the Equivalency Factor by the number of Samples. To calculate the cumulative number of standard axles to be catered for in the design in terms of msa, category-wise VDF is required which is given in **Table-6**.

Table 6: VDF for observed Commercial Vehicles at Various Locations on SH-57

Sl. No.	Survey Location	Direction	Vehicle Damage Factor (VDF)				
			Buses	LCV	2 Axle Truck	3 Axle Truck	Multi Axle Truck (≥ 4 Axle)
1	Near Katageri	UP*	0.25	0.002	0.87	1.63	3.55
		DN*	-	0.001	1.34	2.37	4.16
2	Near Sabdi Village	UP*	-	0.002	1.55	-	-
		DN*	-	0.001	0.11	0.90	-
3	Near Bellatti	UP*	-	0.001	0.77	0.26	-
		DN*	-	0.002	0.68	0.31	-
4	Near Honnatti village	UP*	0.45	0.005	4.72	6.61	-
		DN*	-	0.006	2.56	6.52	3.34
5	Near Halageri village	UP*	-	0.002	3.77	3.70	4.49
		DN*	-	0.009	3.24	2.49	6.95

*Note: UP=Bagalkot to Honnalli & DN=Honnalli to Bagalkot

6. Traffic Forecast

29. For traffic forecast, the techniques of 'Elasticity of Transport Demand', based on historical growth in vehicle registration and trend of the economy in the area, has been adopted for estimating the growth rates for different modes of traffic that are likely to use the project road in future. The consultants have carried out traffic forecast process based on elasticity of transport demand approach. Growth rates have been estimated afresh using the socio-economic data collected from various departments of State of Karnataka by ICT. Traffic forecast carried out by iDeCK has been compared with ICT study.

30. ***Estimation of Growth Rates by ICT Study***. For estimating the traffic growth rates, the elasticity of transport demand obtained for various modes by regressing the vehicle registration data with selected socio-economic parameters were utilised.

31. The elasticity values obtained from the regression of socio-economic data of the entire Karnataka State at aggregate level was also examined to assess the traffic growth rates at State level as well as relative performance project road influencing districts in comparison to State. The regression analysis was also done for all the influence districts identified in Karnataka. Various components of traffic for the traffic forecast were estimated for the project road. These include normal traffic, generated traffic (diverted traffic, Induced traffic) and developmental traffic.

32. The diverted, induced, and developmental traffic are expected to be materialized within first four years after improvement of the project road by the year 2019 (year of opening). This shall happen in two stages having 60% and 40% to be realized by 2020, and 2022 respectively. The projected daily traffic for all the homogenous sections of Gadag to Honnali section of SH-57 (with five yearly projections) is given in **Table-7**.

Table 7: Projected Annual Average Daily Traffic on Various Homogenous Sections of SH-57 & 26 (Gadag to Honnali Section)

Vehicle Type	Year								
	2015	2019	2020	2022	2025	2030	2035	2040	2050
Homogenous Section V-Gadag to Sirhatti km 105+200 to km 130+000									
Car	374	507	651	840	1073	1544	2163	2894	4711

Vehicle Type	Year								
	2015	2019	2020	2022	2025	2030	2035	2040	2050
Total Jeep/ Van	0	0	0	0	0	0	0	0	0
Mini Bus	176	216	244	284	339	439	554	695	1076
Bus	104	129	189	249	294	375	470	592	917
Tempo LGV - Freight (3,4 Axle)	230	308	358	435	549	771	1032	1317	1945
Tempo LGV - Freight (6 Axle)	0	0	0	0	0	0	0	0	0
2 Axle Truck	79	102	116	140	174	243	328	425	657
3Axle Truck	5	5	9	14	18	23	28	34	50
MAV	1	1	4	5	5	5	5	5	5
Three Wheeler	269	327	355	405	475	601	738	907	1317
Two Wheeler	1003	1365	1531	1845	2357	3384	4745	6501	11105
Tractor	58	66	68	72	76	86	96	106	126
Tractor With Trailer	175	197	203	213	223	253	278	308	375
Cycle	6	6	6	6	6	6	6	6	6
Cycle Ricks	0	0	0	0	0	0	0	0	0
Hand Cart	0	0	0	0	0	0	0	0	0
Animal Drawn	6	6	6	6	6	6	6	6	6
Non Tollable	0	0	0	0	0	0	0	0	0
Non Tollable PCUs	0	0	0	0	0	0	0	0	0
Total PCUs	3,236	4,040	4,692	5,582	6,696	8,904	11,587	14,829	22,922
Total Vehicles	2,486	3,235	3,741	4,513	5,595	7,736	10,449	13,796	22,296
Homogenous Section VI-Shirhatti to Guttal km 130+000 to km 181+000									
Car	107	145	253	364	469	683	957	1282	2086
Total Jeep/ Van	41	49	53	60	71	94	121	148	195
Mini Bus	14	17	29	39	45	55	65	80	117
Bus	32	40	93	139	168	218	273	341	529
Tempo LGV - Freight (3,4 Axle)	78	102	131	165	206	287	382	487	717
Tempo LGV - Freight (6 Axle)	0	0	0	0	0	0	0	0	0
2 Axle Truck	38	47	56	68	84	116	155	199	302
3Axle Truck	3	4	8	12	13	13	13	13	13
MAV	0	0	3	4	4	4	4	4	4
Three Wheeler	11	15	21	26	32	42	52	63	91
Two Wheeler	1016	1382	1550	1868	2386	3425	4805	6583	11245
Tractor	12	12	12	12	12	12	12	12	12
Tractor With Trailer	46	52	54	56	58	66	71	77	97
Cycle	107	111	112	114	116	121	126	131	141
Cycle Ricks	0	0	0	0	0	0	0	0	0
Hand Cart	0	0	0	0	0	0	0	0	0
Animal Drawn	24	25	25	25	25	25	25	25	25
Non Tollable	1	1	1	1	1	1	1	1	1
Non Tollable PCUs	1	1	1	1	1	1	1	1	1
Total PCUs	1,451	1,810	2,297	2,844	3,443	4,630	6,096	7,893	12,472
Total Vehicles	1,531	2,002	2,402	2,953	3,690	5,162	7,062	9,446	15,575
Homogenous Section VII- Guttal to Ranebennur km 181+000 to 209+000									
Car	273	372	503	663	851	1231	1726	2311	3758
Total Jeep/ Van	88	110	120	139	169	230	300	374	501
Mini Bus	130	159	182	211	253	326	411	513	790
Bus	121	149	210	272	325	417	526	658	1021
Tempo LGV - Freight (3,4 Axle)	301	403	462	560	703	982	1312	1673	2475
Tempo LGV - Freight (6 Axle)	0	0	0	0	0	0	0	0	0
2 Axle Truck	80	101	114	136	168	234	316	408	624
3Axle Truck	42	55	64	77	94	128	173	222	340

Vehicle Type	Year								
	2015	2019	2020	2022	2025	2030	2035	2040	2050
MAV	9	12	16	19	22	29	38	48	68
Three Wheeler	50	62	71	83	98	124	152	187	272
Two Wheeler	2201	2994	3330	3994	5101	7323	10272	14074	24041
Tractor	10	11	11	11	11	11	11	11	11
Tractor With Trailer	55	62	64	68	72	82	92	102	122
Cycle	86	90	91	93	95	100	105	110	120
Cycle Ricks	0	0	0	0	0	0	0	0	0
Hand Cart	1	1	1	1	1	1	1	1	1
Animal Drawn	9	9	9	9	9	9	9	9	9
Non Tollable	3	3	3	3	3	3	3	3	3
Non Tollable PCUs	3	3	3	3	3	3	3	3	3
Total PCUs	3,292	4,254	4,970	6,010	7,411	10,172	13,658	17,859	28,396
Total Vehicles	3,458	4,593	5,250	6,340	7,975	11,230	15,447	20,704	34,156
Homogenous Section VIII- Ranebennur to Honnali km 209+000 to 253+116									
Car	247	334	460	614	790	1147	1608	2150	3503
Total Jeep/ Van	59	75	82	95	117	160	207	255	342
Mini Bus	88	111	131	153	182	231	289	360	553
Bus	85	104	162	216	259	333	418	522	809
Tempo LGV - Freight (3,4 Axle)	200	266	311	378	473	660	882	1124	1659
Tempo LGV - Freight (6 Axle)	0	0	0	0	0	0	0	0	0
2 Axle Truck	299	391	428	500	622	872	1188	1545	2410
3Axle Truck	88	111	125	148	183	254	341	439	681
MAV	38	49	56	65	76	107	142	179	266
Three Wheeler	63	78	88	102	120	152	187	230	334
Two Wheeler	1584	2156	2404	2888	3688	5295	7427	10176	17381
Tractor	8	8	8	8	8	8	8	8	8
Tractor With Trailer	33	37	38	40	42	47	52	57	67
Cycle	18	19	19	19	19	19	19	19	19
Cycle Ricks	0	0	0	0	0	0	0	0	0
Hand Cart	0	0	0	0	0	0	0	0	0
Animal Drawn	4	4	4	4	4	4	4	4	4
Non Tollable	7	7	7	7	7	7	7	7	7
Non Tollable PCUs	7	7	7	7	7	7	7	7	7
Total PCUs	3,381	4,388	5,112	6,171	7,629	10,566	14,239	18,582	29,439
Total Vehicles	2,822	3,750	4,322	5,239	6,590	9,296	12,779	17,075	28,043

33. ***Projected Traffic– iDeCK Study***: Total traffic forecast given in the iDeCK report comprises normal and induced components. Traffic projections were made by applying the mode-wise growth rates discussed above to the base year (2014) traffic. Apart from the normal traffic, 10% generated traffic is added. No provision for diverted traffic has been made in the iDeCK study. The traffic forecast by iDeCK is given in **Table-8**

Table 8: Traffic Forecast for Gadag to Honnali Section in Various Horizon Years

Section	2014	2018	2023	2028	2033	2038	2043
Gadag to Shirahatti	3236	4673	6645	9538	13756	19850	28625
Shirahatti to Ranebennur	3915	5904	8840	13287	19955	29842	44382
Ranebennur to Honnali	2998	4573	6908	10429	15687	23453	34839

34. ***Capacity and Level of Service Analysis (ICT Study).*** The following guidelines, which recommends different traffic threshold at different level of service for specific carriageway configuration, were used to determine the required improvements of the project road,

- Manual of Standard and Specification for Two laning of State Highways on BOT Basis (IRC: SP: 73-2015); and
- Manual of Standard and Specifications for Four Laning of Highways through PPP (IRC: SP: 84-2014) by IRC.

35. The summary of the above guideline for roadway improvements is shown in **Table-9**.

Table 9: Design Service Volumes at Different Level of Services

Terrain	Warrants for 2- lane		Design Service volume in PCUs per day			
			2 Lane Highway		4 Lane Highway	
	2-lane with granular shoulder	2- lane with paved shoulder	without paved shoulder	with min. 1.5m wide paved shoulder	LOS 'B'	LOS 'C'
Plain	<8,000	>10,000	15,000	18,000	40,000	60,000
Rolling	<6,500	>8,000	11,000	13,000		
Mountainous and Steep	-	-	7,000	9,000	20,000	30,000
As per standard	IRC: SP:73-2015				IRC:SP:84-2014	
Notes:	Unless otherwise specified in the concession agreement, 6 laning shall be done when total traffic (including traffic on service road, if any) reaches design service volume to LOC 'C' for 4 lane highway.					

36. For any National Highway / State Highway, the minimum requirement should be that it should be a two-lane road. In case the traffic is adequate, based on the warrants for two-lane given in the IRC guidelines; it should be provided with granular or paved shoulder.

37. In view of the above considerations, the widening proposal for the project road sections of SH-57 has been formulated. The widening proposal based on the IRC: SP: 73-2015 and IRC: SP: 84-2014 are given in **Table-10**.

38. Homogenous sections V, VI, VII and VIII would require two-lane with granular shoulder configuration at LOS 'B' up to the year 2032, 2045, 2029 and 2029 respectively after which it may be improved to 2 lane with paved shoulder configuration. Four laning for the homogenous sections V, VII and VIII would be required from the year 2044, 2040 and 2039 respectively. Homogenous section VI would not require 4 laning upto year 2050.

Table 10: Improvement Proposal Based on IRC Codes

Sl. No	Homogeneous Section (HS)	Existing Chainage (km)		Terrain	Recommendation			
		From	To		2-lane with granular shoulder	2-lane with paved shoulder	4-lane with paved shoulder	6-lane with paved shoulder (at LOS 'B')
1	HS-V	105+200	130+000	Plain	2015	2032	2044	-
2	HS-VI	130+000	181+000	Plain	2015	2045	-	-
3	HS-VII	181+000	209+000	Plain	2015	2029	2040	-
4	HS-VIII	209+000	253+116	Plain	2015	2029	2039	-

39. However, as the project road is a State Highway the recommended configuration is two-Lane with paved shoulder from the year of opening after widening.

40. ***Capacity Analysis – iDeCK Study***. iDeCK has used the following guidelines to carry out the capacity analysis and to recommend improvements.

- IRC: 64 -1990, 'Capacity of Roads in Rural Areas';
- IRC: SP: 73 - 2007, 'Manual of Specifications and Standards for Two-laning of Highways through Public Private Partnership'; and
- IRC: SP: 84 – 2009, 'Manual of Specifications and Standards for Four laning of Highways through Public Private Partnership'.

41. Improvement proposal for project road given in iDeCK study is given in **Table-11**.

Table 11: Improvement Proposal for the Project Road in iDeCK Study

Section	2014	2018	2023	2028	2033	2038	2043
Gadag to Shirahatti	Intermediate Lane	Intermediate Lane	Two Lane with Earthen Shoulder	Two Lane with Earthen Shoulder	Two Lane with Earthen Shoulder	Four Lane with Earthen Shoulder	Four Lane with Earthen Shoulder
Shirahatti to Ranebennur	Intermediate Lane	Intermediate Lane	Two Lane with Earthen Shoulder	Two Lane with Earthen Shoulder	Two Lane with Earthen Shoulder	Four Lane with Earthen Shoulder	Four Lane with Paved Shoulder
Ranebennur to Honnali	Intermediate Lane	Intermediate Lane	Two Lane with Earthen Shoulder	Two Lane with Earthen Shoulder	Two Lane with Earthen Shoulder	Four Lane with Earthen Shoulder	Four Lane with Earthen Shoulder

42. Although iDeCK study involves estimation of traffic forecast based on growth of traffic coming from different influence zones, but finally one set of growth rate has been applied to all the traffic. However, in ICT study, the share of traffic coming from an influence zone has been forecasted using the growth rate obtained for that particular influence zone using elasticity of transport demand approach. The generated traffic has been taken as 10% which is on the higher side and diversion has not been considered in the iDeCK traffic forecast.

43. In the iDeck study, the project road has been divided into three homogenous sections. Section from Shirhatti to Ranebennur has been taken as one homogenous section in iDeCK study, whereas, ICT study has divided this section into two parts, from Shirhatti to Guttal and from Guttal to Ranebannur, based on traffic flow observed on site.

44. Therefore, ICT traffic forecast which is at more disaggregate level and takes into account induced, generated as well as diverted traffic from competing roads in the project influence area, has been considered for assessing the project improvement schemes.

D. Improvement of Proposal

1. Corridor of Impact

45. The land width required for construction of the road is found to be varying between 26-36m depending on the height of embankment. The available RoW is not consistent and varies significantly along the project road. The IRC (73:1980) recommended minimum RoW for State Highways to be 45 in open country and 30 m in built-up areas, which is not available throughout the length of the project road. Wherever this required width is not available, KSHIP is acquiring only the required width of land for construction to limit the associated social impacts and compensation cost, in turn the project cost.

46. Therefore, the Corridor of Impact (COI) is the proposed construction width, which is varying from 16 to 20 m in built-up areas and 26 to 36 m in rural / open country area. Sections of existing project road at few locations upon verification with land records were noted that the land on which existing road exists is still notified as private land and is now considered in totality for acquisition.

2. Widening Scheme

47. The proposed improvement as far as possible is within the existing right of way avoiding land acquisition except for locations having inadequate width, realignments with geometric improvements, bypasses and provision of highway facilities like Toll plaza, Bus bays, Truck lay byes etc.

48. Considering the need to minimize land acquisition concentric widening of existing carriageway is adopted for majority of the section. At few locations eccentric widening is proposed due to poor geometry of the existing carriageway. It is also proposed from **Ch.200+700 to Ch. 201+965 to save big trees on one side of the road by proposing eccentric widening**. The lane configurations recommended for the project road is as given in **Table-12** and the summary of widening is given in **Table-13.**

Table 12: Recommended Lane Configuration

Sl No.	Design Ch. (Km)		Length (Km)	Remarks
	From	To		
1	105+500	107+000	1.500	4-Lane Built Up Section-Gadag Town
2	107+000	112+200	5.200	2 Lane Paved Shoulder
3	112+200	112+600	0.400	2-Lane Built Up Section-Nagavi Village
4	112+600	114+800	2.200	2 Lane Paved Shoulder
5	114+800	115+600	0.800	2 Lane Paved Shoulder-Belahadi Realignment
6	115+600	122+000	6.400	2 Lane Paved Shoulder
7	122+000	122+200	0.200	2-Lane Built Up Section-Yalishirur Village
8	122+200	124+570	2.370	2 Lane Paved Shoulder
9	124+570	125+650	1.080	2 Lane Paved Shoulder-Soratur Realignment
10	125+650	127+090	1.440	2 Lane Paved Shoulder
11	127+090	130+090	3.000	2 Lane Paved Shoulder-Shirahatti bypass
12	130+090	135+450	5.360	2 Lane Paved Shoulder
13	135+450	136+250	0.800	2-Lane Built Up Section-Chabbi Village
14	136+250	142+200	5.950	2 Lane Paved Shoulder
15	142+200	142+600	0.400	2-Lane Built Up Section-Devihal Village
16	142+600	142+850	0.250	2 Lane Paved Shoulder
17	142+850	143+500	0.650	2-Lane Built Up Section-Devihal Village
18	143+500	146+150	2.650	2 Lane Paved Shoulder
19	146+150	149+365	3.215	2 Lane Paved Shoulder-Bellahati Bypass
20	149+365	153+400	4.035	2 Lane Paved Shoulder

Sl No.	Design Ch. (Km)		Length (Km)	Remarks
	From	To		
21	153+400	153+800	0.400	2-Lane Built Up Section-Alagilawad Village
22	153+800	157+130	3.330	2 Lane Paved Shoulder
23	157+130	159+160	2.030	2 Lane Paved Shoulder-Realignment including major Bridge @ Ch:158+591
24	159+160	165+750	6.590	2 Lane Paved Shoulder
25	165+750	166+200	0.450	2-Lane Built Up Section-Mevundi Village
26	166+200	167+280	1.080	2 Lane Paved Shoulder
27	167+280	170+880	3.600	2 Lane Paved Shoulder-Realignment for Gullagundi, Meeralagi M Guttal
28	170+880	178+660	7.780	2 Lane Paved Shoulder
29	178+660	181+510	2.850	2 Lane Paved Shoulder-Guttal Bypass
30	181+510	183+500	1.990	2 Lane Paved Shoulder
31	183+500	183+800	0.300	2-Lane Built Up Section-Timmapur M Guttal
32	183+800	188+770	4.970	2 Lane Paved Shoulder
33	188+770	189+900	1.130	2 Lane Paved Shoulder-Realignment for Gudivanti
34	189+900	190+500	0.600	4-Lane Built Up Section-Honnati Village
35	190+500	191+500	1.000	2-Lane Built Up Section-Honnati & Kerimallapur Village
36	191+500	191+700	0.200	2 Lane Paved Shoulder
37	191+700	192+025	0.325	Aquaduct Approach
38	192+025	201+965	9.940	2 Lane Paved Shoulder
39	201+965	202+300	0.335	2 Lane Paved Shoulder-Ranebennur Realignment
40	202+300	203+600	1.300	2 Lane ROB Approach - Ranebennur Realignment
41	203+600	205+290	1.690	2 Lane Paved Shoulder -Ranebennur Realignment
42	205+290	209+565	0.000	Not in scope of work (Ranebennur Town section)
43	209+565	215+335	0.000	Not in Scope of work as it is being developed by KSRDCL
44	215+335	216+250	0.915	4-Lane Built Up Section-Halageri Town
45	216+250	222+350	6.100	2 Lane Paved Shoulder
46	222+350	223+130	0.780	2 Lane Paved Shoulder-Realignment for MJB @Ch:222+710
47	223+130	229+265	6.135	2 Lane Paved Shoulder
48	229+265	229+945	0.680	2-Lane Built Up Section-Malanyakanahalli Village
49	229+945	230+315	0.370	2 Lane Paved Shoulder
50	230+315	230+645	0.330	2-Lane Built Up Section-Timmena Halli Village
51	230+645	230+890	0.245	2 Lane Paved Shoulder
52	230+890	232+715	1.825	2 Lane Paved Shoulder-Tuminakatte Realignment
53	232+715	239+465	6.750	2 Lane Paved Shoulder
54	239+465	239+920	0.455	2-Lane Built Up Section-Puradakeri Village
55	239+920	241+215	1.295	2 Lane Paved Shoulder
56	241+215	241+420	0.205	2-Lane Built Up Section-Hallur Village
57	241+420	241+615	0.195	2 Lane Paved Shoulder
58	241+615	242+120	0.505	2-Lane Built Up Section-Hallur Village
59	242+120	247+615	5.495	2 Lane Paved Shoulder
60	247+615	248+620	1.005	2-Lane Built Up Section-Hanumansagara Village
61	248+620	252+365	3.745	2 Lane Paved Shoulder
62	252+365	253+713	1.348	4-Lane Built Up Section-Honnali Town

Table 13: Summary of Widening

Widening length in Km		Realignments and Geometric Improvements (Km)	Bypasses (Km)	Total Length (Km)
Concentric	Eccentric			
82.828	5.925	40.350	9.065	138.168

3. Typical Cross Sections

49. Based on the traffic projection, capacity and the design standards, the typical cross-sections applicable for various sections of the project road have been prepared. The typical cross sections are given in **Annex-2.1**. Proposed Cross-sections in urban locations have been customized to suit field conditions and minimize R&R impact and land acquisition. The cross-sections in urban locations were developed within 16 m and 20 m formation width with 2-lane paved shoulder and 4-lane divided carriageway configuration respectively, without compromising on safety and capacity augmentation requirement of the project road. These typical sections have been prepared separately for various alternatives like reconstruction, rehabilitation, built-up areas, etc. as follows**:**

Table 14: Details of Typical Cross Sections

TCS-1	Typical Cross Section for 2-Lane with Paved Shoulder (Open Country) – Concentric Widening (Embankment Height <3m)
TCS-1A	Typical Cross Section for 2-Lane with Paved Shoulder (Open Country) – Concentric Widening (Embankment Height ≥ 3m)
TCS-2	Typical Cross Section for 2-Lane with Paved Shoulder (Open Country) – Realignment / Bypass / New Construction (Embankment Height <3m)
TCS-2A	Typical Cross Section for 2-Lane with Paved Shoulder (Open Country) – Realignment / Bypass / New Construction (Embankment Height ≥ 3m)
TCS-3	Typical Cross Section for 4-Lane Divided Carriageway (Urban Section) – Concentric Widening Built-Up Section within 20m CoI
TCS-4	Typical Cross Section for 2-Lane with Paved Shoulder (Urban Section) – Concentric Widening Built Up Section with 16m CoI
TCS-5	Typical Cross Section for Approaches to ROB with / without Slip Road (Open Country) – Realignment / Bypass / New Construction
TCS-6	Typical Cross Section for Approaches to Aqueduct – (Concentric Widening) – Retained

4. Bypasses and Realignments

50. The project Road SH-57 & SH-26 passes through few congested settlements having substandard horizontal geometry at few locations. Hence to minimize R&R (Rehabilitation and resettlement) impact and to provide safety three bypasses & fourteen realignments have been proposed in this section of SH-57 & SH-26 with a total length of **32.440 km**. All the bypasses and realignments proposed are summarized in **Table-15**.

Table 15: Bypasses / Realignment of SH-57 & SH-26

Sl. No.	Name of Town/Village	Chainage along Existing Alignment (km)			Chainage along Bypass/Realignment (km)		
		Start	End	Length	Start	End	Length
Proposed Bypass							
1	Shirahatti	128+350	132+105	3.755	127+090	130+090	3.000
2	Bellahati	148+500	151+422	2.922	146+150	149+365	3.215
3	Guttal	188+700	192+140	3.440	178+660	181+510	2.850
						Total Length	**9.065**
Realignments and Geometric Improvements							
1	Realignment for Beladhadi	115+500	116+466	966	114+800	115+600	0.800

Sl. No.	Name of Town/Village	Chainage along Existing Alignment (km)			Chainage along Bypass/Realignment (km)		
		Start	End	Length	Start	End	Length
2	Realignment for Soratur	125+300	127+115	1815	124+570	125+650	1.080
3	Geometric Improvement from Ch. 150+115 to Ch. 150+915	152+000	152+928	928	150+115	150+915	0.800
4	Realignment for Alagilawad	155+640	156+247	607	153+615	154+115	0.500
5	Realignment from Ch. 157+130 to Ch. 159+160 including Major Bridge at Ch. 158+591	159+320	161+534	2214	157+130	159+160	2.030
6	Realignment for Itagi, Taredahalli and Mevundi Villages	164+250	172+208	7958	161+850	166+015	4.165
7	Realignment for Gullagundi, Meeralagi M Guttal	173+675	180+808	7133	167+280	170+880	3.600
8	Realignment for Gudivanti	199+400	200+665	1265	188+770	189+900	1.130
9	Ranebennur Realignment	212+950	216+195	3.245	201+965	205+290	3.325
10	Realignment for MJB @ Ch. 222+710	231+870	232+676	806	222+350	223+130	0.780
11	Geometry Improvement	234+480	235+596	1116	224+930	225+800	0.870
12	Tuminakatte Realignment	240+515	242+895	2.380	230+890	232+715	1.825
13	Geometry Improvement	255+200	256+971	1771	244+780	246+450	1.670
14	Geometry Improvement	259+200	260+138	938	248+700	249+500	0.800
						Total Length	**23.375**

51. The comparative evaluation for all the bypasses / realignments to select the final alignment is based on techno-economic suitability. The study and analysis has been based upon Google Aerial view and ground verification of the possible alignments. A 2-lane section with 7 m wide carriageway and 1.5 m wide paved shoulder and 1m earthen shoulder on both sides with proposed ROW of minimum 26 m has been proposed for all the bypasses & realignments.

5. Improvement of the Existing Road Geometrics

52. In few stretches, where improvement of the existing road geometrics to the prescribed standards is not possible, the existing road geometrics shall be improved to the extent possible within the given right of way and proper road signs and safety measures shall be provided. In the following stretches, the existing road geometrics shall be improved:

Table 16: Road Geometrics Improvement Locations

Sr. No.	Design Chainage (Km)		Length (Km)	Remarks
	From	To		
1	108+830	109+000	0.170	Deficient Geometry
2	109+700	109+900	0.200	Deficient Geometry
3	117+100	117+300	0.200	Deficient Geometry
4	118+570	120+000	1.430	Deficient Geometry
5	121+500	122+000	0.500	Deficient Geometry
6	122+600	123+030	0.430	Deficient Geometry
7	123+500	124+100	0.600	Deficient Geometry
8	125+650	126+740	1.090	Deficient Geometry
9	132+250	132+380	0.130	Deficient Geometry
10	135+170	135+450	0.280	Deficient Geometry
11	137+390	137+490	0.100	Deficient Geometry
12	139+480	139+610	0.130	Deficient Geometry
13	149+470	149+610	0.140	Deficient Geometry
14	151+730	152+420	0.690	Deficient Geometry
15	152+790	153+100	0.310	Deficient Geometry
16	154+300	154+430	0.130	Deficient Geometry
17	154+640	156+060	1.420	Deficient Geometry
18	156+580	156+940	0.360	Deficient Geometry
19	160+010	160+240	0.230	Deficient Geometry
20	166+800	167+050	0.250	Deficient Geometry
21	171+355	171+500	0.145	Deficient Geometry
22	173+385	173+660	0.275	Deficient Geometry
23	173+880	174+020	0.140	Deficient Geometry
24	174+300	174+890	0.590	Deficient Geometry
25	184+400	184+700	0.300	Deficient Geometry
26	186+000	186+200	0.200	Deficient Geometry
27	186+400	187+200	0.800	Deficient Geometry
28	188+200	188+500	0.300	Deficient Geometry
29	191+500	191+700	0.200	Deficient Geometry
30	192+025	192+110	0.085	Deficient Geometry
31	194+210	194+310	0.100	Deficient Geometry
32	195+250	195+550	0.300	Deficient Geometry
33	197+270	197+750	0.480	Deficient Geometry
34	198+170	198+530	0.360	Deficient Geometry
35	198+900	199+360	0.460	Deficient Geometry
36	217+650	217+900	0.250	Deficient Geometry
37	219+700	219+800	0.100	Deficient Geometry
38	221+000	221+300	0.300	Deficient Geometry
39	224+300	224+650	0.350	Deficient Geometry
40	226+390	226+740	0.350	Deficient Geometry
41	227+040	227+350	0.310	Deficient Geometry
42	227+810	227+995	0.185	Deficient Geometry
43	232+945	233+065	0.120	Deficient Geometry
44	234+330	234+530	0.200	Deficient Geometry
45	234+935	235+330	0.395	Deficient Geometry
46	235+615	236+160	0.545	Deficient Geometry
47	236+765	237+165	0.400	Deficient Geometry
48	242+250	242+745	0.495	Deficient Geometry

53. **Horizontal Alignment:** The alignment has been largely designed to a design speed of 100 km per hour except in built-up sections. Wherever the Improvement proposal is limited within existing Right of Way, design speed of 80 km per hour is adopted to avoid land acquisition. Urban Sections are designed for minimum 50 km per hour design speed to minimize the R&R & land Acquisition. The project road has 280 numbers of horizontal curves.

54. **Vertical Alignment:** The vertical alignment of the project road has been designed conforming to the design standards for the design speed limit as per IRC-SP:73-2015. The gradient has been kept below the ruling gradient of 2.5% as far as possible. The project Road has 415 numbers of vertical curves.

6. Pavement Design

55. Pavement for new construction in widening, bypass / realignment and reconstruction portion is designed based on subgrade strength, material characteristics and design traffic. Pavement composition for both 15 years and 20 years design life will be same as adopted design traffic is 20 MSA for both the cases. Pavement compositions for new / widening section have been worked out as per IRC 37-2012. Two pavement composition options are considered for the road section. These are:

- Option-1: Using conventional pavement materials
- Option-2: Recycled Asphalt Pavement (RAP) material

Table 17: Pavement Design for New / Widening Section

HS	Design Chainage (Km)		Design Period	Design Subgrade CBR (%)	Design Traffic (MSA)	Pavement Composition (mm)							Recommended Option
	From	To				Option 1 (Conventional)				Option 2 (RAP)			
						BC	DBM	WMM	GSB	BC	RAP	CTSB*	
HS V	105.2	130.0	2019-38	10	20	40	80	250	200	40	100	200	Option 2
HS VI	130.0	161.0	2019-38	12	20	40	70	250	200	40	90	200	Option 2
	161.0	181.00	2019-38	10	20	40	80	250	200	40	100	200	Option 2
HS- VII	181.0	209.0	2019-38	12	20	40	70	250	200	40	90	200	Option 2
HS- VII	209.0	253.12	2019-38	12	20	40	70	250	200	40	90	200	Option 2

56. For RAP Layer, maximum 30% recycled asphalt materials considered to be recovered from existing pavement. RAP mix design was conducted and test results are shown in Material Report. RAP is found suitable for pavement construction. VG-30 grade bitumen in the project road is suggested as design traffic is less than 30 MSA.

7. Bridges

57. 2 nos. of existing minor bridges are proposed to be rehabilitated and widened as presented in **Table-18**.

Table 18: Existing Minor Bridges to be Rehabilitated and Widened

Sl. No	Existing Ch. (Km)	Design Ch (Km)	Side	Overall Width (m)		Span Arrangement (m)	Type of Structure	
				Existing	Proposed		Super Structure	Sub-Structure
1	209+050	198+040	Both	12.00	16.30	2 x 8.50	RCC Solid Slab	RCC Wall type with open footing
2	211+320	200+325	Both	12.00	16.00	1 x 9.40		

58. 3 nos. of existing minor bridges are proposed to be retained and rehabilitated without widening as presented in **Table-19**.

Table 19: Existing Minor Bridges to be Rehabilitated and Retained

Sl. No	Existing Ch. (Km)	Design Ch (Km)	Overall Width (m)		Span Arrangement (m)	Type of Structure	
			Existing	Proposed		Super Structure	Sub- Structure
1	172+980	166+675	12.00	12.00	3 x 12.85	RCC Solid Slab	RCC Wall type abutment & circular pier with Open footing
2	196+950	186+325	12.00	12.00	3 x 10.80		
3	205+950	195+500	40.00	40.00	2 x 5.0 x 5.0 (Clear opening)	RCC twin cell box structure	

59. 6 no. of existing minor bridges are proposed to be reconstructed as presented in **Table-20.**

Table 20: Existing Minor Bridges to be Reconstructed

Sl. No.	Existing Ch. (Km)	Design Ch (Km)	Overall Width (m)		Span Arrangement (m)	Type of Structure	
			Existing	Proposed		Super Structure	Sub- Structure
1	105+125	105+545	8.50	(26.5 to 22.6) varies	1 x 10.800	RCC Solid Slab	RCC Wall type with open footing
2	114+800	114+140	6.10	16.00	1 x 6.0 x 7.491	RCC Single Cell Box Structure	
3	209+640	198+645	8.30	16.00	2 x 16.84	RCC Girder & Slab	RCC Wall type with open footing
4	210+530	199+540	8.50	16.00	3 x 16.84		
5	6+450 of SH-26	221+750	8.40	16.00	2 x 21.800		
6	33+730 of SH-26	248+227	8.50	16.00	3 x 8.800	RCC Solid Slab	RCC Wall type with open footing

60. 8 no. of new minor bridges are proposed to be constructed on realignments / bypasses and 6 no. of new minor bridges are proposed to be constructed on causeways as presented in **Table-21.**

Table 21: New Minor Bridges to be constructed on Realignments / Bypasses and Causeways

Sl. No.	Existing Ch. (Km)	Design Ch (Km)	Proposed Width (m)	Span Arrangement (m)	Type of Structure		
					Super Structure	Sub- Structure	Remarks

Sl. No.	Existing Ch. (Km)	Design Ch (Km)	Proposed Width (m)	Span Arrangement (m)	Type of Structure		
					Super Structure	Sub- Structure	Remarks
1	126+880	125+345	16.00	1 x 21.00	RCC Girder & Slab	RCC Wall type with open footing	New bridge on Causeway
2	129+600	128+278	16.00	2 x 15.840			New bridge on Causeway
3	146+400	144+263	16.00	2 x 10.800	RCC Solid Slab		New bridge on Causeway
4	150+700	148+854	16.00	1 x 16.241	RCC Girder & Slab		New Bridge on Bellahatti Bypass
5	159+500	157+276	16.00	2 x 6.0 x 6.10	RCC Twin Cell Box Structure		New Bridge on Realignment
6	183+690	173+560	16.00	1 x 10.800	RCC Solid Slab	RCC Wall type with open footing	New Bridge on Realignment
7	191+050	180+355	16.00	3 x 16.840	RCC Girder & Slab		New Bridge on Guttal Bypass
8	198+670	188+020	16.00	2 x 16.20			New bridge on Causeway
9	10+540 of SH-26	225+575	16.00	1 x 8.800	RCC Solid Slab	RCC Wall type with open footing	New bridge on Realignment
10	16+270 of SH-26	231+295	16.00	1 x 14.200	RCC Girder & Slab		New bridge on Tuminakatte Realignment
11	17+120 of SH-26	231+828	16.00	2 x 23.500			New bridge on Tuminakatte Realignment
12	20+380 of SH-26	235+137	16.00	1 x 25.840			New Bridge on Causeway
13	25+665 of SH-26	240+320	16.00	2 x 10.800	RCC Solid Slab		New Bridge on Causeway
14	27+900 of SH-26	242+552	16.00	2 x 19.800	RCC Girder & Slab		New Construction

61. 3 no. of existing major bridges are proposed to be rehabilitated and retained without widening and 4 new major bridges are proposed to be constructed as presented in **Table-22** and **Table-23** respectively.

Table 22: Existing Major Bridges to be Rehabilitated and Retained

Sl. No	Existing Ch. (Km)	Design Ch. (Km)	Overall Width (m)		Span Arrangement (m)	Type of Structure	
			Existing	Proposed		Super Structure	Sub- Structure
1	172+980	166+675	12.00	12.00	3 x 12.85	RCC Solid Slab	RCC Wall type abutment & circular pier with Open footing
2	196+950	186+325	12.00	12.00	3 x 10.80		
3	205+950	195+500	40.00	40.00	2 x 5.0 x 5.0	RCC twin cell box structure	

Table 23: Proposed New Major Bridges

Sl. No.	Existing Ch. (Km)	Design Ch. (Km)	Proposed Width (m)	Span Arrangement (m)	Type of Structure	
					Super Structure	Sub- Structure
1	160+750	158+591	16.00	2 x 21.80 + 1 x 26.850 + 2 x 21.800	RCC Girder & Slab	RCC Wall type with open footing
2	178+950	168+215	16.00	10 x 25.840	RCC Girder & Slab	RCC Wall type with Pile foundation
3	7+430 of SH-26	222+710	16.00	5 x 25.840	RCC Girder & Slab	RCC Wall type with open footing
4	34+500 of SH-26	249+142	16.00	1 x 21.850 + 1 x 26.850 + 1 x 21.850		

8. Road Over Bridges (ROBs)

62. 1 new ROBs is proposed on Ranebennur Realignment as given in **Table-24.**

Table 24: Details of New Road Over Bridges

Sl. No.	Design Ch. (Km)	Carriageway Width (m)	Overall width (m)	Span Arrangement (m)	Type of Structure	
					Super Structure	Sub-Structure
1	203+145	11.00	16.00	1 x 19.040 + 1 x 37.24 + 1 x 19.040	Steel Plate Girder and RCC Slab	RCC Rectangular column with open foundation

9. Culverts

63. Considering the adequacy and hydrological requirements, some additional culverts and replacement of some culverts have been proposed. A total of **250** culverts have been proposed along the project Road. Overall width of all culverts shall be equal to the roadway width of the approaches.

- Reconstruction of existing culverts : 95
- Widening of existing culverts : 43
- Construction of new culverts : 104
- Existing culverts to be retained : 08

10. At-Grade Intersection / Grade Separated Intersection

64. For smooth merging & diverging of cross road traffic, at grade intersections have been proposed at various locations. 28 nos. major and 123 nos. minor junctions have been identified and improvement has been proposed. High mast lighting system has been catered for in the design of major intersections.

11. Service Road / Slip Road

65. There is no major built up section along the project road and due to very low local traffic in settlement area, provision of service roads have not been made. In order to provide U-turn

facility, slip road on both sides of ROB is proposed as per site requirement. Location of slip road is presented in **Table 25**.

Table 25: Details of Slip Road

S. No.	Design Chainage (Km)		Length (Km)	Width of paved carriageway (m)	RHS/LHS or Both Sides
	From	From			
1	203+170	203+800	0.630	5.5	Both Side

12. Road Side Drain

66. Roadside toe drains shall be provided to receive discharge from embankment surface and countryside runoff and carry it safely to the nearest outfall point ensuring safety to the embankment toe, which is the area most vulnerable to erosion / failure. Roadside drains shall generally be provided on both sides of the embankment to safely carry the discharge from the embankment without jeopardizing the safety of the toe resulting safe guard to the pavement from water.

67. In plain section trapezoidal drain sections has been proposed on both side. In urban sections lined drains with footpath has been proposed for safety reasons. The shape and size of the roadside drains has been decided on the basis catchment area and its characteristics to the nearest outfall point. The Length of lined drain along the project is 12,468 m on either side (i.e. 2 x 12,468 = 24,936 m) and the length of unlined drain is 108,955 m on either side (i.e. 2 x 108,955 = 2,17,910 m)

68. For rural areas, the drains have been proposed as open and trapezoidal with 2(H):1(V) side slope. The minimum bed width and depth of flow at starting section shall be 500 mm and 300 mm respectively. The sections shall be gradually increased in terms of bed width and depth of flow up to the outfall point.

13. Footpath

69. Considering the safety of pedestrian traffic, footpath has been proposed on both side of the project road in the following location locations:

Table 26: Location of Footpath along the Project Road

Sl. No	Stretch (Km)		Length (m)	Side
	From	To		
1.	105+500	107+000	1.500	Both sides
2.	112+200	112+600	0.400	Both sides
3.	122+000	122+200	0.200	Both sides
4.	135+450	136+250	0.800	Both sides
5.	142+200	142+600	0.400	Both sides
6.	142+850	143+500	0.650	Both sides
7.	153+400	153+800	0.400	Both sides
8.	165+750	166+200	0.450	Both sides
9.	183+500	183+800	0.300	Both sides
10.	189+900	190+500	0.600	Both sides
11.	190+500	191+500	1.000	Both sides
12.	191+700	192+025	0.325	Both sides
13.	202+300	203+600	1.300	Both sides
14.	215+335	216+250	0.915	Both sides

Sl. No	Stretch (Km)		Length (m)	Side
	From	To		
15.	229+265	229+945	0.680	Both sides
16.	230+315	230+645	0.330	Both sides
17.	239+465	239+920	0.455	Both sides
18.	241+215	241+420	0.205	Both sides
19.	241+615	242+120	0.505	Both sides
20.	247+615	248+620	1.005	Both sides
21.	252+365	253+713	1.348	Both sides

70. **Utilities:** To facilitate utilities along the project road such as electric lines and poles, fiber optics, waterlines etc., sufficient space on both sides of the project road will be provided for sections passing through open country. For project road passing through settlement locations provision of RCC pipes of suitable size along the length of the road below footpath have been proposed. The size of pipes to carry utilities will be based on settlement size and utilities likely to be carried.

14. Bus Bays

71. 74 Bus bays (37 Locations) on the project road are identified as probable locations to address the need of people living along the stretch. Most of the bus bays have been located close to existing bus stops where ever available. Solar power lighting has been proposed at all the bus bays.

15. Truck Lay Byes

72. To facilitate the truck traffic, two truck lay bye on both sides of the project road have been proposed at km 148+213, 201+600 & 249+712 (Left) and Km 148+388, 201+430 & 249+837 (Right).

16. Toll Plaza

73. Considering traffic flow and homogeneous section, three toll plazas has been proposed at Ch. km 118+050, Ch. km. 187+500 and Ch. km. 228+150. However as decided during consultation with the client, construction of toll plaza will not be taken up immediately & only provision of land for the toll plaza has been made.

17. Design Speed

74. Considering the projected traffic on the project road, the project road is proposed to be improved to 2 lane with paved shoulder to a ruling design speed of 100 / 80 km per hour in plain / rolling terrain and with 50 km per hour as the minimum design speed in built up sections.

18. Additional Land Acquisition

75. According to the Land Acquisition Plan (LAP) **240.4263 Ha** of land will be acquired for the project. Out of total 240.4263 Ha of land, which is going to be acquired, 230.7330 Ha land is privately owned, 3.4225 Ha is forest land and remaining 6.2708 Ha land is Government / Waste land. The details of land acquisition requirement are summarized in the **Table-27.**

Table 27: Details of Land being acquired for the Project

Sl. No.	Land Details	Acquisition of Land Area (Ha.)	Percentage
1	Forest Land	3.4225	1.4
2	Govt. Land / Waste Land	6.2708	2.6
3	Private Land	230.7330	96.0
Total		**240.4263**	**100**

Source: Land acquisition Plan, ICT Pvt. Ltd 2015

E. Road Safety Devices

76. Road safety aspects have been well studied and several safety features like road marking, signage, safety barriers, boundary stones, kilometer stones and hectometer stones, pavement marking and lighting has been proposed as discussed below. The engineering design of the road has also considered IRC codal provisions related to road safety such as:

- IRC: SP: 32-1988 Road Safety for Children
- IRC: SP: 44-1994 Highway Safety Code
- IRC: SP: 55-2001 Guidelines for Safety in Construction Zones
- IRC:119:2015 Guidelines for Traffic Safety Barriers

1. Road Markings

- Road Markings shall comprise of carriageway markings such as longitudinal markings and object markings such as raised pavement markers (Cat's Eyes or Road Studs).
- All markings shall conform to IRC:35-2015 and Raised pavement markers shall be provided as per IRC:SP:73-2015

2. Road Signs

- Three types of Road signs shall generally be provided (such as Mandatory / Regulatory, Cautionary / Warnings, and informatory signs.
- Locations of Signs shall conform to IRC:67-2012 and Section 800 of MoRT&H Specifications

3. Roadside Safety Barriers

77. The following types of Road Safety Barriers shall be provided on the Project Road Sections:

- Semi-rigid type / rigid type / flexible type safety barriers shall be provided on the high Embankment Section (where the height of embankment is more than 3.0 m).
- Rigid Type such as Concrete Crash Barriers shall be provided on the bridges, isolated structures and its approaches, as Median for 4-lane urban section.

4. Boundary Stone, Km Stone and Hectometer Stone

78. Road boundary stones have been proposed all along the project highway to discourage future encroachment into the right of way. Km stone and hectometer stones have been proposed all along the project road as per IRC codal provisions

5. Pavement Marking and Lighting

79. Pavement markings will be done for traffic lane line, edge lines and hatching. The marking will be with hot applied thermoplastics materials. The pavement markings will be reinforced with raised RR pavement markers and will be provided for median and shoulder edge longitudinal lines and hatch markings.

80. Highway lightings including high masts will be provided at intersections in order to improve the night time visibility. All the built up locations, bus bays, truck lay byes as well Underpasses has been proposed lighting arrangements.

F. Sources of Construction Materials

81. Soil and material investigation for a road project is very essential to assess the availability of suitable construction material in the vicinity of the project road. This includes investigation of suitable borrow area for borrowing earth and quarries for stone /aggregate material and also for the other construction materials like cement, steel, bitumen etc.

82. **Borrow Areas:** Potential sources of earth for the construction of embankment and subgrade were identified on either side of project road. The details of proposed borrow areas investigated with their respective locations; corresponding chainages and lead from nearest point to project road are tabulated in **Table-28**.

Table 28 Location of Proposed Borrow Areas

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Location / Village Name	Lead From Nearest Point on Project Road (km)	Type of Land	Approx. Quantity(m^3)
1.	92+000	RHS	Kiritigeri	2	Govt.	48,500
2.	100+500	LHS	Chikapa	7	Private	40,000
3.	106+550	RHS	Hulkot	12	Govt.	3,200,000
4.	110+900	LHS	Nagavi West	6	Govt.	300,000
5.	110+990	LHS	Nagavi West	5	Govt.	720,000
6.	116+000	LHS	Beladi	1	Private	81,000
7.	123+000	RHS	Surundari	1	Private	40,000
8.	128+000	LHS	Yalishrur	0.5	Private	97,000
9.	134+950	LHS	Varavi	6	Private	170,000
10.	139+150	LHS	Chebbi	4	Private	32,000
11.	149+300	LHS	Belatti	1	Govt.	65,000
12.	154+000	RHS	Hosur	1	Govt.	40,000
13.	158+000	RHS	Sibana	0.1	Private	36,000
14.	161+000	LHS	Tagoda	0.5	Govt.	121,000
15.	169+200	LHS	Maldi	0.2	Private	80,937
16.	171+600	RHS	Meundi	0.5	Private	202,342
17.	180+800	RHS	Belavigi	1	Private	202,342
18.	189+300	LHS	Guttal	3	Private	10,117
19.	192+150	RHS	Baradi	6	Private	93,000
20.	202+400	RHS	Mardi	0.5	Private	30,351

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Location / Village Name	Lead From Nearest Point on Project Road (km)	Type of Land	Approx. Quantity(m^3)
21.	208+850	RHS	Devarguda	0.5	Govt.	64,749
22.	225+450	RHS	Antrolly	0.5	Govt.	42,492
23.	237+550	LHS	Basapur	1	Private	48,562
24.	245+950	RHS	Beriyanapada	0.5	Govt.	1,011,712
25.	250+250	RHS	Hollur	0.5	Govt.	6,070,275
26.	255+050	RHS	Nalapa	0.5	Private	404,685
27.	257+400	RHS	Jhalgundi	2.3	Private	101,171
28.	260+550	LHS	Anali	0.3	Private	

83. **Stone / Coarse Aggregate Material:** Six stone quarries were identified along the project road section and samples were collected and tested. The sampling locations, name of quarry /village and approximate lead distances from project site are given in **Table-29**.

Table 29: Location of Stone / Coarse Aggregate Material

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Location / Village Name	Lead From Nearest Point on Project Road (km)	Approx. Quantity
1	106+550		Parashapur	37	Huge
2	106+550	LHS	Chilchili	32	Huge
3	106+550	LHS	Annigeri	26	Huge
4	106+550		Bardur	35	Huge
5	206+550	RHS	Derorgudda	2	Huge
6	206+550	RHS	Derorgudda	3	Huge

84. **Fine Aggregate Material:** Local enquiry suggests that extraction / mining of natural sand is banned in Karnataka state. It is therefore suggested to use manufactured sand which can be obtained by crushing the stone at crusher plant itself, in the pavement construction as well as concreting of the structures. During field investigation sis sources of stone dust and one source of River sand were identified and presented in **Table 30** and **Table 31** respectively.

Table 30: Location of Fine Aggregate Material (Stone Dust)

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Location / Village Name	Lead From Nearest Point on Project Road (km)
1	106+550	LHS	Annigeri	26
2	106+550	LHS	Bardur	35
3	106+550	LHS	Chilchili	32
4	106+550	LHS	Parashapur	37
5	206+550	RHS	Derorgudda	2
6	206+550	RHS	Derorgudda	3

Table 31: Location of Fine Aggregate Material (River Sand)

S. No.	Location / Chainage (Km)	Side	Source	Lead From Nearest Point on Project Road (km)
1	106+550	RHS	Kolahalli River	55

85. **Cement:** Ordinary Portland cement of Grade 43 and 53 are available in and around Gadag and Honnali. Cement shall be conforming to IS: 8112 and / or IS: 12269.

86. **Bitumen:** Bitumen can be procured from ONGC oil refinery from Mangalore, Karnataka, with a lead of about 430 Km from Gadag. The Specification of Bitumen must comply with relevant IS / IRC codes.

87. **Steel:** High strength deformed bars manufactured by various steel manufacturing companies conforming to IS 1786 may be available with local stockists in and around Gadag and Honnali. Before incorporation into the work, steel shall be got approved by the Engineer.

88. **Waste Plastic:** Waste plastic creates problem to the environment. The waste plastic is definitely a great worry for our country as well as the whole world. If the plastic is not utilized properly, we need to dump it as a waste. There is a generation of more than 10,000 tons of waste plastic in India every day. The waste plastic is recycled in India in an unorganized way. This un-utilized plastic does not degenerate or bio-degrades but will remain as it is for lakhs of years. Therefore, the best way of disposal of waste plastic is its recycling to the maximum extent and waste plastic has great potential for use in bituminous construction as its addition in small dose helps in substantially improving Marshall Properties, fatigue life and other properties. **IRC: SP: 98-2013** will be followed for conducting mix design of bituminous concrete using waste plastics.

Waste plastic is available from K. K. Plastic Waste Management Pvt. Ltd,
No. 50, 1st Floor, Opp. Post Office, Yelachenahalli, Kanakapura Road, Bangalore - 78
Phone- 91 80 2666 1056/ 2666 1513
Mobile- 98450 78600/ 9880045811
E- mail- kkplasticroads@hotmail.com

G. Project Cost

89. The Project Cost for the project road from Gadag to Honnali is given as follows:

Table 32: Project Cost

Length (In Km)	Civil Cost (In INR Cr.)	Per Km Civil Cost (In INR Cr.)	Total Project Cost (In INR Cr.)	Per Km Total Project Cost (In INR Cr.)
138.168	577.25	4.18	798.92	5.78

III. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Introduction

90. The environmental management and protection policies, regulations and administrative framework governing the project are reviewed in this section. The review includes sector-specific environmental policies and regulations of the Government of India, State Govt. of Karnataka, ADB's Safeguard Policy Statement – June 2009 and the administrative framework of various agencies, such as the Ministry of Environment, Forest and Climate Change (MoEF&CC), the Pollution Control Boards and other bodies associated with the implementation of the proposed project.

B. Policies and Legal Framework

1. Constitutional Provisions

91. The Constitution of India, in Article 48, of Directive Principles of the State, states that "the state shall endeavour to protect and improve the environment and to safeguard forests and wildlife of the country". Further Article 51-A (g), of fundamental duties, emphasizes that, "It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures". These two provisions of the constitution are the guiding principles for the environmental legislation in India.

2. Applicable Environmental Legislations

92. The Government of India has laid down various policy guidelines, regulations, acts and legislations pertaining to sustainability and protection of the environment and its various components. The Environmental Acts, Notifications, Rules and Amendments applicable for the proposed project include the following:

- Environment (Protection) Act and Rules, 1986
- EIA Notification, 14th September 2006 and its subsequent amendments
- The Water (Prevention and Control of Pollution) Act and Rules, 1974, 1975
- The Air (Prevention and Control of Pollution) Act, Rules and Amendment, 1981, 1982, 1983, 1987
- Forest (Conservation) Act, 1980 and its amendments
- Forest (Conservation) Rules, 2003 and its amendments
- Wildlife (Protection) Act, 1972 and Amended in 2003
- The Biodiversity Act, 2002
- The Karnataka Preservation of Trees Act, 1976
- Construction and Demolition Waste Management Rules, 2016
- Municipal solid Waste (Management and Handling) Rules, 2000
- The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016
- Noise Pollution (Regulation & Control) Rules, 2003 and amended in 2010
- Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010
- Disposal of Fly Ash Notification 2009 and its amendments on 25th January 2016
- ADB Safeguard Policy Statement 2009
- The Motor Vehicles Act, 1988

- The Motor Vehicles (Amendment) Bill, 2015
- Public Liability Insurance Act, 1991

C. Description of Key Environmental Legislations

1. The Environment (Protection) Act, 1986

93. This Act is umbrella legislation designed to provide a framework for the coordination of central and state authorities, established under the Water (Prevention and Control) Act, 1974 and Air (Prevention and Control) Act, 1981. Under this Act, the central government is empowered to take measures necessary to protect and improve the quality of the environment by setting standards for emissions and discharges; regulating the location of industries; management of hazardous wastes, and protection of public health and welfare. Empowered by the EP Act, the MoEF&CC, GoI has issued various notifications regulating the siting of industry and operations, procuring clearance to establish industries and development of projects with appropriate EIA studies, coastal zone regulations and many other aspects of environment through notifications.

2. EIA Notification and its Subsequent Amendments

- As per the Environmental Impact Assessment (EIA) Notification, 14th September 2006 and its amendment up to 17th April 2015, new national /state highway projects as well as expansion of national /state highway require Prior Environmental Clearance.
- Projects have been grouped under Category 'A' requiring clearance from Expert Appraisal Committee (EAC) of MoEF&CC, GoI and Category 'B' requiring clearance from the State / Union territory Environment Impact Assessment Authority (SEIAA). The SEIAA shall base its decision on the recommendations of a State or Union territory level Expert Appraisal Committee (SEAC).
- The concerned Committee (EAC or SEAC) will finalize the TOR on the basis of Form-1, proposed draft TOR & Pre-Feasibility / Feasibility Report.
- Environmental Impact Assessment study is to be carried out strictly as per the TOR provided by the Committee. Public Hearing is required for Category 'A' project.
- Public Hearing is required for road & highway projects **except** expansion of Roads and Highways (item 7 (f) of the Schedule) which do not involve any further acquisition of land

94. List of projects requiring Prior Environmental Clearance is given in the "SCHEDULE" of EIA Notification. As per the Schedule categorization of the highway project is as follow:

Project Activity	Category 'A'	Category 'B'	Conditions if any
Highways *7(f)*	*i) New National High ways; and* *ii) Expansion of National Highways greater than 100 km involving additional right of way or land acquisition greater than 40m on existing alignments and 60m on re-alignments or by-passes*	*i) All New State Highway Projects* *ii) State Highway Expansion projects in Hilly terrain (above 1,000 m MSL) and or Ecologically Sensitive Areas.*	*General Condition shall apply* ***Note:*** *Highways include expressways*

95. **General Condition of the EIA Notification.** Any project or activity specified in Category 'B' will be appraised at the Central level as Category 'A', if located in whole or in part within 5 km from the boundary of:

i) Protected Areas notified under the Wild Life (Protection) Act, 1972 (53 of 1972),
ii) Critically Polluted areas as identified by the Central Pollution Control Board constituted under the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974) from time to time,
iii) Eco-sensitive areas as notified under sub-section (2) section 3 of the Environment (Protection) Act, 1986, and
iv) Inter-State boundaries and international boundaries;

96. **Conclusions:** The proposed project is the strengthening & widening of existing State Highway. Project road is passing through plain terrain (below 1,000 m MSL) and is not passing through any ecologically sensitive area. **Therefore, Environmental Clearance is not required from Government of India for improvement of SH-57 & SH-26 from Gadag to Honnali (138.168 Km) in the State of Karnataka**. .

3. The Water (Prevention and Control of Pollution) Act and Rules, 1974, 1975

97. This Act represented India's first attempts to comprehensively deal with environmental issues. It was enacted for the prevention and control of water pollution, and the maintaining and restoring of the wholesomeness of water. The Act prohibits the discharge of pollutants into water bodies beyond a given standard, and lays down penalties for non-compliance. The Act was amended in 1988 to conform closely to the provisions of the EPA, 1986. It set up the CPCB (Central pollution Control Board), which lays down standards for the prevention and control of water pollution. At the state level, the SPCBs (State Pollution Control Board) function under the direction of the CPCB and the state government.

98. As per the "Modified Directions under Section 18(1)(b) of The Water ((Prevention and Control of Pollution) Act and Rules, 1974 and The Air (Prevention and Control of Pollution) Act, 1981 regarding Harmonization of Classification of Industrial Sectors under Red / Orange / Green / White Categories" of **Central Pollution Control Board, dated March 07, 2016**, NOC from SPCB is required only for "New Highway Construction Project". Improvement / expansion of existing highway do not fall under any other four categories (Red, Orange, Green and White). Therefore, **NOC (under Water Act) from SPCB will not be required for improvement of existing State Highway 57 & 26 (Gadag to Honnali).** It has also been verified from the Karnataka State Pollution Control Board.

4. The Air (Prevention and Control of Pollution) Act, Rules and Amendment, 1981, 1982, 1983, 1987

99. To counter the problems associated with air pollution, ambient air quality standards were established, under the 1981 Act. The Act provides means for the control and abatement of air pollution. The Act seeks to combat air pollution by prohibiting the use of polluting fuels and substance, as well as by regulating appliances that given rise to air pollution. Under the Act establishing or operating of any industrial plant in the pollution control area requires consent from state boards. The boards are also expected to test the air in air pollution control areas, inspect pollution control equipment, and manufacturing processes. The Air (Prevention and Control of Pollution) Rules formulated in 1982, defined the procedures for conducting meeting of

the boards, the powers of the presiding officers, decision-making, the quorum, manner in which the records of the meeting were to be set etc. They also prescribed the manner and the purpose of seeking assistance from specialists and the fee to be paid to them.

100. National Ambient Air Quality Standard (NAAQS) for major pollutants were notified by the CPCB in April 1994 and amended in 16th November 2009 (**Annex-3.1**). To empower the central and state pollution boards to meet grave emergencies, the Air (Prevention and Control of Pollution) Amendment Act, 1987 was enacted.

101. As per the "Modified Directions under Section 18(1)(b) of The Water ((Prevention and Control of Pollution) Act and Rules, 1974 and The Air (Prevention and Control of Pollution) Act, 1981 regarding Harmonization of Classification of Industrial Sectors under Red / Orange / Green / White Categories" of **Central Pollution Control Board, dated March 07, 2016**, NOC from SPCB is required only for "New Highway Construction Project". Improvement / expansion of existing highway do not fall under any other four categories (Red, Orange, Green and White). Therefore, **NOC (under Air Act) from SPCB will not be required for improvement of existing State Highway 57 & 26 (Gadag to Honnali).** It has also been verified from the Karnataka State Pollution Control Board.

5. Forest (Conservation) Act, 1980 and its amendments

102. The Act came into force with effect from October 25, 1980. This Act provides for the conservation of forests and regulating diversion of forestlands for non-forestry purposes. The basic objective of the Act is, to regulate the indiscriminate diversion of forestlands for non-forestry uses and to maintain a logical balance between the development needs of the country and the conservation of natural resources/ heritage.

103. When projects fall within forestlands, prior clearance is required from relevant authorities under the Forest (Conservation) Act, 1980. For diversion of forestland, the project proponent needs to apply to the State Government. Depending on the area required to be diverted, the proposals are cleared by MoEF Regional or Central Offices provided that the cost of compensatory afforestation, cost of rehabilitation of endangered/rare species of flora/fauna, and the net present value of the forest resources are deposited upfront with the state Forest Department.

6. Forest (Conservation) Rules, 2003 and its amendments

104. These are rules by the Central Government for working and conduct of business outlined under the Forest (Conservation) Act, 1980. As per the Forest (Conservation) Rules, 2003 & its amendment, proposal involving diversion of forest land up to 5 hectares other than the proposal relating to mining and encroachments are decided by the Regional Offices of the MOEF. The Regional Office of MOEF is competent to process, scrutinize and forward decision on proposal involving diversion of more than 5 ha to 40 ha of forest land along with the recommendation (if any), to MOEF, New Delhi. For proposal involving diversion of more than 40 ha forest land the state Government/ Union Territory would forward the proposal with recommendation to MOEF as per para 2.5(ii) of guidelines issued under Forest (Conservation) Act.

7. Wildlife (Protection) Act, 1972 and Amended in 2003

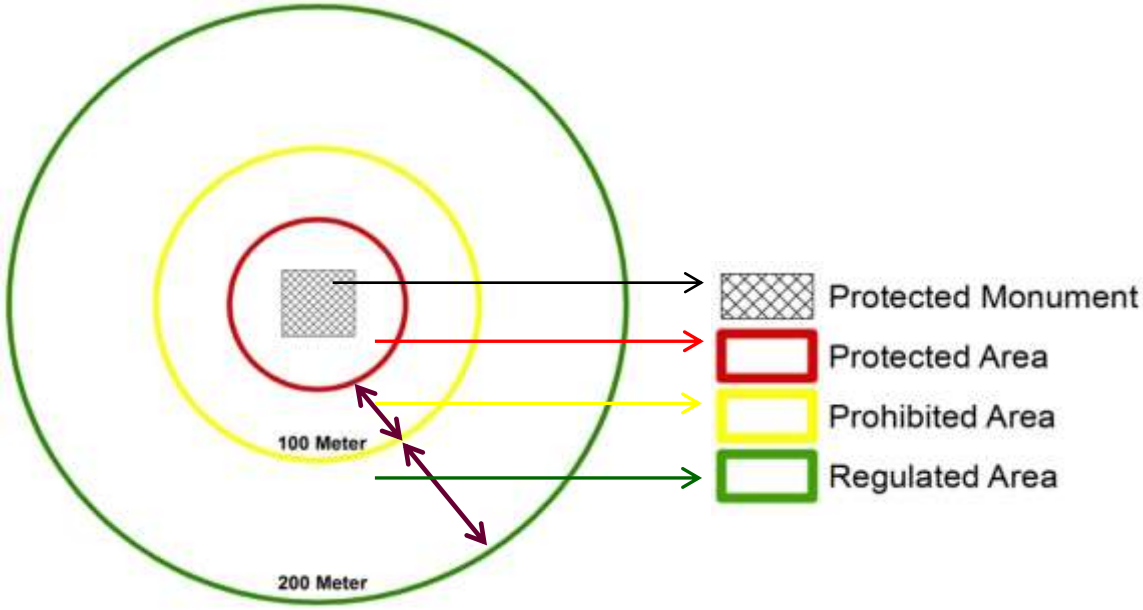
105. This Act empowers the Central and State Governments to establish National Parks and Sanctuaries; to formulate rules and designate authorities for the maintenance of National Parks, Sanctuaries and Zoos; to protect and conserve the flora and fauna. Vide Circular No. 11-9/98-FC dated 4-12-1998 issued by the Asst. Inspector General of Forests states that the Ministry of Environment and Forest has taken a decision not to permit development activities inside National Park/Sanctuaries and Tiger reserves areas that are not in consonance of Section 29 of the Wildlife (Protection) Act, 1972.

8. The Karnataka Preservation of Trees Act, 1976

106. This Act has put restriction on felling of trees in the State unless and until permitted by the Tree Officer. Any person desiring to fell a tree shall apply in writing to the tree officer for permission in that behalf. It further defines clauses for planting adequate number of trees, planting in place of fallen / destroyed trees, preservation of trees and adoption of trees.

9. Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010

107. This Act provides for the preservation of ancient and historical monuments and archaeological sites and remains of national importance and for the regulation of archaeological excavations and for the protection of sculptures, carvings and other like objects. According to this Act, areas within the radii of 100m and 300m from the "Protected Monument" are designated as "Prohibited Areas" and "Controlled / Regulated Areas" respectively.



108. No development activity (including building, mining, excavating, blasting) is permitted in the "prohibited areas". Development activities likely to damage the protected monument are not permitted in the "controlled / regulated areas" without prior permission from the Archaeological Survey of India (ASI) if the site/remains/ monuments are protected by ASI or the State Directorate of Archaeology.

109. None of the notified archaeological monuments recognized by the ASI, UNESCO or World Heritage Monuments intercept with the road improvements.

10. Disposal of Fly Ash Notification 2009 and its amendment on 25th January 2016

110. The main objective of the Fly Ash Notification is to conserve the topsoil, protect the environment and prevent the dumping and disposal of fly ash discharged from coal based power plants. The fly ash notification makes essential the use of fly ash in road construction activities.

111. As per the amendment of the Notification dated 25th January 2016 “No agency, person or organization shall, within a radius of **300 kilometres** of a thermal power plant undertake construction or approve design for construction of roads or flyover embankments with top soils; the guidelines or specifications issued by the Indian Road Congress (IRC) as contained in IRC specification No. SP: 58 of 2001 as amended from time to time regarding use of fly ash shall be followed and any deviation from this direction can only be agreed to on technical reasons if the same is approved by Chief Engineer (Design) or Engineer-in-Chief of the concerned agency or organization or on production of a certificate of "fly ash not available” from the Thermal Power Plant(s).

112. The amendment further states that “The cost of transportation of ash for road construction projects within a radius of 100 km from a coal or lignite based thermal power plant shall be borne by the thermal power plant and the cost of transportation beyond the radius of 100 km and up to 300 km shall be shared equally between the user and the thermal power plant”. The time period to comply with the provisions of the amendment by all concerned authorities is 31st December, 2017.

113. Two coal based thermal power plants namely Bellary Thermal Power Plant and Udupi Thermal Plant are located within 300 km from the proposed project road. Fly ash will be utilized for construction of road embankment as per IRC Guidelines.

11. ADB Safeguard Policy Statement, 2009

114. The Asian Development Bank has defined its Safeguard requirements under its ‘Safeguard Policy Statement 2009 (SPS 2009). The prime objectives of safeguard policy are to: (i) avoid adverse impacts of projects on the environment and affected people, where possible; and (ii) minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible. This policy requires assessment, mitigation and commitment towards environmental protection. The extent of assessment depends on the category of the project. ADB’s SPS 2009 classify a project depending on following three categories.

- **Category A:** A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An Environmental Impact Assessment is required.

- **Category B:** A proposed project is classified as category B if its potential

adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, none or very few of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An Initial Environmental Examination is required.

- **Category C:** A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed

115. The proposed project cause environmental impacts which are less adverse in nature and few of them are reversible and mitigation measures can be designed more readily for the identified impacts. As per the ADB's Safeguard Policy Statement the proposed **Gadag to Honnali** Project corridor having length of **138.168 km** has been classified as **Category 'B'** project requiring Initial Environmental Examination (IEE).

12. Construction and Demolition Waste Management Rules, 29 March, 2016

116. The rules shall apply to everyone who generates construction and demolition waste such as building materials, debris, rubble waste resulting from construction, re-modeling, repair and demolition of any civil structure of individual or organization or authority. This will address the indiscriminate disposal of C&D Waste and enable channelization of the waste for reuse and recycling in gainful manner. Under the Rule, permission for building construction or any other infrastructure activity will not be given unless the waste generators submit specific plans to local authorities on how to dispose the waste.

117. ***Responsibility of Waste Generators***

- Every waste generator shall be responsible for collection, segregation of concrete, soil and others and storage of construction and demolition waste generated separately; deposit at collection centre so made by the local body or handover it to the authorized processing facilities, ensure that there is no littering or deposition so as to prevent obstruction to the traffic or the public or drains.
- Waste generators who generate more than 20 tons or more in one day or 300 tons per project in a month shall submit waste management plan and get appropriate approvals from the local authority before starting construction or demolition or remodeling work, segregate the waste into four streams such as concrete, soil, steel, wood and plastics, bricks and mortar; keep the concerned authorities informed regarding the relevant activities from the planning stage to the implementation stage and this should be on project to project basis.
- Waste generators shall pay relevant charges for collection, transportation, processing and disposal as notified by the concerned authorities;

118. ***Responsibility of Local Authority (LA)***

- LA shall be responsible for proper management of construction and demolition waste within its jurisdiction including placing appropriate containers for collection of waste, removal at regular intervals, transportation to appropriate sites for processing and disposal.

- LA shall seek detailed plan or undertaking as applicable, from generator of construction and demolition waste and sanction the waste management plan; seek assistance from concerned authorities for safe disposal of construction and demolition waste contaminated with industrial hazardous or toxic material or nuclear waste if any;
- LA shall give appropriate incentives to generator for salvaging, processing and or recycling preferably in-situ;
- LA shall establish a data base and update once in a year, device appropriate measures in consultation with expert institutions for management of construction and demolition waste generated including processing facility and for using the recycled products in the best possible manner

119. ***Duties of State Government or Union Territory Administration***

- The Secretary in-charge of development in the State Government or Union territory administration shall prepare their policy with respect to management of construction and demolition of waste within one year from date of final notification of these rules.
- The concerned department in the State Government dealing with land shall be responsible for providing suitable sites for setting up of the storage, processing and recycling facilities for construction and demolition waste.
- The Town and Country planning Department shall incorporate the site in the approved land use plan so that there is no disturbance to the processing facility on a long term basis.
- Procurement of materials made from construction and demolition waste shall be made mandatory to a certain percentage (say 10-20%) in municipal and Government contracts subject to strict quality control.

Table 33: Timeframe for Planning & Implementation

Sl. No.	Compliance Criteria	Cities with population of ≥ 01 million	Cities with population of 0.5-01 million	Cities with population of <0.5 million
1.	Formulation of policy by State Government	12 months	12 months	12 months
2.	Identification of sites for collection and processing facility	18 months	18 months	18 months
3.	Commissioning and implementation of the facility	18 months	24 months	36 months
4.	Monitoring by SPCBs	3 times a year	2 times a year	2 times a year

D. Applicable Indian Road Congress (IRC) Codes

120. Over and above, the project also gives due importance to the road construction standards, norms, guidelines and management procedures prescribed by the Indian Roads Congress (IRC), which includes:

Table 34: Applicable IRC Codes

IRC:SP:108-2015	Guidelines on Preparation and Implementation of EMP
IRC:SP:98-2013	Guidelines for the use of Waste Plastic in Hot Bituminous Mixes
IRC:SP:93-2011	Guidelines on Requirements for Environmental Clearance for

	Road Projects
IRC:104 1988	Guidelines for EIA of Highway Projects
IRC:SP:21:2009	Guidelines on Landscaping and Tree Plantation
IRC:103 1988	Guidelines for Pedestrian Facilities
IRC: SP: 32-1988	Road Safety for Children
IRC: SP: 44-1994	Highway Safety Code
IRC: SP: 55-2001	Guidelines for Safety in Construction Zones
IRC:10:1961	Recommended Practices for Borrowpits for Road Embankments Constructed by Manual Operation
IRC:56-1974	Recommended Practices for Treatment of Embankment Slopes for Erosion Control
IRC:119:2015	Guidelines for Traffic Safety Barriers
IRC:120:2015	Recommended Practice for Recycling of Bituminous Pavement

E. Clearances Required for the Project

121. A summary of various statutory clearances required for the project road is presented in **Table-35**.

Table 35: Statutory Clearances required for the Project Road

Type of Clearance	Name of the Authority	When Required
Forest Clearance	Department of Forest, GoK	Before Construction
Tree Felling Permission	Department of Forest, GoK	Before Construction

122. Apart from the clearances for the overall project work, the contractor, before starting the construction work, has to obtain required Clearances / NOCs listed in **Table-36** for operating his equipment and carrying out construction work.

Table 36: Clearances Required to be obtained by the Contractor

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
1.	Consent for Establishment of Hot Mix Plant, WMM Plant, Stone Crushers and Batching Plant	▪ Karnataka State Pollution Control Board	▪ Air (Prevention and Control of Pollution) Act, 1981 ▪ Water (Prevention and Control of Pollution) Act, 1974 ▪ The Noise Pollution (Regulation and Control) Rules, 2000
2.	Consent for Operation of Hot Mix Plant, WMM Plant, Stone Crushers and Batching Plant		
3.	Permission for withdrawal of groundwater for construction	▪ Central Ground Water Authority ▪ State Ground Water Board	▪ Environment (Protection) Act, 1986 ▪ Ground Water Rules, 2002
4.	Permission for extraction of sand from river bed	▪ Department of Mines & Geology, Government of Karnataka	▪ Environment (Protection) Act, 1986
5.	Permission for extraction of sand from river bed	▪ District Level Environment Impact Assessment ▪ Authority	▪ Environment (Protection) Act, 1986

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
		(DEIAA)	
6.	New Quarry and its operation	▪ Department of Mines & Geology, Government of Karnataka ▪ Karnataka State Pollution Control Board	▪ Environment (Protection) Act, 1986 ▪ Karnataka Minor Mineral Concession Rules, 1994 ▪ The Mines Act. 1952 ▪ Mines and Minerals (Development and Regulation) Amendment Act, 2015 ▪ The Explosive Act, 1984 ▪ Air (Prevention and Control of Pollution) Act, 1981 ▪ Water (Prevention and Control of Pollution) Act, 1974
7.	Opening of New Borrow Areas / Quarry	▪ MoEF&CC / SEIAA / DEIAA ▪ Karnataka State Pollution Control Board ▪ District Collector	▪ Environment (Protection) Act, 1986 ▪ Air (Prevention and Control of Pollution) Act, 1981 ▪ Minor Mineral and Concession Rules, 2015
8.	Location and layout of workers camp, & equipment and storage yards	▪ Karnataka State Pollution Control Board	▪ Environment (Protection) Act, 1986; Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989
9.	Discharges from labour camp	▪ Karnataka State Pollution Control Board	▪ Water (Prevention and Control of Pollution) Act, 1974
10.	Storage, handling and transport of hazardous materials	▪ Karnataka State Pollution Control Board	▪ Hazardous and Other Waste (Management and Trans-boundary Movement) Rules, 2016 ▪ Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989
11.	Disposal of Bituminous Wastes	▪ Intimate local civic body to use local solid waste disposal site	▪ Hazardous and Other Waste (Management and Trans-boundary Movement) Rules, 2016
12.	PUC Certificate for all construction vehicles and all machineries	▪ Transport Department of Govt. of Karnataka	▪ The Motor Vehicle Act 1988 ▪ The Motor Vehicles (Amendment) Bill, 2015 ▪ The Central Motor Vehicles Rules, 1989
13.	Installation of DG Set (Consent to Establish)	▪ Karnataka State Pollution Control Board	▪ Air (Prevention and Control of Pollution) Act, 1981 ▪ The Noise Pollution (Regulation and Control) Rules, 2000
14.	Operation of DG Set (Consent to Operate)		
15.	Engagement of Labour - Labour License	▪ Labour Commissioner (Ministry of Labour and Employment)	▪ The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 ▪ Contract Labour (Regulation and Abolition) Act 1970 along with Rules, 1971
16.	Engagement of Labour - Social Security - Labour Welfare - Wages	▪ Labour Commissioner (Ministry of Labour and Employment)	▪ The Employees' Provident Fund & Miscellaneous Provisions (Amendment) Act, 1996 ▪ The Personal Injuries (Compensation Insurance) Act, 1963

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
			▪ The Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979 ▪ Equal Remuneration Act, 1976 ▪ The Payment of Wages (Amendment) Act, 2005 ▪ The Minimum Wages Act, 1948 ▪ The Minimum Wages (Central) Rules, 1950

123. In addition to the above, Contractor has to obtain:

- Insurance related to 3rd party insurance, Indemnity, Workmen Compensation etc.
- Permission / license to store explosive materials
- Permission from local Panchayat / Municipal body for setting up Construction Camp
- Change of Land Use Certificate from District Land Revenue Officer (DLRO)

F. Administrative Framework

124. The Government through specific legislations regulates the environmental management system in India. The Ministries / Statutory bodies responsible for ensuring environmental compliance by project promoters include following agencies.

1. Ministry of Environment, Forest and Climate Change

125. The Ministry of Environment, Forest and Climate Change is the nodal agency in the administrative structure of the Central Government for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programs. The primary concerns of the Ministry are implementation of policies and programs relating to conservation of the country's natural resources including its lakes and rivers, its biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention and abatement of pollution.

2. Central Pollution Control Board

126. The Central Pollution Control Board (CPCB) basically designs the scheme, procedures and standards to control the water, air & noise pollution, land degradation and hazardous substances and waste management. The executive responsibilities for the industrial pollution prevention and control are primarily executed by the CPCB at the Central level, which is a statutory body. CPCB advise the MoEF&CC on matters concerning prevention, control and abatement of water and air pollution; coordinate the activities of State Pollution Control Boards & provide technical and research assistance; prepare manual, codes, guidelines & standards etc.

3. Karnataka State Pollution Control Board

127. The KSPCB is the government agency responsible for ensuring the compliance to relevant standards related to discharges to the environment. Activities of KSPCB include, planning and execution of State wide program for prevention, control and abatement of water

and air pollution; advise the State Government on prevention, control and abatement of water and air pollution and siting of industries; ensure compliance with the provisions of relevant environmental legislation; establish and review local effluent and emission standards; ensure legal action against defaulters; and develop cost effective methods for treatment, disposal and utilization of effluent.

4. Archaeological Survey of India

128. The Archaeological Survey of India (ASI), has been formed for the archaeological researches and protection of the cultural heritage of the nation. Maintenance of ancient monuments and archaeological sites and remains of national importance is the prime concern of the ASI. It regulates all archaeological activities and development works in and around archeological sites in the country as per the provisions of the Ancient Monuments and Archaeological Sites and Remains Act, 1958 as amended by the Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010 and the rules made there under.

5. National Board for Wildlife

129. The National Board for Wildlife (NBWL) is the apex advisory body in the field of wildlife conservation in the country and is headed by the Prime Minister of India. The NBWL takes decision regarding the impact on wildlife due to road development activities and issues recommendations related to proposed road up-gradation.

IV. DESCRIPTION OF THE ENVIRONMENT

A. Introduction

130. The existing environmental conditions of the study area covering an area spread over 15 km on either side of the road, in general and specific environmental features of the study corridor, i.e., 50 m on either side of the existing centerline of the road, in particular, has been studied as described in the subsequent sections.

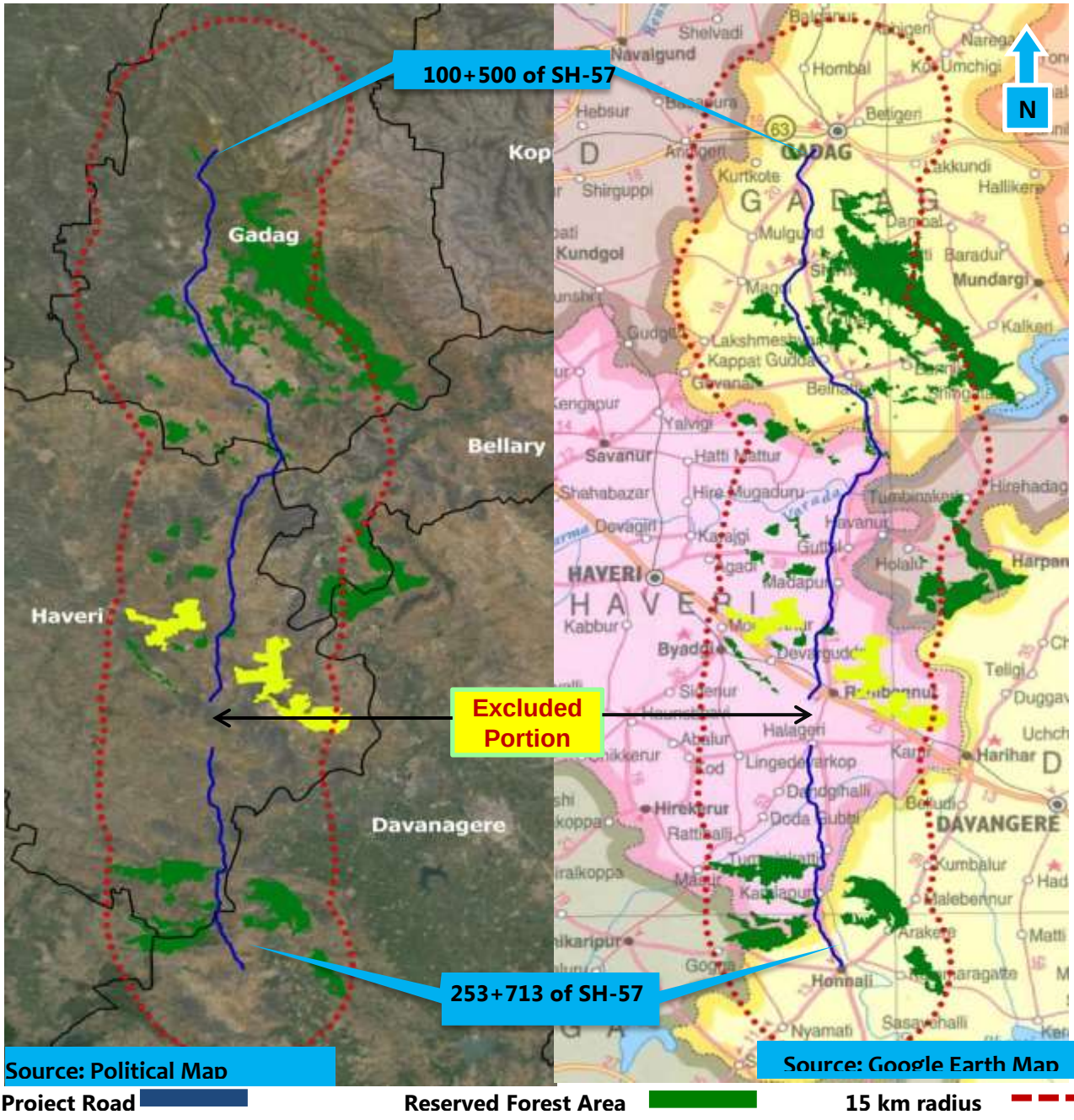


Figure 3: Map showing location of the Project Road

B. Location – Districts En Route

131. The project road starts at Ch. Km 105+500 after Gadag Town and ends at Ch. Km 253+713 near the KSTC Bus terminus at Honali. Approx. 4.275 km (Ch. Km 205+290 to 209+565) in Ranebennur town is excluded in the improvement proposal. Approx. 5.77 km (Ch. Km 209+565 to 215+335) is also excluded from the package as the stretch is being developed by KSRDCL. Therefore, total length of the project road is **138.168 km**. The project road is passing through **Gadag, Haveri and Davangere districts**. The location of the project road is shown on Index Map at **Figure-3.**

C. Geology, Topography & Soil

132. The project road is passing through Gadag, Haveri & Davangere districts. The Gadag district falls in the semi-arid tracts of Karnataka. It lies to the east of the Western Ghats in the rain – shadow region. Hence receives low rainfall and generally drought prone. The area of the district is plain to gently undulating terrain varies in altitude from 508m-740m amsl.

133. Haveri district except, for small part occupied by gneiss, exhibit the schistose formations comprised of greywacke, metasedementaries, meta-volcanics, green-stones, chloriteserecite-schist, etc. These formations are later traversed by various intrusive. The district is generally a gently undulating plain except for the hilly area on the western most part of the district. The Tungabhadra River flowing on the eastern boarder of the district is the only perennial river in the district.

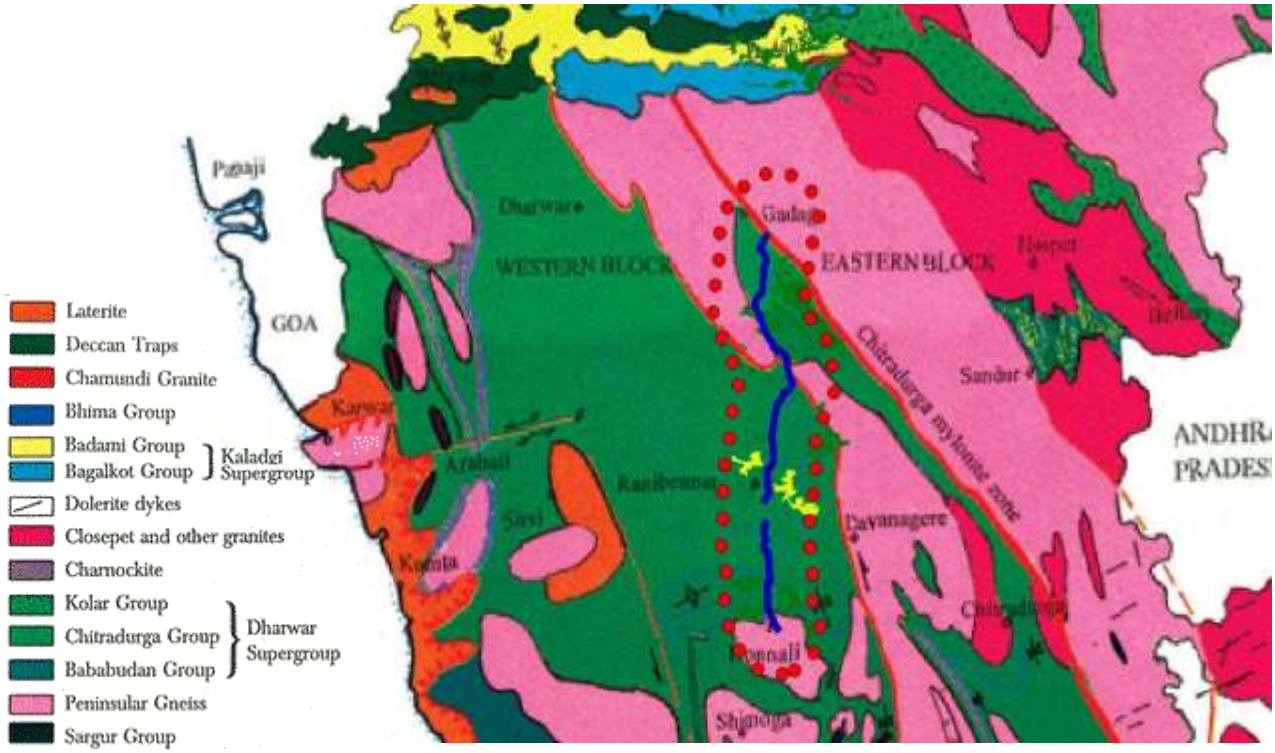


Figure 4: Geological Map of the Study Area

134. Geomorphology of Davangere district is characterized by vast stretches of undulated plains (Honnali, Harihar, Davangere, Channagiri) interspersed with sporadic ranges or isolated clusters of low ranges of rocky hills. The geological map of the area superimposed with the project road alignment is presented in **Figure-4.**

135. The soils of the study area can be classified into different groups as described below:

- Soils in Basaltic terrain: Soils of this type are again classified as shallow, moderate and **deep black cotton soils**. They are usually light black to black in colour and vary in thickness and have high water holding capacity. These soils are fertile but when occupy the low-lying area cause water logging conditions in canal command areas.
- Soils in Limestone terrain: These are dark grey in colour, clayey and calcarious. These have high water holding capacity and low permeability. Low in N and but high in K. When compared to black cotton soil is low in nutrients.
- Soils in Schist and phyllite terrain: These soils are clayey in nature and limited in thickness. They are well drained with moderate permeability and are less fertile.
- Soils in Gneissic terrain: These soils are generally sandy-loam in nature with grayish to pinkish in colour. Moderate in fertility, good water holding capacity and low in permeability.

136. Along the project road in Haveri and Davangere districts, **red sandy soil** is observed to be side by side with medium black soil and deep black soil. The Red Sandy soil comprises of red loams, red sandy, sandy loams and medium black soils.

Red Sandy Soil & Deep Black Soil found side by side along the project

Mixing Zone of Red and Deep Black

D. Seismicity

137. The project area is located in the southern India which is moderately active seismic region. The project road is situated in the Zone II (having low seismic intensity) of the Seismic Map of India (as per IS: 1893, Part I, 2002) and therefore has a low risk of potential damage due to earthquake.

E. Drainage and River System

138. Drainage is controlled by topography. The project area is located in the Tungabhadra Sub-basin system of main Krishna River basin system. All the rivers of the study area together with their distributaries exhibit dendritic pattern. Major drainage channels of the study area comprises of rivers such as Tungabhadra and its tributaries namely Varada and Kumdavati, which forms a part of Tungabhrada sub-basin. Tungabhadra River runs parallel to the project road between Ch. Km 164+000 to 185+000 and again Ch. Km 228+500 to Ch. Km. 253+713.

139. All the drainage channels are north flowing up to Ch. Km. 115+000 (from the start point of the project road) and joins river Malaprabha, which is a major tributary of Krishna River. Thereafter, the flow is primarily oriented towards south and south east. However, a few channels flow westwards in between Ch. Km 115+000 to 128+500 to join tributaries of Ghataprabha river, which confluences with Krishna river at the north of Bagalkote Town.

140. Drainage pattern beyond Belahatti Village (Ch. Km 148+000 approx.) are south bound; all drainage channels join either Tungabhadra directly or its tributary Dodda Halla, which crosses the project road at Ch. Km 158+600. Varada River, a major tributary of Tungabhadra crosses the project road alignment at Ch. Km 168+500 and a large number of channels drain into it. Varada River has its confluence with Tungabhadra only at 1.5 km east of Ch. 168+500.

141. The drainage channels near Guttal and Ranibennur mostly joins east flowing Savala Halla (crosses project road at 199+600) or Bandapura Halla (does not cross project road, runs parallel on left at 4-5 km). Drainage channels beyond Hageri Village (start of project road after the excluded portion) mostly join Kusaguru Halla (crossing with project road at Ch. Km 222+000) and Kumdavati River (crossing with project road at Ch. Km 223+000). Drainage channels beyond Ch. Km 225+000 up to the end of the project road joins Tungabhadra River directly as the river flows close the project road on its left.

F. Agriculture and Irrigation Practices

142. Agriculture is predominant occupation of the people in the area.

143. Red and black soil is found in the region. The major crops grown in the study area are Jawar, groundnut, sunflower, cotton and wheat and other crops like maize, bajara, sorghum, sugarcane, chickpea, tobacco, paddy, ragi, turgram, vegetables (Tomato, Brinjal, Carrot, Cabbage, Potato, Beans, Chillies etc.) are also grown. Normally in command LAND USE areas crops like sugarcane, maize and jawar, wheat, gram, paddy and pulses are grown while in non-command areas sunflower,

Agricultural activity along the Project Road

groundnut, chilies, millet and pulses are grown.

G. Land Use

1. Method of Data Preparation

144. The land use/land cover has been presented in the form of a map prepared by using Survey of India Topographical sheet no. 48M/10, 48M/11, 48M/12, 48N/9, 48N/10, 48N/11 and 48N/12 (1:50000 scale) and satellite images. The map data has been processed using geo-processing software ArcGIS and Erdas Imagine software supported with ground truth verification. Area and distance calculations have been carried out using the software after geo-referencing the interpreted data with the help of the topographical maps. The land use map of the study area covering 15 km on either side in 1:50,000 scales is provided in **Annex 4.1** and a compressed version is 1:100,000 scale is shown in **Figure-6** below. The topographical sheets, as mentioned above, superimposed with the project road alignment and its 15 km radius are provided in **Annex 4.2.**

2. Land use within Corridor of Impact

145. Agriculture is the main land use along the project road. Commercial activities were only noted when alignment passes through settlements however no major industries are noted along project road. The project road passes through various small and big settlements such as Gadag, Chabbi village, Guttal village, Ranebennur, Halageri village, Hallur village and Honnali.

View of the Project Road inside Settlements

146. The land use pattern within 50 m on either side of the project road is agricultural (80.1%) followed by residential cum commercial area (16.1%) and forest (3.8%). Within ROW the land use is mainly open land with trees by the side of the earthen shoulder. There are a good number of wind power mills in the agricultural fields along the project road in between village Nagavi (Ch. Km 112+000) to Shirunj (Ch. Km 121+000).

Wind mills near Nagavi Village along the Project

3. Land Use within the Study Area

147. The land use classification within approximately 15 km area of the project site is summarized in **Table-37** and major land use types are graphically presented in **Figure-5**.

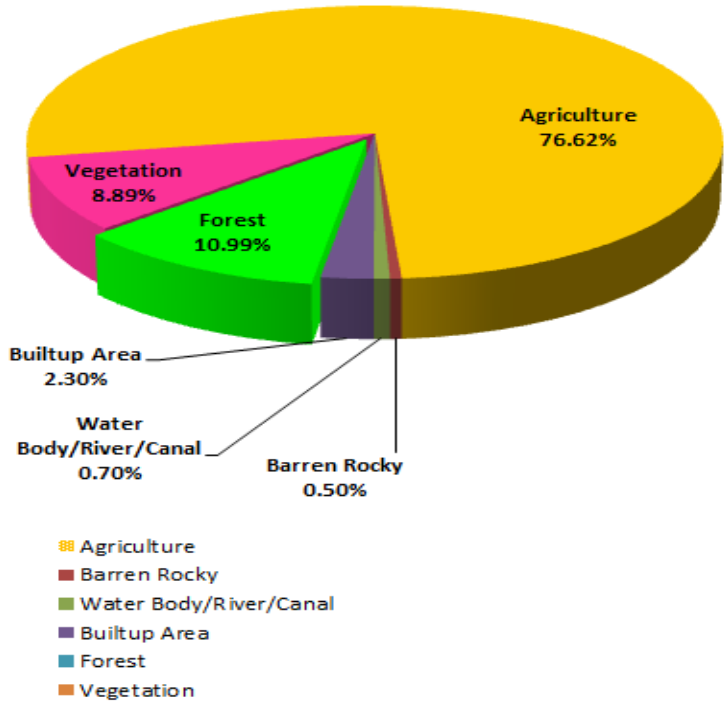


Figure 5: Major Land use types in the study area

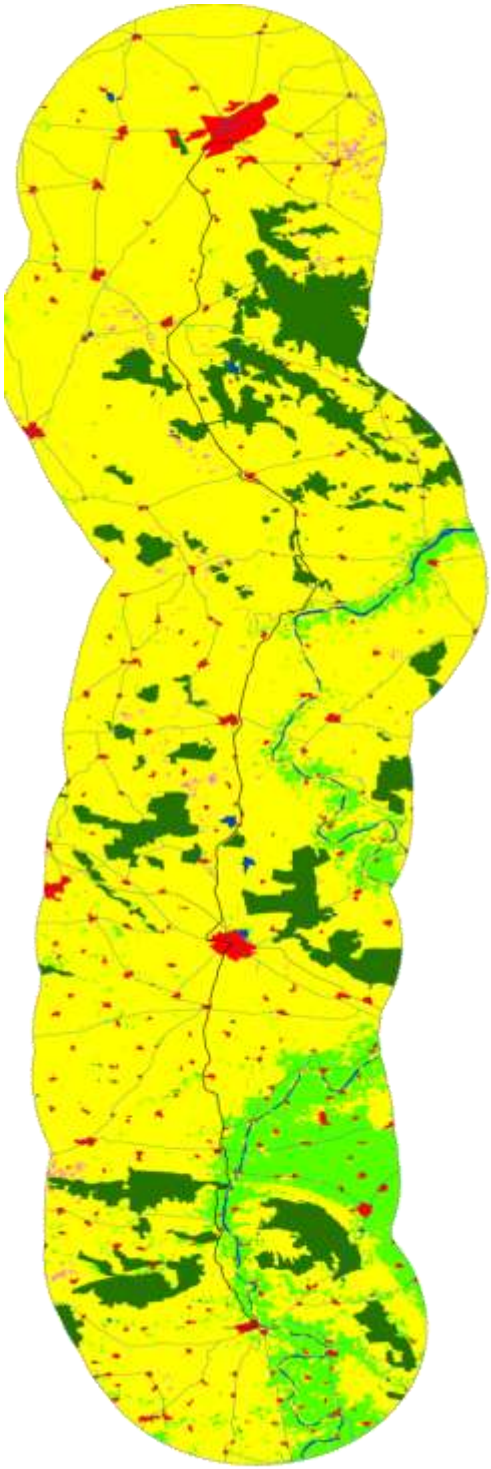


Figure 6: Land Use map of 15 km radius of the project area

148. Majority of the land is under agrarian use (77%), followed by forest (11%) and sparse vegetation (8.9%)

Table 37: Area Statistics of Land Use Map

Land use Classes	Sq. km	Percentage
Agriculture	3762.22	76.7
Barren Rocky	23.50	0.5
Water Body/River/Canal	32.69	0.7
Builtup Area	112.77	2.3
Forest	539.61	11.1
Vegetation	436.73	8.9
Total	**4907**	100.0

Source: Field Survey and interpretation of Satellite Imagery by ICT, December 2015

H. Soil Quality

149. Soil quality is the capacity of the soil to function within the ecosystem boundaries to sustain biological productivity, maintain environmental quality and promote plant and animal growth.

1. Soil Monitoring Stations

150. The physico-chemical characteristics of soils within the study area were examined by obtaining soil samples from selected points and analyzing the same. Details of the sampling stations are provided in **Table-38**

Table 38: Details of Soil Monitoring Stations

SN	Station Code	Place	Chainage (Km)	Side	Distance# (m)	Area category
1	SQ1	Shirunj Village	121+200	RHS	30	Agriculture
2	SQ2	Guttal Village	177+900	LHS	25	Agriculture
3	SQ3	Hallur Village	235+700	LHS	40	Agriculture

Source: Field Survey in December 2015

Distance in meter from existing centerline

151. M/s Mantec Environmental Laboratory (A NABL Accredited & MoEF Recognized laboratory) was engaged for collection and analysis of Soil samples. The samples were collected by ramming a core-cutter into the soil up to a depth of 90 cm. Three (3) sampling locations within the study area were selected for studying soil characteristics.

Photographs of Soil Sampling

2. Soil Characteristics of the Study Area

152. While characterizing soil samples, analytical methods for various parameters have been adopted from M. L. Jackson and SSA series (USA) Volume I and II and applicable IS Codes.

153. The physico-chemical characteristics of the soils in the study area, as obtained from the analysis of the soil samples, are presented in **Table-39** & **Table-40**. The results are compared with standard soil classification**.**

Table 39: Sand, Silt, Clay & Soil Porosity

Sl. No.	Location Code	Sand (%)	Silt (%)	Clay (%)	Porosity (%)	Soil Texture
1	SQ1	65	62	63	65	Sandy Loam
2	SQ2	21	26	24	21	Sandy Loam
3	SQ3	14	12	13	14	Sandy Loam

Source: Field Survey in December 2015

Table 40: Physico-Chemical Characteristics of Soil in the Study Area

SN	Parameters	Unit	Location Code		
			SQ1	SQ2	SQ3
1.	pH	-	7.55	7.7	7.54
2.	Colour		Brown	Brown	Brown
3.	Bulk Density	g/cm^3	1.46	1.43	1.43
4.	Electrical Conductivity	µs/cm	236	244	235
5.	Moisture	%	11	15	16
6.	Potassium as K	mg/100g	0.94	0.86	0.92
7.	Nitrogen as NO3-N	mg/100gm	50	44	46
8.	Phosphorous as P	mg/100gm	92	90	84
9.	Chloride (Cl–)	mg/kg	218	224	230
10.	Sodium	mg/kg	13	15	14
11.	SAR	-	1.2	1.3	1.3
12.	Lead	mg/Kg	6.5	8	7.2
13.	Sodium Sulphate	%	0.08	0.1	0.13
14.	Calcium Sulphate	%	0.007	0.008	0.009
15.	Organic Matter	%	2.5	2.2	2.3
16.	Iron as Fe	ppm	1.46	1.67	1.55
17.	Infiltration Rate	mm/hr.	1.08	0.9	1.05

Source: Field Survey in December 2015

154. It has been observed that the texture of soil is sandy loam with 62-65% sand content and only 12-14% clay content. The pH of the all samples varied between 7.5-7.7, which is slightly above the neutral mark of 7.0, indicating slightly alkaline soil which can hold excess calcium and molybdenum salts and are generally low in iron and boron nutrients. This kind of soil is suitable for growing cereals such as wheat, oat and barley, subject to availability of water while most of the other crops including corn and soybeans require slight pH correction towards the lower rages. The studied pH range also indicates the suitability of the soils for optimum growth of blue green bacteria, which fixes atmospheric nitrogen and also supports growth of other bacteria, Actinomycetes (range 6.5-9.5), which boost the fertility status of the soil.

155. The Electrical conductivity was very low, varies between 235-244 µs/cm, which indicates low salinity status of the soil. This low conductivity values also favors growth of soil microorganisms. Exchangeable potassium, sodium, calcium and magnesium were found to be

low. The organic matter was observed to sufficient and varying in the range of 2.2-2.5%. The sodium absorption ratio is low (1.2 to 1.3%), while the nitrogen content of the soil is sufficient. Thus, it can be inferred that the overall fertility status of the soils within the study area is good.

I. Climate and Meteorology

1. Climatic Conditions of the Study Area

156. The climate of the study area is quite moderate throughout the year with fairly hot summer and cold winter. Gadag & Davangere districts fall under semi-arid tract of the state and rainfall varies between 556 mm to 808 mm. In the study area, December to February month is winter season; in April to May temperature reaches up to 42°C and December and January temperature go down up to 16°C. The standard deviation of rainfall in the district varies from 1.3 to 263.5mm from west to east. South West monsoon is dominant followed by northeast monsoon. Climate of Haveri district is sub-tropical with temperatures ranging in between 18°C and 40°C.

157. Past meteorological data of three nearest IMD Observatories, namely Gadag (2 km) and Shimoga (34 km) deemed to be representative to the study area, has been collected for the period of 1951-1984 to establish the baseline climatic conditions of the area. The key parameters of collected meteorological data have been summarized in **Table-41** below.

Table 41: Summaries of Climatological Data (Based on IMD Records of 1951-80)

		Gadag		Shimoga	
Parameter	**IST**	**Monthly[1]**	**Annual[2]**	**Monthly[1]**	**Annual[2]**
Mean daily max temperature (°C)		28.4 Jul - 37.3 Apr	31.7	27.0 Jul – 35.8 Apr	30.7
Mean daily min temperature (°C)		16.4 Dec - 22.5 Apr	20.0	14.3 Dec - 22.3 May	19.2
Relative humidity (%)	0830	61 Feb - 88 Jul & Aug	76	76 Feb - 88 Jul & Aug	81
	1730	32 Mar - 75 Jul	53	27 Mar - 80 Jul	55
Total rainfall (mm)		1.1 Feb - 134.3 Sep	682.6	1.0 Feb - 254.5 Jul	987.1
Wind speed (km/h)		6.9 Nov -18.8 Jul	11.1	3.4 Oct -6.3 Jun	4.5
Cloud cover (all cloud oktas)	0830	1.5 Feb - 7.3 Jul	4.0	3.3 Jan - 7.2 Jul	5.1
	1730	2.2 Jan - 7.2 Jul	4.8	3.0 Jan - 7.1 Jul	5.0

Source: Climatological Data of Gadag & Shimoga, Indian Meteorological Department
1 Monthly Range; 2 Annual Mean/Total

158. **Temperature.** A semi-arid climate, characterized by typical monsoon, tropical weather with hot summers and mild winters is observed in the study area. Past climatic data show little fluctuation in the temperature of Gadag and Shimoga IMD. April is usually the hottest month with the mean daily maximum temperature at 37°C in Gadag and 36°C in Shimoga, while December is coolest month with mean daily minimum at 16.4°C at Gadag and 15.0°C at Shimoga. In the hot season the temperature sometimes goes above 39°C. With the onset of the monsoon early in June, there is appreciable drop in day temperature but that of night temperature is remains same. In October the temperature decreases. The monthly ambient temperature profile in the study area is presented in **Figure-7**.

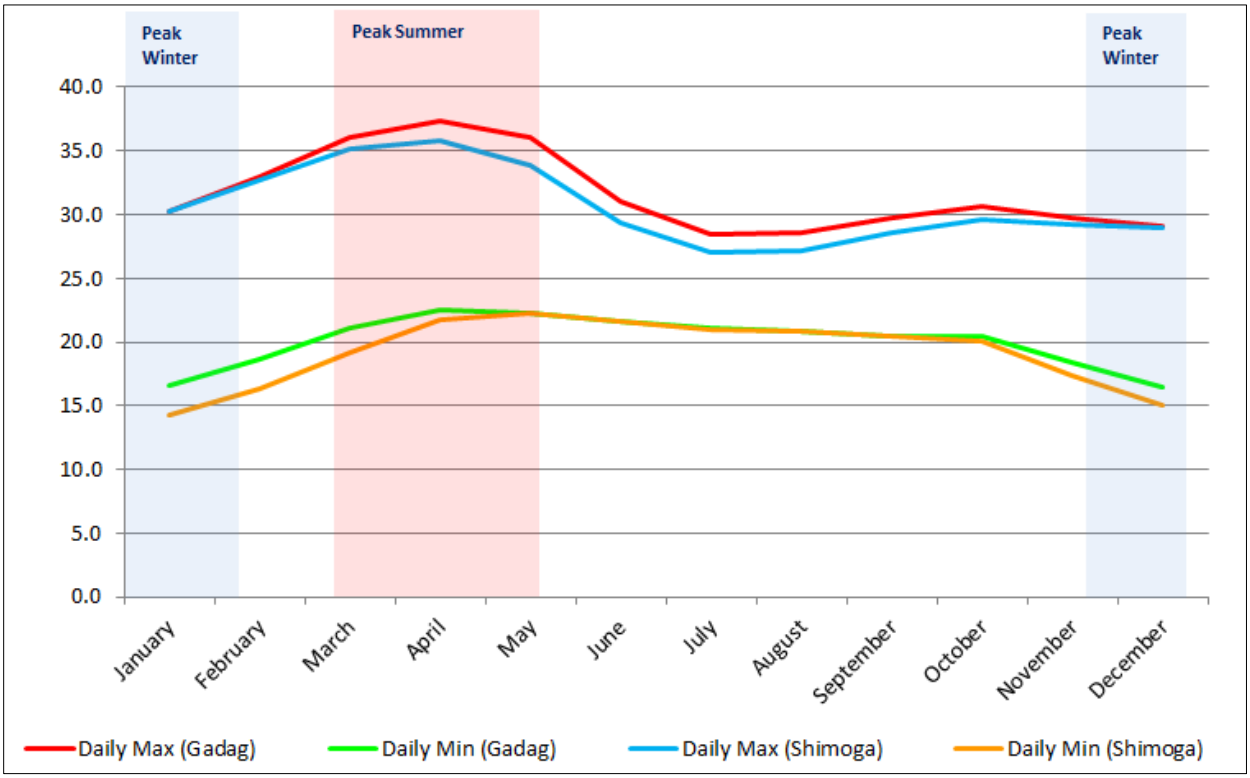


Figure 7: Monthly Ambient Temperature Profile

159. Rainfall & Relative Humidity - **Gadag**: Normal annual rainfall is around 682.6 mm. Historical data shows that moderate rains occur in the month of November due to NE monsoon. The southeast monsoon contributes around 55 percent of the annual rainfall. The North East Monsoon yields around 25 percent and the balance of around 20 percent results from the pre-monsoon and winter.

160. The average monthly rainfall, relative humidity and wind speed data and bar projections denoting incremental frequency and high/low values are provided in **Table 42.** July is the wettest months with 8 days rainy days on average. On seasonal basis dry season rainfall is most inconsistent whereas the monsoon rainfall is least inconsistent. The rainfall profile in the study area is presented in **Figure 8**.

161. **Shimoga**: Normal annual rainfall is around 987.1 mm. Historical data shows that moderate rains occur in the month of November due to NE monsoon. The southeast monsoon contributes around 62 percent of the annual rainfall. The North East Monsoon yields around 21 percent and the balance of around 17 percent results from the pre-monsoon and winter.

162. The average monthly rainfall, relative humidity and wind speed data and bar projections denoting incremental frequency and high/low values are provided in **Table-43.** July is the wettest months with 17 days rainy days on average. On seasonal basis dry season rainfall is most inconsistent whereas the monsoon rainfall is least inconsistent. The rainfall profile in the study area is presented in **Figure-9**.

Table 42: Monthly Rainfall, Wind Speed and Relative Humidity of Gadag

Months	Monthly Rainfall (mm)	No of Rainy Days	Mean Wind Speed (kmph)	Relative Humidity (%)	
				0830 Hours	1730 Hours
January	2.6	0.1	7.1	68	41
February	1.1	0.1	7.1	61	35
March	5.3	0.4	7.7	62	32
April	43.4	3.0	9.6	70	37
May	85.8	5.3	13.4	78	45
June	83.9	5.6	18.1	84	66
July	72.4	7.9	18.8	88	75
August	81.5	6.8	17.2	88	73
September	134.3	7.2	12.8	87	69
October	130.1	6.9	7.6	82	60
November	34.5	1.9	6.9	73	51
December	7.7	0.5	7.3	72	48
Total	**682.6**	**45.7**	**11.1**	**76**	**53**

Source: Climatological Data of Gadag, Indian Meteorological Department

Table 43: Monthly Rainfall, Wind Speed and Relative Humidity of Shimoga

Months	Monthly Rainfall (mm)	No of Rainy Days	Mean Wind Speed (kmph)	Relative Humidity (%)	
				0830 Hours	1730 Hours
January	1.1	0.1	3.8	77	34
February	1.0	0.1	3.7	76	28
March	7.7	0.6	4	77	27
April	53.6	3.8	4.3	76	41
May	103.7	5.7	5.4	77	55
June	123.3	9.5	6.3	83	73
July	254.5	17.1	6	88	80
August	135.4	13.2	4.7	88	79
September	100.9	8.0	4.4	86	73
October	146.9	7.8	3.4	86	67
November	52.4	3.3	4	81	56
December	6.6	0.6	4.3	77	45
Total	**987.1**	**69.8**	**4.5**	**81**	**55**

Source: Climatological Data of Shimoga, Indian Meteorological Department

163. ***Wind Speed***. Average winds speed is high in monsoon south-west monsoon months, while in October & November witness lowest wind speed. The wind speed profile in the study area is presented in **Figure-8 (Gadag) and Figure-9 (Shimoga).**

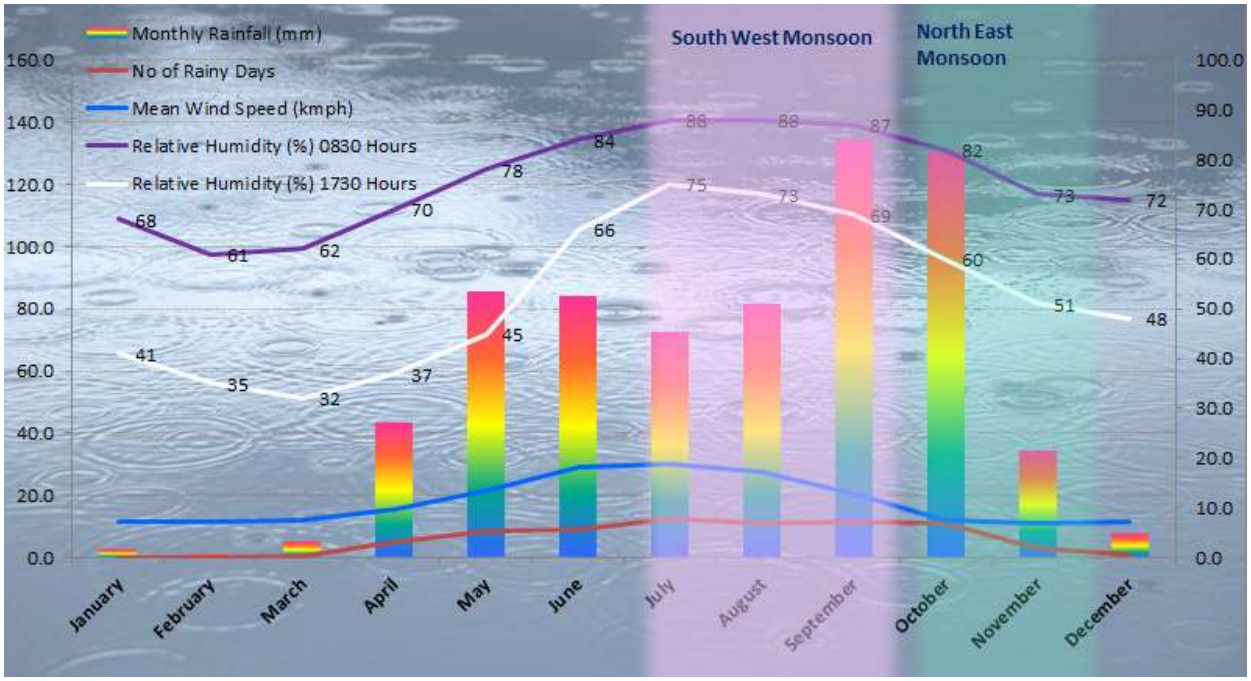


Figure 8: Monthly Rainfall, Rainy Days, Wind Speed and Relative Humidity of Gadag IMD

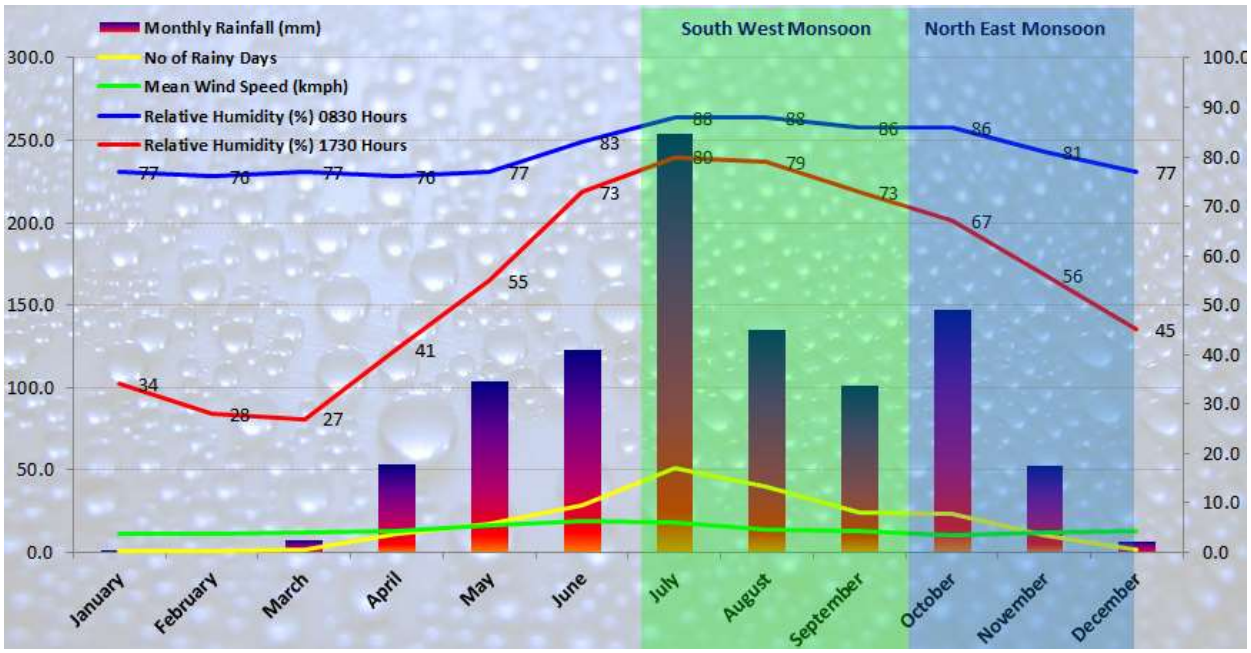


Figure 9: Monthly Rainfall, Rainy Days, Wind Speed and Relative Humidity of Shimoga IMD

164. **Weather Extremes - Gadag:** High summer temperature over 40°C occurs occasionally in the month of April and May. Highest temperature has been recorded to be 41.7°C in April 1939. Moderately low temperatures had been recorded during winter months, the lowest being 10.0°C in December 1975. Thunder storms occur in April-May and also in September-October but dust storm and hails have not been recorded.

165. On an average, the study area received 0.3 mm or more rainfall in 80.1 days in a year. Occurrence of fog in winter is rare. **Table-44** shows the extreme weather data with bar projections denoting incremental frequency.

Table 44: Numbers of days with Extreme Weather Conditions – Gadag IMD

	Weather Phenomena					Visibility#				
Months	**Rain more than 0.3 mm**	**Hail**	**Thunder**	**Fog**	**Dust Strom**	**Up to 1 km**	**1-4 km**	**4-10 km**	**10-20 km**	**Over 20 km**
January	0.2	0.0	0.1	0.0	0.4	0-0	0.1-0	0.5-0	4.2-1.4	26.2-29.6
February	0.3	0.0	0.3	0.0	0.0	0-0	0-0	0.5-0	4.5-0.6	23-27.4
March	0.7	0.0	1.0	0.0	0.0	0-0	0.1-0	0.5-0.1	3.3-1.8	27.1-29.1
April	5.1	0.0	6.6	0.0	0.0	0-0	0-0	0.3-0.5	2.3-3.1	27.4-26.4
May	7.6	0.1	7.5	0.0	0.0	0-0	0-0.1	1-0.6	3.9-3.6	26.1-26.7
June	9.9	0.0	3.6	0.0	0.0	0-0	0.1-0	1.9-1.3	9.2-8.2	18.8-20.5
July	15.8	0.0	0.8	0.0	0.0	0-0	0.1-0	4.1-2.1	13.6-13	13.2-15.9
August	14.2	0.0	1.0	0.0	0.0	0-0	0-0	2.1-1.9	14.4-10	14.5-19.1
September	12.5	0.0	4.6	0.0	0.0	0-0	0.1-0.1	2-1.2	10-7.8	17.9-20.9
October	9.9	0.0	3.2	0.3	0.0	0.1-0	0-0	1.6-1.1	7.3-6.2	22-23.7
November	3	0.0	0.8	0.2	0.1	0-0	0-0	0.7-0.6	4.5-3.2	24.8-26.2
December	0.9	0.0	0.1	0.2	0.0	0-0	0.1-0	0.9-0.4	5-2.5	25-28.1
Annual Mean	**80.1**	0.1	**29.6**	**0.7**	**0.5**	0.1-0	0.6-0.2	16.1-9.8	82.2-61.4	266-293.6

Source: Climatological Data of Gadag, Indian Meteorological Department
Hyphenated values refers to the visibility at 0830 hours and 1730 hours

Table 45: Numbers of days with Extreme Weather Conditions –Shimoga IMD

	Weather Phenomena					Visibility#				
Months	**Rain more than 0.3 mm**	**Hail**	**Thunder**	**Fog**	**Dust Strom**	**Up to 1 km**	**1-4 km**	**4-10 km**	**10-20 km**	**Over 20 km**
January	0.2	0.0	0.0	5.8	0.0	3.7-0	6.7-1.3	8.3-8.5	6.2-4.6	6.1-16.6
February	0.2	0.0	0.1	4.0	0.0	3.5-0	5.6-1	7.3-7.3	5.4-4	6.2-15.7
March	1.2	0.0	0.8	4.6	0.0	2.8-0.1	6.5-2.7	5.6-7.9	6.8-4	9.3-16.3
April	5.3	0.0	3.8	0.2	0.0	0-0.1	5.3-3.1	4-7.2	8.4-4.8	12.3-14.8
May	7.4	0.0	4.3	0.0	0.0	0-0	4.4-1.8	3.9-7.3	8.8-5.8	13.9-16.1
June	14.4	0.0	0.8	0.0	0.0	0.1-0.1	4.6-2.8	6.4-7.7	8.2-7	10.7-12.4
July	21.8	0.0	0.2	0.0	0.0	0.1-0	5.1-4.3	8.8-7.8	8.5-8	8.5-10.9
August	19.9	0.0	0.2	0.0	0.0	0.2-0	4.4-3.8	9-8.1	8.2-6.5	9.2-12.6
September	13.7	0.0	1.4	0.1	0.0	0.1-0	3.5-2	7.7-7.7	8-6.2	10.7-14.1
October	10.4	0.0	1.4	1.4	0.0	1-0	4.2-2.2	7.2-7.5	8.6-5.9	10-15.4
November	4.3	0.0	0.8	2.3	0.0	1.9-0	4.8-1.4	7.3-7.6	7.7-5.3	8.3-15.7
December	1.1	0.0	0.0	5.0	0.0	2.4-0	5.9-2.4	7.3-8.3	6.3-4.1	9.1-16.2
Annual Mean	**99.9**	0.0	**13.8**	**23.4**	**0.0**	15.8-0.3	61-28.8	82.8-92.9	91.1-66.2	114.3-176.8

Source: Climatological Data of Shimoga, Indian Meteorological Department
Hyphenated values refers to the visibility at 0830 hours and 1730 hours

166. **Shimoga:** High summer temperature over 39°C occurs occasionally in the month of April and May. Highest temperature has been recorded to be 39.5°C in April 1973. Low temperatures had been recorded during winter months, the lowest being 6.5°C in January 1975. Thunder storms occur in April-May and occasionally in September-October but dust storm and hails have not been recorded.

167. On an average, the study area received 0.3 mm or more rainfall in 99.9 days in a year. Occurrence of fog in winter is occasional. **Table-45** shows the extreme weather data with bar projections denoting incremental frequency.

2. On-site Meteorological Monitoring

168. An automatic weather station was established at Gadag for collection of meteorological data from 9th December 2015 to 8th January 2016. M/s Mantec Environmental Laboratory (A NABL Accredited & MoEF Recognized laboratory) was engaged for collection of on-site meteorological data. The location details and meteorological monitoring parameters measured through the meteorological station are provided in **Table 46.**

Table 46: Location of Meteorological Station and Monitored Parameters

Parameters	Frequency	Location	Latitude & Longitude
Hourly Wind Speed, Wind Direction, Relative Humidity, Temperature & Rainfall	Hourly data	Gadag	15°25'20.82"N 75°37'2.89"E

Source: Field Survey during Dec 2015 to Jan 16

169. The weather station is equipped with sensors for temperature, relative humidity, wind speed, wind direction, atmospheric pressure, solar radiation and rain fall mounted on a tripod stand. The station consists of a weatherproof enclosure, which contains the data logger & power supply and having a solar panel. The data stored in a pocket-sized data shuttle from where the data downloaded in the computer. After downloading the data has been processed. The daily average of meteorological parameters like temperature, relative humidity, wind speed, wind direction and rain fall is presented in **Annex-4.3** and summarized in **Table-47.**

170. **Meteorological Monitoring Results:** A maximum temperature of 33°C and minimum temperature of 6.1°C was observed during the monitoring period. Daily fluctuations in maximum and minimum temperature are presented graphically in **Figure-10**.

Table 47: Summary of Meteorological Data of the Study Area

Parameters	Dec 2015 – Jan 2016
Maximum Temperature (^{o}C)	33
Minimum Temperature (^{o}C)	6.1
Maximum Relative Humidity (%)	99
Minimum Relative Humidity (%)	7.6
Total Rainfall (mm)	0
Average Wind Speed (m/sec)	2.8
Calm condition	0.00
Predominant wind direction (blowing from)	South-west
Dry hours (%)	100%

Source: On-site Monitoring during Dec15-Jan16

171. The minimum temperature during study period shows a consistent inclining trend from early December to end of December and then starts declining towards January. December is considered as month having lowest night time temperature in the area.

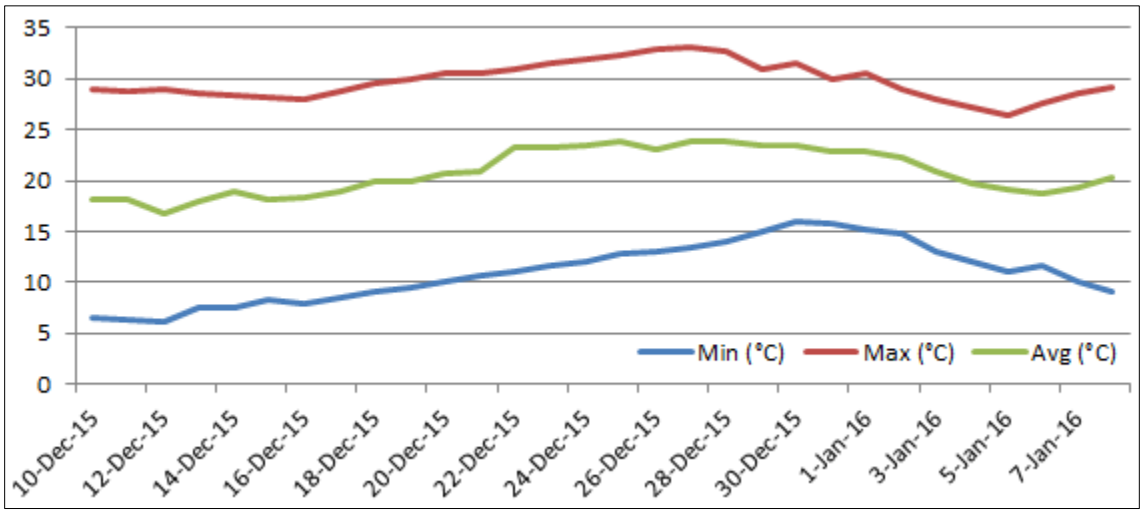


Figure 10: Daily Fluctuation of Ambient Temperature in the Study area

172. Maximum wind speed monitored was found to be 4.5m/sec while the average wind speed was 2.8 m/sec. The wind speeds show a consistent upward trend towards the month of January. The predominant wind direction (blowing from) was North West. Daily fluctuation of wind speed during the monitoring period is shown in **Figure-11**. Maximum Relative humidity during the monitoring period is found to be 99% while the average relative humidity was about 72%. The period was dry; no rainfall has been received during the monitoring period. The wind rose diagram of the study area is presented in **Figure-12**. Predominant wind direction during the monitoring period is observed to be south west (blowing from).

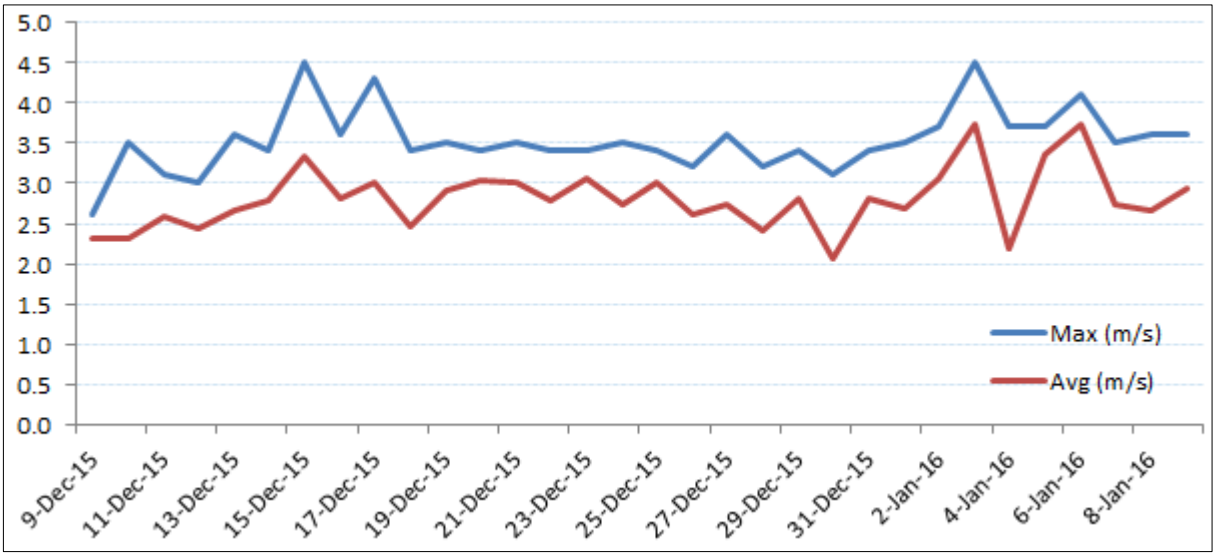


Figure 11: Daily Fluctuation of Wind Speed in the Study Area

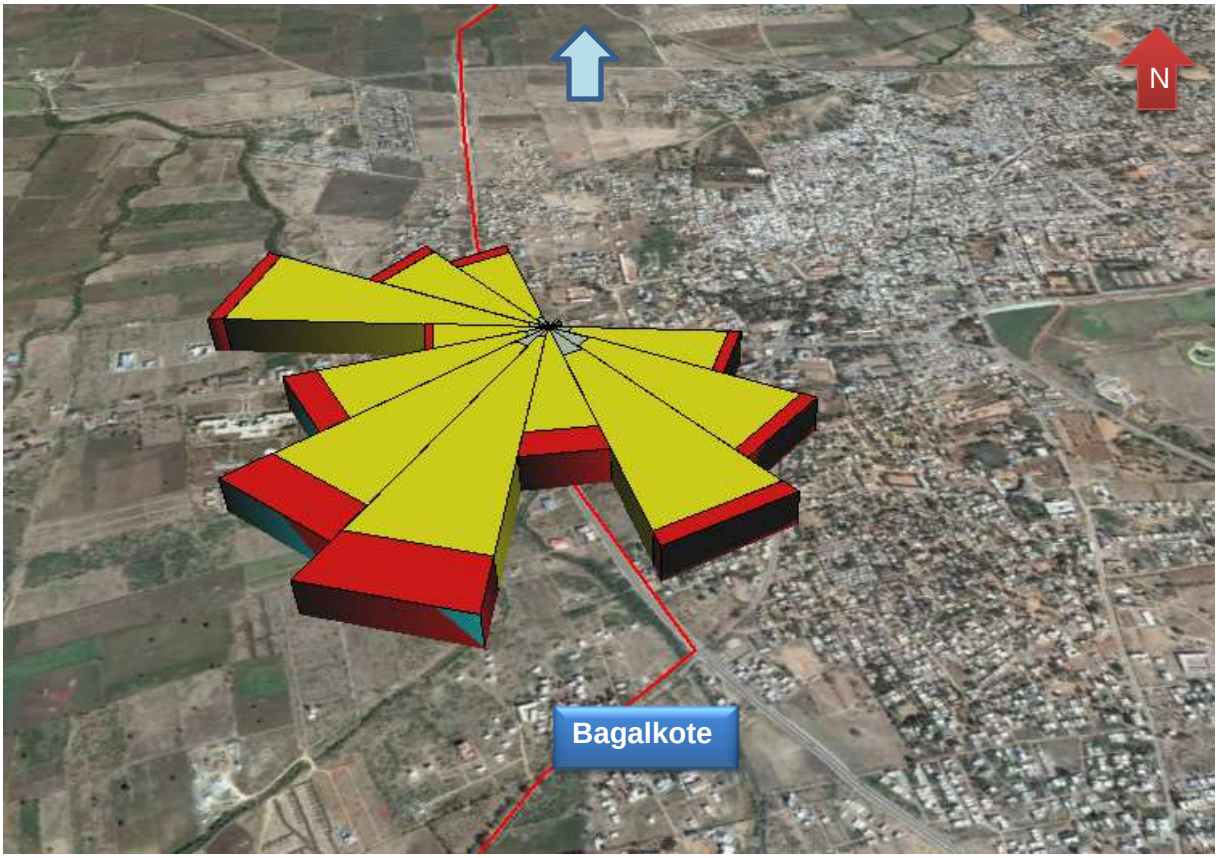


Figure 12: Wind Rose Diagram of the Study Area

J. Ambient Air Quality

1. Ambient Air Quality Monitoring Stations

173. M/s Mantec Environmental Laboratory (A NABL Accredited & MoEF Recognized laboratory) was engaged for ambient air quality monitoring. Eight sampling stations were set up for monitoring ambient air quality within the study area. The locations of the monitoring stations were selected so as to accord an overall idea of the ambient air quality scenario in the study area. Logistic considerations such as accessibility, security, and availability of reliable power supply etc. were considered while finalizing the locations of such stations. The locations of the ambient air quality monitoring stations in the study area are given in **Table-48**

Table 48: Details of Ambient Air Quality Monitoring Stations

SN	Station Code	Place	Existing Ch. Km	Side	Distance# (m)	Area category
1	AQ1	Soratur	126+500	LHS	35	Residential
2	AQ2	Chabbi	137+610	LHS	40	Residential & Agricultural
3	AQ3	Alagilawad	155+600	LHS	38	Residential
4	AQ4	Guttal	189+600	RHS	40	Residential
5	AQ5	Ranebennur	215+300	LHS	45	Residential
6	AQ6	Halageri	225+050	LHS	35	Residential & Agricultural
7	AQ7	Hallur	252+250	LHS	35	Residential & Agricultural
8	AQ8	Honnali	263+650	LHS	25	Residential

Source: On-site Field Monitoring during Dec 15 – Jan 16
Distance in meter from existing centerline

2. Parameters Monitored & Monitoring Period

174. Monitoring was conducted in respect of the following parameters:

- Particulate matter of size less than 2.5 micron or PM2.5
- Particulate matter of size less than 10 micron or PM10
- Sulphur Dioxide (SO2)
- Nitrogen Dioxide (NO2)
- Carbon monoxide (CO)

Air Quality Monitoring at Soratur Village

Air Quality Monitoring at Chabbi Village

175. Ambient air quality monitoring was conducted over one month period (Dec 15-Jan 16) at a frequency of twice a week at each station adopting a 24-hours schedule. CO has been measured 1-hourly. Ambient air quality monitoring methodology has summarized in **Table-49.**

Table 49: Methodology for Ambient Air Quality Monitoring

Parameter	Sampling Frequency	Sampler Name, Model & Make	Measurement Methods
$PM_{2.5}$	24-hourly twice a week	Fine Particulate Sampler Ecotech (AAS127)	Gravimetric
PM_{10}		Respirable Dust Sampler Ecotech (AAS127)	Gravimetric
SO_2			Colorimetric (EPA modified West & Gaeke Method)
NO_2			Colorimetric (Arsenite modified Jacobs & Hochheiser Method)
CO	1-hourly twice a week	-	Non Dispersive Infra Red (NDIR) Spectroscopy Technique

Source: NABL & CPCB Guidelines on Air Quality Analysis

3. Monitoring Results

176. National ambient air quality standards are reproduced in **Annex-3.1**. The detailed on-site twice a week 24-hourly monitoring results of $PM_{2.5}$ PM_{10} SO_2 NO_2 and 1-hourly CO corresponding to air quality stations AQ1 and AQ8 are presented in **Annex-4.4.**

177. ***Particulate Matter of Size less than 2.5 micron or $PM_{2.5}$***

Table 50: Summary of PM2.5 levels in Study Area

Station Code	Station Location	Area Category	$PM_{2.5}$ (µg/m^3)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Soratur	Residential & Rural	9.8-15.8	12.48	15.60	60
AQ2	Chabbi		11.0-18.0	14.75	17.88	
AQ3	Alagilawad		8.4-10.2	9.25	10.16	
AQ4	Guttal		13.0-20.0	16.13	19.86	
AQ5	Ranebennur		10.6-16.4	13.55	16.26	
AQ6	Halageri		9.9-13.5	11.18	13.36	
AQ7	Hallur		9.7-13.8	11.78	13.73	
AQ8	Honnali		10.0-14.0	11.75	13.88	
Overall of 8 locations			**8.4-20.0**	**13.00**	**19.30**	

Source: On-site Field Monitoring during Dec15 – Jan 16

178. Arithmetic mean of the 24-hourly average values of PM2.5 varied station-wise between 8.4-20 µg/m3 with overall mean of the all stations being 13.0 µg/m_3. The 24-hourly average 98-percentile values of PM2.5 (max 19.86 µg/m^3 at AQ4) at all locations were observed to be within the limit of 60 µg/m^3 for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009.

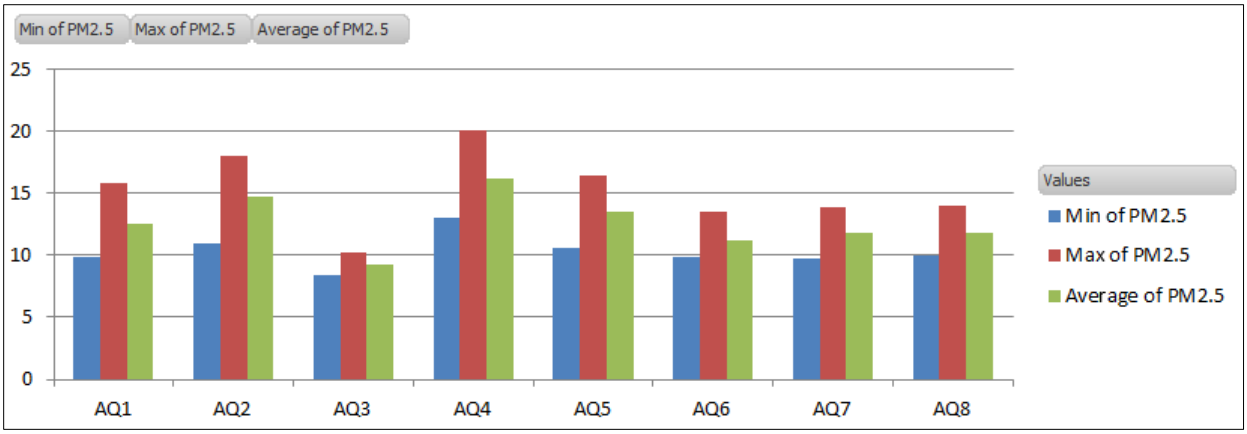


Figure 13: Variation in PM2.5 Levels

179. Particulate Matter of Size less than 10 micron or PM_{10}. Arithmetic mean of the 24-hourly average values of PM_{10} varied station-wise between 34-76 µg/m^3. The overall mean for all stations was 55.83 µg/m^3. The 24-hourly average 98-percentile values of PM_{10} (max 75.64 µg/m^3 at AQ2) at all locations were observed to be within the limit of 100 µg/m^3 for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards.

Table 51: Summary of PM10 levels in Study Area

Station Code	Station Location	Area Category	PM_{10} (µg/m^3)			
			Range	Mean	98% tile	NAAQ Standard
AQ1	Soratur	Residential & Rural	48-56	52.50	55.88	100
AQ2	Chabbi		64-76	69.00	75.64	
AQ3	Alagilawad		36-44	40.00	43.88	
AQ4	Guttal		62-74	68.25	73.72	
AQ5	Ranebennur		58-68	62.00	67.64	
AQ6	Halageri		34-48	42.00	47.88	

Station Code	Station Location	Area Category	PM_{10} (µg/m^3)			
			Range	Mean	98% tile	NAAQ Standard
AQ7	Hallur		43-59	49.75	58.58	
AQ8	Honnali		44-57	50.75	56.70	
Overall of 8 locations			**34-76**	**55.83**	**74.60**	

Source: On-site Field Monitoring during Dec15 – Jan 16

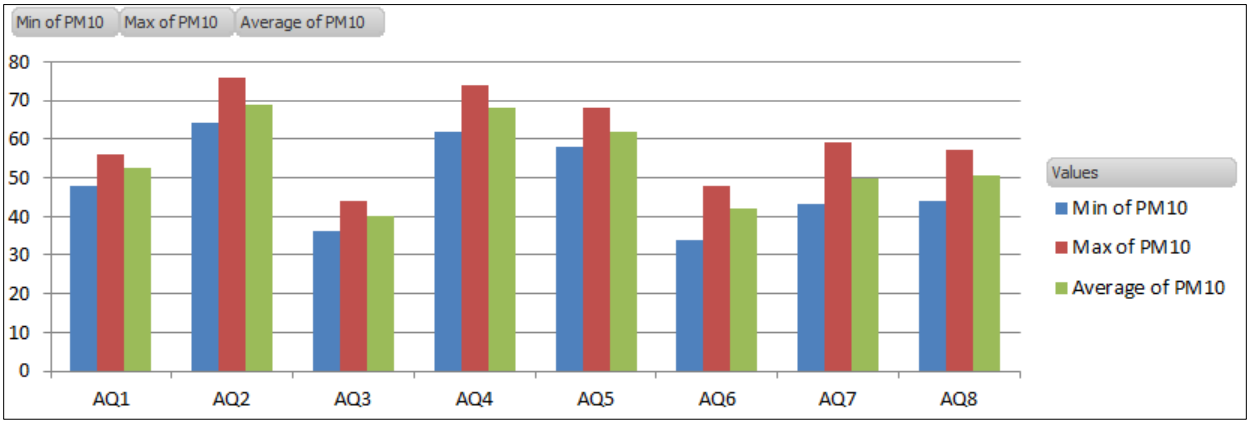


Figure 14: Variation in PM10 Levels

180. ***Sulphur Dioxide (SO_2)***

Table 52: Summary of SO2 levels in Study Area

Station Code	Station Location	Area Category	SO_2 (µg/m^3)			
			Range	Mean	98%tile	Standard
AQ1	Soratur	Residential & Rural	7.2-10.4	8.55	10.32	80
AQ2	Chabbi		7.8-10.6	9.13	10.55	
AQ3	Alagilawad		6.6-8.7	7.43	8.62	
AQ4	Guttal		6.0-8.5	7.34	8.49	
AQ5	Ranebennur		9.8-13.4	11.28	13.30	
AQ6	Halageri		7.9-10.7	9.03	10.61	
AQ7	Hallur		6.2-9.8	7.88	9.75	
AQ8	Honnali		8.6-11.3	9.53	11.19	
Overall of 8 locations			**6.0-13.4**	**8.61**	**12.21**	

Source: On-site Field Monitoring during Dec15 – Jan 16

181. Arithmetic mean of the 24-hourly average values of SO_2 varied station-wise between 6.0-13.4 µg/m^3 with overall mean of the all stations being 8.61 µg/m^3. The 24-hourly average 98-percentile values of SO_2 (max 13.3 µg/m^3 at AQ5) at all locations were observed to be within the limit of 80 µg/m^3 for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009.

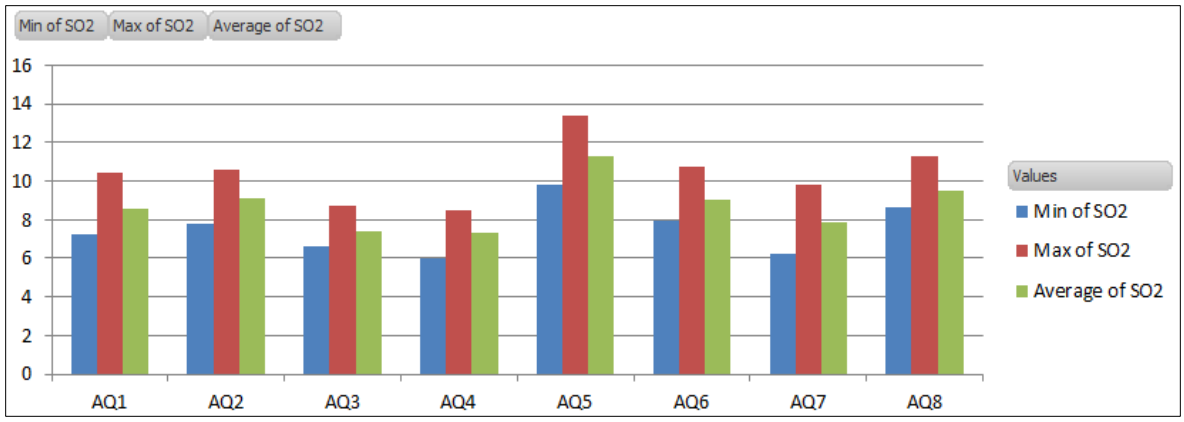


Figure 15: Variation in SO2 Levels

182. ***Nitrogen Dioxide (NO_2)***

Table 53: Summary of NO2 levels in Study Area

Station Code	Station Location	Area Category	NO_2 (µg/m^3)			
			Range	Mean	98%tile	Standard
AQ1	Soratur	Residential & Rural	14-20	17.00	19.88	80
AQ2	Chabbi		20-28	23.50	27.76	
AQ3	Alagilawad		16-24	19.00	23.76	
AQ4	Guttal		16-28	20.88	27.44	
AQ5	Ranebennur		24-32	28.00	31.88	
AQ6	Halageri		12-22	17.50	21.88	
AQ7	Hallur		11-20	15.50	19.82	
AQ8	Honnali		22-30	25.50	29.76	
Overall of 8 locations			**11-32**	**20.86**	**30.60**	

Source: On-site Field Monitoring during Dec15 – Jan 16

183. Arithmetic mean of the 24-hourly average values of NO_2 varied station-wise between 11-32 µg/m^3 with overall mean of the all stations being 20.86 µg/m^3. The 24-hourly average 98-percentile values of NO_2 (31.88 µg/m^3 at AQ5) at all locations were observed to be within the limit of 80 µg/m^3 for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009.

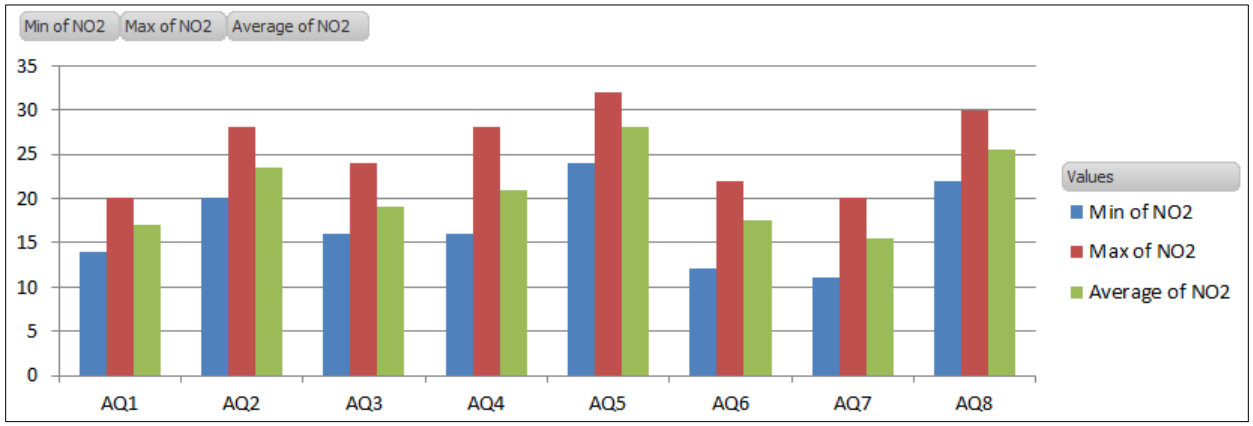


Figure 16: Variation in NO2 Levels

184. ***Carbon monoxide (CO)***

Table 54: Summary of CO levels in Study Area

Station Code	Station Location	Area Category	CO (mg/m^3)			
			Range	Mean	98%tile	Standard
AQ1	Soratur	Residential & Rural	0.04-0.049	0.05	0.05	4
AQ2	Chabbi		0.06-0.068	0.06	0.07	
AQ3	Alagilawad		0.039-0.044	0.04	0.04	
AQ4	Guttal		0.064-0.075	0.07	0.07	
AQ5	Ranebennur		0.039-0.047	0.04	0.05	
AQ6	Halageri		0.03-0.038	0.03	0.04	
AQ7	Hallur		0.033-0.04	0.04	0.04	
AQ8	Honnali		0.032-0.042	0.04	0.04	
Overall of 8 locations			**0.03-0.075**	**0.05**	**0.07**	

Source: On-site Field Monitoring during Dec15 – Jan 16

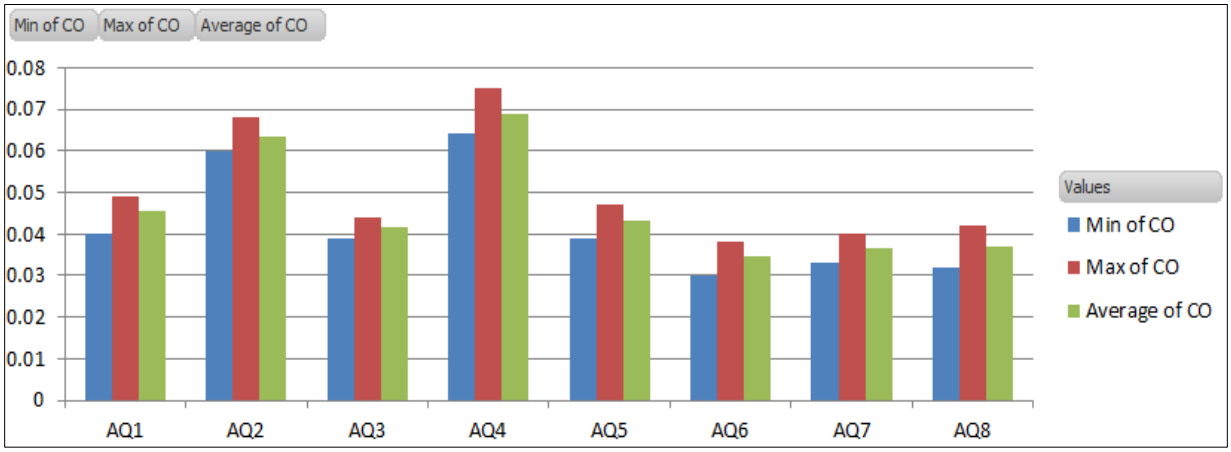


Figure 17: Variation in CO Levels

185. Arithmetic mean of the 24-hourly average values of CO varied station-wise between 0.03-0.075 mg/m^3 with overall mean of the all stations being 0.05 mg/m^3. The 24-hourly average 98-percentile values of CO (max 0.07 mg/m^3 at AQ4) at all locations were observed to be within the limit of 4 mg/m^3 for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009.

186. Monitoring station-wise as well as overall statistical analysis comprising of minimum, maximum, arithmetic mean, standard deviation and 98-percentile of the ambient air quality are shown in **Table-55**.

Table 55: Statistical Analysis of Ambient Air Quality in the Study Area

Pollutant	AAQMS	Location	Mes	Min	Max	SD	p98	PTV^{IND}	PTV^{WB}
$PM_{2.5}$ ($\mu g/m^3$)	AQ1	Soratur	4	9.80	15.80	2.15	15.60	0.0	0.0
	AQ2	Chabbi	4	11.00	18.00	2.59	17.88	0.0	0.0
	AQ3	Alagilawad	4	8.40	10.20	0.67	10.16	0.0	0.0
	AQ4	Guttal	8	13.00	20.00	2.42	19.86	0.0	0.0
	AQ5	Ranebennur	4	10.60	16.40	2.07	16.26	0.0	0.0
	AQ6	Halageri	4	9.90	13.50	1.41	13.36	0.0	0.0
	AQ7	Hallur	4	9.70	13.80	1.56	13.73	0.0	0.0
	AQ8	Honnali	4	10.00	14.00	1.48	13.88	0.0	0.0
	Overall 8 Locations		**36**	**8.40**	**20.00**	**2.94**	**19.30**	**0.0**	**0.0**

Pollutant	AAQMS	Location	Mes	Min	Max	SD	p98	PTV^{IND}	PTV^{WB}
PM_{10} ($\mu g/m^3$)	AQ1	Soratur	4	48.00	56.00	2.96	55.88	0.0	0.0
	AQ2	Chabbi	4	64.00	76.00	4.58	75.64	0.0	0.0
	AQ3	Alagilawad	4	36.00	44.00	3.16	43.88	0.0	0.0
	AQ4	Guttal	8	62.00	74.00	3.80	73.72	0.0	0.0
	AQ5	Ranebennur	4	58.00	68.00	3.74	67.64	0.0	0.0
	AQ6	Halageri	4	34.00	48.00	5.48	47.88	0.0	0.0
	AQ7	Hallur	4	43.00	59.00	6.30	58.58	0.0	0.0
	AQ8	Honnali	4	44.00	57.00	4.66	56.70	0.0	0.0
	Overall 8 Locations		**36**	**34.00**	**76.00**	**11.59**	**74.60**	**0.0**	**0.0**
SO_2 ($\mu g/m^3$)	AQ1	Soratur	4	7.20	10.40	1.26	10.32	0.0	0.0
	AQ2	Chabbi	4	7.80	10.60	1.09	10.55	0.0	0.0
	AQ3	Alagilawad	4	6.60	8.70	0.79	8.62	0.0	0.0
	AQ4	Guttal	8	6.00	8.50	0.88	8.49	0.0	0.0
	AQ5	Ranebennur	4	9.80	13.40	1.42	13.30	0.0	0.0
	AQ6	Halageri	4	7.90	10.70	1.08	10.61	0.0	0.0
	AQ7	Hallur	4	6.20	9.80	1.55	9.75	0.0	0.0
	AQ8	Honnali	4	8.60	11.30	1.07	11.19	0.0	0.0
	Overall 8 Locations		**36**	**6.00**	**13.40**	**1.67**	**12.21**	**0.0**	**0.0**
NO_2 ($\mu g/m^3$)	AQ1	Soratur	4	14.00	20.00	2.24	19.88	0.0	0.0
	AQ2	Chabbi	4	20.00	28.00	2.96	27.76	0.0	0.0
	AQ3	Alagilawad	4	16.00	24.00	3.32	23.76	0.0	0.0
	AQ4	Guttal	8	16.00	28.00	3.72	27.44	0.0	0.0
	AQ5	Ranebennur	4	24.00	32.00	3.16	31.88	0.0	0.0
	AQ6	Halageri	4	12.00	22.00	3.84	21.88	0.0	0.0
	AQ7	Hallur	4	11.00	20.00	3.35	19.82	0.0	0.0
	AQ8	Honnali	4	22.00	30.00	2.96	29.76	0.0	0.0
	Overall 8 Locations		**36**	**11.00**	**32.00**	**5.11**	**30.60**	**0.0**	**0.0**
CO (mg/m^3)	AQ1	Soratur	4	0.04	0.05	0.00	0.05	0.0	0.0
	AQ2	Chabbi	4	0.06	0.07	0.00	0.07	0.0	0.0
	AQ3	Alagilawad	4	0.04	0.04	0.00	0.04	0.0	0.0
	AQ4	Guttal	8	0.06	0.08	0.00	0.07	0.0	0.0
	AQ5	Ranebennur	4	0.04	0.05	0.00	0.05	0.0	0.0
	AQ6	Halageri	4	0.03	0.04	0.00	0.04	0.0	0.0
	AQ7	Hallur	4	0.03	0.04	0.00	0.04	0.0	0.0
	AQ8	Honnali	4	0.03	0.04	0.00	0.04	0.0	0.0
	Overall 8 Locations		**36**	**0.03**	**0.08**	**0.00**	**0.07**	**0.0**	**0.0**

Source: On-site Field Monitoring during Dec15 – Jan 15

AAQMS: Ambient Air Quality Monitoring Station Code, Mes: Number of Measurements, SD: Standard Deviation, p98: 98-Percentile Value, PTV^{IND}: Percent time violation with respect to the Indian standards; PTV^{WB}: Percent time violation with respect to the World Bank Standards

187. As evident from Table 55 and the discussion above, the air quality at the monitored locations are well within the National Standard. No industrial sources of air emission are observed along the project road. The emission sources at the monitored locations appear to be primarily from domestic and local activities.

K. Ambient Noise Level

1. Noise Monitoring Stations

188. To assess the background noise levels in the study area ambient noise monitoring was conducted at six locations. The stations were selected judiciously based on the following considerations:

- Obstruction free exposure of equipment
- Away from temporary noise generating sources to monitor true background levels
- Accessibility of the location during day and night
- Security and safety of the instrument

189. M/s Mantec Environmental Laboratory (A NABL Accredited & MoEF Recognized laboratory) was engaged for ambient noise monitoring. The locations of the ambient noise level monitoring stations in the study area are given in **Table-56.**

Table 56: Details of Noise Monitoring Stations

SN	Station Code	Place	Chainage (Km)	Side	Distance# (m)	Area category
1	NQ1	Chabbi Village (Govt. Primary School)	135+200	LHS	45	Silence
2	NQ2	Kerimalpur	190+850	LHS	18	Residential
3	NQ3	Ranebeenur	208+530	RHS	40	Residential
4	NQ4	Halagiri Village (Sri Sai Public School)	215+500	RHS	37	Silence
5	NQ5	Hallur Village (Ranganatha Swami PU College)	240+600	LHS	30	Silence
6	NQ6	Honnali Town (Swami Vivekananda School)	252+350	LHS	23	Silence

Source: On-site Noise Monitoring during December 2015

Distance in meter from existing centerline

2. Methodology of Noise Monitoring

190. Ambient noise level or sound pressure levels (SPL) are measured by a continuous sound level meter having built in facilities to read noise level directly in dB(A). Since loudness of sound is important for its effects on people, the dependence of loudness upon frequency is taken into account by the A-weighting filters in-built in the noise meter which gives a direct reading of approximate loudness.

191. A-weighted equivalent continuous sound pressure level (Leq) values were computed from the values of A-weighted SPL measured with the noise meter. Noise measurement was conducted as per IS:4954 as adopted by CPCB. Ambient noise level monitoring was carried out during December 2015.

3. Ambient Noise Levels in the Study Area

192. The ambient noise levels of the study area are presented in **Table-57**. Ambient air quality standards in respect of noise are reproduced in **Annex-3.1**.

Table 57: Ambient Noise Levels of the Study Area

Station	Zone	L_{d10}	L_{d90}	L_{deq}	L_{n10}	L_{n90}	L_{neq}	L_{dn}	$L_{eq(24)}$	L_{Min}	L_{Max}
NQ1	Silence	66.7	63.6	64.1	63.1	60.5	61.8	62.9	65.1	60.1	67.4
NQ2	Resi	66.5	63.2	64.5	62.2	58.3	62.0	63.4	64.5	57.6	69.4
NQ3	Resi	**68.4**	63.8	65.8	63.5	62.1	62.9	64.7	**66.2**	61.5	68.4
NQ4	Silence	58.9	55.6	57.7	54.8	52.7	53.6	56.6	57.1	52.6	59.1
NQ5	Silence	68.0	62.3	64.0	61.1	58.1	60.8	62.9	64.2	53.7	68.1
NQ6	Silence	**68.3**	64.1	65.5	63.5	62.0	63.2	64.3	**65.8**	61.9	68.8

Source: On-site Noise Monitoring during December 2015

Note: Noise Standard in Residential Zone : Day Time: 55 dB(A) Night Time: 45 dB(A)
Noise Standard in Silence Zone : Day Time: 50 dB(A) Night Time: 40 dB(A)

193. The daytime and night time noise equivalent levels in the residential & silence areas show that the ambient noise levels exceeds the stipulated of Noise standards. Highest equivalent noise level observed in residential and silence zone in day time is 66.2 dB(A) and 65.8 dB(A) respectively.

194. Ld10 values (highest among the monitored values) are found to be 68.4 dB(A) and 68.30 dB(A) for residential and silence zone respectively, which signifies that measured noise levels exceeded these values in only 10% of the time of measurement duration. The noise levels were recorded sufficiently away from the project road to avoid influence of traffic induced noise. Therefore, it can be inferred that the moderately high noise levels at monitoring locations originates from local activities including domestic.

L. Surface Water Bodies, Rivers and Wate Quality

195. The project road crosses a number of rivers, canals and causeways en-route, which has been detailed in **Table-58**. There are good number of water bodies located along the project road, many of which gets filled up during the rainy seasons and act as a natural rainwater store. Photographs of two water bodies along with their location details (chainage & side) are provided below. List of water bodies, their location details along with the distances from the existing centerline as well as length along the project road are provided in **Table-59.**

Pond at Ch. Km 144+600 on

Pond at Ch. Km 150+900 on

Table 58: List of River, Canal and Causeway Crossings En-route

SN	Description	Village	Existing Ch. km	Design Ch. Km
River Crossing				
1.	Dodda Halla	Tangada	160+750	158+600
2.	Varada River	Guyilagundi	179+000	168+200
3.	Savala River	Guddadavaveri	210+500	199+500
4.	Hire Halla*	Halageri	223+280	213+870
5.	Kusaguru Halla	Godihal	231+250	221+750
6.	Kumadvati River	Kuppelur	232+220	222+700
Canal / Stream / Causeway Crossing				
7.	Canal Crossing	Soratur	126+800	125+350
8.	Canal Crossing	Shirahatti	129+400	128+300
9.	Canal Crossing	Devihal	146+400	144+250
10.	Canal Crossing	Belahatti	150+700	148+850
11.	Canal Crossing	Tangad	159+450	157+300
12.	Canal Crossing	Tangad	160+700	158+600
13.	Canal Crossing	Mevundi	173+000	166+700
14.	Canal Crossing	Gullagundi	178+900	168+200
15.	Canal Crossing	Guttal	188+200	178+100
16.	Canal Crossing	Timmapur	195+300	184+700
17.	Canal Crossing	Nukapur	196+900	186+300
18.	Canal Crossing	Kerimallapur	202+800	191+890
19.	Canal Crossing	Devargudda	205+900	195+000
20.	Canal Crossing	Devargudda	209+000	198+000
21.	Canal Crossing	Guddada Anveri	210+500	199+500
22.	Canal Crossing	Guddada Anveri	211+300	200+300
23.	Canal Crossing	Halageri	225+450	216+000
24.	Canal Crossing	Kuppelur	231+200	221+700
25.	Canal Crossing	Kuppelur	232+200	222+700
26.	Canal Crossing	Sanna Sangapura	235+350	225+550
27.	Canal Crossing	Tuminakotte	243+420	235+200
28.	Canal Crossing	Hallur	252+900	242+500
29.	Canal Crossing	Balamuri	259+540	249+100
30.	Canal Crossing	Balamuri	260+670	249+970

Source: Field Survey conducted by ICT Pvt. Ltd.

* River located in the excluded portion

Table 59: Lists of Water Bodies along the Project Road

SN	Particular	Existing Ch. km	Design Ch. Km	Distance[1] (m)	Side	Village	Use of Water	Length[2] (m)
1	Road Side Ditch	111+100	110+660	14.39	Left	Mallasamudra	Irrigation	44.0
2	Pond	133+300	131+500	280.80	Right	Shirahatti	Irrigation	*
3	Road Side Ditch	138+300	136+535	6.42	Right	Chabbi	No Use	16.0
4	Water Storage Area	142+800	141+030	8.96	Left	Devihala	Irrigation	20.0
5	Pond	144+000	142+225	34.72	Right	Devihala	Irrigation, Livestock watering	70.0
6	Pond	144+600	142+800	10.31	Right	Devihala	Irrigation, Domestic except drinking	116.0
7	Rain Water Storage for Irrigation	145+850	144+050	71.63	Left	Devihala	Irrigation	*
8	Pond	148+000	146+200	279.80	Right	Bellatti	Irrigation,	*

S N	Particular	Existing Ch. km	Design Ch. Km	Distance[1] (m)	Side	Village	Use of Water	Length[2] (m)
							Domestic except drinking	
9	Pond	148+500	-	181.56	Left	Bellatti	Domestic except drinking	#
10	Road Side Ditch	150+275	-	5.77	Left	Narayanapura	No Use	#
11	Pond	150+900	149+400	7.09	Left	Narayanapura	Irrigation	117.0
12	Pond	156+050	154+582	14.28	Right	Algilwada	Irrigation	90.0
13	Pond	184+600	174+500	12.31	Left	Guttal	Irrigation	55.0
14	Pond	189+550	-	9.71	Right	Guttal	Domestic except drinking, Livestock Watering	#
15	Pond	190+800	-	5.52	Left	Guttal	Domestic except drinking, Irrigation	#
16	Pond	200+000	-	9.38	Right	Honnatti	Irrigation	#
17	Lake	201+800	191+000	386.65	Right	Keri Mallapura	Irrigation	*
18	Road side Ditch	203+030	192+125	5.69	Left	Keri Mallapura	No Use	20.0
19	Pond	208+440	197+500	15.56	Right	Guddada Anveri	Irrigation	30.0
20	Pond	213+750	-	39.66	Left	Ranebennur	Irrigation	#
21	Pond	215+850	-	10.85	Right	Ranebennur	Domestic except drinking, Irrigation	#
22	Road side Ditch	225+750	216+300	15.64	Right	Halageri	No Use	10.0
23	Road Side Ditch	233+375	223+850	12.00	Right	Kasaba Kuppellur	Livestock Watering	30.0
24	Pond	236+930	227+115	12.88	Left	Sanna Sangapura	Irrigation	20.0
25	Road Side Ditch	251+210	240+850	16.22	Right	Hallur	No Use	5.0
26	Road Side Ditch	251+410	241+050	17.00	Right	Hallur	Livestock Watering	30.0
							Total	**673.0**

Source: Field Survey conducted by ICT Pvt. Ltd.

1 Distance in meter from existing centerline; 2 Length in meter of the Water Bodies along the Project Road

* Not located adjacent to the project road; # realignment / bypass

1. Surface Water Quality Monitoring Stations

196. Surface water bodies are important in local context and therefore, their water quality needs to be monitored to assess the impacts of the project. M/s Mantec Environmental Laboratory (A NABL Accredited & MoEF Recognized laboratory) was engaged for collection of surface water samples and analysis. For generating data on surface water quality parameters and drawing up the baseline scenario, **6 surface water quality monitoring stations** were selected for sampling. Details of the location of Surface Water Quality Stations are provided in **Table-60.**

Table 60: Details of Surface Water Quality Monitoring Stations

S N	Station Code	Place	Existing Ch. Km	Side	Distance# (m)	Usage
1	SW1	Pond - Devilhal Village	144+600	RHS	10.3	Irrigation & Live Stock
2	SW2	Varada River	179+000	RHS	25	Irrigation
3	SW3	Pond - Guttal Village	190+800	LHS	5.5	Irrigation & Live Stock
4	SW4	Canal Crossing - Guddad Anveri Village	211+300	LHS	14	Irrigation

S N	Station Code	Place	Existing Ch. Km	Side	Distance# (m)	Usage
5	SW5	Kumadvati River	232+220	LHS	15	Irrigation
6	SW6	Tungabhadra River	245+900	LHS	110	Irrigation & Live Stock

Distance in meter from existing centerline

* 50 m from centerline of the bridge on upstream direction

Source: On-site Water Quality Monitoring in December 2015

Photographs of Surface Water Sampling

197. Water samples (grab samples) were collected once in the month of December 2015 from these stations and analyzed for physical, chemical and bacteriological parameters as per established standard methods and procedures. All the basic precautions and care were taken during the sampling to avoid contamination. Analysis of the samples was carried out as per established standard methods and procedures prescribed by the CPCB, e.g. relevant IS Codes (IS:2488 (Part-1 to 5) "Methods for Sampling and Testing of Industrial Effluents"), and "Standard Methods for Examination of Water and Wastewater" published by APHA.

2. Surface Water Quality in the Study Area

198. The salient water quality parameters are statistically analyzed and presented **Table-61** depicting minimum, maximum, arithmetic mean and standard deviation. The percent time violations (PTV) i.e. the percentages of time the water quality parameters violate the permissible standards are also depicted therein.

Table 61: Salient Surface Water Quality Features

SN	Parameter	Range	AM	SD	PTV
1.	pH	7.52-8.22	7.9	0.28	0
2.	DO (mg/l)	5.5-6.3	5.9	0.28	50
3.	BOD (3 days at 27°C) (mg/l)	6-22	10.7	5.28	100
4.	TDS (mg/l)	180-1028	559.0	316.07	50
5.	Total hardness (mg/l as $CaCO_3$)	82-454	257.2	138.55	33
6.	Nitrate nitrogen (mg/l as NO_3)	1.4-11.4	6.5	3.64	0
7.	Iron (mg/l as Fe)	0.055-0.11	0.1	0.02	0
8.	Fluoride (mg/l as F)	0.31-0.74	0.5	0.16	0

Source: On-site Water Quality Monitoring in December 2015

AM- Arithmetic mean, SD- Standard deviation, BDL- Below detection limit, PTV- Percent time violations over permissible limits* (maximum) stipulated for Inland Surface Waters (Class D) i.e. fish culture and wildlife propagation (IS:2296).

199. Temperature remained around 25.0°C in all samples. pH values were above the neutral mark (7.52-8.2) which were within the tolerance limit of 6.5-8.5. The slight alkalinity of the surface water may be associated with predominantly alkaline soil of the region. Conductivity varied between 277-1582 μmhos/cm with TDS ranging between 180-1028 mg/l. Such low values of conductivity and TDS in all samples except SW3 (Pond at Guttal Village) indicate that the water is marginally mineralized and devoid of any industrial discharges. However, the river water is found to be more mineralized than the pond water, possibly because of the characteristics of its runoff received from a larger area.

200. Dissolved oxygen levels are found to be in the range of 5.5-6.3 mg/l, which is slightly lower than the Class A(6.0 mg/l) but higher than Class D (4.0 mg/l) Surface water quality standards. Except SW3, BOD ranges from 6-10 mg/l while COD ranges are found be 18-32 mg/l. Such moderate values of BOD and COD signifies presence of decomposable and oxidizeable organic matter in the water resulting increase of oxygen demand and thereby, lowering of dissolved oxygen levels. However, in SW3, both BOD and COD levels are found to be very high. Total hardness values were observed to vary in the range of 80-454 mg/l. It has been observed that the pond water at Guttal Village (SW3) and Kumavati river (SW5) exceed the prescribed total hardness limit of 300 mg/l for Class A surface water. Oil & grease and nitrates remain undetected in all samples.

201. Chloride and sulphate contents were 25-391 mg/l and 17.4-77.0 mg/l respectively. While calcium content varied between 26-246 mg/l, magnesium ranged between 56-368 mg/l. Levels of iron was 0.05-0.11 while arsenic, chromium, cadmium, copper, manganese, zinc and mercury are found to be low detectable limit. All of the samples are found to be high in total and fecal coliforms and therefore not suitable for human use in any manner. Details of water quality monitoring results of the surface water bodies and rivers are presented in **Table-62.**

Table 62: Surface Water Quality Analysis Results

SN	***Parameters***	***Units***	***SW1***	***SW2***	***SW3***	***SW4***	***SW5***	***SW6***	***Limits#***
1.	pH	-	7.55	7.97	8.22	8.04	8.19	7.52	6.5-8.5
2.	Temperature	^{O}C	25	25	25	25	25	25	---
3.	Conductivity	μmhos/cm	549	849	1582	277	1424	481	---
4.	Colour	Hazen	<5	<5	<5	<5	<5	<5	10
5.	Turbidity	NTU	3.4	3.6	4.1	1.9	4.5	2.9	---
6.	Total Hardness as $CaCO_3$	mg/l	130	259	454	82	419	199	300
7.	Total Dissolved Solids	mg/l	357	552	1028	180	925	312	500
8.	Total Suspended Solids	mg/l	15	13	20	8	21	14	---
9.	Sodium as Na	mg/l	45	49	120	15	93	9	---
10.	Potasium as K	mg/l	4	4	9	3	8	1	---
11.	Calcium as $CaCO_3$	mg/l	69	151	86	26	246	69	200
12.	Magnesium as $CaCO_3$	mg/l	61	108	368	56	173	130	100
13.	Dissolved Oxygen	mg/l	5.7	6.3	5.5	5.8	6.2	6	6
14.	COD	mg/l	32	20	68	26	28	18	---
15.	BOD 3 days at 27^{o}C	mg/l	10	7	22	9	10	6	2
16.	Chloride as Cl	mg/l	51	110	391	25	253	55	250
17.	Sulphate as SO_4	mg/l	17.4	62.5	47.2	19.8	77	37.8	400
18.	TKN as N	mg/l	4.6	10.8	8.3	1.7	12.1	4	---
19.	Nitrate as NO_3	mg/l	4.2	10.2	7.9	1.4	11.4	3.6	20

SN	*Parameters*	*Units*	*SW1*	*SW2*	*SW3*	*SW4*	*SW5*	*SW6*	*Limits#*
20.	Iron as Fe	mg/l	0.055	0.075	0.11	ND	0.092	0.064	0.3
21.	Manganese as Mn	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.5
22.	Cadmium as Cd	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
23.	Total Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
24.	Total Chromium as Cr	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
25.	Copper as Cu	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.5
26.	Mercury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
27.	Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
28.	Zinc as Zn	mg/l	0.13	0.15	0.34	ND	0.25	0.12	15
29.	Boron as B	mg/l	0.26	0.25	0.34	0.23	0.23	0.22	---
30.	Fluoride as F	mg/l	0.42	0.63	0.74	0.39	0.66	0.31	1.5
31.	Chlorine	mg/l	0.17	ND	0.18	0.24	ND	ND	---
32.	Phenolic Compound	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002
33.	Surfactants	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	---
34.	Phosphate as PO_4	mg/l	0.07	0.18	0.12	0.05	0.19	0.07	---
35.	SAR	mg/l	1.71	1.32	2.44	0.72	1.97	0.28	---
36.	Total Coliform	MPN/100ml	850	1080	2500	560	1200	940	50
37.	Fecal Coliform	MPN/100ml	110	160	320	80	180	130	---

Source: On-site Water Quality Monitoring in December 2015

 # Tolerance Limit as per IS:2296 (Class-A)

202. The water quality results shows the surface waters in the study area are devoid of any extraneous chemical contamination; no toxic or organic constituents are detected in samples. However, all the samples have high coliform count, high BOD levels and low dissolved oxygen indicates discharge of fecal matters and agricultural runoff in the water.

M. Ground Water Quality in the Study Area

203. Ground water has been found to be an important source for catering to the local needs of water consumption for various purposes, mainly domestic, in the villages and towns. Therefore, any kind of deterioration in the quality of ground water owing to the developmental activities will pose threat to the village population and attention needs to be paid towards maintaining the quality of water using all possible tools such as monitoring with spontaneous remedial suggestions, if required. Since the ground water is used without treatment by a large portion of population for drinking purpose and domestic use, the quality of ground water is of more concern.

1. Ground Water Quality Monitoring Stations

204. M/s Mantec Environmental Laboratory (A NABL Accredited & MoEF Recognized laboratory) was engaged for collection of ground water samples and analysis. **Four (4) ground water quality monitoring stations** comprising hand operated tube wells (hand-pumps) in the study area were identified for the monitoring and assessment of ground water quality. The details of ground water quality monitoring stations are provided in **Table-63.**

Table 63: Details of Ground Water Quality Monitoring Stations

SN	Station Code	Place	Chainage (Km)	Side	Distance# (m)	Usage
1	GW1	Chabbi Village	138+200	LHS	10	Drinking
2	GW2	Guttal	189+500	LHS	50	Drinking

SN	Station Code	Place	Chainage (Km)	Side	Distance# (m)	Usage
3	GW3	Ranebennur	215+600	LHS	40	Drinking
4	GW4	Honnali	263+650	RHS	8	Drinking

Source: On-site Water Quality Monitoring in December 2015

Distance in meter from existing centerline

205. Ground water samples were collected once in the month of December 2015 from all stations and analyzed for physical, chemical and bacteriological parameters as per established standard methods and procedures.

2. Ground Water Quality in the Study Area

206. Salient features of ground water quality monitoring results are presented in **Table-64**. The ground water quality monitoring results are statistically analyzed in **Table -65**.

Table 64: Salient Ground Water Quality Features

SN	Parameter	Range	AM	SD	PTV
1.	pH	7.39-7.74	7.39	0.0	0
2.	TDS (mg/l)	294-1569	1208	0.0	0
3.	Total hardness (mg/l as $CaCO_3$)	82-1002	782	0.0	75
4.	Chloride (mg/l as Cl^-)	20-417	233	0.0	0
5.	Iron (mg/l as Fe)	0.09-0.29	0.21	0.0	0

Source: On-site Water Quality Monitoring in December 2015

N- No of measurements, AM- Arithmetic mean, SD- Standard deviation, BDL- Below detection limit; PTV- Percent time violations over permissible limits* (maximum) stipulated for drinking water (IS:10500-2012).

207. All the hand pumps exhibited limited variation of temperature, which are the typical characteristics of ground water. There has been little fluctuation in pH with overall range of 7.4-7.7, marginally above the neutral mark but within the permissible limits of 6.5-8.5 stipulated in drinking water quality standards (IS 10500:2012).

208. Total hardness values for three samples are observed to high (644-1002 mg/l) are higher than both desirable limits (200 mg/l) and permissible limits (600mg/l) of drinking water quality standards, except GW2- Guttal village where hardness (82 mg/l) and alkalinity (80 mg/l) are found to be low. Chloride contents for three samples were found to be 233-417 mg/l, while it is only 20 mg/l for GW2. Sulfate content for all samples varied between 61-96 mg/l. Calcium content of GW2 is also found to be low (7 mg/l), while it varies from 142-164 mg/l for the other three samples. Similarly, the magnesium content of the samples except GW2 varied between 71-144 mg/l, while the same for GW2 is found to be only 16 mg/l. Heavy metals remain undetected in the samples. The fluoride levels are also found to be in higher sides but within the stipulated standards, with GW4 (Honnali Town) has fluoride value very close to the permissible limits.

Table 65; Ground Water Quality Analysis Results

SN	Parameters	Units	GW1	GW2	GW3	GW4	Indian Standard[1]		WHO Limits
							Desirable	Permissible	
1.	pH	-	7.39	7.73	7.74	7.39	*6.5-8.5*	*No relaxation*	-
2.	Temperature	^{O}C	25	25	25	25	-	-	-
3.	Conductivity	µmhos/cm	1859	453	1724	2414	-	-	-
4.	Turbidity	NTU	3.5	2	3.2	4	*1*	*5*	-

SN	Parameters	Units	GW1	GW2	GW3	GW4	Indian Standard[1]		WHO Limits
							Desirable	Permissible	
5.	Total Hardness as $CaCO_3$	mg/l	782	82	644	1002	*200*	*600*	-
6.	Total Alkalinity as $CaCO_3$	mg/l	522	80	474	562	*200*	*600*	-
7.	Total Dissolved Solids	mg/l	1208	294	1121	1569	*500*	*2000*	-
8.	Sodium as Na	mg/l	29	47	48	68	-	-	-
9.	Potassium as K	mg/l	3	4	5	5	-	-	-
10.	Calcium as Ca	mg/l	157	7	142	164	*75*	*200*	-
11.	Magnesium as Mg	mg/l	95	16	71	144	*30*	*100*	-
12.	Chloride as Cl	mg/l	233	20	241	417	*250*	*1000*	-
13.	Sulphate as SO_4	mg/l	79	93.5	61	96	*200*	*400*	-
14.	Nitrate as NO_3	mg/l	10.7	7.6	5.6	9.5	*45*	*No relaxation*	*50*
15.	Iron as Fe	mg/l	0.21	0.09	0.16	0.29	*0.3*	*No relaxation*	-
16.	Manganese as Mn	mg/l	<0.02	<0.02	<0.02	<0.02	*0.1*	*0.3*	-
17.	Cadmium as Cd	mg/l	<0.001	<0.001	<0.001	<0.001	*0.003*	*No relaxation*	*0.003*
18.	Total Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	*0.01*	*0.05*	*0.01*
19.	Total Chromium as Cr	mg/l	<0.05	<0.05	<0.05	<0.05	*0.05*	*No relaxation*	*0.05*
20.	Copper as Cu	mg/l	<0.01	<0.01	<0.01	<0.01	*0.05*	*1.5*	*2*
21.	Mercury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001	*0.001*	*No relaxation*	*0.006*
22.	Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01	*0.01*	*No relaxation*	*0.01*
23.	Zinc as Zn	mg/l	0.38	0.18	0.36	0.46	*5*	*15*	-
24.	Boron as B	mg/l	ND	ND	ND	ND	*0.5*	*1*	*2.4*
25.	Fluoride as F	mg/l	0.86	0.76	0.84	0.98	*1*	*1.5*	*1.5*
26.	Total Coliform	MPN/100 ml	Absent	Absent	Absent	Absent	*Absent*	*Absent*	*Absent*

Source: On-site Water Quality Monitoring in December 2015

1 Refers to Drinking Water Quality Standards as stipulated in IS- 10500:2012

209. From above it can be concluded all parameters were generally within the tolerance limits for drinking water except hardness. Therefore, the ground water quality of the study area, in general, is hard in nature and the physico-chemical quality at large satisfies the permissible limit as stipulated in Drinking Water Standards of India as well as World Health Organization.

3. Ground Water Availability

210. **Gadag:** As per CGWB study of March 2004, total annual replinishable ground water resource in Gadag district was estimated as 24605 ham, and draft for irrigation during the period was estimated as 19966 ham. The whole of **Ron** taluk, 85% of Nargund taluk and 71 % of area of **Gadag** taluk are overexploited while **Shirhatti** taluk is safe. According to minor irrigation census 2000-2001, it was recorded 2201 dug wells, 6772 shallow bore wells and 57 dug cum bore wells are present. The water quality deterioration in many parts of the district can be attributed partly to the natural means of decomposing of host rock / aquifer by prevailing weather condition over the year or indiscriminate dumping of wastes on the land and usage of chemical fertilizers in the agricultural land. The present water supply to Gadag and other semi-urban areas in the district are reported to be inadequate especially during summer months. This scarcity is not only because of limited source but also because of leakage and other losses through pipeline network.

211. **Haveri:** The ground water resource estimation by **CGWB** indicates that total annual ground water recharge in the district is 596.32 mcm (Million Cubic meters) and net annual ground water availability as 547.50 mcm for Haveri district for year 2009.

212. Annual ground water draft for domestic and industrial uses was 26.65 mcm and for irrigation purposes the draft computed was 320.67 mcm. Total draft during the year 2009 was 347.33 mcm. The net ground water availability for future irrigation development was computed as 197.52 mcm, after allocating 34.85 mcm of ground water for domestic and industrial uses for the next 25 years. Taluk wise ground water estimation data indicates the in Hangal, Savanur and Shiggaon taluks 100% area belongs to safe category. It also indicates that in Byadagi, Haveri and **Ranibennur,** 60 to 80 % of area of these taluks belongs to over exploited category.

213. **Davangere:** As per CGWB study, major parts of Davangere, Harpanahalli, Harihar and Jagalur fall under over exploited category**.** Major parts of Honnali taluk falls under safe category. In Harpanahalli Taluk 89% area falls under over exploited category, 10% of the area falls under semi critical and 1% of the area falls under **safe** category. In **Honnali** taluk **15% under over exploited and 85% of the area falls under safe category**.

N. Ecology and Biodiversity

1. Introduction

214. The project area falls in predominantly dry Agro-climatic zone and experiences a semi-arid climatic condition. The flora along the project road comprise of plantation of *Eucalyptus tereticornis* (Eucalyptus), *Delonix regia* (May flower), *Azadirachta indica* (Bevu), *Dalbergia sissoo* (Shisam), *Ziziphus mauritiana* (**Indian** Jujube), *Peltophorum pterocarpum* (Copper pod)**,** *Cassia siamea* (Rain tree), *Pongamia pinnata* (Karanj), *Tecoma grandis* (Teak), *Acacia nilotica* (Babool), *Tamarindus indica* (Tamarind), *Leucaena leucocephala* (Subabool), *Ficus relegiosa* (Pipal), *Bauhinia purpurea* (Basavana paada) etc. Invasive species such as *Prosopis juliflora*, *Lanta camara,* and *Parthenium hysterophorus* are commonly found in the degraded areas and along roadside.

215. The major horticultural crops cultivated are *Cocus nucifera* (Coconut), *Areca catechu* (Areca nut), *Mangifera indica* (Mango), *Psidium guajava* (Guava), *Musa paradisiaca* (Banana) and *Carica papaya* (Papaya), **Annona** *squamosa* (Sitaphai) and *Artocarpus heterophyllus* (Jack fruit).

216. Agriculture crops cultivated are ragi, rice, sugarcane, pulses (horse gram tur, cowpea green gram, black gram, avare) and oilseeds (groundnut and sesame). Other crops grown are sunflower, jowar and maize. Vegetables such as tomato, gourd varieties, brinjal, ladies finger, etc are grown. Agriculture is dependent on rainfall, river, well and tank irrigation.

View of Trees along Project Road

2. Road Side Trees

217. The number of roadside trees within existing row is estimated to be 3,865. Side and girth size wise distribution of existing trees are provided in **Table-66.** Chainage wise detailed survey data is provided in **Annex 4.5.**

Table 66: Number of Trees along the Project Road

Side	No of Trees in Girth Class (in cm)					Total
	<30	31-59	60-119	120-180	>180	
RHS	498	516	818	182	59	2,073
LHS	507	410	302	247	326	1,792
	1005	**926**	**1120**	**429**	**385**	**3,865**

Source: Field Survey conducted by ICT Pvt. Ltd.

3. Green Tunnels and Giant Trees

218. Green tunnels are formed along the road at some locations. These tunnels provide shade, reduce heat effect, reduce glaring of road and provide overall cooling. Species observed in the green tunnel mainly includes *Ficus benghalensis* (**Banyan**), *Tamarindus indica* (Tamarind), *Delonix regia* (Gulmohar) *Ficus religiosa*, (Pipal), *Azadirachta indica* (Neem), *etc* The stretches will be impacted due to widening activity. The location of green tunnel is given in **Table-67** and also marked in map in **Annex 4.6**

View of Green Tunnel along Gadag to Honnali

Table 67: Location of Green Tunnels along the Project Road

Sl. No.	GPS Reading		Existing Chainage Km		Design Chainage Km		Length (m)
	Start Point	End Point	From	To	From	To	
1.	15°22'56.21"N 75°35'54.06"E	15°22'52.40"N 75°35'51.20"E	110+120	110+265	109+625	109+770	145.0
2.	14°44'51.01"N 75°38'21.25"E	14°44'44.74"N 75°38'20.80"E	198+840	199+035	189+960	190+155	195.0
3.	14°44'40.24"N 75°38'19.69"E	14°44'36.46"N 75°38'18.93"E	199+175	199+290	190+300	190+415	115.0
4.	14°44'20.18"N 75°38'17.95"E	14°44'15.02"N 75°38'18.00"E	199+800	199+960	190+915	191+075	160.0
5.	14°44'7.09"N 75°38'13.86"E	14°44'3.79"N 75°38'11.51"E	200+230	200+360	191+350	191+480	130.0
Total Length of Green Tunnel							**745.0**

Source: Field Survey conducted by ICT Pvt. Ltd.

219. **Giant Trees:** Field survey was conducted to identify the location of giant trees (girth size more than 3.0 m). **104 giant trees** are found along the project road, out of which 62 trees are on the left side and 42 trees are on the right side. Details of the giant trees i.e., Chainage, side, distance from existing centerline of the road, species and girth size is presented in **Table-A.4.5.4** of **Annex 4.5.**

View of Giant Trees along the Project Road

4. Biodiversity Survey

220. The biodiversity study for Gadag to Honalli was carried in the month of December, 2015 to study the flora and fauna of the project area. Total ten **sample** plots of 100 m x 10 m were laid for the purpose of biodiversity assessment. The sample plots were laid around an interval of

10-15 km such that the plots are located on either side of the road. The data collected on the number of individuals present in each species, for both flora and fauna, were subjected to further analysis. Importance Value Index (IVI), Shannon Diversity Index and Simpson's Index were calculated. The GPS co-ordinates and altitude were recorded for each of the sample plots are provided in **Table-68.**

Table 68: GPS co-ordinates and altitude for the Sample plots

Sample Plots	Latitude	Longitude	Altitude (m)	Vegetation Type
1	14°15'23.4"	75°38'17.8"	545	Shrubby vegetation
2	14°25'40.9"	75°37'17.7"	540	Shrubby vegetation
3	14°34'38.8"	75°36'57.4"	554	Vegetation along seasonal water course
4	14°47'37.9"	75°38'06.8"	553	Shrubby vegetation
5	14°55'10.9"	75°39'26.3"	507	Shrubby vegetation
6	15°03'01.0"	75°40'56.0"	567	Shrubby vegetation
7	15°11'33.9"	75°34'54.0"	654	Vegetation along seasonal water course
8	15°16'36.3"	75°36'19.9"	717	Shrubby vegetation
9	15°23'14.8"	75°36'3.6"	667	Shrubby vegetation
10	15°34'06.2"	75°40'03.33"	588	Shrubby vegetation

Source: Biodiversity Study conducted by ICT Pvt. Ltd.

221. ***Floral Composition.*** Primary data on the floral composition was recorded along proposed project road. In each plot, floral species were botanically identified to the species level by using local flora (Saldanha and Ramesh, 1984[1]; Gurudev, 2002[2]) and other field guides separately for trees, shrubs and herbs; and their scientific names and individual numbers were recorded during field survey for further analysis. 55 floral species were identified. Out of which, 24 were tree species, 16 shrubs and 15 herb species (Plate 1, 2 & 3).The list of floral species along with the status as per International Union for Conservation of Nature (IUCN), red list of threatened species is provided in the **Table-69.**

Table 69: List of Flora recorded during Survey

SN	Species Name	Common Name	IUCN category
1.	*Acacia nilotica*	Babool	NE
2.	*Albizia lebbeck*	Siris	NE
3.	*Azadirachta indica*	Neem	NE
4.	*Bauhinia purpurea*	Basavapada	LC
5.	*Cassia siamea*	Kassod tree	NE
6.	*Dalbergia sissoo*	Shisham	NE
7.	*Delonix regia*	May Flower	LC
8.	*Eucalyptus tereticornis*	Forest Red Gum	NE
9.	*Ficus amplissima*	Paras pipal	NE
10.	*Ficus religiosa*	Pipal	NE
11.	*Gliricidia maculata*	Quickstick/ Gobbarda mara	NE
12.	*Gmelina arborea*	Gamar	NE
13.	*Grevillea robusta*	Silver Oak	NE
14.	*Leucaena leucocephala*	Subabul	NE
15.	*Limonia acidissima*	Wood apple/ Belavu	NE
16.	*Morinda tinctoria*	Indian mulberry	NE

[1] Saldanha, C.J. and Ramesh, S.R. 1984; Flora of Karnataka. Department of Science and Technology, Oxford and IBH Publishers, New Delhi

[2] Gurudev, M.R., 2002; Karnatakada Sasyagala Sasyashastriya Kannada, Konkani Mathu Tulu Hesarugalu. Divyachandra Prakashana, Bangalore. 628 p

SN	Species Name	Common Name	IUCN category
17.	*Peltophorum pterocarpum*	Copper pod	NE
18.	*Pongamia pinnata*	Karanj	NE
19.	*Psidium guajava*	Guava	NE
20.	*Samanea saman*	Rain Tree	NE
21.	*Syzigium cumini*	Jamun	NE
22.	*Tamarindus indica*	Imli	NE
23.	*Tectona grandis*	Teak wood	NE
24.	*Ziziphus mauritiana*	Indian jujube	NE
	Shrubs		
25.	*Agave americana*	American aloe	LC
26.	*Calotropis procera*	French Cotton	NE
27.	*Canthium parviflorum*	Kadbar	NE
28.	*Cassia auriculata*	Anval	NE
29.	*Cassia tora*	Coffee cassia	NE
30.	*Chromolaena odorata*	Siamweed	NE
31.	*Dodonaea viscosa*	Hop-bush	NE
32.	*Jatropha curcas*	Physic nut	NE
33.	*Lantana camara*	Ghaneri	NE
34.	*Prosopis juliflora*	Indian Mesquite	NE
35.	*Securinega virosa*	Dalme	NE
36.	*Sida acuta*	Blue okra	NE
37.	*Solanum indicum*	Ban Tobacco	NE
38.	*Stachytarpheta indica*	Kaadu uttarani	NE
39.	*Tephrosia tinctoria*	Orange Tephrosia	LC
40.	*Vitex negundo*	Chaste Tree	NE
	Herbs		
41.	*Achyranthes aspera*	Prickly Chaff-flower	NE
42.	*Asparagus racemosus*	Shathaavari	NE
43.	*Cynodon dactylon*	Bermuda grass	NE
44.	*Desmodium triflorum*	Matty desmodium	LC
45.	*Dolichos falcatus*	Kaduhurali	NE
46.	*Evolvulus alsinoides*	English speedwheel	NE
47.	*Hemidesmus indicus*	Nannari	NE
48.	*Leucas aspera*	Chhota-halkusa	NE
49.	*Mimosa pudica*	Touch me not	LC
50.	*Mitracarpous vertisilata*	Girdlepod	NE
51.	*Parthenium hysterophorus*	Carrot grass	NE
52.	*Phyllanthus urinaria*	Hazarmani	NE
53.	*Spilanthes acmella*	Toungue cleaner	NE
54.	*Tridax procumbens*	Coatbuttons	NE
55.	*Vernonia cinerea*	Ash-coloured fleabane	NE

LC- Least Concern, NE- Not Evaluated, Status as per IUCN Red list

Source: Biodiversity Study conducted by ICT Pvt. Ltd.

Plate 1: **trees**. a. *Dalbegia sissoo, b. Zizyphus mauritiana c. Tamarindus indica* d. *Cassia siamea*

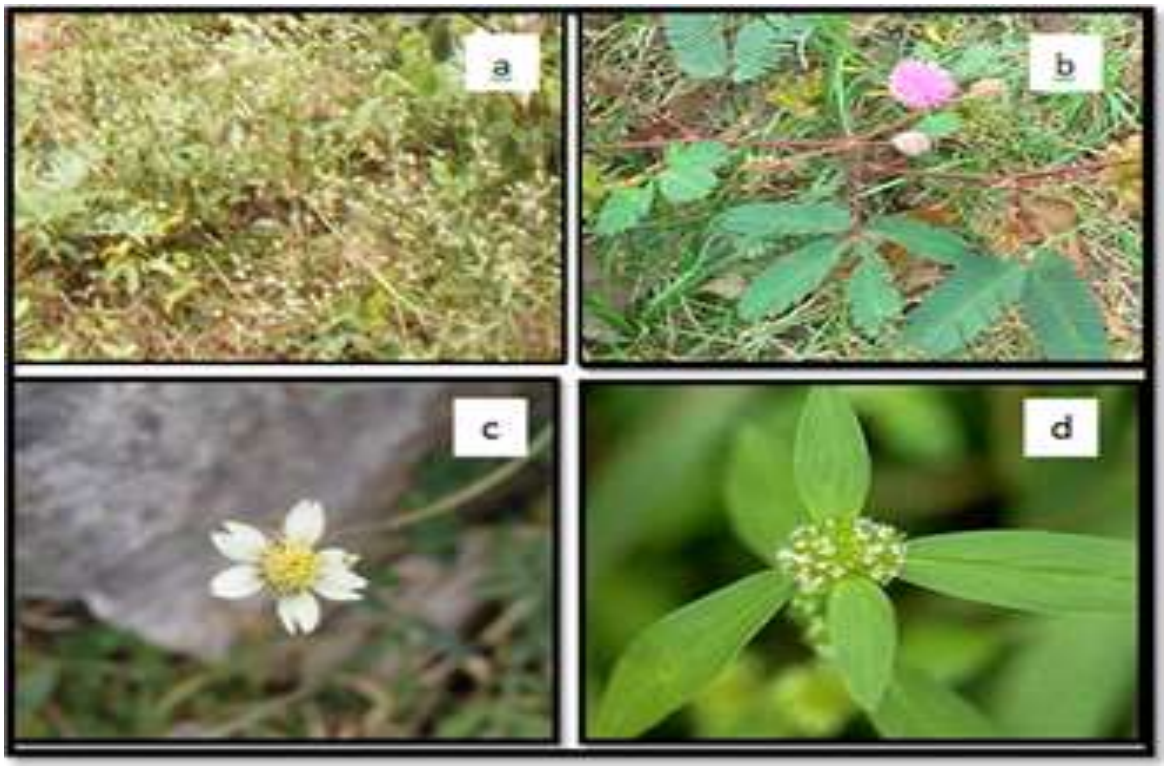


Plate 2 Shrub: a. Agave americana b. Lantana camara, c. Dodonaea viscosa d. Calotropis procera

Plate 3 Herb species: a. Parthenium hysterophorus b. Mimosa pudica, c. Tridax procumbens d. Mitracarpus verticillata

222. Importance Value Index (IVI) indicates the population structure of species since, it takes collective account of structural **parameters** such as relative density and frequency of the species. The results of biodiversity study are presented in **Table A.4.7.1, Table-A.4.7.2** and **Table-A.4.7.3 of Annex 4.7** for trees, shrubs and herbs respectively. *Acacia nilotica* was found to be dominant in with 26.07 IVI and the least was observed for *Ficus amplissima* (1.54).According to the species abundance calculated for the tree species, inferred that *Cassia siamea* was having highest abundance value of 5.00 compared to other species, this is ascribable to the fact that, the species though not distributed equally, the number of individual were more.

223. *Lantana camara ora* was dominating species with an IVI of 32.08 among the 16 shrub species identified and the least IVI (1.75) was **observed** for *Securinega virosa*. The species abundance for individual shrubs revealed that *Tephrosia tinctoria* was having highest abundance value of 37.50.

224. *Cynodon dactylon* was found to be dominating with an IVI of 32.51. The species abundance was calculated for herb species and it is prudent to mention that *Parthenium hysterophorus* was having highest abundance value of 42.50 compared to other herb species.

225. **Shannon's Diversity index (H'):** Diversity index is used to characterize the species abundance relationship in a community. The simple measure of species diversity is Shannon's diversity index. It is estimated by using the **formula**:

$$H' = -\sum_{i=1}^{S}[(\mathbf{ni}/\mathbf{N})\ \mathbf{ln}\ (\mathbf{ni}/\mathbf{N})]$$

Where,

H = the Shannon diversity index
ni = Number of individuals belonging to the i^{th} species,
N= Number of individuals in the sample,
S = Number of species encountered
∑ = sum from species 1 to species S

226. Diversity index can be used to characterize the **species** abundance relationship in a community. The simple measure of species diversity is Shannon's diversity index. The estimated Shannon's diversity index is presented in **Table-70**.

Table 70: Shannon's Diversity Index

SN	Flora	Shannon's Diversity Index
1	Tree	2.75
2	Shrub	2.37
3	Herb	2.42

227. In the present assessment, the Shannon's diversity index for tree species was 2.75, for shrubs was 2.37 and for herbs 2.42. **Shannon's** diversity index values obtained for different sites was found to be moderate to low when compared to reported values of 3.6 to 5.4 for tropical forests (Knight, 1975[3]) and is nearer to the range (2.557 to 3.375) reported for Permanent Preservation Plots at Western Ghats of Karnataka (Karthik, 2009[4]) and 2.31 to 3.30 for the Western Ghats of Southern Karnataka (Sarkar *et al.,* 2011[5]).

228. **Simpson's index**: It is also called concentration of **dominance**, it was calculated by following formula:

$$D = \sum_{i=1}^{s} (pi)^2$$

229. Where, pi is proportion of important value of the i^{th} species (pi =ni / N, ni is the important value index of i^{th} species and N is the **important** value index of all the species). It is noteworthy that $0 \leq D \leq 1$, with values near zero corresponding to highly diverse or heterogeneous ecosystems and values near one corresponding to more homogenous ecosystems. Lower Simpon's values are an indicator of higher diversity. The calculated Simpson's index indicated that the tree diversity was more compared to shrubs and herbs (**Table-71)**.

Table 71: Simpson's Index

S.No.	Flora	Simpson's Index
1	Tree	0.08
2	Shrub	0.11
3	Herb	0.12

Source: Biodiversity Study conducted by ICT Pvt. Ltd

[3] Knight, D.H., 1975; A phytosociological analysis of species rich tropical forest a Barro Colorado Island, Panama. Ecological Monograph, 45: 259-284

[4] Karthik, M.L., 2009; Assessment of structure, diversity and regeneration in tropical evergreen forests of Karnataka using permanent preservation plots. *M.Sc. Thesis*, University of Agricultural Sciences, Bangalore

[5] Sarkar, P.K., Ahir, K.C., Hegde, R. and Poonacha, N. M., 2011; Assessment of density, population structure of selected flagship tree species in the Western Ghats of southern Karnataka. Journal of Swamy Botany, 28: 49-58

230. ***Faunal Composition.*** Primary data on the fauna was collected along proposed project road. In each plot, faunal species were identified based on direct sightings and indirect evidences such as call, foot prints if any, nesting **etc**. Based on the identification; scientific name, common name and individual numbers were recorded for further analysis. Total **67 faunal** species were identified out of which 43 bird species, 21 insects, 1(one) reptile and 2(two) mammals were observed (Plate 4).The status of fauna is provided as per Schedule list of Wildlife Protection Act and IUCN redlist category is presented in **Table-72.**

Table 72: List of Faunal Species identified in the Project Area

SN	Scientific Name	Common Name	Schedule	IUCN Category
		Mammal		
1.	*Funambulus palmarum*	Three stripped squirrel	NA	Least Concern
		Reptile		
2.	*Calotes versicolor*	Garden lizard	NA	Least Concern
3.	*Lampropholis guichenoti*	Skink	NA	NE
		Avifauna		
4.	*Accipiter badius*	Shikra	Schedule I	Least Concern
5.	*Acridotheres tristis*	Common myna	Schedule IV	Least Concern
6.	*Ardeola grayii*	Indian pond heron	Schedule IV	Least Concern
7.	*Bubulcus ibis*	Cattle egret	Schedule IV	Least Concern
8.	*Casmerodius albus*	large egret	Schedule IV	Least Concern
9.	*Centropus sinensis*	Greater coucal	Schedule IV	Least Concern
10	*Columbia livia*	Blue rock pigeon	NA	NE
11	*Coracias benghalensis*	Indian roller	Schedule IV	Least Concern
12	*Corvus splendens*	House crow	Schedule V	Least Concern
13	*Cuculus micropterus*	Indian cuckoo	Schedule IV	Least Concern
14	*Cypsiurus balasiensis*	Asian palm swift	NA	Least Concern
15	*Dicaeum agile*	Thick billed flowerpecker	Schedule IV	Least Concern
16	*Dicrurus caerulescens*	White billed drango	Schedule IV	Least Concern
17	*Dicrurus leucophaeus*	Ashy drango	Schedule IV	Least Concern
18	*Dicrurus macrocercus*	Black drango	Schedule IV	Least Concern
19	*Egretta garzetta*	Little egret	Schedule IV	Least Concern
20	*Elanus caeruleus*	Black shoulder kite	NA	Least Concern
21	*Gallus sonneratii*	Gray junglefowl	Schedule IV	Least Concern
22	*Halcyon smyrnensis*	White brested kingfisher	Schedule IV	Least Concern
23	*Hirundo rustica*	Common swallow	NA	Least Concern
24	*Ictinaetus malayensis*	Black eagle	Schedule I	Least Concern
25	*Lanius meridionalis*	Southern grey shrike	NA	NE
26	*Lanius schach*	Rufous backed shrike	NA	Least Concern
27	*Lonchura punctulata*	Spotted munia	Schedule IV	Least Concern
28	*Merops leschenautti*	Chestnut headed bee eater	NA	NE
29	*Merops orientallis*	Small bee eater	NA	NE
30	*Mirafra contillans*	Singing bush lark	NA	NE
31	*Motacilla alba*	White wagtail	Schedule IV	Least Concern
32	*Motacilla maderaspatensis*	Large pied wagtail	Schedule IV	NE
33	*Muscicapa dauurica*	Asian brown flycatcher	Schedule IV	Least Concern
34	*Nectarinia zeylonica*	Purple rumper sunbird	Schedule IV	Least Concern
35	*Parus major*	Grate tit	Schedule IV	Least Concern
36	*Passer domesticus*	House sparrow	Schedule IV	Least Concern
37	*Psittacula krameri*	Rose ringed parakeet	Schedule IV	Least Concern
38	*Pycnonotus jocosus*	Red wiskered bulbul	Schedule IV	Least Concern
39	*Saxicola caprata*	Pied bushchat	Schedule IV	Least Concern
40	*Saxicoloides fulicata*	Indian robin	Schedule IV	Least Concern

SN	Scientific Name	Common Name	Schedule	IUCN Category
41	*Streptopelia chinensis*	Spotted dove	Schedule IV	NE
42	*Streptopelia orientalis*	Oriental turtle dove	Schedule IV	Least Concern
43	*Streptopelia senegalensis*	Little brown dove	Schedule IV	Least Concern
44	*Sturnus pagodarum*	Bhraminy starling	Schedule IV	Least Concern
45	*Turdoides malcolmi*	Large gray babler	Schedule IV	Least Concern
46	*Turnix suscitator*	Button quail	Schedule IV	Least Concern
Insect				
47	*Apis dorsata*	Rock bee	NA	NE
48	*Atrophaneura hector*	Crimson rose	NA	NE
49	*Catopsilia pomona*	Common emigrants	NA	NE
50	*Chorthippus brunneus*	Grass hopper	NA	Least Concern
51	*Colotis etrida*	Small orange tip	NA	NE
52	*Euploea core*	Common indian crow	NA	Least Concern
53	*Eurema brigitta*	Small grassyellow	NA	Least Concern
54	*Eurema hecabe*	Common grassyellow	NA	NE
55	*Hypolimnas misippus*	Dandaid eggfly	NA	Least Concern
56	*Ischnura hecterostica*	Damson fly	NA	NE
57	*Junonia lemonias*	Lemon pansy	NA	NE
58	*Orsotrioena medus*	Nigger	NA	NE
59	*Papillio polytes*	Common mormon	NA	NE
60	*Phalanta phalanta*	Common leopard	NA	NE
61	*Psuedocoladenia dan*	Fulvouspied flat	NA	NE
62	*Sympetrum flavolum*	Dragon fly	NA	NE
63	*Tirumala septentrionis*	Dark blue tiger	NA	NE
64	*Vespula vulgaris*	Wasp	NA	NE
65	*Xylocopa Violacea*	Carpenter bee	NA	NE
66	*Ypthima baldus*	Common five ring	NA	NE
67	*Ypthima huebneri*	Common four ring	NA	NE

Source: Biodiversity Study conducted by ICT Pvt. Ltd.

NA- Not Applicable under Wildlife Schedule according to Wildlife Protection Act 1972

NE- Not Evaluated as per the IUCN Red List of Threatened Species

231. ***Accipiter badius* (Shikra)** and ***Ictinaetus malayensis* (Black Eagle)** are **Schedule I** species as per Wildlife Protection Act, 1972.Schedule I species are provided absolute protection –offence under these are prescribed the highest penalities. According to IUCN Global Conservation status both the species are under Least Concern (LC) category in the redlist. This species have an extremely large range, and hence does not approach the thresholds for vulnerable under the range size criterion. The population trend appears to be stable; globally there are no major threats to this species. No threatened species reported as per IUCN Red list.

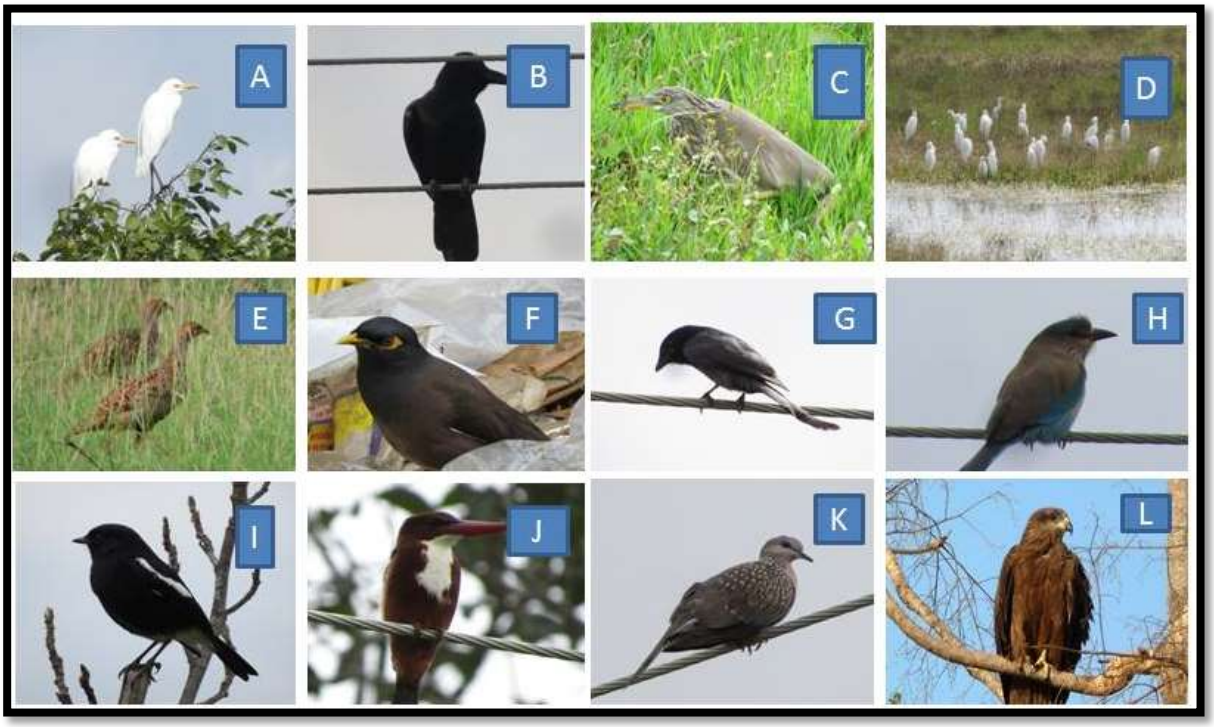


Plate 4. a. Cattle egret, b. House crow, c. Indian pond heron, d. Large egret, e. Button quail, f. Common myna, g. Black drango, h. Indian roller, i. Indian robin, j. White breasted kingfisher, k. Spotted dove, l. Black eagle

232. **Analysis of Primary Data:** Relative Frequency (RF), Relative density (Rd), Importance value index (IVI) and Abundance for **overall** faunal species was calculated and provided in **Table-A.4.7.4 of Annex 4.7.** In the present investigation, among the faunal diversity, the bird species were abundant. Shannon and Simpson index is given in the **Table-73**.

Table 73: Shannon and Simpson Index

Shannon's Diversity Index	Simpson's Index
3.40	0.06

Source: Biodiversity Study conducted by ICT Pvt. Ltd.

5. Protected Areas

233. The project road does not traverse through any National Park, Wildlife Sanctuary or Biosphere Reserve. Ranebennur wildlife **sanctuary** is located within 10km radius of the project area and the nearest distance of the WLS from project road is 2.3 km.

234. **Ranibennur Wildlife Sanctuary:** The Ranebennur Wildlife Sanctuary was declared vide Government of Karnataka Notification No. AFD-58-PWL-74 dated 17-6-1974 with an area of 119 Sq.km to protect Blackbuck (*Antilope* **cervicapra**). Location map of the sanctuary is provided in **Figure-18.** The Sanctuary has a core area of 14.87 sq.km and buffer zone of 104.13 sq.km.

235. The Blackbuck occurred across almost the whole of the Indian subcontinent previously. Their range decreased **sharply** during the 20th century and are now extinct in Bangladesh, Nepal and Pakistan due to extensive poaching and habitat loss. It is listed in Schedule I of the Indian Wildlife (Protection) Act, 1972, and categorized as **Neat Threatened in the IUCN Red List, 2008**. Although the blackbuck population has declined dramatically in the past, numbers in India are now thought to have stabilized. Hunting of this species is strictly prohibited under the Wildlife (Protection) Act, 1972.

Blackbuck in Ranebennur Wildlife Sanctuary

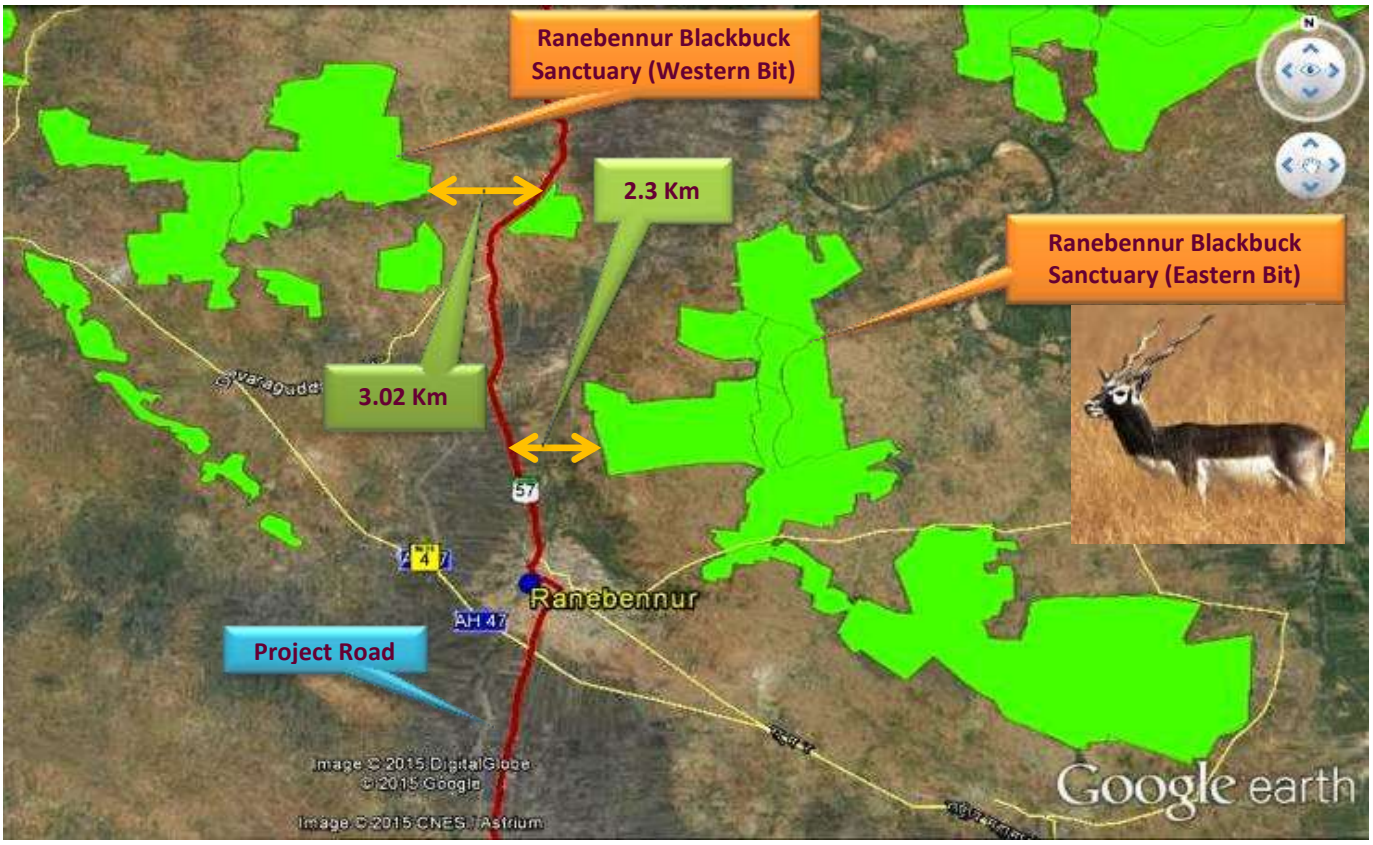


Figure 18: Map showing Location of Wildlife Sanctuary near the Project Road

236. The sanctuary has the distinction of harboring the **Great Indian Bustard (*Ardeotis nigriceps*).** The species is listed as **Critically Endangered on the IUCN Red List, 2015**. It is listed in Schedule I of the Indian Wildlife (Protection) Act, 1972. The population of this species is confined to Rajastan, Gujarat, Maharastra, Andra Pradesh and Karnataka. The species has an extremely small population that has undergone an extremely rapid decline owing to habitat loss and degradation, hunting and direct disturbance. This species has been identified as one of the

species for the recovery programme under the Integrated Development of Wildlife Habitats of the Ministry of Environment and Forests, Government of India.

237. The other fauna found in the sanctuary are Jackal (*Caris aureus*), Fox (*Vulpes bengalensis*), Wild Boar (*Sus scrofa*), Porcupine (*Hystrix indica*), Hares (*Lepus rigricoltis*) Common mangoose (*Herpestes edwardsi*) etc. The commonly observed snakes are green snakes, vipers, Rat snakes, Cobras, pythons. Variety of birds are also seen in the sanctuary, most commonly seen are cattle egret, pond Heron, king Vulture Kites, Shrike, Hawk, Grey Partridge, Grey Quail, Common peafowl, Red wattle Lapwing, Blue rock pigeon, Ring Dove, Parakeet, Koel, Crow Pheasant, Swifts, Hoopoe, small green Bee-eater, white Breasted King fisher, Grey Hornbill, Common Sand grouse etc. The WLS is surrounded by vast agricultural fields growing crops like maize, millets, jowar, etc during rainy season. The people living adjacent to the sanctuary are very poor with small land holdings. Most of the population of the villages is of Kurbas (Shepherds) and Lambani (Tribals). Human animal conflict is common in the area with crop raiding by Black Buck and Wild Boar. Cattle and sheep also depend on water holes created for Wildlife Management inside the Sanctuary. People are also depended on forests for firewood and small timber.

View of livestock grazing in Ranebennur WLS

Eucalyptus plantation in Ranebennur WLS

238. There are many religious places in the vicinity of the Wildlife Sanctuary - Sri. Malatesh Temple, Devaragudda, Sri. Mylaralingeshwara temple, Myalara, Sri. Karibasaveshwara temple, Ukkadagatri, Sri. Kantesh temple, Kadaramandalagi.

239. ***Threats to Wildlife Sanctuary:*** The sanctuary is susceptible to poaching, forest fires, grazing and viral diseases. The blackbuck habitat is subject to heavy pressure from human population growth and increasing numbers of domestic livestock and economic development. People living around the Sanctuary are depended on the sanctuary for cattle and sheep grazing. Measures for the conservation of the Sanctuary

- Maintain blackbuck habitat area as open grasslands and halt plantation of Eucalyptus in the area.
- Protect bio-diversity by protecting the native wild plants and trees
- Fencing to prevent the blackbuck from raiding crops which will avoid/ reduce conflict with farmers,
- The nallas and tanks in the sanctuary dry up as early as February or March hence more soil and water conservation measures are necessary
- Managing grasslands

- Vaccination camps should be conducted in all the villages around the sanctuary
- Capacity building and adequate field level staff.
- Providing alternative energy saving devices
- Involve local people through awareness and education campaigns
- Providing alternative energy saving devices to villages

240. The project road does not cause any fragmentation or diversion of wildlife habitat. No construction activity envisaged within the sanctuary. The improvement of project road will have no adverse impact on the Wildlife Sanctuary.

6. Forest

241. The project road passes through Reserved / Protected Forest Area for 4.848 Km stretch. The forests located along the project stretch are presented in **Table-74.** At Ch. Km 236+750, one reserve forest is located along the project road but the forest area is located at a distance of 100-150 m from the edge of the road. Location of the forest areas along the project road is shown in **Figure-19** and **Figure-20.**

Table 74: Location of Forest along Project Road

SN	Design Chainage Km		Length (Km)	Side	Existing Chainage km		Length (Km)	Forest Type
	From	To			From	To		
1	139+950	140+800	0.850	Both	142+140	142+990	0.850	RF
2	152+100	152+170	0.070	LHS	154+160	154+230	0.070	RF
3	152+900	153+115	0.215	LHS	154+970	155+185	0.215	RF
4	153+115	153+153	0.038	Both	155+185	155+223	0.038	RF
5	155+400	155+600	0.200	RHS	157+500	157+820	0.320	RF
6	160+500	161+100	0.600	RHS	162+935	163+535	0.600	RF
7	161+100	161+600	0.500	Both	163+535	164+035	0.500	RF
8	192+050	194+050	2.00	LHS	202+775	204+775	2.000	Gudgure RF
9	235+747	235+852	0.105	Both	21+000	21+100	0	RF[1]
10	236+750	236+900	0	RHS	22+100	22+300	0	RF[2]
11	241+667	241+830	0.163	RHS	27+025	27+200	0.175	PF
12	241+830	242+130	0	RHS	27+200	27+575	0	PF
13	242+130	242+275	0.145	RHS	27+575	27+655	0.080	PF
	Total		**4.886**		**Total**		**4.848**	

Note: RF – Reserved Forests; PF – Protected Forests

1 Located at 50m away from the road on right side; 2 Located at 100m away from the road on right side

Source: Field Survey and joint visit with Forest Department conducted by ICT Pvt. Ltd.

242. The vegetation of project area fall under Southern Tropical Dry Deciduous and Southern Tropical Thorn Forest type of Champion and Seth's classification (1968). The distribution of the Forests in the project districts are scattered and found in patches. The major species found in forest area are *Chloroxylon swietenia, Albizia amara, Cassia fistula, Diospyros melanoxylon, Wrightia tinctoria, Melia azadirachta, Acacia catechu.* The species found near the banks of the rivers are *Pongamia pinnata, Eugenia corymbosa, Alangium lamarckii, Terminalia arjuna, Vitex negundo, etc.* The list of flora and fauna collected from Forest Department is provided in **Annex 4.8 (Table – A.4.8.1)**

243. Afforestation work has been carried out by the Forest Department in the forest area and has established *Eucalyptus hybird* as the dominant tree species. Other species planted in afforestation are *Santalum album, Albizia lebbeck, Cassia sps., Acacia sps., Prosopis juliflora, Tamarindus indica, Leucaena leucocephala, Albizia lebbeck, Tamarindus indica,* etc. As per Forest Working Plan of Gadag division the wildlife commonly found in Forests are *Hyaena hyaena* (Stripped Hyaena), *Canis aurens* (Jackal), *Canis lupus* (Wolf), *Hystrix indica* (Porcupine), *Herpestes edwardsi* (Common mangoose), *Lepus nigricollis* (Indian Hare), *Sus scrofa* (Wild Boar), *Manis crassicaudata* (Pangolin), *Tetracerus quadricornis* (Four horned antelope), *Antilope cervicapra* (Blackbuck) *etc.* Snakes such as *Naja naja* (Cobra), *Ptyas mucosa* (Rat snake) and *Vipera russelli* (Viper). The list of wildlife provided State Forest Department is given in **Annex 4.8 (Table – A.4.8.2).** During Public consultation in the project area the locals informed that Wild Boar, Deer and Rabbit were found in the Forest areas. Wild boars were also reported for destroying agricultural crop in the area.

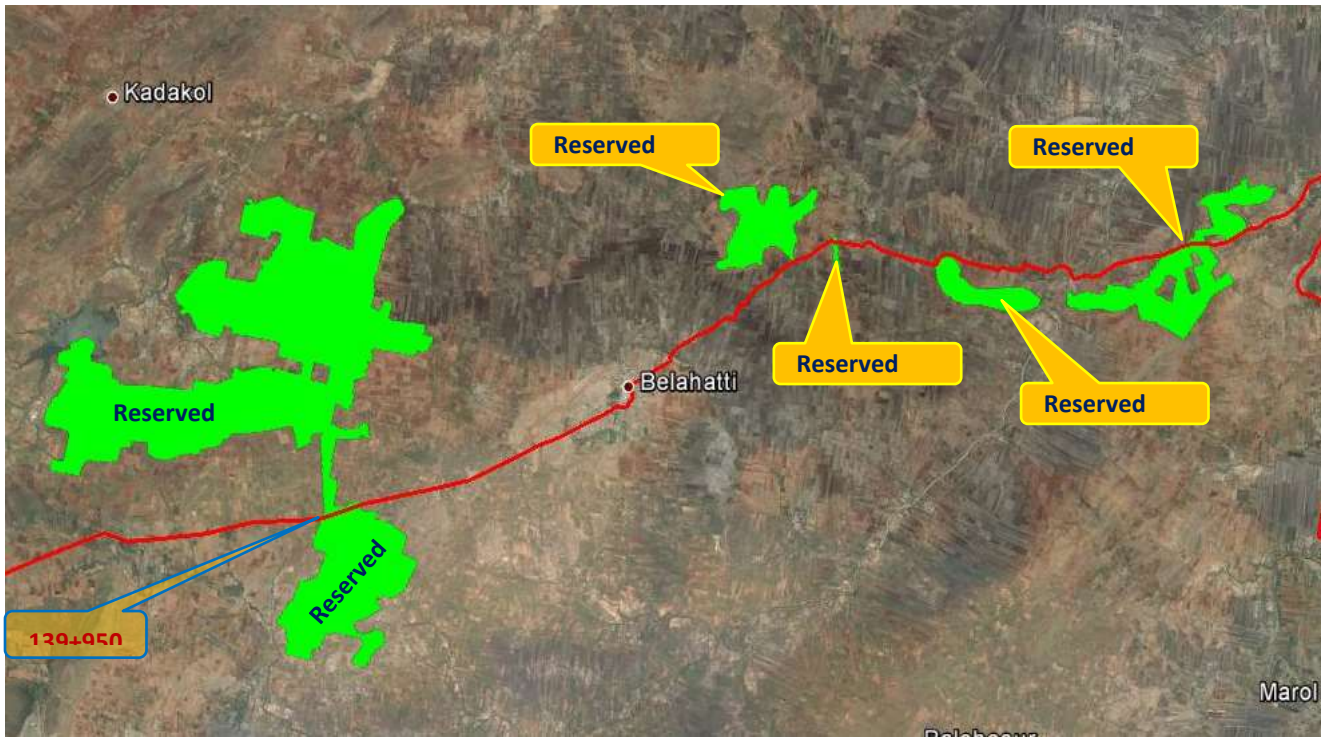


Figure 19: Location of Forest areas along the Project Road in Gadag & Haveri District

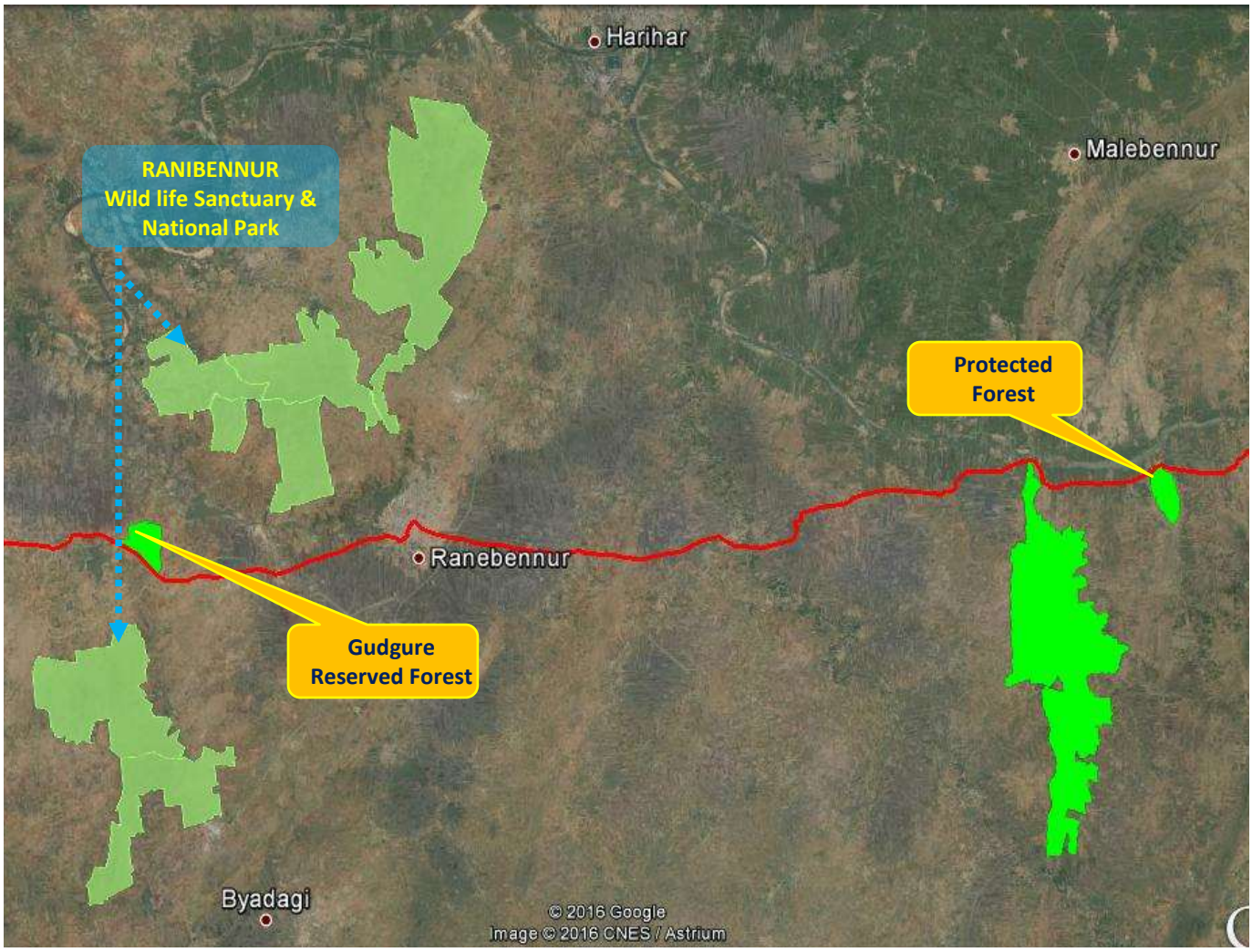


Figure 20: Location of Forest areas along the Project Road in Haveri & Davangere District

O. Educational, Medical and Religious Properties

244. **Educational Institutions:** 64 educational institutions are located on either side of the project road; out of which, 35 are located on the right side and 29 are located on the left side of the project road. Chainage wise list of educational institutions along with distance from the center line of the project road are given in **Table-75**.

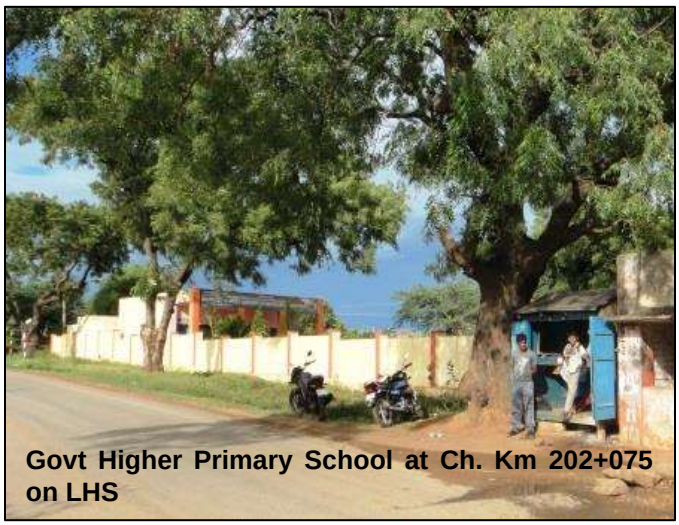
Table 75: List of Educational Institutions along the Project Road

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1	Mothoshre Gurumma Shoratti Preprimary and Primary Convent School	Gadag	107+430	106+950	Right	19.00
2	Anjuman-E-Islam ITI	Gadag	108+700	108+200	Right	34.00
3	Anjuman-E-Islam Polytechnic	Gadag	109+100	108+600	Left	13.70
4	Govt. Primary School	Nagavi	112+720	112+240	Left	39.00
5	Govt. Primary School	Yalishirur	122+300	121+840	Left	43.00
6	ICDS (Aanganwadi)	Soratoor	125+900	*	Left	39.50
7	Govt. Primary School	Soratoor	126+200	*	Left	13.70

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
8	Govt. High School	Shirahatti	129+900	*	Right	23.00
9	St Paul's Primary and High School	Shirahatti	130+700	*	Left	53.15
10	Govt. High School	Shirahatti	131+200	*	Left	66.91
11	Govt. Higher Primary School	Chabbi	137+300	135+500	Left	14.50
12	Govt. Lower Primary School	Chabbi	138+200	136+450	Right	10.00
13	Govt. Lower Primary School	Devihala	144+100	142+310	Left	9.00
14	Sri Holalamma Devi Tutorial	Bellahati	149+300	*	Left	79.28
15	Vivekananda High School	Bellahati	149+550	*	Left	187.93
16	Govt. High School	Bellahati	148+800	*	Right	235.97
17	Govt. Primary School	Bellahati	149+780	*	Left	89.28
18	Govt. Lower Primary School	Narayanapura	149+900	*	Right	12.20
19	Govt. Primary School	Tangoda	160+850	*	Right	17.50
20	Govt. Primary School Annexe	Tangoda	160+875	*	Right	11.00
21	Shri Guru Bishtappaya Mahapurusha High School	Itagi	166+775	*	Right	11.00
22	ICDS (Aanganwadi)	Itagi	170+980	*	Right	26.40
23	Govt. Lower Primary School	Itagi	170+985	*	Right	57.62
24	Govt. High School	Meundi	172+425	166+135	Right	15.50
25	Govt. Primary School	Guyilagundi	174+400	*	Right	48.60
26	Govt. Primary School	Guyilagundi	176+600	*	Right	15.70
27	Govt. Primary School	Belavegi	179+225	*	Right	40.70
28	Govt. Primary School	Belavegi	179+950	*	Left	8.00
29	Santa Kabi Kanakadasa High School	Belavegi	180+250	*	Left	10.00
30	Govt. Industrial Training Institute	Guttal	189+700	*	Right	32.70
31	Govt. Higher Primary Girls School	Guttal	190+220	*	Right	9.10
32	Govt. Primary School	Thimmapur	194+180	183+600	Left	142.00
33	Govt. Primary School	Madurayarapura	197+650	187+000	Right	12.00
34	Govt. Boys Hostel	Honnatti	200+750	189+900	Left	34.90
35	Govt. Higher Primary School	Honnatti	200+960	190+100	Right	10.80
36	Govt. High School	Honnatti	201+275	190+400	Right	10.00
37	Govt. Higher Primary School	Kerimallapur	202+075	191+200	Left	12.40
38	Govt. Higher Primary School	Guddada Anveri	210+280	199+300	Right	9.00
39	New Era Public School	Ranebennur	214+000	*	Right	17.60
40	Veera Madakari Nayaka Girls High School	Ranebennur	215+580	*	Left	46.90
41	Basav Chetana College of Education	Ranebennur	215+840	*	Left	11.80
42	Govt. Urdu Primary School	Ranebennur	215+925	*	Right	9.30
43	Hosamani Siddappa Arts And Commerce College	Ranebennur	216+130	*	Right	6.20
44	Siddhaswara Rural Residential High School and Lower Primary School	Ranebennur	216+200	*	Right	30.46
45	Shri Sai Public School	Halageri	224+800	215+350	Right	16.00
46	Govt. Urdu Lower Primary School	Halageri	225+480	216+040	Right	40.00
47	Govt. Higher Primary School	Halageri	225+500	216+040	Right	42.00
48	SGK Pvt. ITI	Halageri	225+650	216+200	Left	15.00
49	Govt. Urdu High School	Halageri	225+850	216+400	Right	236.06
50	Govt. Primary School	Malanayakanahalli	239+450	229+600	Left	17.60
51	ICDS (Aanganwadi)	Malanayakanahalli	239+470	229+645	Left	51.00
52	Govt. Lower Primary School	Thimmenahalli	240+270	230+440	Left	13.50
53	Govt. Primary School	Tuminakatte	242+150	*	Left	113.53
54	Swami Vivekananda High School	Tuminakatte	242+200	*	Right	165.01
55	Govt. Primary School	Chatnalli	248+550	238+190	Left	57.74

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
56	Sri Ranganatha Swami PU College	Hallur	251+530	241+170	Left	11.20
57	ICDS (Aanganwadi)	Hallur	252+200	241+850	Right	11.75
58	Govt. Lower and Higher Primary School	Hanumasagara	258+400	247+840	Left	17.20
59	Govt. Lower Primary School	Hanumasagara	259+040	248+465	Right	9.50
60	ICDS (Aanganwadi)	Hanumasagara	259+000	248+430	Right	60.45
61	Library	Anjanapura	263+280	252+570	Right	11.78
62	ICDS (Aanganwadi)	Honnali	263+290	252+590	Right	12.60
63	Swami Vivekananda English Medium School	Honnali	263+640	252+950	Left	22.50
64	ITI	Honnali	263+650	252+970	Left	61.53

(*Source: Field Survey conducted by ICT Pvt. Ltd.*)
Distance in meter from existing centerline
* Realignment / bypass proposed in this section



Govt Higher Primary School at Ch. Km 202+075 on LHS

Swami Vivekananda English Medium School at Ch. Km 263+640 on LHS

245. **Religious Places:** 95 religious places are located on either side of the project road, out of which 52 religious places are located on the right side and 43 are located on the left side of the project road. Chainage wise list of religious places along with distance from the center line of the project road are given in **Table-76**.

Table 76: List of Religious Places along the Project Road

S.N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1.	Small Shiv Temple	Gadag	106+980	106+490	Left	35.13
2.	Mini Worship Place (Durga)	Kalasapura	108+550	108+060	Left	8.95
3.	Mini Worship Place (Siddhi Lingeshwara)	Gadag	109+635	109+150	Right	14.74
4.	Road Side Mini Worship Place (Lingeshwara)	Beladadi	115+600	*	Right	8.87
5.	Manjunath Temple	Yalishirur	122+550	122+110	Right	25.67
6.	Guru Mallaja Temple	Soratoor	126+225	*	Left	34.57
7.	Idgah	Soratoor	126+760	*	Left	10.75
8.	Mosque	Soratoor	129+430	*	Left	4.47
9.	Ganapati Temple	Shirahatti	130+600	*	Left	10.22
10.	Devi Temple	Shirahatti	137+040	135+250	Right	18.20
11.	Mylara Lingeshwara Temple	Chabbi	137+720	135+950	Right	10.00

S.N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
12.	Side Mini Worship Place (Hollalama)	Devihala	144+120	142+340	Right	14.20
13.	Hanuman Temple	Devihala	144+350	142+580	Right	11.62
14.	Panduranga Temple	Devihala	144+360	142+575	Right	52.64
15.	Mini Worship Place (Hanuman)	Bellahati	148+525	*	Left	9.79
16.	Benchamma Temple	Bellahati	149+100	*	Right	4.12
17.	Renkaji Temple	Bellahati	149+300	*	Left	39.90
18.	Devamma devi Temple	Bellahati	149+425	*	Left	19.27
19.	Basaveshwara Temple	Bellahati	149+800	*	Right	24.55
20.	Mini Worship Place (Basaveshwara)	Narayanapura	150+225	*	Left	14.16
21.	Basaveshwara Temple	Narayanapura	152+000	150+560	Left	6.93
22.	Gram Devta Temple	Algilwada	155+950	154+500	Right	32.50
23.	Hanuman Temple	Algilwada	160+625	*	Right	10.97
24.	Durgamma Platform	Itagi	167+000	*	Left	8.15
25.	Panduranga Temple	Itagi	167+300	*	Left	226.43
26.	Basaveshwara Temple	Itagi	170+900	*	Left	4.72
27.	Side Mini Worship Place	Itagi	171+170	*	Left	6.82
28.	Mini Worship Place (Mylara Lingeshwara)	Itagi	171+180	*	Right	13.28
29.	Mini Worship Place (Honetamma)	Itagi	171+300	*	Right	8.41
30.	Mini Worship Place	Itagi	171+500	165+200	Left	3.98
31.	Mini Worship Place	Teredahalli	171+580	165+300	Right	9.02
32.	Basaveshwara Temple	Meundi	172+225	165+930	Left	28.15
33.	Hanuman Temple	Guyilagundi	174+225	*	Left	36.86
34.	Kalaseshwara Temple	Guyilagundi	176+550	*	Right	67.54
35.	Small Basaveshwara Temple	Guyilagundi	176+920	*	Right	6.48
36.	Mini Worship Place (Hanuman)	Belavegi	180+600	170+525	Right	6.49
37.	Mini Worship Place (Shiv)	Havanoor	184+550	174+450	Left	35.35
38.	Small Basaveshwara Temple	Guttal	187+650	177+550	Right	7.34
39.	Mylara Lingeshwara	Guttal	189+525	*	Left	12.26
40.	Dargah	Guttal	190+300	*	Left	10.05
41.	Mini Worship Place (Shiv)	Guttal	190+850	*	Left	11.83
42.	Mini Worship Place (Uttudamma)	Guttal	191+275	*	Right	9.00
43.	Small Udchamma Temple	Thimmapur	194+350	183+750	Right	20.87
44.	Mini Worship Place (Mylara Lingeshwara)	Thimmapur	195+260	184+665	Left	4.30
45.	Beeralingeshwara Temple	Nookapura	196+850	186+225	Right	25.77
46.	Beeralingeshwara Temple	Nookapura	196+860	186+235	Right	34.63
47.	Mini Worship Place (Nag Dev)	Honnatti	198+670	188+020	Right	36.56
48.	Mini Worship Place (Mylara Lingeshwara)	Honnatti	199+860	*	Right	40.75
49.	Mini Worship Place	Honnatti	200+520	*	Right	36.75
50.	Honetemma Temple	Honnatti	200+760	189+950	Right	66.75
51.	Mini Worship Place (Nag Dev)	Kerimallapur	202+975	192+055	Right	6.00
52.	Shiv Temple	Guddapura	207+850	196+910	Right	44.96
53.	Chouramma Temple	Guddada Anveri	208+460	197+510	Right	4.55
54.	Mini Worship Place (Hanuman)	Guddada Anveri	209+780	198+800	Right	6.88
55.	Swami Temple	Guddada Anveri	210+330	199+375	Right	52.25
56.	Small Hanuman Temple	Guddada Anveri	210+470	199+480	Right	10.00
57.	Mini Worship Place	Ranebennur	213+760	*	Left	8.00
58.	Basaveshwara Temple	Ranebennur	215+220	*	Right	8.14
59.	Mini Worship Place (Beeralingeshwara)	Ranebennur	215+590	*	Right	37.51
60.	Mallikarjuna Temple	Ranebennur	216+075	*	Right	16.12

S.N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
61.	Shree Anjaneya Temple	Ranebennur	216+110	*	Left	8.87
62.	Choudamma Temple	Halageri	224+975	215+515	Right	9.90
63.	Mosque	Halageri	225+400	215+940	Right	46.64
64.	Idgah	Kuppellur	232+325	*	Left	14.50
65.	Durgamma Temple	Malanayakanahalli	239+490	229+660	Left	23.03
66.	Basaveshwara Temple	Thimmenahalli	240+390	230+555	Left	32.95
67.	Idgah	Thimmenahalli	240+700	230+870	Left	29.28
68.	Mazar	Thimmenahalli	240+960	*	Right	121.72
69.	Mini Worship Place (Mylara Lingeshwara)	Tuminakatte	241+350	*	Left	17.52
70.	Banashankari Temple	Tuminakatte	241+510	*	Left	16.89
71.	Mini Worship Place (Nag Dev)	Tuminakatte	241+520	*	Left	11.46
72.	Hanuman Temple	Tuminakatte	241+630	*	Left	18.70
73.	Kalka Devi Temple	Tuminakatte	241+635	*	Left	13.55
74.	Durga Temple	Tuminakatte	241+940	*	Left	6.34
75.	Ayyappa Swami Temple	Tuminakatte	242+100	*	Left	51.49
76.	Mini Worship Place	Tuminakatte	242+200	*	Right	7.76
77.	Choudamma Temple	Tuminakatte	242+300	*	Left	13.89
78.	Mini Worship Place	Tuminakatte	242+510	*	Right	7.92
79.	Mini Worship Place (Gram Devta)	Kirigeri	244+660	234+450	Right	17.95
80.	Bhuteshwara Temple	Kirigeri	245+380	235+155	Left	20.15
81.	Hanuman Temple	Chatnalli	245+950	235+700	Left	7.32
82.	Bhairo Siddeshwara Temple	Chatnalli	245+975	235+750	Right	36.50
83.	mini Worship Place (Kalamma Devi)	Puradakeri	249+915	239+580	Right	13.63
84.	Mini Worship Place (Bhutnath)	Puradakeri	250+120	239+780	Right	5.83
85.	Chowdeshwari Devi Temple	Hallur	251+150	240+805	Left	15.48
86.	Hanuman Temple	Hallur	252+150	241+900	Right	205.36
87.	Lakshmi Ranganatha Temple	Hallur	252+950	242+150	Right	569.21
88.	Hanuman Temple	Hanumasagara	258+425	247+860	Left	9.71
89.	Durga Temple	Hanumasagara	258+440	247+900	Left	22.59
90.	Mini Worship Place (Hanuman)	Hanumasagara	259+035	248+460	Left	9.47
91.	Mini Worship Place (Mylara Lingeshwara)	Anjanapura	263+240	252+540	Right	21.48
92.	Hanuman Temple	Anjanapura	263+270	252+560	Right	8.67
93.	Matingamma Temple	Anjanapura	263+300	252+590	Right	9.66
94.	Durgamma Temple	Honnali	263+400	252+700	Right	11.00
95.	Nilkantheswara Temple	Honnali	264+060	253+355	Right	26.36

(*Source: Field Survey conducted by ICT Pvt. Ltd.*) # Distance in meter from existing centerline

* Realignment / Bypass proposed in this section

246. ***Medical Facilities:*** There are 15 medical facilities; out of which, 7 are located on the right side and remaining 8 are located on the left side of the project road. Chainage wise list of medical facilities along with distance from the center line of the project road are given in **Table-77**.

Table 77: List of Medical Facilities along the Project Road

S.N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1.	Adamya Hospital & Orthocare Centre	Gadag	106+230	105+750	Right	14.56
2.	Govt. District Hospital	Gadag	110+000	109+500	Left	282.08
3.	Primary Health Centre	Nagavi	112+500	112+020	Left	86.05

S.N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
4.	Primary Health Centre	Guyilagundi	176+225	*	Left	16.22
5.	Veterinary Hospital	Guyilagundi	179+220	*	Right	22.65
6.	Veterinary Hospital Old Building	Guttal	189+600	*	Right	46.34
7.	Veterinary Hospital	Guttal	189+650	*	Right	31.70
8.	Shri Hemagiri Hospital	Guttal	190+050	*	Left	7.96
9.	Primary Health Centre	Honnatti	201+285	190+410	Left	42.23
10.	Primary Health Centre	Halageri	225+700	216+250	Right	23.84
11.	Primary Health Centre	Tuminakatte	241+360	*	Left	13.56
12.	Primary Health Centre	Hallur	252+130	241+750	Left	28.23
13.	Primary Health Centre	Hanumasagara	258+370	247+800	Left	15.82
14.	Ayurvedic Hospital	Hanumasagara	259+000	248+430	Right	10.50
15.	Old Hospital Building	Honnali	264+270	253+550	Right	5.93

(*Source: Field Survey conducted by ICT Pvt. Ltd.*) # Distance in meter from existing centerline

* Realignment / bypass proposed in this section

247. ***Hand Pump & Wells:*** There are 11 hand pumps and 8 bore well are located along the project road.

P. Archaeological Sites

248. There are no archaeological sites within 300 m on either side of the project road.

Q. Demographic Details of Affected Population

1. Total Affected Households

249. 1,518 households are likely to be affected due to the up-gradation of the existing road, out of which 310 structures households, 1203 land owners households and 5 tenants will be losing their livelihood. The details for the same are shown in **Table-78.**

Table 78: Number of Affected Households

Sl.No.	Type of Households	Number of Households	Number of Families*
1	Structure Owners	310	478
2	Tenants	5	8
3	Employees	0	0
4	Land Owners	1203	2,509
	Total	**1,518**	**2,995**

Source: Census Survey 2015-16

**Family as defined in RFCTLARRA, 2013.*

2. Number of Affected Persons (APs)

250. There are a total of 7,159 APs being affected due to the loss of land, structures and assets and income, which includes 3859 (53.90%) males and 3300 (46.10%) females. The average household size is 4.7 and the sex ratio amongst APs is 855 (**Table-79**).

Table 79: Number of Affected Persons

Sl. No.	Categories of APs	Number of Affected Persons	Percentage (%)
1	Male	3,859	53.90
2	Female	3,300	46.10
	Total	**7,159**	**100**

Source: Census Survey 2015-16

3. Religious Category

251. The majority of the PAHs belong to the Hindu religion (92.49 %) and (2.50 %) of them are Muslims. However, nearly (5.01 %) of households did not respond to the question related to religion. The trend shows that Hindu communities dominate the project road. **Table-80** delineates the religious categories of the affected households.

Table 80: Religious Categories of PAHs along the Project Road

Sl. No.	Religious Group	No. of Households	Percentage (%)
1	Hindu	1404	92.49
2	Muslim	38	2.50
3	NA/NR	76	5.01
	Total	**1,518**	**100**

Source: Census Survey, 2015-16

4. Social Categories

252. As per the census survey of all of the 1518 affected households, the social stratification of the project area shows that 362 households (23.85 %) are from general category, 567 households (37.35 %) are from other backward caste (OBC), 134 household (8.83 %) are from scheduled caste (SC), and 82 household (5.40%) are from scheduled tribe (ST) category. The details of social categories in the project area are presented in **Table-81**.

Table 81: Social Categories of the PAHs

Sl. No.	Type of Social Category	No. of Households	Percentage (%)
1	General	362	23.85
2	Other Backward Class	567	37.35
3	Scheduled Caste	134	8.83
4	Scheduled Tribe	82	5.40
5	NA/NR	373	24.57
	Total	**1,518**	**100**

Source: Census Survey 2015-16

5. Annual Income

253. The census data revealed that 150 affected households (9.88 %) earn income that is up to Rs. 30000. Most households (36.82 %) earn above Rs.1,00,000 annually, while 13.83 % households did not respond. The average income level of households is summarized in **Table-82**.

Table 82: Annual Income Level of the Affected Households

Sl. No.	Annual Income	No. of Households	%
1	24001-30000	150	9.88
2	30001 to 40000	109	7.18

Sl. No.	Annual Income	No. of Households	%
3	40001 to 50000	105	6.92
4	50001 to 60000	142	9.35
5	60001 to 70000	11	0.72
6	70001 to 80000	92	6.06
7	80001 to 90000	64	4.22
8	90001 to 100000	76	5.01
9	Above 100000	559	36.82
10	NA/NR	210	13.83
Total		**1,518**	**100**

Source: Census Survey 2015-16

6. Educational Status

254. A significant percentage of the head of affected households (28.52 %) are illiterate, 9.95 % are up to middle school, 15.09 % are below matric, 13.31 % APs are Matric (10th standard), 8.76 % are educated up to graduate level. The details are summarized in **Table-83.**

Table 83: Educational Status of Affected Population

Sl. No.	Type of Educational Category	No. of Head of Household	Percentage
1	Illiterate	433	28.52
2	Litterate	129	8.50
3	Up to middle (7th standard)	151	9.95
4	Below Matric (Below 10th standard)	229	15.09
5	Matric (10th standard)	202	13.31
6	Up to graduate	133	8.76
7	Above Graduate	53	3.49
7	NA/NR	188	12.38
Total		**1,518**	**100**

Source: Census Survey 2015-16

7. Occupational Status

255. The findings of census survey revealed that out of 1518 affected households, 60.47 % households are engaged in agriculture, 2.57 % are agriculture labour, 3.10 % are daily wage earner, and 7.77% households are carrying out businesses as their main occupation. The details of occupational status of affected households are summarized in **Table-84.**

Table 84: Occupational Status of Affected Households

Sl. No.	Occupation	No. of Households	Percentage
1	Agriculture	918	60.47
2	Agriculture Labour	39	2.57
3	Daily Wage Earner & Labour	47	3.10
4	Private Employee	48	3.16
5	Rural Artisan	3	0.20
6	Service	46	3.03
7	Unemployed	62	4.08
8	Business	118	7.77
9	NA	237	15.61
Total		**1,518**	**100**

Source: Census Survey 2015-16

8. Women Headed Households

256. In this road stretch out of 1518 affected households there are 44 women headed households being affected. From the field notes it is found that these households are characterized by higher number of dependents and the economic standing is also poor.

Table 85: Number of Women Headed Households

Sl. No.	Properties	No. of Women Headed Household	Percentage (%)
1	Land	18	90
2	Structure	2	10
Total		**20**	**100**

Source: Socio Economic Survey, 2015-16

V. ANALYSIS OF ALTERNATIVES

A. General

257. In the present chapter, development study of existing road (SH-57 & 26) has been considered for the improvement keeping in mind the environmental aspects associated. The analysis of alternatives has been carried out 'with the project' and 'without the project' scenarios in terms of potential environmental impacts. Further, analysis of alternatives have been done for bypasses and realignments to avoid the places of congestion, human settlements, environmentally sensitive areas keeping in view traffic condition, obligatory points, geometric designs, congestions and socio economic viability and other environmental aspects of the region.

258. The project Road SH-57 & SH-26 passes through few congested settlements having substandard horizontal geometry at few locations. Improvement through settlement may also account provision of service road for segregating local traffic from Highway traffic. Also this would lead to wider width of strip through settlement which would lead impact on existing settlers and in turn opposition for improvement from stake holders. It is to be also noted that in Indian scenario along the project road passing through settlements have sensitive establishments such as schools, colleges, hospitals etc. As such mixing of highway traffic with local traffic considering future several fold increase would lead to safety concerns and also increase in pollution level, noise level thus jeopardizing settler's health and safety. Hence to minimize R&R (Rehabilitation and Resettlement) impact and to provide safety **three bypasses** (9.065 km) & realignments at **fourteen locations** (23.375 km) have been proposed with a total length of **32.440 km.** All the bypasses and realignments proposed are presented below:

Table 86: List of Proposed Bypasses / Realignment of SH-57 & SH-26

Sl. No.	Name of Town/Village	Chainage along Existing Alignment (km)			Chainage along Bypass/Realignment (km)		
		Start	End	Length	Start	End	Length
Proposed Bypass							
1	Shirahatti	128+350	132+105	3.755	127+090	130+090	3.000
2	Bellahati	148+500	151+422	2.922	146+150	149+365	3.215
3	Guttal	188+700	192+140	3.440	178+660	181+510	2.850
						Total Length	**9.065**
Realignments and Geometric Improvements							
1	Realignment for Beladhadi	115+500	116+466	966	114+800	115+600	0.800
2	Realignment for Soratur	125+300	127+115	1815	124+570	125+650	1.080
3	Geometric Improvement from Ch. 150+115 to Ch. 150+915	152+000	152+928	928	150+115	150+915	0.800
4	Realignment for Alagilawad	155+640	156+247	607	153+615	154+115	0.500
5	Realignment from Ch. 157+130 to Ch. 159+160 including Major Bridge at Ch. 158+591	159+320	161+534	2214	157+130	159+160	2.030
6	Realignment for Itagi, Taredahalli and Mevundi Villages	164+250	172+208	7958	161+850	166+015	4.165

Sl. No.	Name of Town/Village	Chainage along Existing Alignment (km)			Chainage along Bypass/Realignment (km)		
		Start	End	Length	Start	End	Length
7	Realignment for Gullagundi, Meeralagi M Guttal	173+675	180+808	7133	167+280	170+880	3.600
8	Realignment for Gudivanti	199+400	200+665	1265	188+770	189+900	1.130
9	Ranebennur Realignment	212+950	216+195	3.245	201+965	205+290	3.325
10	Realignment for MJB @ Ch. 222+710	231+870	232+676	806	222+350	223+130	0.780
11	Geometry Improvement	234+480	235+596	1116	224+930	225+800	0.870
12	Tuminakatte Realignment	240+515	242+895	2.380	230+890	232+715	1.825
13	Geometry Improvement	255+200	256+971	1771	244+780	246+450	1.670
14	Geometry Improvement	259+200	260+138	938	248+700	249+500	0.800
						Total Length	**23.375**

259. The study and analysis has been based upon Google Aerial view and ground verification of the possible alignments. A 2-lane section with 7 m wide carriageway and 1.5 m wide paved shoulder and 1m earthen shoulder on both sides with proposed ROW of minimum 26 m has been proposed for all the bypasses & realignments.

B. "With" and "Without" Project Scenario

260. The Project road between Gadag to Honnali forms an important connectivity between three districts Gadag, Haveri & Davanagere and in existing condition is intermediate lane. The project road is being developed on a North-South corridor development concept based on the feasibility study done on the Core Road Network (CRN). The proposed improvement proposal would help to uplift the project road of SH 57 & SH-26 to the required design & geometric standards. The improvement proposal would facilitate capacity augmentation and safer movement of people and goods and is designed for minimum speed of 80 km per hour in open country locations and minimum speed of 50 to 60 km per hour in settlement locations.

1. Current Project Road Condition and Improvement recommendation:

261. The existing Project road at majority location is intermediate lane and a few locations found to be single lane carriageway.

262. *The proposed improvement would now address the current and future capacity augmentation. As part of the improvement for capacity augmentation and improve safety of highway users, existing carriageway is widened with 7 m carriageway way and 1.5 m paved shoulders on both sides*

263. With the history of roject road once village road further upgraded to SH, however without any geometrics improvement as per codal provision, majority section of the project road has both horizontal and vertical geometric deficiencies not confirming to design standards and the same is indicated in **Figure-21**. Due to these sharp curves, the traffic movement is subjected to inconvenience and also would lead to unsafe movement of traffic resulting in accidents.

Figure 21: Project Road with Geometric deficiencies observed in majority sections

264. *The proposed improvement proposal now address these deficiencies and are corrected as stipulated in applicable standards and codes. As such the improvement proposal would lead to several realignments. Further this would help reduce travel time and help in safer movement of traffic.*


Causeways along the Project Road

265. There are **13 Causeways** along the project road where new high level bridges need to be constructed. These cause ways sometimes during heavy rains would lead to disrupt movement of traffic. Also due to these deficiencies the project road also becomes less preferred option for travel.

266. *The proposed improvement proposal now, recommends and has designed all weather permanent bridge structures as such movement of goods and people will not be hampered during heavy rains and maintain free flow movement of traffic.*

267. The project road passes through various small and big settlements. Some of the major settlements along project road include Shirahatti, Bellahati, Itagi, Guttal, Ranebennur, Tuminakatte and Honnali etc.

Settlements on Both sides at Tumminakatte

Settlements on Both sides at Ranebennur

268. *The project road when passing through settlement location is now proposed with urban cross-section within 16 m at settlement locations with no commercial activities and includes two lane carriageway, 2.0 m paved shoulders and footpath with drain / utility on both sides, (TCS 4). Some of these locations include Yalishirur, Chabbi, Alagilawad, Honnati, Hallur settlements and etc. Settlement locations with commercial activities is proposed within Urban Cross-section within 20 m COI and includes 4-lane divided carriageway with, 2.0 m paved shoulders and* footpath *with drain / utility on both sides (TCS 3). Some of these locations include Guivanti, Halageri settlements etc. Project road when passing through settlement locations with very poor geometry and improvement leading to impact of large scale settlements, sensitive receptors (temples, Educational institutions etc.) have been proposed with. 5 nos. of bypasses and realignments at 12 locations, thus the long distance travelers can avoid congested settlements with local traffic.*

269. ***Other Improvements*:**

- The improvement proposal has also proposed one ROB structures along existing at grade railway crossing thus ensuring safety and also faster movement of traffic.
- The proposed improvement also ensures that existing bridge structures, have been checked against 100 year return storm and improvement proposal drawn accordingly to meet the requirements. Thus improvement of drainage facilities along project roads in form of increased waterway vent for bridge structures and improvement proposal drawn for existing cross drainage structures would ensure quick disposal of storm water and improve living conditions of settlers in the vicinity.
- The improvement proposal also ensures provision of road side facilities which include Rest areas at Two (2) different locations, bus laybys and truck laybys. Road side furniture's such as signage's indicating restricted speed limits and other valuable information for road users are also proposed. The provision of bus laybys and truck laybys would ensure passengers safety and non-disruption of through traffic when busses stop at designated locations.

270. The major advantage of the proposed improvement proposal is that the project road connects several important tourist destinations as such improvement would facilitate improved tourist connectivity and boost economy due to increased number of tourists. Some of *these* attractions along project road include Trikuteshwara temple, Brahma Jinalaya & Ranebennur Wild Life Sanctuary.

Trikuteshwara Temple near Gadag

Brahma Jinalaya near Gadag

Ranebennur Wild Life Sanctuary

271. The proposed improvement proposal would facilitate connectivity to Major towns for business, Medical requirement, educational facilities, employment opportunities and market for finished goods also would ensure safer movement of goods and people.

272. Keeping this in view, the site conditions and the scope of development of the area, the 'with' and 'without' project scenarios have been compared as shown in Table-5.1. By looking at the table it *can* be concluded that "with" Project Scenario, with positive / beneficial impacts will greatly enhance social & economic development of the region and improve the environment, when compared to the "without" project scenario, which will further deteriorate the existing environment and quality of life. Hence the "With" project scenario with some reversible impacts is an acceptable option rather than the "Without" project scenario. The implementation of the project therefore will definitely be advantageous to improve the environmental quality of the sub-region besides to achieve an all-round development of the economy and progress of the region.

273. If the project is not implemented, the existing bad pavement of the corridor will deteriorate further. Increased air pollution, due to bad road condition, slow moving traffic and congestion *will* increase. Noise levels will rise due to deterioration of the pavement as well as increased honking. Without the improvement, the traffic would continue to pose a safety risk for the road users. There is little increase in the pollution levels during construction. Dust and particulate matter during construction will affect the air quality on a short-term basis. However, Potential benefits of the proposed road improvements are substantial and far reaching both in terms of the geographical spread and time.

274. Implementation of the project will be a definite advantage to Karnataka State in order to achieve all-round *development* of its economy and progress for its people. It will provide mitigation not only for air & noise level but will also provide other appropriate mitigative measures such as roadside plantation, arboriculture & landscaping, compensatory afforestation and other short term reversible negative impact on environment.

Table 87: "With" and "Without" Project Scenario

With Project		Without Project	
Impacts		Impacts	
Positive	Negatives	Positive	Negative
▪ With the improvement of road surface, the traffic congestion due to obstructed movement of vehicles will be minimized and thus wastage of fuel and emissions from the vehicles will be reduced reducing air pollution ▪ Improvement in ecology through compensatory afforestation ▪ Enhanced trade and commerce. ▪ The dust clouds associated with vehicles movement on tracks/earth roads will also be eliminated. ▪ Providing better level of service in terms of improved riding quality and smooth traffic flow. ▪ Reduction in accident rate ▪ Reduced transportation costs and increased access to markets ▪ Access to new employment opportunities ▪ Employment to local workers during the execution of the project ▪ Better access to health care centers and other social services ▪ Improved quality of life ▪ Strengthening of local economies and local industries.	▪ Minor changes in land use pattern ▪ Loss of some properties and livelihood ▪ Removal of vegetative cover along the road ▪ Minimum diversion of forest land ▪ Increase in air pollution due to increased vehicular traffic ▪ Short term increase in dust due to earth work during construction at micro-level ▪ Increase in noise pollution during construction phase	Nil	▪ Increase in travel time ▪ Increase in fuel consumptions ▪ Increase in dust pollution & vehicular emission ▪ Increase in accident rate ▪ Overall economy of the State will be affected. ▪ Further deterioration of the project road ▪ Increased vehicle operation cost ▪ Reduced employment/ economic opportunities ▪ Arrest of possible significant enhancement and economic development of the region ▪ Land degradation, dust pollution and damage to agricultural land, contamination in water bodies due to vehicles traveling along multiple tracks on the open ground ▪ In absence of the project, it will be difficult for the state to finance such a massive improvement of the road infrastructure from its own resources.

C. Analysis of Alternatives

275. Various factors that influence selection of realignment are as given below. After careful *evaluation* preferred option is recommended for the proposed Highway alignment.

- Length of Proposed Option
- Road Geometric Standards
- Spread of the town i.e. left side or right side
- Type of Land Acquisition
- Structures – Minor Bridges, Major Bridges
- Environmental Constraints
- Social Impact – Relocation and Rehabilitation costs.
- Construction Problem
- Cost

1. Shirahatti Bypass

276. The project road passes through Shirahatti town from existing Km. 129+400 to Km. 130+700. The existing project road is intermediate lane width from Km. 129+400 to Km. 130+100 with building to building distance approx. 8-10m and further is 4-lane section from existing Km. 130+100 to Km. 130+*600*. .There is a 90 degree bend at existing Km. 129+900 and poor road geometry of curves radius varying from 30 m to 110 m which do not conform to codal provisions and also improvement proposal through town could impact structures on both side of the project road. SH-136 crosses the project road at existing Km. 130+100. To avoid large scale R&R impact on both residential and commercial structures, religious structures buildings along the existing alignment and from safety consideration, proposal of bypass is recommended for Shirahatti Town.

277. Two bypass options on both sides of the existing road are studied and further compared with the improvement along *existing* alignment as shown in **Figure-22** and comparison on various parameters is given below:

- Bypass Option I: Bypass on LHS of existing road
- Bypass Option II: Bypass on RHS of existing road

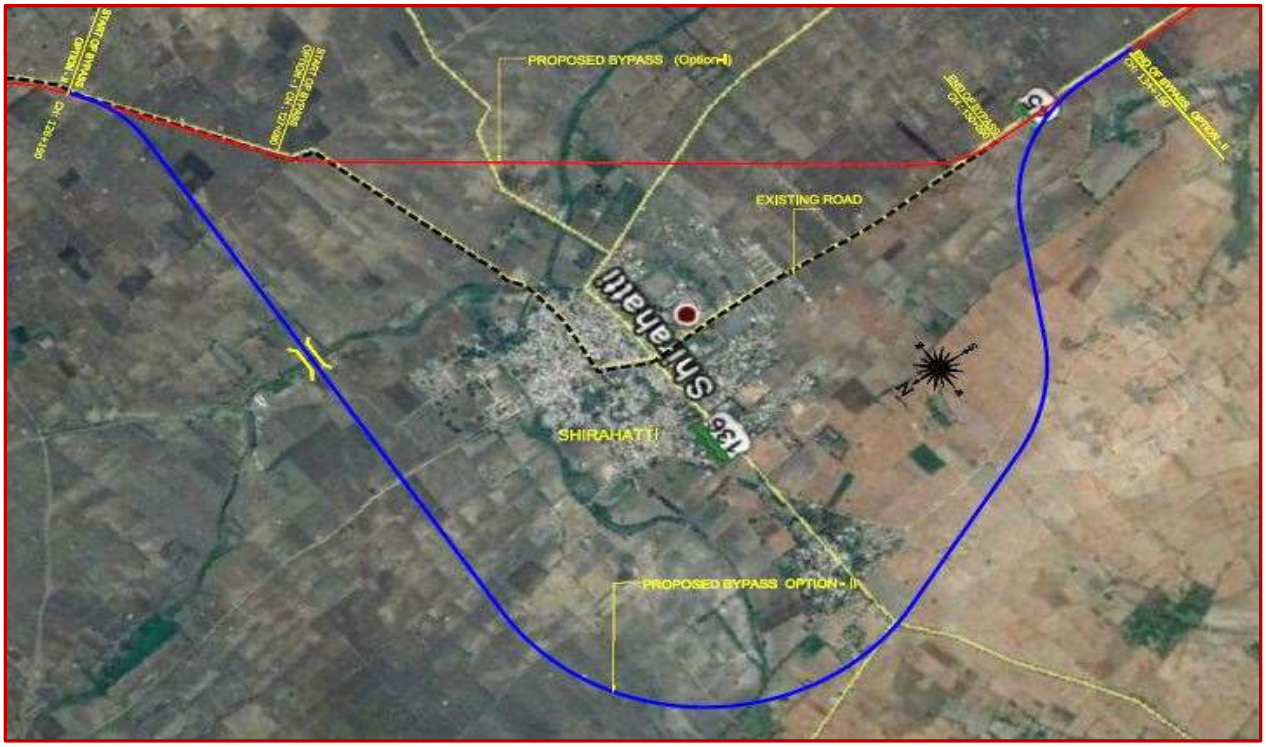


Figure 22: Proposed Shirahatti Bypass Options

Factor	Option I	Option II	Existing Alignment
Bypass Length (Km)	3.000	8.000	--
Length of corresponding Existing Road to be Bypassed (Km)	3.755	5.335	3.755
Net Increase in Project Length due to Proposed Bypass (km)	-0.755	2.665	--
Geometrics	Good	Good	Poor Geometry, and

Factor	Option I	Option II	Existing Alignment
			passing through congested town with settlements and commercial activities on both sides
Proposed Lane Configuration	2-lane with paved shoulders	2-lane with paved shoulders	4-lane with Foot path and Utilities on both sides.
Land Acquisition (Hectare)	9.0	24.0	--
Change in land use	Medium	High	Low
Trees to be felled	Low	Low	High
R&R Impact	Low	Low	High
Bridges/ structures.	1	1	1
Junctions	2	1	1
Construction Cost (Crs.)	10.5	28.00	16.89

278. Length of proposed alignment in option I is less than option II as the spread of town is more towards RHS. Construction *cost* of Option-I is much less than of Option-II Therefore, Option-I is recommended in the improvement proposal.

2. Bellahati Bypass

279. The project road passes through Bellahati town from existing Km. 148+500 to Km. 150+700. Radius of the existing alignment *varies* from 50 m to 200 m with four back to back curves of radius of 50 m to 80 m in a short length of 350 m. Apart from this, there is a 90 degree bend at existing Km. 149+200. The geometry of the existing road is not conforming to codal provisions and also improvement proposal through town could impact structures on both side of the project road. To avoid large scale R&R impact on both residential & commercial structures and religious structures along the existing alignment and from safety consideration, proposal of bypass is recommended for Bellahati Town. Two bypass options on both sides of the existing road are studied and further compared with the improvement along existing alignment through the town as shown in **Figure-23** and comparison on various parameters is given below:

- Bypass Option I: Bypass on RHS of existing road
- Bypass Option II: Bypass on LHS of existing road

Factor	Option I	Option II	Existing Alignment
Bypass Length (Km)	3.215	4.700	--
Length of corresponding Existing Road to be Bypassed (Km)	2.922	4.270	2.922
Net Increase in Project Length due to Proposed Bypass (km)	0.293	0.430	--
Geometrics	Good	Good	Poor Geometry, and passing through congested town with settlements and commercial activities on both sides
Proposed Lane Configuration	2-lane with paved shoulders	2-lane with paved shoulders	4-lane with Foot path and Utilities on both sides.
Change in land use	High	High	Low
Trees to be felled	Low	Low	High

Factor	Option I	Option II	Existing Alignment
Land Acquisition (Hectare)	9.63	14.1	--
R&R Impact	Low	Low	High
Bridges/ structures.	1	1	1
Junctions	2	2	3
Construction Cost (Crs.)	11.23	16.45	13.15

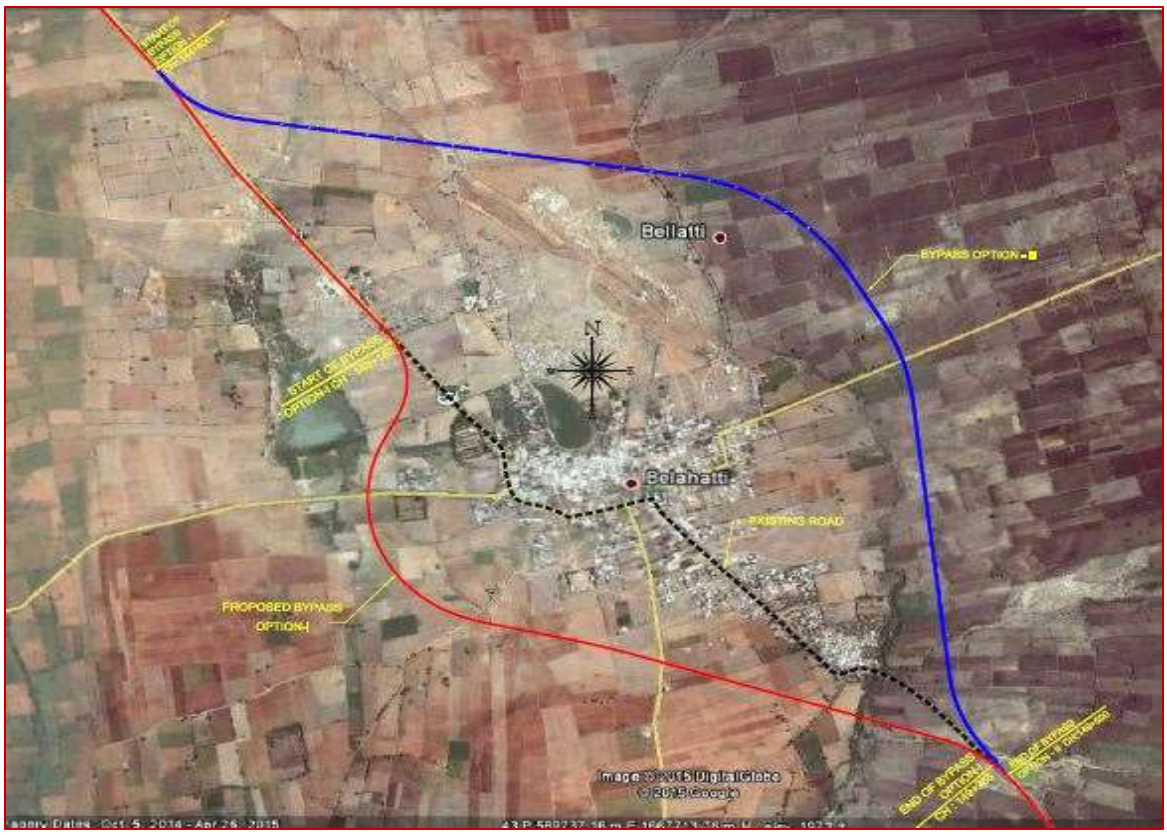


Figure 23: Proposed Bellahati Bypass Options

280. Length of proposed alignment in option I is less than option II, which in turn will require less land for the acquisition. Construction cost of the proposed bypass in case of option I (on RHS) is also less than that option II. Therefore, **Option I** is recommended in the improvement proposal.

3. Guttal Bypass

281. The project road passes through Guttal town from existing Km. 187+700 to Km. 189+100. Radius of the existing alignment varies from 20 m to 170 m with two 90 degree bends. There are commercial *activities* on both sides of the project road in Guttal Village. The geometry of the existing road is not conforming to codal provisions and also improvement proposal through town could impact structures on both side of the project road. Apart from above, there is a broken back curve just after the village and a causeway where the high level bridge is required. A section of project road in the main market area is 4-lane divided carriageway. To avoid large scale R&R impact on residential, commercial and religious structures along the existing alignment and from safety consideration, proposal of bypass is recommended for Guttal Town. Two bypass options on both sides of the existing road are studied and further compared

with the improvement along existing alignment through the town as shown in **Figure-24** and comparison on various parameters is given below:

- Bypass Option I: Bypass on LHS of existing road
- Bypass Option II: Bypass on RHS of existing road

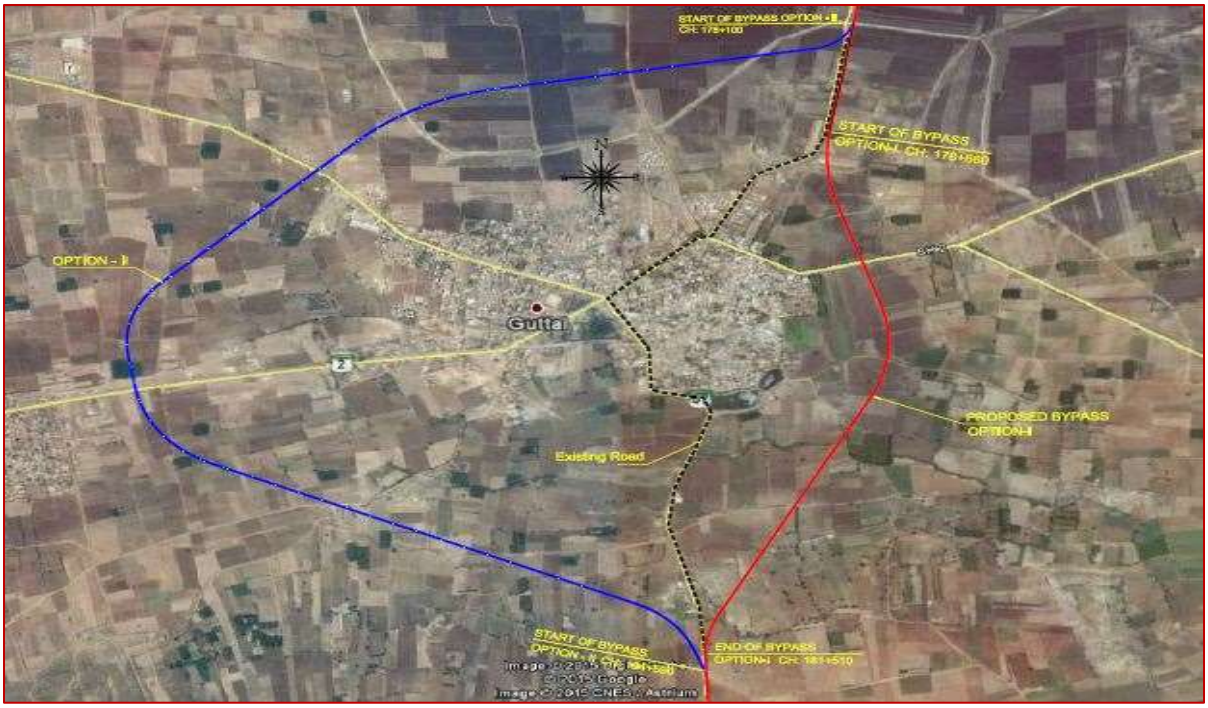


Figure 24: Proposed Guttal Bypass Options

Factor	Option I	Option II	Existing Alignment
Bypass Length (Km)	2.850	6.490	--
Length of corresponding Existing Road to be Bypassed (Km)	3.440	3.900	3.440
Net Increase in Project Length due to Proposed Bypass (km)	-0.590	2.590	--
Geometrics	Good	Good	Poor Geometry, and passing through congested town with settlements and commercial activities on both sides
Proposed Lane Configuration	2-lane with paved shoulders	2-lane with paved shoulders	4-lane with Foot path and Utilities on both sides.
Change in land use	Medium	High	Low
Trees to be felled	Low	Low	High
Land Acquisition (Hectare)	8.55	19.47	--
R&R Impact	Low	Low	High
Bridges/ structures.	Nil	Nil	Nil
Junctions	1	2	3
Construction Cost (Crs.)	9.975	22.715	15.48

282. Length of proposed alignment in option II is more than double the length of alignment in option I as the spread of town is more on RHS. Accordingly the Land Acquisition shall be less in case of Option I. With Option I *alignment*, the proposed length of project road further reduces by 590 m, whereas in option II, the length of project road increases by 2590 m. Construction cost of the proposed bypass in case of option I is also much less than that in case of option II. Therefore, **Option I** is recommended in the improvement proposal.

4. Ranebennur Realignment

283. The project road passes through Ranebennur Town from existing Km. 212+800 to existing Km. 216+700. Project road crosses railway level crossing at existing Km. 212+630 where ROB is to be proposed. Radius of the existing alignment varies from 70 m to 170 m with two 90 degree bends. Existing road is 4-lane with paved shoulder from existing Km. 214+250 to Km. 214+850 which was part of old NH-4 and having building to building distance of about 25 m to 27 m. Existing project road is very congested from existing Km. 212+800 to Km. 214+250 with building to building distance of about 8-10m.Project road from Km. 214+850 to Km. 216+700 is intermediate lane width with building to building distance of about 20 m to 22 m. There are residential and commercial activities on both sides of the project road. Geometry of the existing road is not conforming to codal provisions. To avoid large scale R&R impact on residential and commercial structures, educational institutes along the existing alignment and from safety consideration, proposal of realignment is explored for Ranebennur Town.

284. NH-4 is already bypassing to Ranebennur town and is crossing our project road at existing Km. 216+730 with Underpass. Since portion of old NH-4 is already 4-lane road with paved shoulder with 25 to 27 m building to building distance and is passing through the Ranebennur *town* and joins our project road at existing Km. 214+250, it is proposed to use the existing 4-lane with paved shoulder section of NH-4 and connect it to proposed bypass alignment. Since extent of Ranebennur town is more on LHS side of the project road, two realignment options on RHS are studied and further compared with the improvement entirely along existing alignment through the town as shown in **Figure-25** and comparison on various parameters is given below:

- Option I : Realignment on RHS of existing road and using existing 4 lane old NH-4
- Option II : Realignment on RHS of existing road and crossing over NH-4.

Factor	Option I	Option II	Existing Alignment
Realignment Length (Km)	3.325	7.500	--
Length of old NH-4 being used	1.400	-	-
Length of corresponding Existing Road (Km)	3.245	6.620	3.245
Net Increase in Project Length due to Proposed Realignment (km)	1.480	0.880	--
Geometrics	Good	Good	Poor Geometry, and passing through congested town with settlements, school and commercial activities on both sides.
Change in land use	Medium	High	Low
Trees to be felled	Low	Medium	High
Land Acquisition (Hectare)	10.05	22.5	--
R&R Impact	Low	Low	High

Factor	Option I	Option II	Existing Alignment
Flyover	-	3	-
ROB	1	1	1
Junctions	3	2	3
Construction Cost (Crs.)	26.725	50.250	16.225

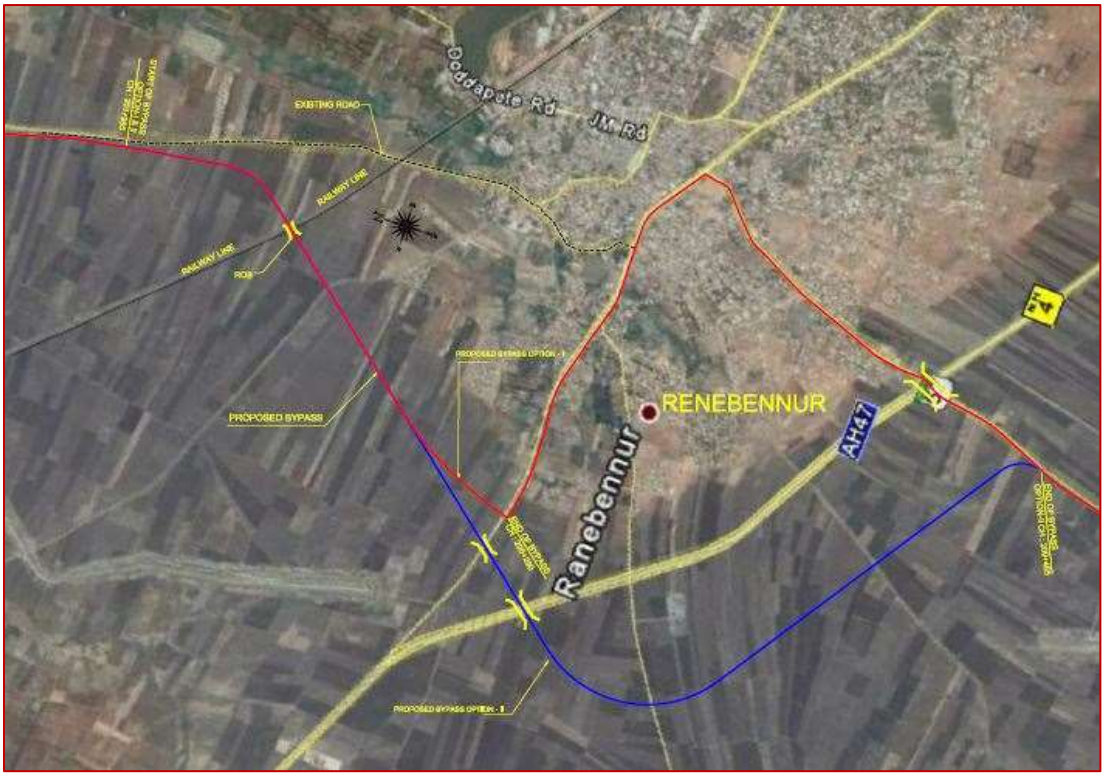


Figure 25: Proposed Ranebennur Realignment Options

285. In case of option I, it is proposed to connect the bypass with old NH-4 and use the existing 4-lane with paved shoulder section of *old* NH-4 for about 1400 m. In this option, the congested stretch of Ranebennur town (from Km 212+800 to Km 214+250) is proposed to be realigned (which otherwise require huge R&R) and use the existing section of old NH-4 and SH-57. Further in the above option, it is proposed to retain the existing 4-lane section from Ch. 205+300 to Ch. 207+700 and 2-lane section from Ch. 207+700 to Ch. 209+500 which will reduce the project cost. The land acquisition requirement shall also be less in this case.

286. In option II, the realignment is proposed over old NH-4 and NH-4 with Flyovers at both the locations and then connects to project road. In this option, two Flyovers over old NH-4 and NH-4 need to be provided. Land acquisition *is* also more in this case. Since NH-4 is on high embankment with service roads on both sides, keeping the future widening of NH-4 into consideration, a Flyover of minimum 60m length needs to be provided. This option also requires approval from NHAI. ROB is to be provided in each option as project road crosses railway line including in proposed realignment. Construction cost of project road in case of option I is less than that of Option II. Therefore, **Option I** is recommended in the improvement proposal.

5. Tuminakatte Realignment

287. The project road passes through Tuminakatte town from existing Km. 238+600 to existing Km. 239+600. Radius of the existing *alignment* varies from 10 m to 50 m with two 90 degree bends. There are commercial activities on both sides of the project road with building to building distance of about 8-10 m. There is an old temple abutting project road at km. 239+200 and is also on a sharp bend. The geometry of the existing road is not conforming to codal provisions and also improvement proposal through town could impact structures on both side of the project road.

288. To avoid large scale R&R impact on residential, commercial and religious structure and from safety consideration, proposal of realignment is recommended for Tuminakatte Town. Two realignment options on both sides of the existing road are studied and further compared with the improvement along existing *alignment* through the town as shown in **Figure-26** and comparison on various parameters is given below:

- Realignment Option I: Bypass on LHS of existing road
- Realignment Option II: Bypass on RHS of existing road

Factor	Option I	Option II	Existing Alignment
Realignment Length (Km)	1.825	3.700	--
Length of corresponding Existing Road (Km)	2.380	3.400	2.380
Net Increase in Project Length due to Proposed Realignment (km)	-0.555	0.300	--
Geometrics	Good	Good	Poor Geometry, and passing through congested town with settlements and commercial activities on both sides
Proposed Lane Configuration	2-lane with paved shoulders	2-lane with paved shoulders	4-lane with Foot path and Utilities on both sides.
Change in land use	High	High	Low
Trees to be felled	Low	Low	High
Land Acquisition (Hectare)	5.47	11.1	--
R&R Impact	Low	Low	High
Bridges/ structures.	2	2	2
Junctions	1	1	2
Construction Cost (Crs.)	6.38	12.95	10.71

Figure 26: Proposed Tuminakatte Realignment Options

289. Length of proposed alignment in option II is almost double the length of option I whereas the corresponding existing road to be realigned is approx. 1.5 times only. Land Acquisition is also less in case of Option I. Moreover with Option I alignment, the proposed length of project road further reduces by 555 m, whereas in option II, the length of project road increases by 300 m. Construction cost of option I is also almost half than that in case of option II. Therefore, **Option I** is recommended in the improvement proposal.

6. Realignment from Ch. 157+130 to 159+160 including Major Bridge at Ch. 158+591

290. The project road passes through a series of sharp curves along project road and over existing major bridge in Village Tangod which is proposed for reconstruction due to inadequate hydrology and overtopping. Existing Major Bridge is constructed on S-Curve with radius of 100 m and 50 m. Moreover there are various sharp curves of radius varies from 45 m to 150 m along existing alignment which do not meet *codal* requirement.

291. Hence to improve the *safety* of road users and traffic management during construction, geometric improvement in form of realignment including realignment for major bridge (Ch. 158+591) between Ch. 157+130 to Ch. 159+160 is proposed. The realignment road length is 2030 m and the corresponding existing road length is 2215 m. Hence due to this realignment, length of proposed road reduces by 185 m. The proposed realignment on google Imagery is shown in **Figure-27.**

Figure 27: Proposed Realignment from Ch. 157+130 to Ch. 159+160 including Major Bridge at Ch. 158+591

7. Combined Realignment for Itagi, Taredahalli and Mevundi Villages

292. The project road from existing Km. 163+350 traverse towards East direction for a length of 2.5 km and connect Itagi Village. Existing alignment along the village portion is having curve radius varies from 25 m to 100 m which are not as per design standards. From there onwards, existing road takes a U-turn and travel towards west side for approx. length of 2 km and then again take a 90 *degree* turn towards South side and passes through congested Taredahalli Village where the existing road geometry is not as per standards having curve radius of 60 m to 150 m. After crossing the village, the project road again takes a 90 degree bend and shift towards west side where the existing alignment passes through village Mevundi. There is a sharp S-Curve along the village having curve radius of 100m on both ends with almost no straight length. Apart from above, the existing project road is too close (about 200 m) to the Tungabhadra River from existing Km. 170+000 to existing Km. 171+000.

293. Hence to improve the safety of road users, geometric improvement in form of realignment from Ch. 161+850 to Ch. 166+015 is proposed. The realignment road length is 4165 m and the corresponding existing road length is 7958 m. Hence due to this realignment, length of proposed road reduces by 3793 m. Any improvement proposal along existing alignment would also require substantial *realignment* for geometric improvement and further Land acquisition for the same. The proposed realignment on google Imagery is shown in **Figure-28.**

Figure 28: Proposed Realignment for Itagi, Taredahalli and Mevundi Villages

8. Combined Realignment for Guyilagundi, Niralagi and Belavegi Villages

294. The project road from existing Km. 173+000 to Km. 179+000 traverses through Guyilagundi, Niralagi and Belavegi Villages. At each village, there are settlements on both sides of the project road. Project road takes a 90 degree bend along the alignment at village location. In all there are 6 locations in this stretch where the existing project road takes 90 degree bend including that in the villages which is not as per design standards. Apart from above, there is an existing major bridge in Village Belavegi which is proposed for reconstruction due to inadequate hydrology and overtopping every year.

295. Hence to improve the safety of road users and avoid large scale R&R impact along the existing alignment at village locations and from safety consideration, geometric improvement in form of realignment from Ch. 167+280 to Ch. 170+880 is proposed. The realignment road length is 3600 m and the corresponding existing road length is 8055 m. Hence due to this realignment, length of proposed road reduces by 4455 m. Any improvement proposal along existing *alignment* would also require substantial realignment for geometric improvement and further Land acquisition for the same. The proposed realignment on google Imagery is shown in **Figure-29.**

Figure 29: Proposed Realignment for Guyilagundi, Niralagi and Belavegi Villages

VI. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Introduction

296. The proposed project will have impacts on the environment in two distinct phases. During the construction phase which may be regarded as temporary or short-term; the other during the *operation* stage which will have long term effects. The negative impacts can be reduced or minimized only if proper safeguards are put in place during the design and construction stage itself. These can include reducing pollutant discharge from the harmful activities at source or protecting the sensitive receptor. An effective mitigation strategy will utilize a combination of both options to arrive at practically implementable measures. Conscious efforts have been worked out to minimise any adverse impacts on the various environmental and social components. Where the impacts on various environmental components have been unavoidable, mitigation measures have been worked out.

B. Land Environment

1. Topography & Geology

297. ***Construction Phase:*** The impacts on existing topographical setting originate primarily from embankment preparation and opening up borrow pits to fulfill the requirement of huge quantity of earth material. Disfiguration of land may result from unplanned opening up of borrow pits / quarry *sites*. Aggregate and sand will be procured from the authorized suppliers and prevalent rules will be followed for borrowing of soil. Hence the impact on geology of the region is insignificant.

298. ***Impacts:***

- Disfiguration & change in existing profile of the land due to proposed K. R. Pet bypass and realignments at 14 locations
- Disfiguration of topography due to indiscriminate digging of borrow pits
- Uncontrolled digging of borrow pits resulting in water accumulation & breeding of vector disease
- Disturbance on geological setting due to quarrying

299. ***Seismological Characteristics of the Area:*** The project road is in Zone-II (having low seismic intensity) of the *seismic* map of India (as per IS:1893, Part-1, 2002), and therefore it will have a low risk of potential damage due to earthquake.

300. ***Road Building Materials:*** During road construction mainly stone aggregates & bitumen will be required for pavement, while stone aggregates, sand & cement will be required for concrete making for rigid pavement, bridges, culverts, urban drains etc. Diesel will be required to run construction equipment. Stone aggregates and sand will be brought from the pre-identified quarry areas. The contractors usually depend on the local commercial suppliers for obtaining various construction materials. Active existing sources are most likely to be used with cost and the quality considerations. The estimated raw materials requirement during construction stage is given in **Table-88**.

Table 88: Raw Materials Requirement during Construction

Sl. No.	Item & Unit	Quantity	Mode of Transport	Source
1.	Blue metal (m^3)	7,70,000	Truck	Pre-identified quarry areas
2.	Sand (m^3)	5,10,000	Truck	Pre-identified quarry areas
3.	Cement (MT)	41,000	Truck	Local traders
4.	Bitumen (MT)	23,000	Truck	Refinery
5.	Diesel (KL)	18,000	Tanker	Local petrol pumps
6.	Steel (MT)	7,645	Truck	Local traders
7.	Earth (m^3)*	32,00,000	Truck	Identified Borrow areas

301. ***Construction of Borrow Areas:*** about **32,00,000 cubic meter** of earth materials is to be used for the project road. This has to be obtained from earth generated through cutting of the road or from the existing borrow areas. Quantity of earth material likely to be generated through cutting operation is **10,75,000 Cum**. Therefore, **21,25,000 Cum** earth will required *from* the borrow area. The details of proposed borrow areas investigated with their respective locations; corresponding chainage and lead from nearest point to project road are tabulated in **Table-89**.

Table 89: Location of Proposed Borrow Areas

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Location / Village Name	Lead From Nearest Point on Project Road (km)	Type of Land	Approx. Quantity(m^3)
1.	92+000	RHS	Kiritigeri	2	Govt.	48,500
2.	100+500	LHS	Chikapa	7	Private	40,000
3.	106+550	RHS	Hulkot	12	Govt.	3,200,000
4.	110+900	LHS	Nagavi West	6	Govt.	300,000
5.	110+990	LHS	Nagavi West	5	Govt.	720,000
6.	116+000	LHS	Beladi	1	Private	81,000
7.	123+000	RHS	Surundari	1	Private	40,000
8.	128+000	LHS	Yalishrur	0.5	Private	97,000
9.	134+950	LHS	Varavi	6	Private	170,000
10.	139+150	LHS	Chebbi	4	Private	32,000
11.	149+300	LHS	Belatti	1	Govt.	65,000
12.	154+000	RHS	Hosur	1	Govt.	40,000
13.	158+000	RHS	Sibana	0.1	Private	36,000
14.	161+000	LHS	Tagoda	0.5	Govt.	121,000
15.	169+200	LHS	Maldi	0.2	Private	80,937
16.	171+600	RHS	Meundi	0.5	Private	202,342
17.	180+800	RHS	Belavigi	1	Private	202,342
18.	189+300	LHS	Guttal	3	Private	10,117
19.	192+150	RHS	Baradi	6	Private	93,000
20.	202+400	RHS	Mardi	0.5	Private	30,351
21.	208+850	RHS	Devarguda	0.5	Govt.	64,749
22.	225+450	RHS	Antrolly	0.5	Govt.	42,492
23.	237+550	LHS	Basapur	1	Private	48,562
24.	245+950	RHS	Beriyanapada	0.5	Govt.	1,011,712
25.	250+250	RHS	Hollur	0.5	Govt.	6,070,275
26.	255+050	RHS	Nalapa	0.5	Private	404,685
27.	257+400	RHS	Jhalgundi	2.3	Private	101,171
28.	260+550	LHS	Anali	0.3	Private	

302. If contractor decides to open new borrow area, Environment Clearance and is to be obtained from concerned authority. Opening of new borrow areas could lead to the formation of large depression. If no proper measures are taken, there could be loss of fertile top soil and loss of agriculture crops.

303. ***Establishment of Crushers:*** Contractor will be required to establish a number of crushers along the project road. It is the responsibility of the contractor to obtain statutory clearance (such as NOC from SPCB etc.) from concerned authorities before start of stone crushing operation. The maintenance and management of access road/ haul road could be a major impact. It is appropriate to consider the environmental implications in the selection of crusher areas since poor maintenance may create dust pollution, contribute to noise pollution, water pollution as well as loss of natural resources.

304. **Mitigation Measures**: All construction works are directly related to the land environment. Therefore, contractor needs to prepare / follow several mitigation / management plan / guidelines for various construction activities. These guidelines are listed below and detailed out in "Part-B Annexes of IEE & EMP".

- Guidelines for Siting and Layout of Construction Camp (Annex-8.2)
- Guidelines for Siting, Operation and Re-Development of Borrow Areas (Annex-8.4)
- Guidelines for Siting, Operation and Re-development of Quarrying and Stone Crushing Operations (Annex-8.5)
- Guidelines for Siting and Management of Debris Disposal Site (Annex-8.7)
- Guidelines for Preparing Comprehensive Waste Management Plan (Annex-8.8)

305. Some of the important provisions are *given* below:

- Earthquake resistance structures with seismic restrainers are being planned to be constructed under the project. Design of all structures like bridges and CD structures have taken the area's seismic characteristics into account.
- Opening up new borrow pits will be in accordance with the IRC: 10-1961 specifications. Topsoil from the new borrow pits should be preserved and reused in restoring the pits to the satisfaction of the Independent Engineer (IE). Opening up of new borrow pits will be restricted to 1 m depth followed by resurfacing of pits with top soil (15 cm).
- No borrow pits will be allowed in the forest land.
- Uncontrolled digging of borrow pits will be avoided to prevent water accumulation in abandoned pits which results in breeding ground of vector disease.
- Road building materials will be procured from existing approved and licensed quarries only where crusher is already operating. Therefore, mitigative measure for the environmental impacts due to quarrying and rehabilitation plan of the quarries is the responsibility and scope of the licence holder of the quarry.
- On owner's choice, borrow pits will be converted to water bodies (pond) with proper landscaping (i.e. rectangular in shape, proper sloping and plantation on the bank) which will add scenic beauty in those localities.

306. ***Operation Phase:*** During operation phase of the project road, no impact is anticipated on the topography and *geology* of the area.

2. Soil

307. **Impacts: Soil Erosion:** Erosion of topsoil can be considered a moderate, direct and long term negative impact resulting from construction and maintenance of the road. Erosion problems may occur on newly constructed slops and fills depending on the soil type, angle of slope, height of slope and climatic factors like wind (direction, speed & frequency) and rain (intensity & duration). In the project road, embankment will be raised for a length of **124.400 km**, out of which height of embankment is more than 3.0 m for a length of **16.745 km**. Slope protection measures (stone pitching or turfing with Coir Geotextile & Vetiver grasses) form part of good engineering practice and therefore, it has been incorporated into the EMP.

308. **Construction of Bridges & Culverts:** Along the corridor, new construction, replacement and widening of a number of major & minor bridges and culverts are planned. Construction of bridges involves excavation for construction of the foundation and piers. If the residual spoil is not properly disposed of, increased sedimentation may take place during the monsoon. During the construction period, some amount of drainage alteration and downstream

309. **Soil Contamination:** Contamination of the soil may take place from the following activities at the construction zones, construction labour camps and other auxiliary facilities required for the *construction*. Details of the activities from which contamination may occur are given below:

- Scarified bitumen wastes, excess production of bituminous product
- Debris generation due to dismantling of structures
- Maintenance of the machinery and operation of the diesel pumps, diesel generator sets, diesel storage and during transportation
- Operation of hot mix plant
- Storage and stock yards of bitumen and
- Form various activities in the labour camps

310. **Mitigation Measures: Top Soil Conservation:** The top soil from all sites including road side widening and working area, cutting areas, quarry sites, borrow areas, construction camps, haul roads in agricultural fields (if any) and areas to be permanently covered shall be stripped to a specified depth of 15 cm and *stored* in stock piles for reuse. At least 10% of the temporary acquired area shall be earmarked for storing top soil. Contractor has to strictly follow the "Guidelines for Tor Soil Conservation and Reuse" as given in **Annex-8.1**.

311. **Slope Stabilization:** Adequate measures like adequate drainage, embankment consolidation & slope stabilization will be taken along the road to avoid soil erosion. The slopes have been restricted to 1 vertical : 2 horizontal for most of the sections. Soil erosion through embankments will be prevented and controlled by stone pitching or turfing with Coir Geotextile & Vetiver grasses. Bio-engineering is the technique of utilizing vegetation in addressing geotechnical problems. Environmental uncertainties are prompting engineers to favour bioengineering measures. Vegetation as an aid to artificial methods in controlling surficial soil erosion is gaining larger acceptability among engineers all over the world. Growth of appropriate vegetation on exposed soil surface is facilitated by use of natural geotextiles such as Coir Geotextiles. Properly designed Coir Geotextiles lay on slopes or any other exposed soil surface provides a cover over exposed soil lessening the probability of soil detachment and at the same time reduces the velocity of surface runoff, the main agent of soil dissociation. Natural geotextiles bios-degrade quicker than man-made counterpart, but facilitate growth of vegetation

quicker and better due to its inherent characteristics. Road slope stabilization can range from allowing native grass (Vetiver grass) to re-establish on a disturbed slope to building an engineered wall. Guideline on Slope Stabilization is given in **Annex-8.3A**.

312. **Recycling of Bituminous Surface:** The bituminous pavement rehabilitation alternatives are mainly overlaying, recycling and construction. In the recycling process the material *from* deteriorated pavement, known as Reclaimed Asphalt Pavement (RAP), is partially or fully reused in fresh construction. Some of the advantages associated with pavement recycling are:

- Preservation of environment
- Reduction in greenhouse gases emission
- Conservation of energy
- Conservation of fresh aggregates and binder
- Minimization of health hazards
- Minimization of cost of construction
- Preservation of existing pavement geometrics etc.

313. Recycled Asphalt Pavement (RAP) material is found suitable for pavement construction and proposed in this project. Existing bituminous layer will be milled and used in RAP mix comprising 20 -30% of RAP and 70-80% of fresh aggregate depending on the grading. 38,910 *Cum* of existing bituminous surface generated from the existing road surface will be utilized. Various methods for recycling of bituminous pavement are given in Annex-8.3B.

314. **Disposal of Bituminous Waste:** no bituminous waste will be generated for disposal.

315. Accidental spills of lubricants / oil and *molten* asphalt will be avoided by following the "Guideline for Storage, Handling, Use and Emergency Response for Hazardous Substances" as given in **Annex-8.11**.

- Oil Interceptor shall be provided for wash down, refueling areas and accidental spill of oil and diesel.
- Vehicle parking area of the construction camp will be made impervious using 75 mm thick P.C.C. bed over 150 mm thick rammed brick bats. The ground will be uniformly slopped towards to adjacent edges towards the road. A drain will take all the spilled material to the oil interceptor.

3. Land Use

316. **Construction Phase**: Widening of existing road will lead to change in land use pattern of areas adjacent to *the* road that comes under the proposed ROW. The land use pattern in most of the stretch along the project road is agricultural (80.1%) followed by residential cum commercial area (16.1%) and forest (3.8%). Within ROW the land use is mainly open land with trees by the side of the earthen shoulder.

317. Preparatory activities like clearing of ROW, construction of temporary construction camps and godowns, storage of construction materials etc. will be confined within the camp & ROW. This will not *hamper* the land use aspects outside ROW. However, indirectly there may be some change in the land use pattern of the proximate area due to influx of construction work-force and supplier who are likely to construct temporary tents in the vicinity.

318. **Impacts:**

- Loss of agricultural land due to land acquisition for the road
- Changes in existing land use pattern of the ROW for construction of the road

319. **Mitigation Measures:**

- Earth material generated from excavation of roadways & drainage will be reused to the maximum possible extent as filling material during site development.
- The small amount of construction debris and surplus excavated material will be disposed of by mechanical transport in suitable pre-identified (jointly by project proponent & local administration) dumping areas in tune with the local condition to avoid land degradation & water logging due to indiscriminate dumping.
- Identification, operation and redevelopment of dumping areas will be as per the Guideline provided in Annex-8.7.
- Construction camp will be provided for construction personnel to avoid indiscriminate settlement of construction workers & labourers.
- Regular inspection of haul roads and construction site will be carried out to ensure regular and timely removal of construction debris to the designated dumping sites.
- Construction activities will be kept confined to ROW only.

320. **Operation Phase:** In the operation phase, *the* temporarily modified land use pattern such as temporary construction camps / tents would be dismantled. The road, after completion of its development, would consist of neat landscape to lead to a pleasing outlook.

321. The existing road passes through mainly agricultural field and some congested stretches of residential / commercial areas. The safe & quicker accessibility would result in increased scope of commercial, industrial and residential development along the project corridor. Squatter settlement and encroachment along the project road is very likely to take place unless proper controlled measures are adopted.

322. **Impacts:**

- Likely change of land use due to squatter / encroachment within ROW
- Likely change of land use due to induced roadside development outside the ROW

323. **Mitigation Measures:**

- Immediately after the construction phase, it is necessary to ensure that no further deterioration or major land use changes such as ribbon development takes place in a manner that will jeopardize the interests of the State.
- Squatter development along the project shall be strictly avoided by proper regulation and vigilance.
- Land use control measures will be prepared & administered to avoid occurrence of induced development as far as possible.
- Planning agencies and Collector/ Revenue Officer will be made involved for controlled development and prohibiting squatter / encroachment within ROW.

C. Water Environment

1. Drainage & Hydrological Flow

324. The project road runs through mainly plain terrain and crosses river & streams at six locations. The project road also crosses canal at twenty four locations. During heavy rainfall these natural drainage channels carry swift flow. As the existing CD structures and minor bridges will be suitably augmented & additional CD structures will be constructed, it will not obstruct the water flow in the channels. Therefore, no impact on drainage is envisaged.

Table 90: Location of River Crossings

SN	Description	Village	Existing Ch. km	Design Ch. Km
1.	Dodda Halla	Tangada	160+750	158+600
2.	Varada River	Guyilagundi	179+000	168+200
3.	Savala River	Guddadavaveri	210+500	199+500
4.	Hire Halla*	Halageri	223+280	213+870
5.	Kusaguru Halla	Godihal	231+250	221+750
6.	Kumadvati River	Kuppelur	232+220	222+700

325. **Impacts:**

- Change in drainage pattern of the land around bypass and realignments
- Increased incidence and duration of floods due to obstruction of natural drainage courses by the road embankment
- Chances of filling of existing drainage courses during earth filling
- There may be potential drainage impacts relating to the establishments of construction camps and various plants such as hot mix plant, batching & asphalt mixing plants etc. drainage impacts at these locations may result in loss of top soil.

326. **Mitigation Measures:**

- Adequate roadside drains will be provided along the road to facilitate its better maintenance and increase in the life of the carriageway. This will also help in avoiding soil erosion and land degradation due to water stagnation on the either side of the road. Length of lined drain along the project is 24.936 km on either side and the length of unlined drain is 217.910 km on either side.
- Detailed drainage survey and hydrological investigations have been carried out and accordingly capacity of existing drainage works & cross drainage (CD) structures have been duly augmented, wherever necessary, to accommodate high discharges to avoid flooding & formation of water pool
- Inadequate water vents of drainage structures now replaces with new drainage structures
- Adequate new drainage works & cross drainage (CD) structures have been provided for smooth passage of runoff to avoid flooding
- Filling of existing drainage courses will be strictly avoided
- Construction works of culverts and bridge (cross drainage structures) will be taken up during the lean flow periods in summer to minimize the impacts on drainage.
- Construction work near river / natural drainage channels / low lying areas have to be carried out in such a way that flow of water is not blocked and even if it has to be blocked then the contractor must ensure that the local communities are informed about the same in advance
- Suitable drainage at construction site & camp will be provided to eliminate the chances of formation of stagnant water pools that leads to soil erosion & breeding of mosquitoes

2. Drinking Water Sources

327. **Impacts:** 11 hand Pumps and 8 bore well are located within the proposed right of the way of the project road. Removal of all *drinking* water sources along the ROW is essential for the widening. This will lead to major community problems if not resolved.

328. **Mitigation Measures:**

- Affected hand pump, bore well and open well shall be relocated in such a manner that it should not hamper the access to drinking water.
- Construction will not be started until all drinking water sources are replaced with new ones.
- Supply water is the main sources of drinking water in the project area. Therefore, no major impact is envisaged on the user.

3. Water Use

329. **Impacts:** During construction period water is required for compaction of embankment, dust suppression, concrete making and *domestic* use in construction camp. The estimated tentative water requirement during construction stage is given in **Table-91**.

Table 91: Breakup of Fresh Water Requirement during Construction

SN	Purpose	Quantity (KL)
1.	For road construction:	34,18,550
	a) Construction related to earthwork	
	b) Construction of GSB	
	c) Construction of WMM	
	d) Bridges, culverts, retaining walls & other structures	
2.	Dust suppression	15,000
3.	For drinking & other household purpose	16,450
	Total	**34,50,000**

330. **Mitigation Measures**:

- Minimum use of water from existing sources for construction purpose will be ensured to minimize likely impacts on other users
- The contractor will arrange water required for construction in such a way that the water availability and supply to nearby communities remain unaffected.
- If new tube-wells are to be bored, due to the non-availability of water required for construction, prior approvals of the Ground Water Department / CGWB has to be obtained by the Contractor. Without permission from CGWB, contractor will not be allowed to extract ground water.
- Wastage of water during the construction should be minimized

4. Water Quality

a. Construction Phase

331. **Impacts:**

- During construction phase, leakage of POL could lead to an increase in water pollution level of the region. Anticipated potential impacts are due to spillage of construction materials, such as, cement, POL, bitumen etc. falling in to the

drainage channels from workshops, construction camps, quarry/ borrow areas etc. of the Contractor.

- Accident involving hazardous materials (bitumen) may cause pollution but the occurrence of large scale spillage of bitumen is extremely rare.
- Increase of sediment load in the run off from construction sites and increase in turbidity in receiving streams/water bodies
- Water pollution due to sewage from construction camps

332. **Mitigation Measures:**

- Quality of construction wastewater emanating from the construction site will be controlled through suitable drainage system with silt traps for arresting the silt / sediment load before its disposal into the main natural drainage system around the site
- Proper sanitation facilities will be provided at the construction site to prevent health related problems due water contamination
- An effective traffic management plan is to be implemented to avoid any accidental spillage of hazardous materials.
- All the construction and preparatory activities including construction of culverts and bridges will be carried out during dry seasons only
- The CD structures should not be drained to the agricultural and horticultural farms or to the immediate vicinity of houses of the villagers.
- The fuel storage and vehicle cleaning area shall be stationed at least 500 m away from the nearest drain / water body
- Provision for oil interceptors shall be made at all the construction camps / workshop areas to separate the oil and grease waste generated from servicing of equipment and vehicles used in the construction
- The unlined roadside drains in rural stretches carrying storm water will be connected to the nearest natural drainage channel, water bodies with silt traps.

333. **Water Quality Monitoring:** Apart from provision of the mitigation measures, water quality shall be monitored to understand the effectiveness and further improvement in designs in reducing the concentration of pollutants. The monitoring plan shall be functional in construction as well as in operation stages. The frequency, duration and responsibility will be as per the Environmental Monitoring Plan (Table-8.3 of Chapter-8). The maximum desirable limits as per the water quality standards are given in **Annex-3.1** and the monitored values should correspond with the table. All deviated results shall be reported to Environmental Specialist of IE for remedial measures. It should be ensured that no construction camps or stockyards are set up near rivers, irrigation canals and water bodies to prevent oil spills.

334. **Silt Fencing:** Silt fencing will be provided to prevent sediments from the construction site entering into the nearby watercourses. The silt fencing consists of geo textile with extremely small size supported by a wire mesh mounted on a panel made up of angle / wooden frame and post. The frame will be installed at the edge of the water body, near river crossing *along* which construction is in progress. It is proposed to install silt trap at the edge of all water bodies located along the project road, major and minor bridge locations. Further, silt fence will be mounted in guiding drains at a distance of 3 to 5 m in the upstream direction depending on the gradient of the guiding drains. However location of silt traps will depend on contractor's proposal for site facilities and work sites and should be provided in the contractor's proposals. This will be checked by Sr. Environmental Specialist of the Independent Engineer and monitored by PIU. Drawing of typical silt trap is given in **Annex-8.22**.

335. **Oil Interceptor:** Oil and grease from road run-off is another major concern during construction as well as operation. During construction, discharge of oil and grease is most likely from workshops, oil and waste oil storage locations, vehicle parking areas of the contractor and the concessionaires' camps. Therefore, location of Oil Interceptors has been considered such that each construction camp having refueling stations, oil and lubricants storage *places* will have one oil interceptor to stop & separate the floating oils. The arrested products shall be disposed as per MoEF&CC and CPCB guidelines. However the number of interceptors shall increase as the situation demands or during the accidental spillages. Actual number will be decided by the Contractor with the consent of Sr. Environmental Specialist of the Independent Engineer. Drawing of typical Oil Interceptor is given in **Annex-8.23**.

336. **Ground Water Recharge Pit/ Rainwater Harvesting Structures:** Raising of embankment height and improvement of both longitudinal and cross drainage shall be done to avoid water accumulation in the area. Ground water recharge pits shall be constructed to facilitate the infiltration of runoff water into the ground. Paved surface of the road will reduce the percolation of runoff water and decreases the ground water recharge. Ground water recharge pits / Rainwater Harvesting Structures and silt fences has been proposed at **13 locations** near water bodies, river crossing, canal crossing, forest area and agricultural area (**Table-6.4**) to improve the water table in this region and conserve water bodies. These locations have been selected because rain water from both side of the road converges in those areas due to natural slope of the region. Unlined drain along the project road may also be connected with the ground water recharge pit to facilitate the recharge of runoff water in to the ground, augmenting the water table of the project area.

337. It has been *observed* from the past meteorological data of IMD, total number of rainy days and annual average rainfall varies along the project road as tabulated below:

Table 92: District wise Annual Average Rainfall & No. of Rainy Days

Sl. No.	IMD Observatory	Annual Average Rainfall (mm)	Number of Rainy Days
1	Gadag	682.6	45.7
2	Shimoga	987.1	69.8
	Average	**834.85**	**57.75**

338. However, the locations of proposed ground water recharge will be reviewed by the Sr. Environmental Specialist *of* the Independent Engineer and finalized in consultation with EMPIU. These locations should be permanent which shall be handed over to the local civic bodies at the end of the project so that the water shortages can be reduced to a certain extent. Lump sum cost provision has been provided in the EMP. Typical drawing of Ground water recharge pits / Rainwater Harvesting Structures is given in **Annex-8.24**.

Table 93: Proposed Location of Ground Water Recharge Pit

Design Ch. Km	Village	Description
110+600	Mallasamudra	Near Water Body
128+200	Shirahatti	Near Stream
140+100	Devihala	In Forest Area
149+300	Narayanapura	Near Water Body
158+500	Tangoda	Near River Crossing
161+300	Itagi	In Forest Area
168+100	Guyilagundi	Near River Crossing
193+000	Gudagoor	Near Forest Area
198+700	Guddada Anveri	Near Stream Crossing

Design Ch. Km	Village	Description
222+800	Kasaba Kuppellur	Near River Crossing
228+700	Malanayakanahalli	Near Forest Area
235+000	Kirigeri	Near Causeway
251+100	Honnali	Agricultural Area

339. ***Operation Phase:*** Widening will result in increase of surface run-off due to more paved road surface. It will have adverse impact on ground water recharging if measures are not taken during the design stage.

340. **Impacts:**

- Increase of surface run-off due to more paved road surface
- Filthy environment due to improper maintenance of drainage
- Chances of contamination of water bodies from road surface run off containing oil spills due to traffic movement & accidents

341. **Mitigation Measures:**

- Longitudinal roadside drains of sufficient capacity will be provided on both sides of the road to accommodate increased run-off. The out fall for these drains will be the nearby culverts / bridges or natural drainage channel. Silt fencing will be provided to sediment entering into the water courses.
- Contingent actions will be taken for speedy cleaning up of oil spills, fuel and toxic chemicals in the event of accidents.
- Regular maintenance of rainwater harvesting structures shall be done during the operation stage to prevent choking of these structures.
- Regular monitoring of water quality at specified representative locations will be conducted at fixed interval.

5. Water Bodies

- Corridor of Impact (COI) is the proposed construction width, which is varying from 16 to 20 m in built-up areas and 26 to 36 m in rural / open country areas. There are 14 water bodies, which are located within the COI (Table-94).
- All water bodies (pond & lakes) have been saved by providing toe wall / change in engineering design or through realignment except 1 water storage area, which will be partially affected.

Table 94: List of Water Bodies Located within the COI

Sl. No.	Particulars	Existing Ch. km	Design Ch. Km	Distance# (m)	Side	Village	Affected Status	Remarks
1	Road Side Ditch	111+100	110+660	14.39	Left	Mallasamudra	Not Affected	Toe wall
2	Road Side Ditch	138+300	136+535	6.42	Right	Chabbi	Not Affected	Toe Wall
3	Water Storage Area	142+800	141+030	8.96	Left	Devihala	Partially Affected	Rainwater stored for irrigation
4	Pond	144+600	142+800	10.31	Right	Devihala	Not Affected	
5	Pond	150+900	149+400	7.09	Left	Narayanapura	Not Affected	Toe Wall
6	Pond	156+050	154+582	14.28	Right	Algilwada	Not Affected	
7	Pond	184+600	174+500	12.31	Left	Guttal	Not Affected	
8	Road side Ditch	203+030	192+125	5.69	Left	Keri Mallapura	Not Affected	

Sl. No.	Particulars	Existing Ch. km	Design Ch. Km	Distance# (m)	Side	Village	Affected Status	Remarks
9	Pond	208+440	197+500	15.56	Right	Guddada Anveri	Not Affected	
10	Road side Ditch	225+750	216+300	15.64	Right	Halageri	Not Affected	
11	Road Side Ditch	233+375	223+850	12.00	Right	Kasaba Kuppellur	Not Affected	
12	Pond	236+930	227+115	12.88	Left	Sanna Sangapura	Not Affected	
13	Road Side Ditch	251+210	240+850	16.22	Right	Hallur	Not Affected	
14	Road Side Ditch	251+410	241+050	17.00	Right	Hallur	Not Affected	

Distance in meter from existing centerline

Partially Affected Water Storage Area at Ch. Km 142+800 at Devihala Village

6. Enhancement of Water Body

342. Enhancement measures have been proposed for roadside ponds / water bodies. A typical enhancement plan for road side pond / water bodies is given in **Annex-8.26**. Location of the water body proposed for enhancement is given in **Table-95.**

Table 95: Water Bodies Proposed for Enhancement

SL	Particular	Existing Ch. km	Design Ch. Km	Distance# (m)	Side	Village
1.	Pond	150+900	149+400	7.09	LHS	Narayanapura

Distance in meter from existing centerline

View of the Pond (Ch. Km 150+900) proposed for Enhancement

343. Followings have been proposed as a part of *enhancement*:

- Earth excavation along the boundary (excluding the portion where retaining wall has been proposed)
- Stabilization of the slope using Vetiver Grass
- Phyco-Remediation of water using NUALGI
- Turfing of surrounding area of the water body
- Sitting arrangement with RCC Precast Benches with back support
- Pathway with Interlocking Paver Blocks & sand filling
- Approach Road
- Oil interceptor

344. **Phyco-Remediation using NUALGI.** Phyco- remediation is the use of algae to remediate polluted waters. Among all the algae, diatoms are the most prolific photosynthesizes *because* of their silica shells, which are translucent. This helps the diatoms to photosynthesize even in low light conditions.

345. The "NUALGI Technology" is based on providing micro nutrients required for diatom algae growth to speed up the nutrient removal in stagnant water and converting these nutrients to fish biomass. NUALGI contains micronutrients along with silica which is required for diatom growth. During photosynthesis, diatoms consume Nitrates and Phosphorous, as also uses up CO_2 from the atmosphere. In the process, they release oxygen (pure oxygen in water) to almost saturation levels, which will help the water body regain its original levels of Dissolved Oxygen. The absorption of CO_2 will also mitigate the water acidification and pH levels would move towards more basic levels. The high levels of DO would set up a chain of benefits, primarily it promotes aerobic bacteria which would digest the excess nutrients in water and convert them into the base constituents. Such high levels of DO would also oxidize the heavy metals which would precipitate out of water, where other bacterial strains would consume them.

346. NUALGI will also trigger growth of Zooplanktons, which consume diatom algae. The zooplanktons are consumed by fish, thus ensuring that the diatom algae exits the water as fish biomass and does not decay in water like other cellulose algae. This will lead to environmentally friendly way of converting the excess nutrients to fish biomass.

347. Guideline on Phyco-Remediation of Water using NUALGI is given in **Annex-8.26** and a Typical Enhancement Plan for road side pond / water bodies is given in **Annex-8.27**. Cost of enhancement is covered in the EMP budget.

D. Air Environment

1. Construction Phase

348. Particulate matter would be the predominant pollutant affecting the air quality during the construction phase as it is likely to generate considerable quantities of dust, especially during dry condition. *Dust* will be generated mainly during excavation, backfilling, hauling & transportation activities through unpaved haul roads, loading/ unloading & transportation of construction materials, spilling of material during transportation, and open storage of fine construction materials.

349. Undesirable gaseous pollutants will be generated mostly by the automobile traffic and construction machineries. Pollutants of primary concern include $PM_{2.5}$ and PM_{10}. However, suspended dust particles may be coarse and will be settled within a short distance of construction *area*. Therefore, impact will be temporary and restricted within the closed vicinity along the road only. Further, this would not lead to any tangible effect, as the expected traffic volume is low. Operation of hot mix plants and Asphalt plants will cause emission of fumes and gases.

350. **Impacts:**

- Deterioration of air quality due to fugitive dusts emission from construction activities like excavation, backfilling & concreting, and hauling & dumping of earth materials & construction spoils, and vehicular movement along unpaved roads.
- Deterioration of air quality due to gaseous emissions from construction equipment & vehicular traffic
- Deterioration of air quality due to emission from asphalt and hot mix plants
- Emission of Carbon monoxide, sulfur-di-oxide, nitrogen oxides etc. will be generated from the hot mix plant

351. **Mitigation Measures:**

a. Dust Control:

- Proper and prior planning and appropriate sequencing and scheduling of all major construction activities will be done, and timely availability of infrastructural supports needed for construction will be ensured to shorten the construction period vis a vis reduce pollution.
- Construction materials will be stored in covered godowns or enclosed spaces to prevent the windblown fugitive emissions.
- Truck carrying soil, sand and stone will be duly covered to avoid spilling.
- Adequate dust suppression measures such as regular water sprinkling on

unpaved haul roads & vulnerable areas of the construction sites from trucks or other suitable means will be undertaken to control fugitive dust during material handling & hauling activities particularly near habitation especially in the dry seasons.

b. Emission Control

352. **Use of Recycled Asphalt Cold Mix Technology:** Most bituminous mixes are produced at a very high temperature (nearly 160°C), mainly because bitumen is very viscous at low temperatures and cannot coat the aggregates, unless heated to high temperatures. Technologies are available, which *can* facilitate the coating at low temperatures, which can save energy and release less pollutant in the atmosphere.

353. In the recommended pavement design, recycled asphalt pavement (RAP) materials generated out of the existing distressed bituminous layers are proposed to be used as the base layer. The recycling *method* to be adopted for the purpose is Full Depth Reclamation wherein all of the existing asphalt pavement section and a pre-determined amount of underlying base materials, if available or fresh aggregate materials will be treated with bitumen emulsion, lime and cement to produce a stabilized base course. It being a **cold recycling process does not require any heating arrangement**. Thus, it has manifold advantages which are detailed here below:

354. **Environmental Benefits:**

- The single most important justification for use of this technology is that it reduces the emission of greenhouse gases and thereby controls global warming. This would earn tradable carbon credit.
- The technology is quite compatible with Reclaimed Asphalt Pavement technology, which saves the requirement of fresh aggregates and reduces the environmental hazard associated with dumping of damaged pavement materials.
- The fumes from hot mix asphalt are known to be potential health hazards, especially for the construction workers. Construction at normal air temperature of the mix avoids this health hazard.
- It reduces oxidation and permits longer haul distance from the plant to work sites and better cold weather construction opportunities.

355. **Cost Benefits:** Reduced cost of construction considerably because of providing lesser thickness of pavement *crust* compared to the pavement incorporating conventional materials.

356. **Other Measures:**

- During construction period, all activities are to adhere to the contractual obligations and all clearances and approvals such as ‘Consent to Establish’ and ‘Consent to Operate’ shall be obtained from the Karnataka State Pollution Control Board under Air Act. All vehicles operating for the Contractor, Supervision Consultants and PIU shall obtain Pollution under Control (PUC) certificate.
- All required clearances are to be obtained from the Karnataka State Pollution Control Board and the Mining Department for establishing quarries, borrow areas and crushers. Contractor should submit copy of such clearances to EMPIU & IE before start of activities.
- Asphalt and hot mix plants will be located at least 500 m away from inhabited

areas and sensitive receptors such as school, hospital, temple etc. A written agreement with the land owner clearly specifying the terms and conditions of opening, operation and closing activities of the Contractor must be part of the management plan

- Pollution control devices such as cyclone separators /scrubbers shall be installed to control emissions from hot mix plants, crushing units and concrete batching plants. Height of the stacks shall be as per the statutory requirements.
- It will be ensured that all the construction equipment & vehicles are in good working condition, properly tuned and maintained to keep emissions within the permissible limits and engines turned off when not in use to reduce pollution.

c. Air Quality Monitoring

357. Apart from provision of the mitigation measures, air quality shall be monitored. The monitoring plan shall be functional in construction as well as in operation stages. The frequency, *duration* and responsibility will be as per the Environmental Monitoring Plan (Table-8.3 of Chapter-8). The maximum desirable limits as per the National Ambient Air Quality Standards are given in **Annex-3.1** and the monitored values should correspond with the table. All deviated results shall be reported to IE, for remedial measures.

2. Operation Phase

358. **Prediction of Impacts.** Vehicular emission will be the principle source of pollution during operation stage. Quantitative assessment for predicted level of pollutants concentration has been done using ISC-AERMOD, a recommended model by USEPA for prediction of air quality from point, area and *volume* sources. AERMOD is a long range dispersion model based on Gaussian dispersion which incorporates the Pasquile-Gifford (P-G) dispersion parameters for estimating horizontal cross wind and vertical dispersion. In ISC-AERMOD software, the line sources are characterized either are area source or volume sources. After drawing the road alignment of particular traffic segment and putting the information related to carriageway width, vertical dimension, source elevation, base elevation and release height, the model converts the road alignment to volume source. The model simulates the effect of emissions from continuous/variable volume sources on neighborhood air quality. The model is an hour-by-hour steady state Gaussian model which takes into account special features like Terrain adjustments, Gradual plume rise, Buoyancy-induced dispersion, Complex terrain treatment, etc.

359. **Emission Rate:** Composite Emission factors were calculated to assess the contribution of the vehicles in air emission based on the emission factors developed for Indian road conditions by "The Automotive Research Association of India (ARAI)", Pune in its study for "Emission Factor *Development* for Indian Vehicles" as a part of Ambient Air Quality Monitoring and Emission Source Apportionment Studies under Air Quality Monitoring Project - Indian Clean Air Program (ICAP). Composite Emission Factor (CEF) represent the various vehicular emission pollutant for different types of vehicles (viz. two wheelers, three wheelers, Cars, Commercial vehicle, Buses etc.) used in India as requirement of AERMOD.

360. **Meteorological Data:** The primary factors affecting transport and dispersion of pollutants are wind and stability. The winds are caused by differences in pressure between areas of the *atmosphere*. Differences in pressure cause air to move from high-pressure areas to low-pressure areas. Wind speed can affect the pollutant concentration in a selected area. In general, the higher the wind speeds, the lower the pollutant concentration. The winds dilute

pollutants and rapidly disperse them throughout the near areas. In the present case, **meteorological data of winter season (December 2015)** generated through primary survey has been used for prediction of the impacts.

361. **Homogeneous Traffic Sections:** As per the traffic study the project road CNS 05 (SH-57 & 26) from Gadag to Honnali has been divided into four sections.

Table 96: Homogeneous Traffic Sections

Section No.	Sections	Start Chainage (Km)	End Chainage (Km)	Distance (Km)	Traffic Volume AADT(PCU)
HS-V	Gadag to Shirahatti	105+200	130+000	24.800	3,236
HS-VI	Shirahatti to Gutal	130+000	181+000	51.000	1,451
HS-VII	Gutal to Ranebennur	181+000	209+000	28.000	3,292
HS-VIII	Ranebennur to Honnali (excluding approx. 5.9 km)	209+000	253+116	44.116	3,381

362. **Predicted Ground Level Concentrations:** The prediction of maximum ground level concentration on each traffic sections for CO, NO_x and particulate matters have been carried out using AERMOD for the base year 2015, start year of operation 2020 and design life ending year 2040 for homogeneous traffic section VI and VIII (major variation is not observed between traffic section V & VII). The predicted levels are plotted in isopleths and superimposed on a gridded topographical sheet within 10 km radius of the volume source to simulate the dispersion of pollutants. The predicted concentration range is shown in color scale on the right of each isopleths, which are presented in **Figure-30** to **Figure-47.**

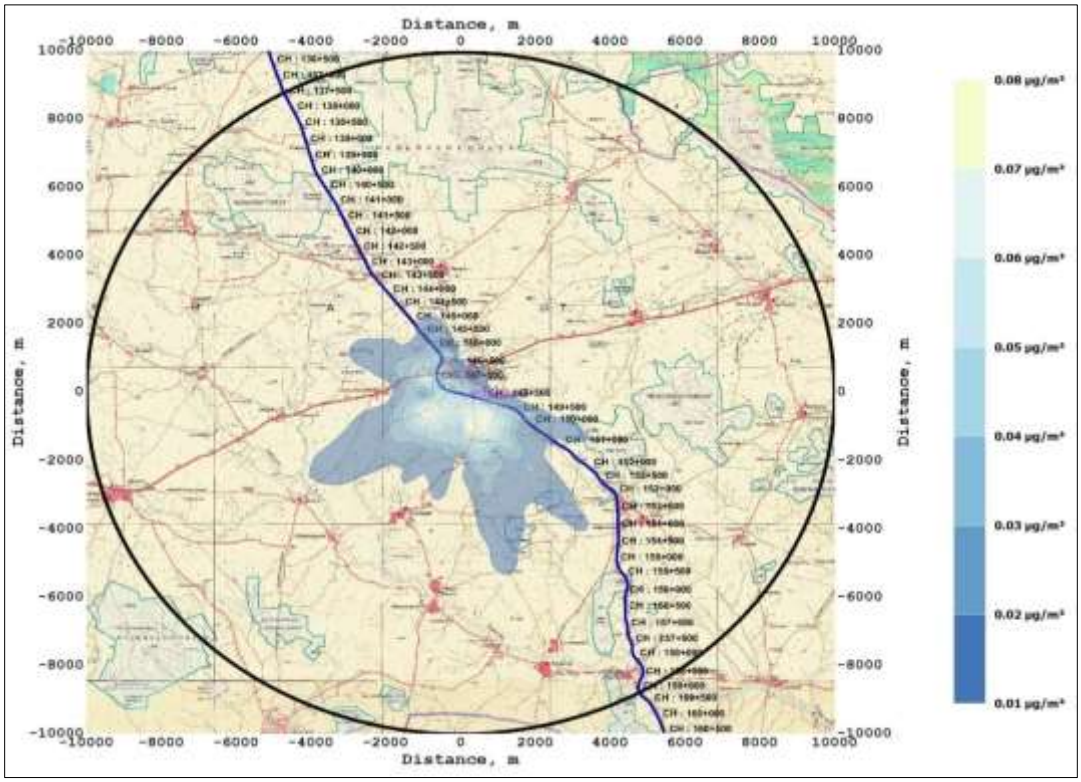


Figure 30: Predicted CO Levels in Traffic Section VI for the Base Year 2015

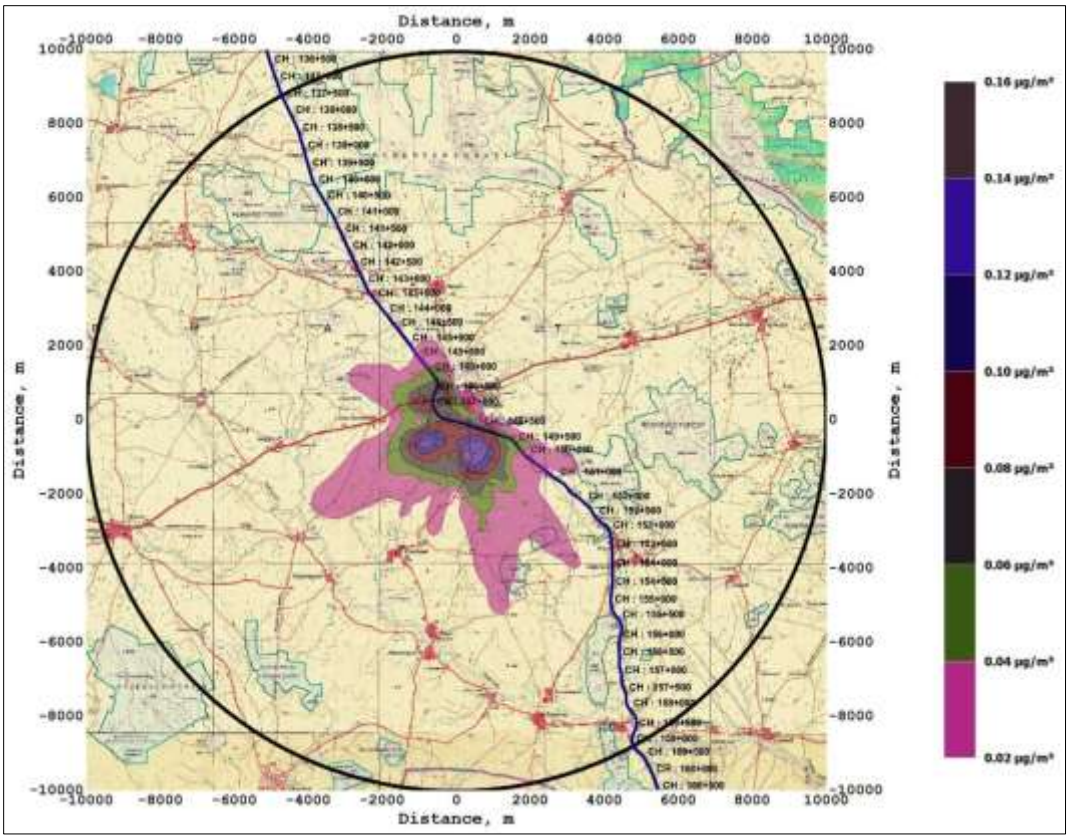


Figure 31: Predicted CO Levels in Traffic Section VI for the Year of Operation 2020

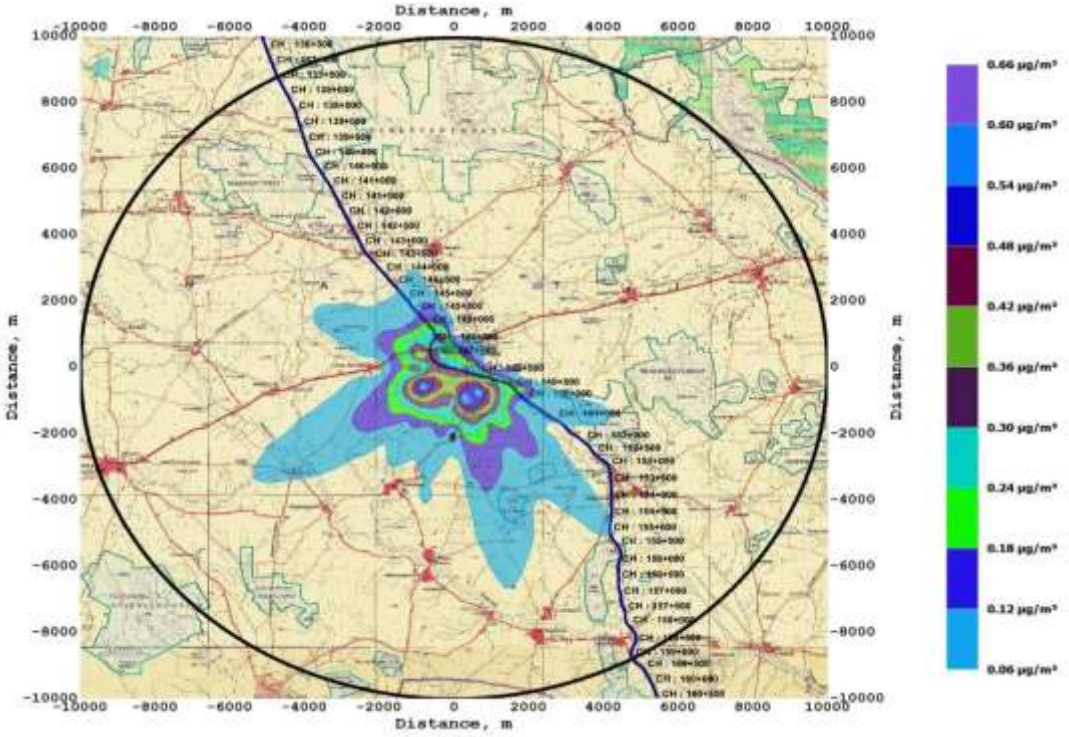


Figure 32 Predicted CO Levels in Traffic Section VI for the Year 2040

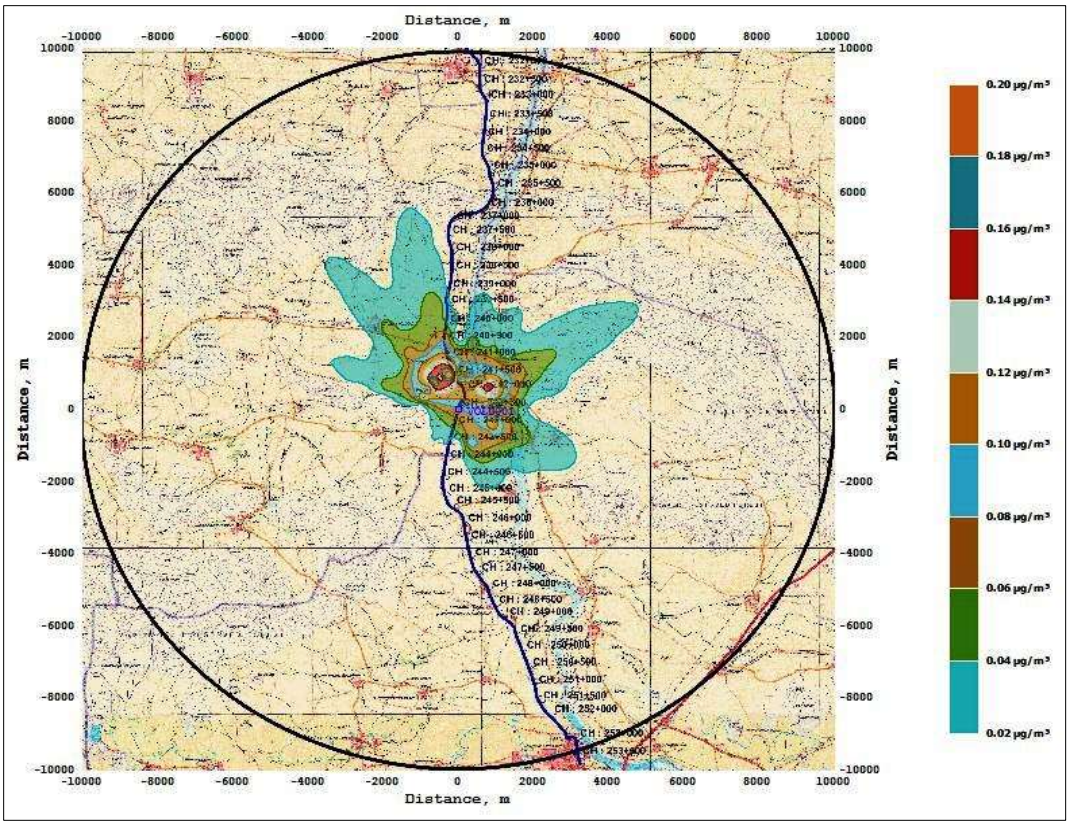


Figure 33: Predicted CO Levels in Traffic Section VIII for Base Year 2015

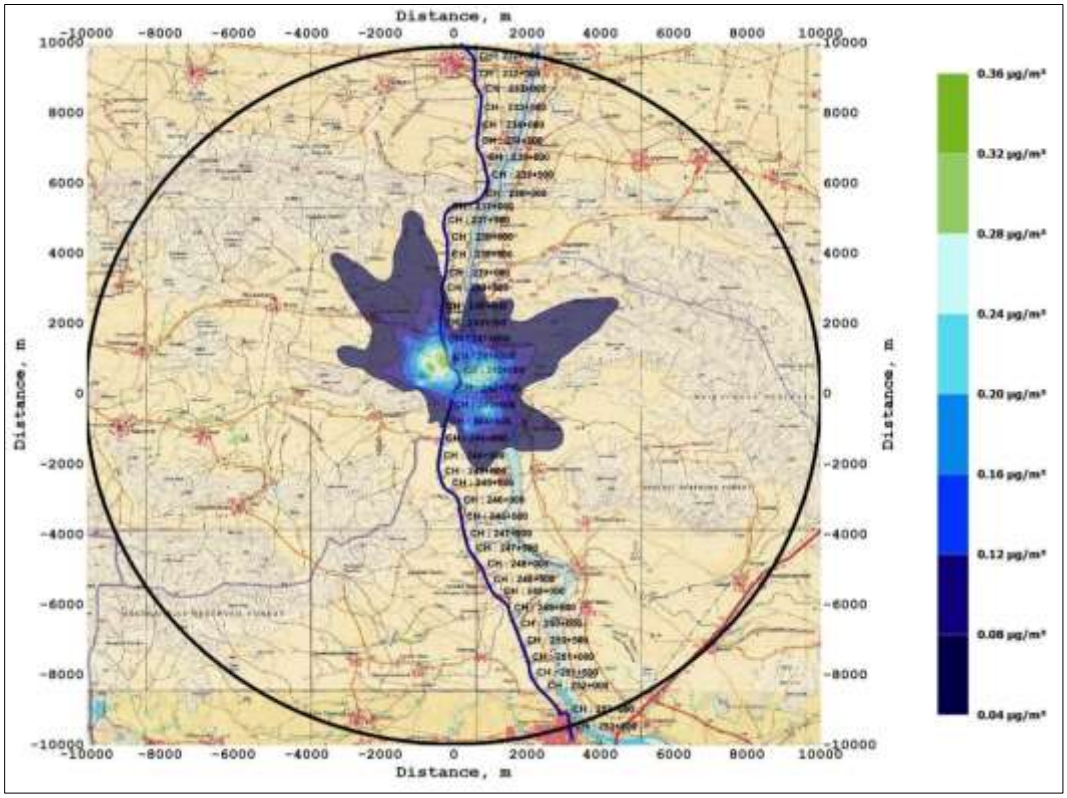


Figure 34: Predicted CO Levels in Traffic Section VIII for the Year of Operation 2020

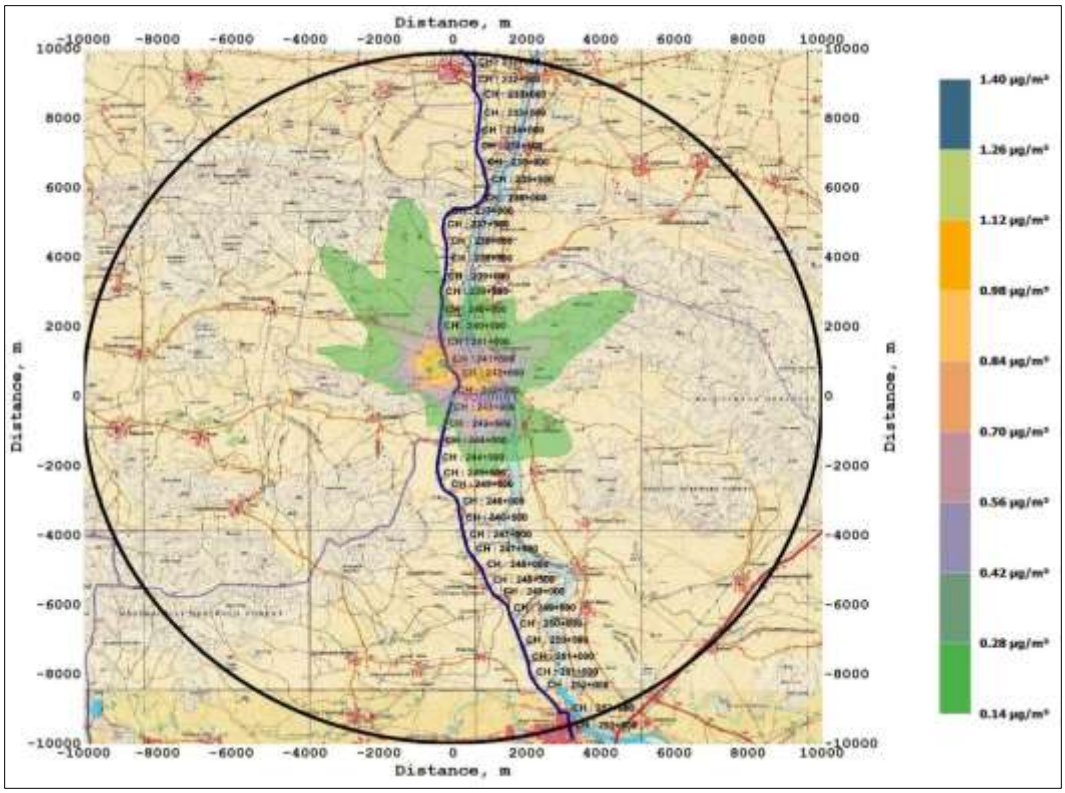


Figure 35: Predicted CO Levels in Traffic Section VIII for the Year 2040

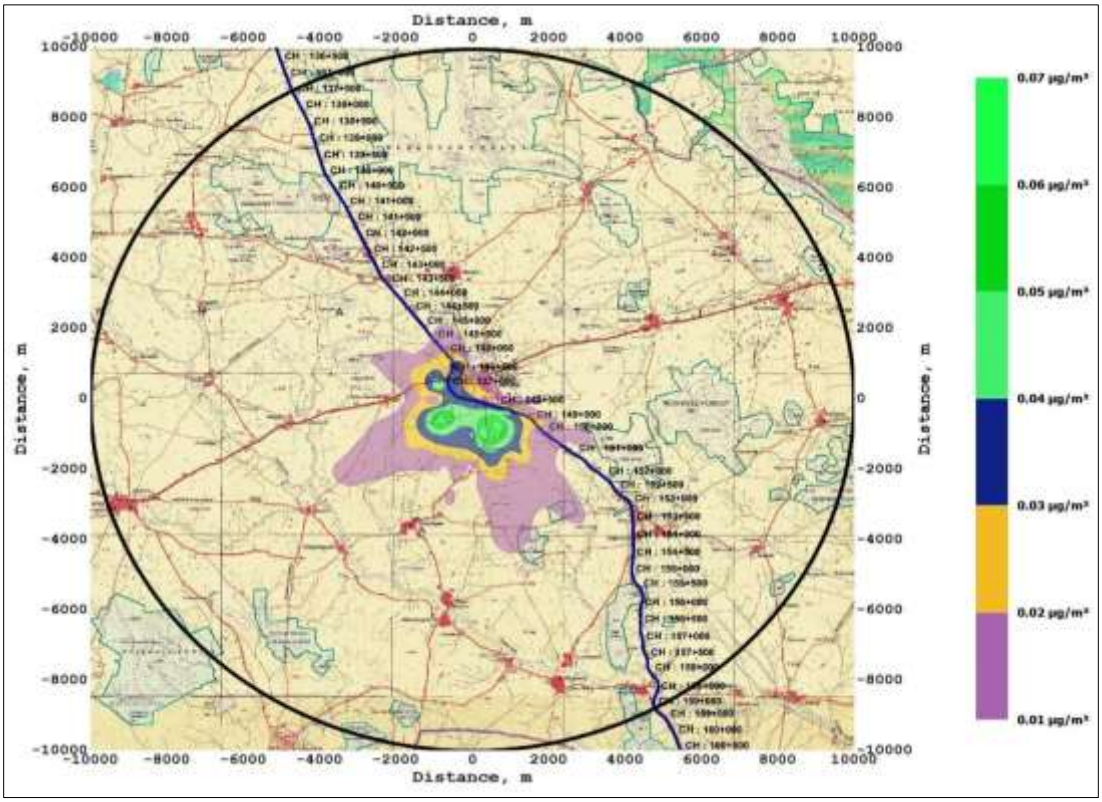


Figure 36: Predicted NOx Levels in Traffic Section VI for Base Year 2015

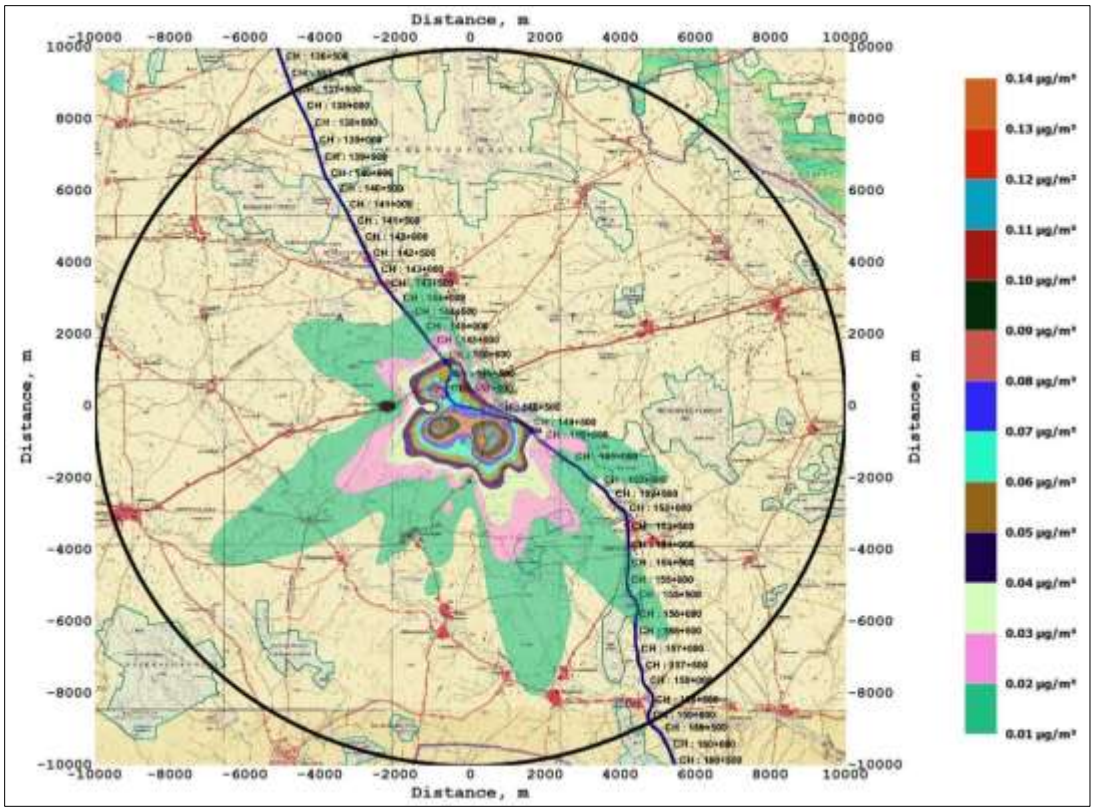


Figure 37: Predicted NOx Levels in Traffic Section VI for the Year of Operation 2020

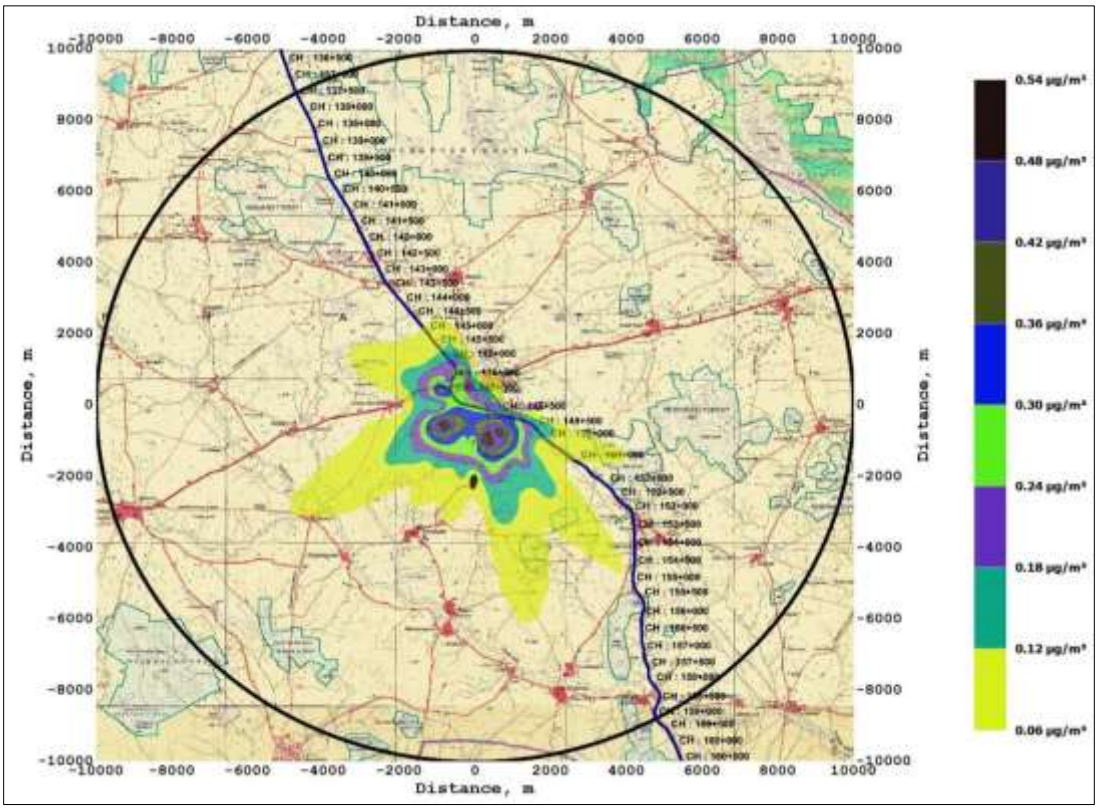


Figure 38: Predicted NOx Levels in Traffic Section VI for the Year 2040

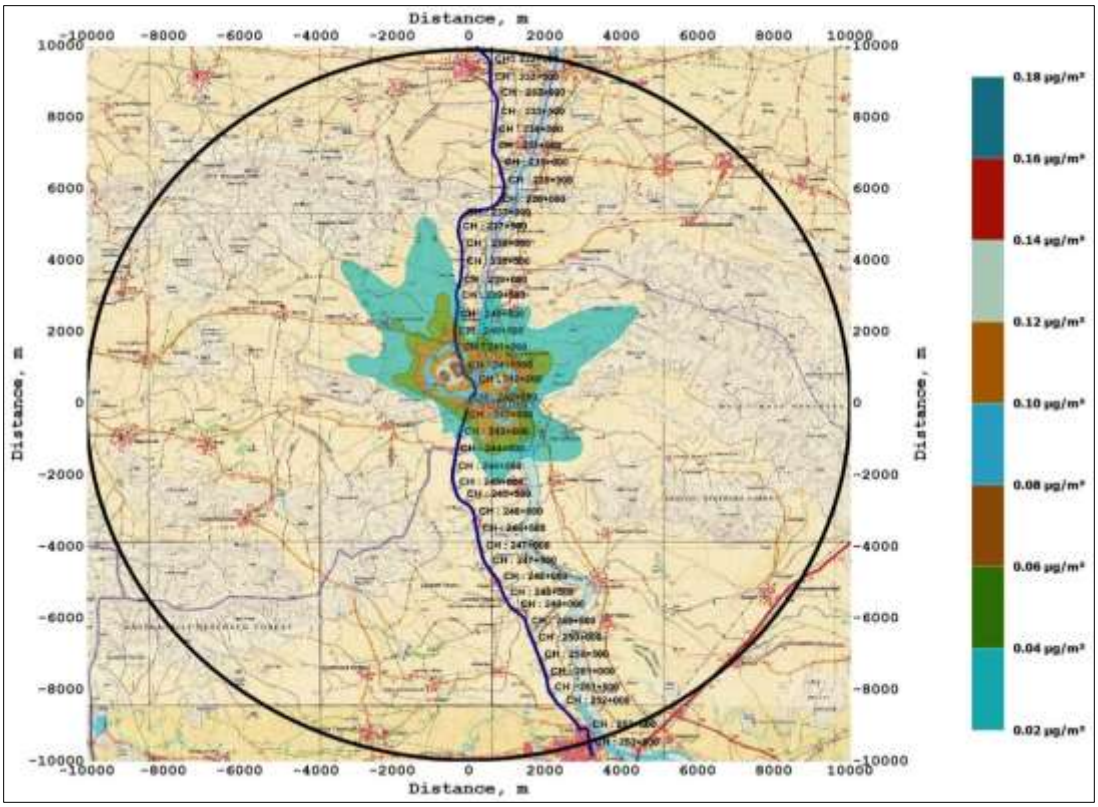


Figure 39: Predicted NOx Levels in Traffic Section VIII for Base Year 2015

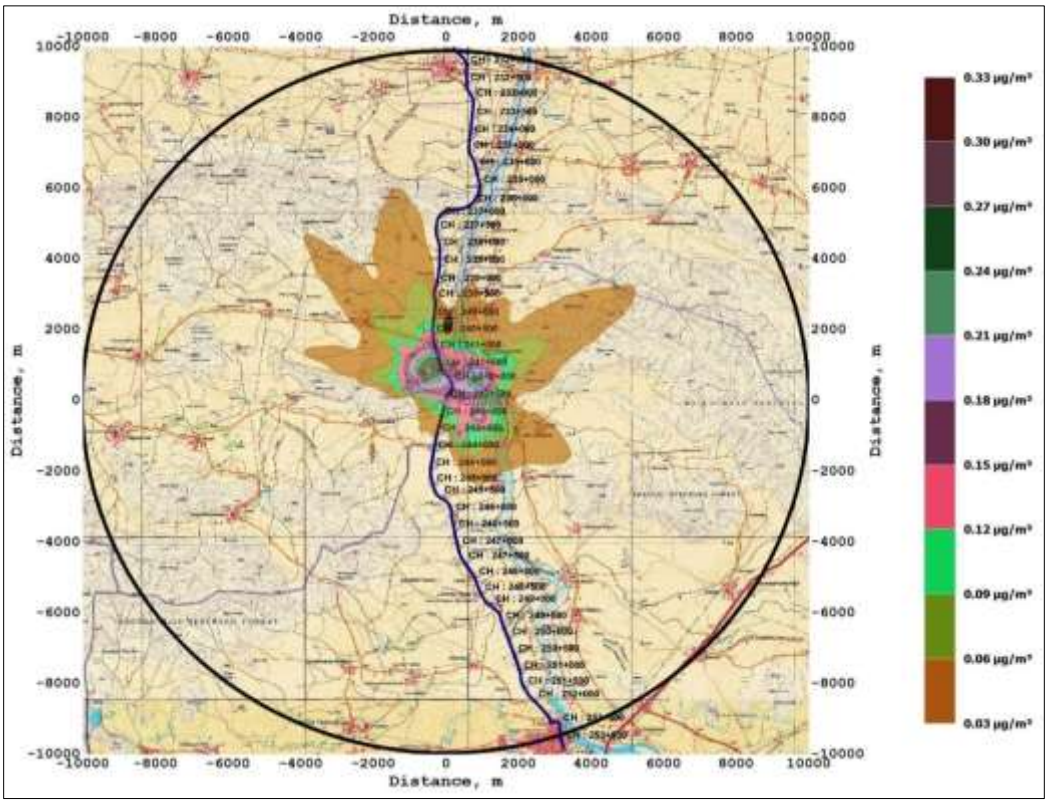


Figure 40: Predicted NOx Levels in Traffic Section VIII for the Year of Operation 2020

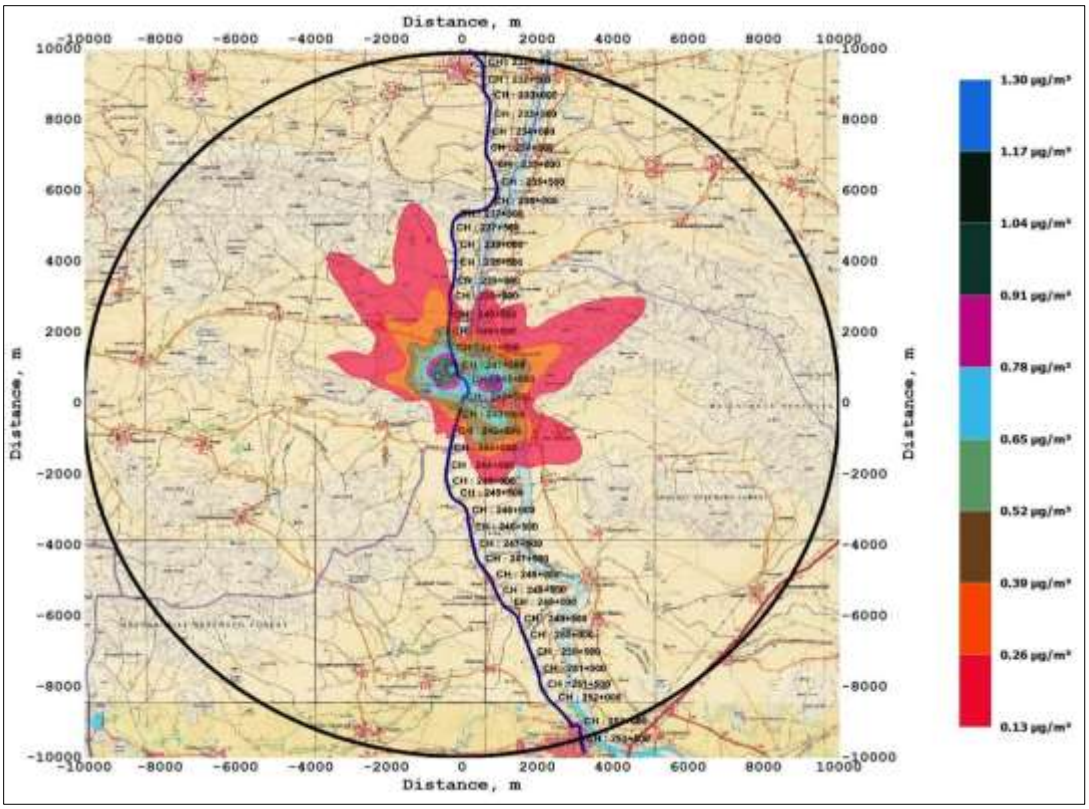


Figure 41: Predicted NOx Levels in Traffic Section VIII for the Year 2040

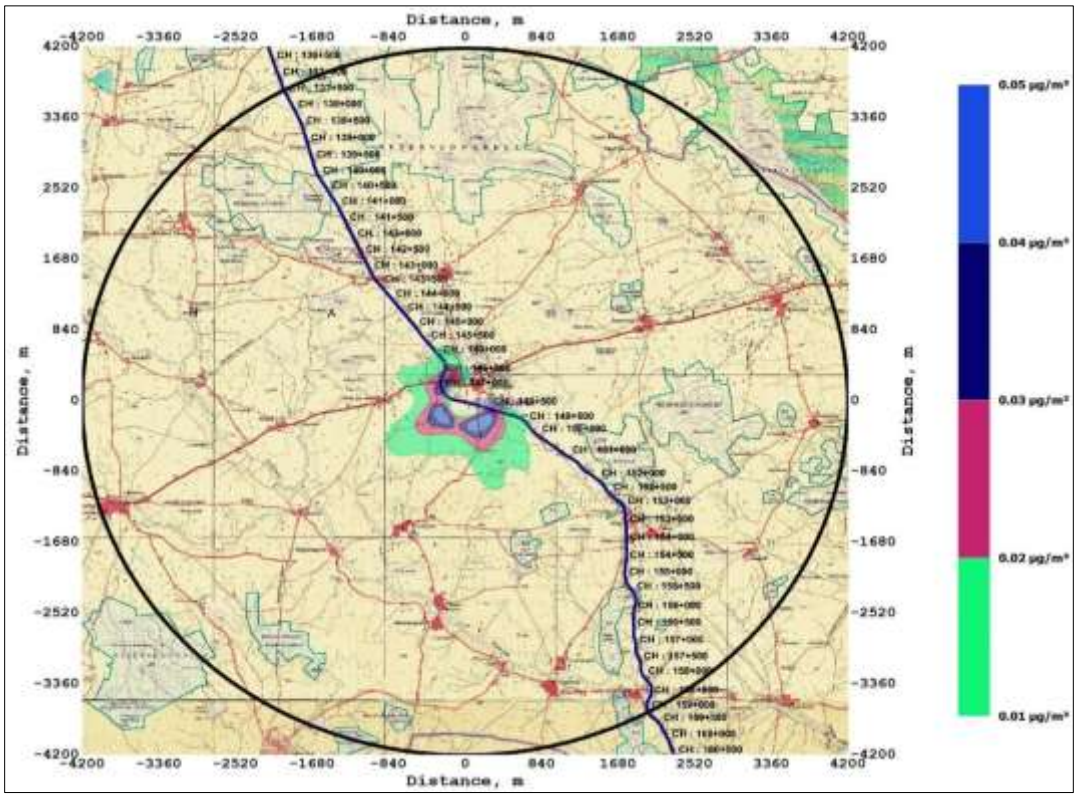


Figure 42: Predicted PM Levels in Traffic Section VI for Base Year 2015

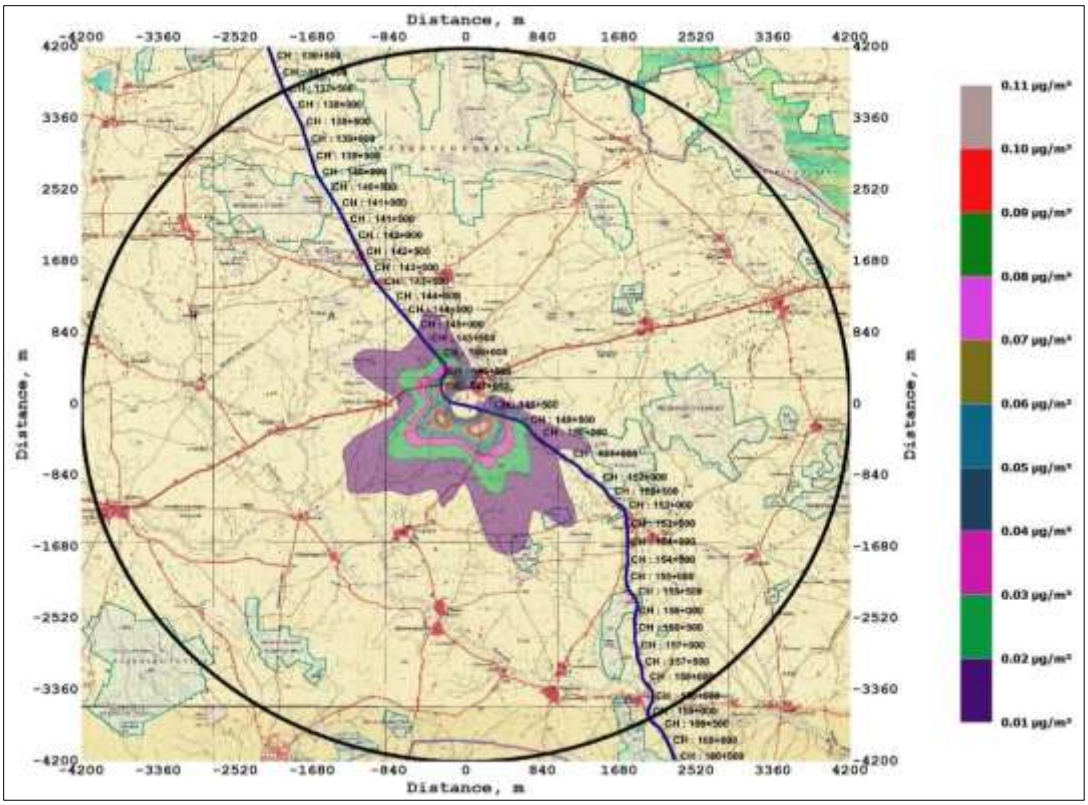


Figure 43: Predicted PM Levels in Traffic Section VI for the Year of Operation 2020

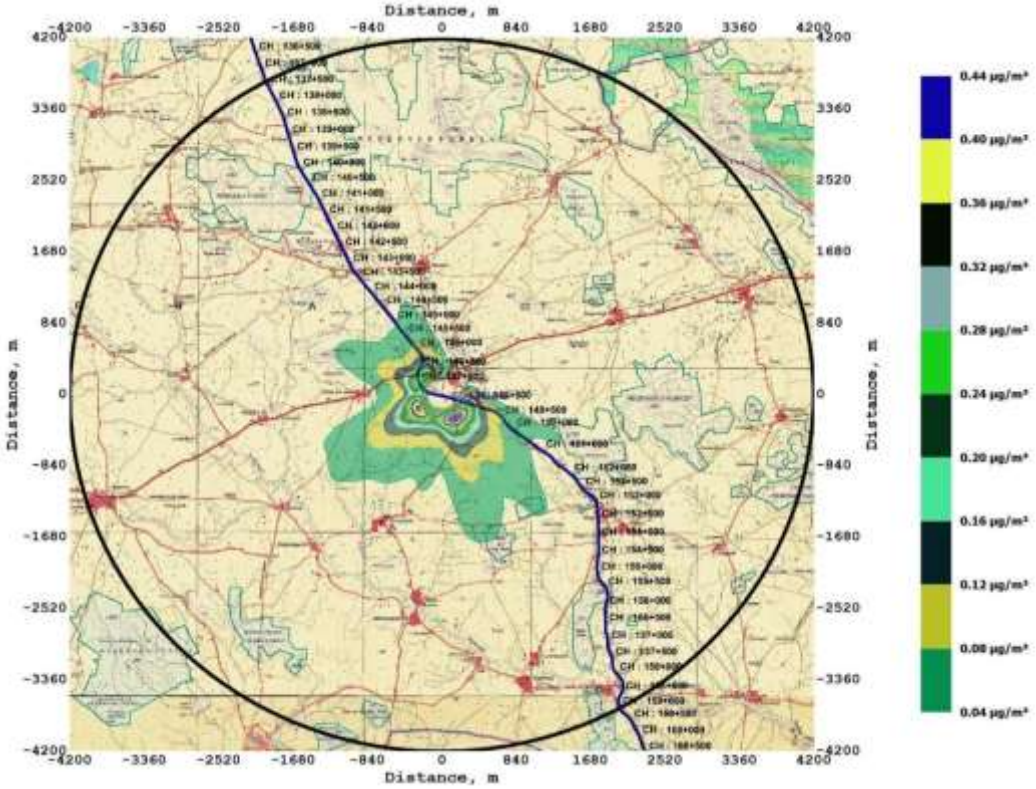


Figure 44: Predicted PM Levels in Traffic Section VI for the Year 2040

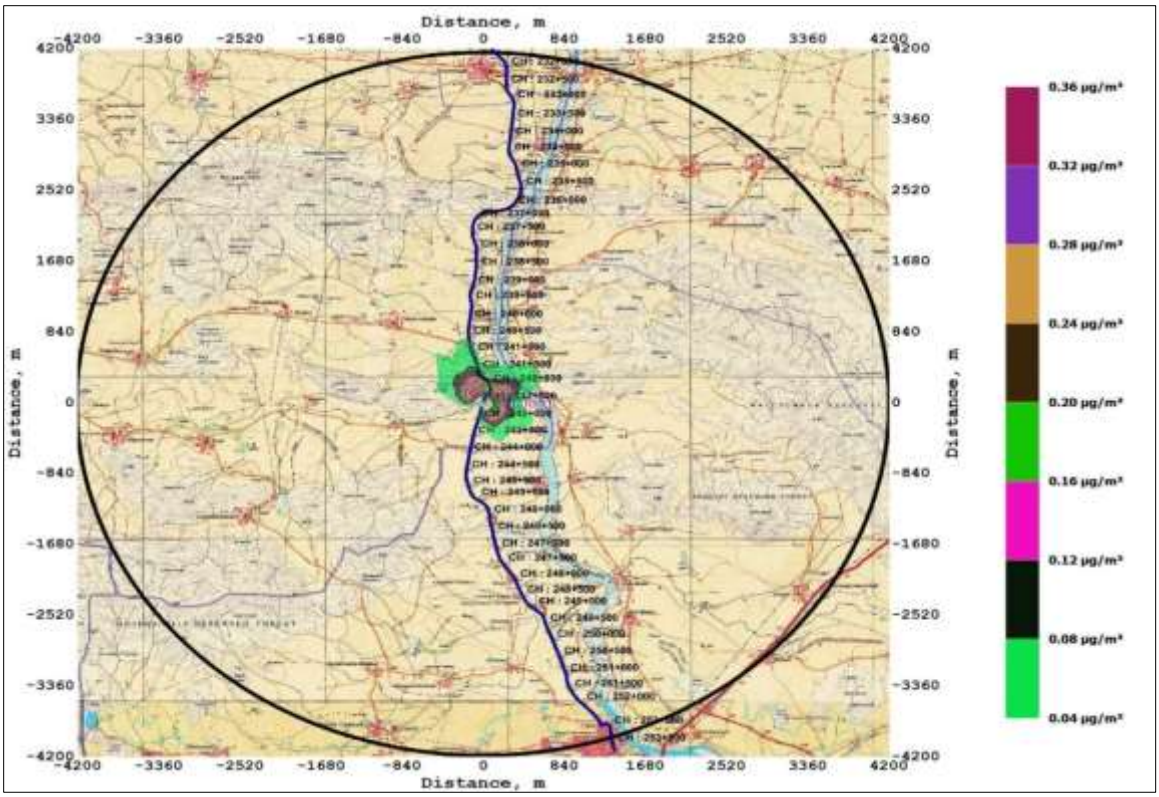


Figure 45: Predicted PM Levels in Traffic Section VIII for Base Year 2015

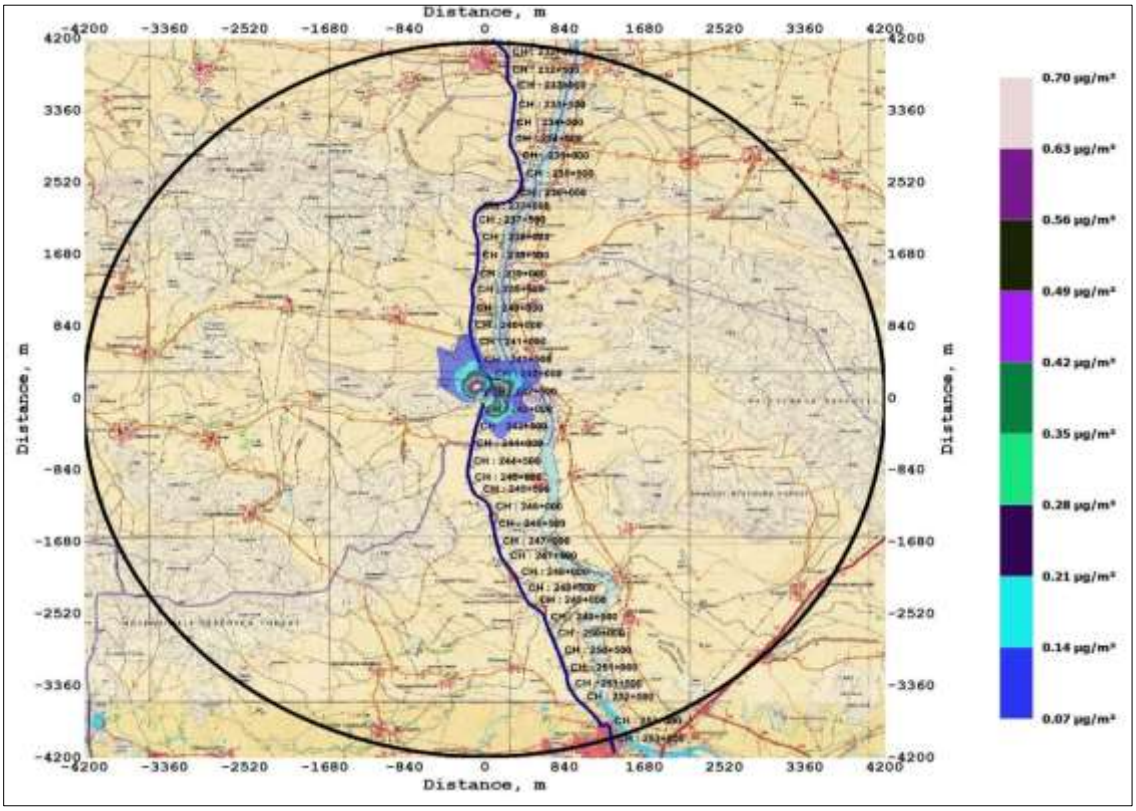


Figure 46: Predicted PM Levels in Traffic Section VIII for the Year of Operation 2020

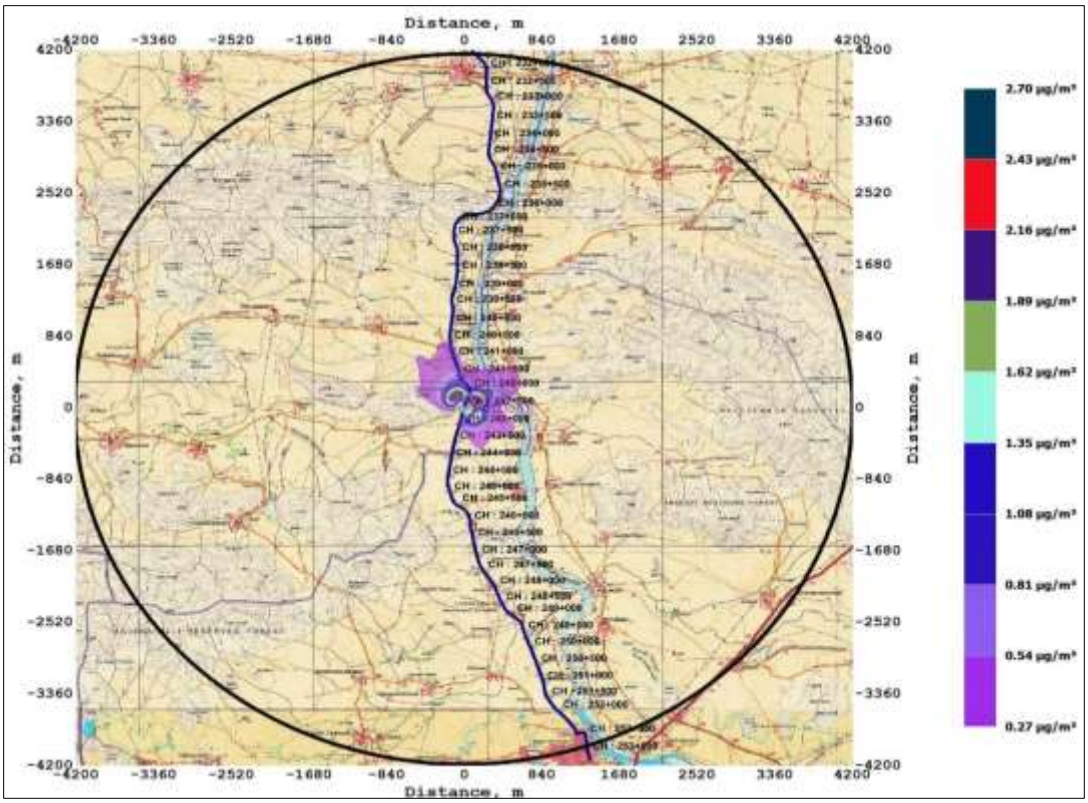


Figure 47: Predicted PM Levels in Traffic Section VIII for the Year 2040

363. Thereafter, the concentration will *gradually* increase with the increase in the traffic flow.

364. ***Prediction Results*** Analyses of modeling results ascertain that the predicted level of concentrations for all parameters along the project road in two homogeneous sections are within the prescribed range. However, the pollutant concentrations and its spread (dispersion) increase consistently with the increase in traffic volume. It may be inferred from the above isopleth that the predicted concentration of pollutants is expected to decrease in the year of operation (2020) due to construction of 2 lane road with paved shoulder. The dispersion of gaseous pollutants have wide geographical spread in comparison to the particulate matters, as it tends to settle down owing to gravitional forces.

365. **Caline 4 Model:** Caline-4 has high applicability in Indian Scenario and is a recommended model by USEPA for prediction of air quality from line sources like highway projects. Quantitative assessment for predicted level of pollutants concentration has been done using Caline-4 Model Ver. 2011,

366. CALINE4 (Caltrans, 1989) is a fourth-generation line source Gaussian plume dispersion model that predicts carbon monoxide (CO) impacts near roadways. Its purpose is to help planners protect public health from the adverse effects of excessive CO exposure. The Caltrans publication, Transportation Project-Level Carbon Monoxide Protocol (CO Protocol) recommends the use of CALINE4 when a proposed transportation project requires a more detailed analysis than initial screening analysis. The 2011 version of caline-4 can also be used for prediction of NO_x and PM_{10}. Pollution Control Authorities/ Regulatory Agencies in India using CALINE- 4 to predict the future air quality trends along highways/roads from vehicular traffic for regulatory purposes.

367. CALINE-4 model employs a mixing zone concept to characterize pollutant dispersion in the proximity of roadways. The model employs source strength, meteorology, site geometry and site characteristics as input parameters and predicts pollutant concentrations for receptors located within 150 meters either side of the roadways. The CALINE-4 model allows *roadways* to be broken into multiple links that can vary in traffic volume, emission rates, height, width, etc. CALINE-4 is capable of specifying links at heights above grade (z = 0), links as bridges (allowing air to flow above and below the link) and links as parking lots (which should be defined by the user as having a height of zero). Also, unlike CAL3QHCR, CALINE-4 is capable of analyzing the dispersion of pollutants in wind speeds of less than 1 m/s. in CALINE-4 the concentration at a point with coordinates (x,y,z) is calculated based on the following equation:

$$C(x,y,z,H) = \frac{Q}{2\pi u \sigma z \sigma y} * \left[\exp - \left(\frac{y^2}{2\sigma y^2} \right) \right] \left[\exp \frac{-(z-H^2)}{2\sigma z^2} \right] + \exp \left[\frac{-(z+H^2)}{2\sigma z^2} \right]$$

Where:

C = Concentration of the pollutant in air [m/L3]
Q = Rate of chemical emission [m/T]
U = Wind speed in X direction [L/T]
óy = Standard deviation in y direction [L]
óz = Standard deviation in z direction [L]
y = Distance along a Horizontal axis perpendicular to the wind [L]
z = Distance along a vertical axis.[L]
H = effective stack height [L]

368. Emission Rate, Meteorological Data and Homogeneous Traffic Sections are same with that of ISC=AERMOD model.

369. **Receptors:** The complete road alignment has been drawn with respect to UTM co-ordinates. A set of link receptors were taken at various receptor locations within each section at a distance of 10 m, 30 m, 50 m, 100 m, 150 and 200 m both sides from edge of the carriageway to know the dispersion of pollutant from the road.

370. **Predicted Ground Level Concentrations:** The prediction of maximum ground level concentration on each road section has been carried out. The prediction for CO was conducted for 8-hourly concentrations, whereas for NO_X, SO_2 and PM_{10}, it was conducted for 24 hourly concentrations. Predicted concentrations on four homogenous section of the Project for CO, NO_X, and PM_{10} and their spread around the road sections have been presented in **Figure-48** to **Figure-53.**

371. **Prediction Results.** Analyses of modeling *results* ascertain that the predicted level of concentrations for all parameters along the project road in four homogeneous sections are within the prescribed range. However, the pollutant concentrations are estimated to increase after 2030 within 30 m from the road edge.

372. The tree plantation and habitat improvement activities included in the project scope will help to check air pollution. Road signage at regular intervals to remind motorists to maintain

their vehicles and minimize fuel consumption may be posted. Raising awareness amongst drivers on good driving practices to reduce fuel consumption and promote road safety may also be carried out. As part of the routine maintenance works good riding conditions of the road surface will be maintained to reduce dust and vehicular pollution.

373. **Conclusions:** In the existing scenario, due to lesser carriageway width, the average vehicle speed is low, which results in traffic congestions causing more exhaust gas emissions. In the post-project scenario, improved road conditions and congestion free traffic movement will reduce emissions. It is also expected that over the period, the fleet/fuel type will significantly improve contributing significantly in emission reduction

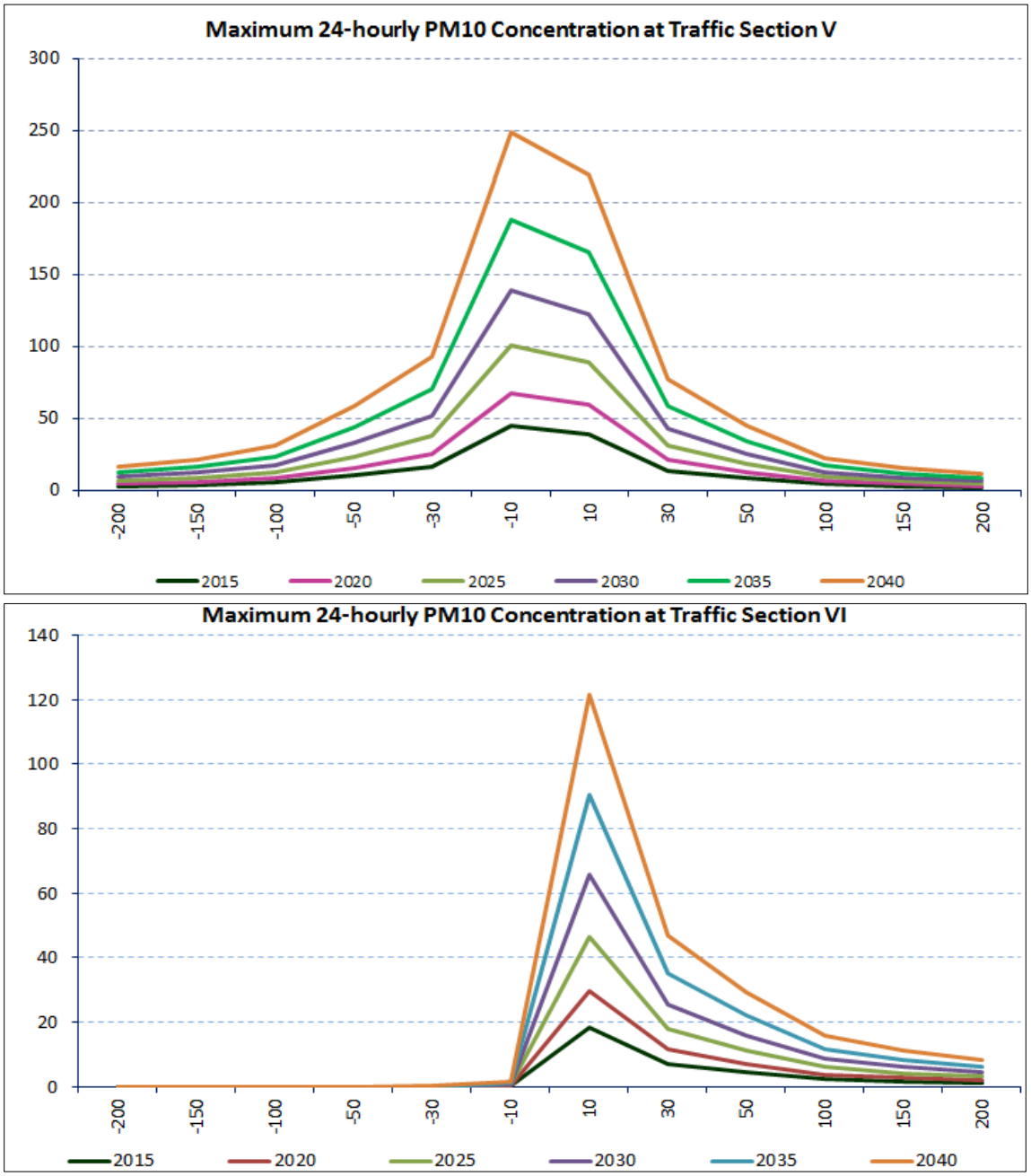


Figure 48: Maximum 24 Hourly PM10 Concentration at Traffic Section-V and VI

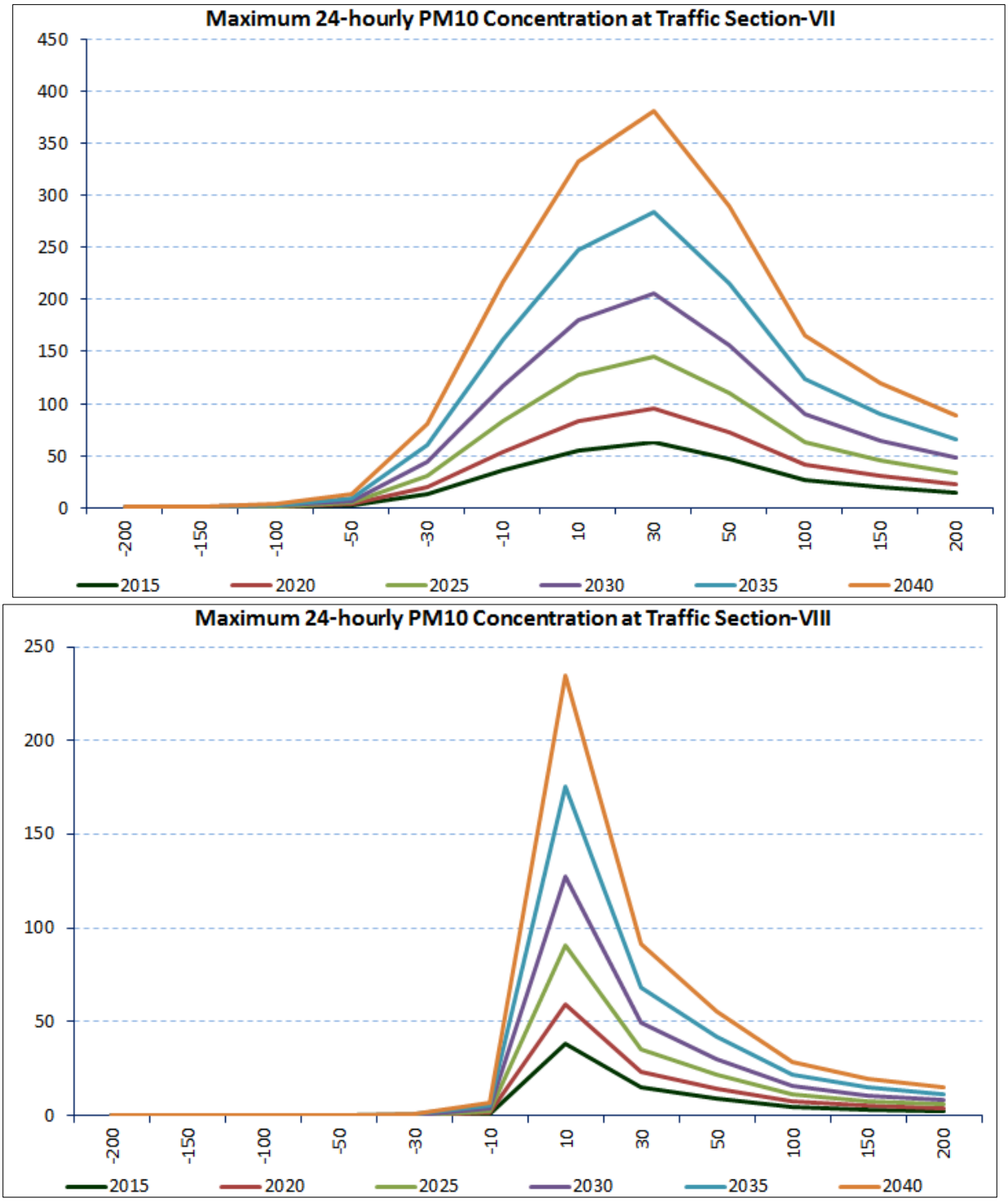
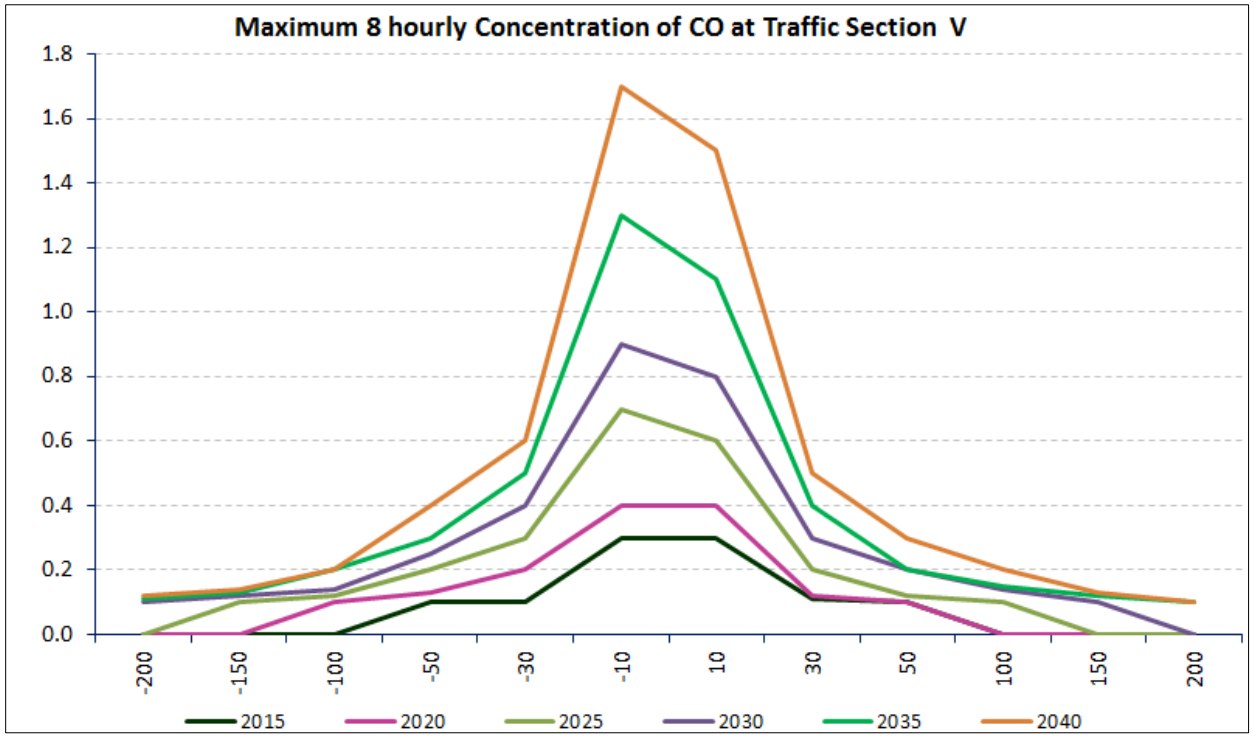


Figure 49: Maximum 24 Hourly PM10 Concentration at Traffic Section-VII and VIII



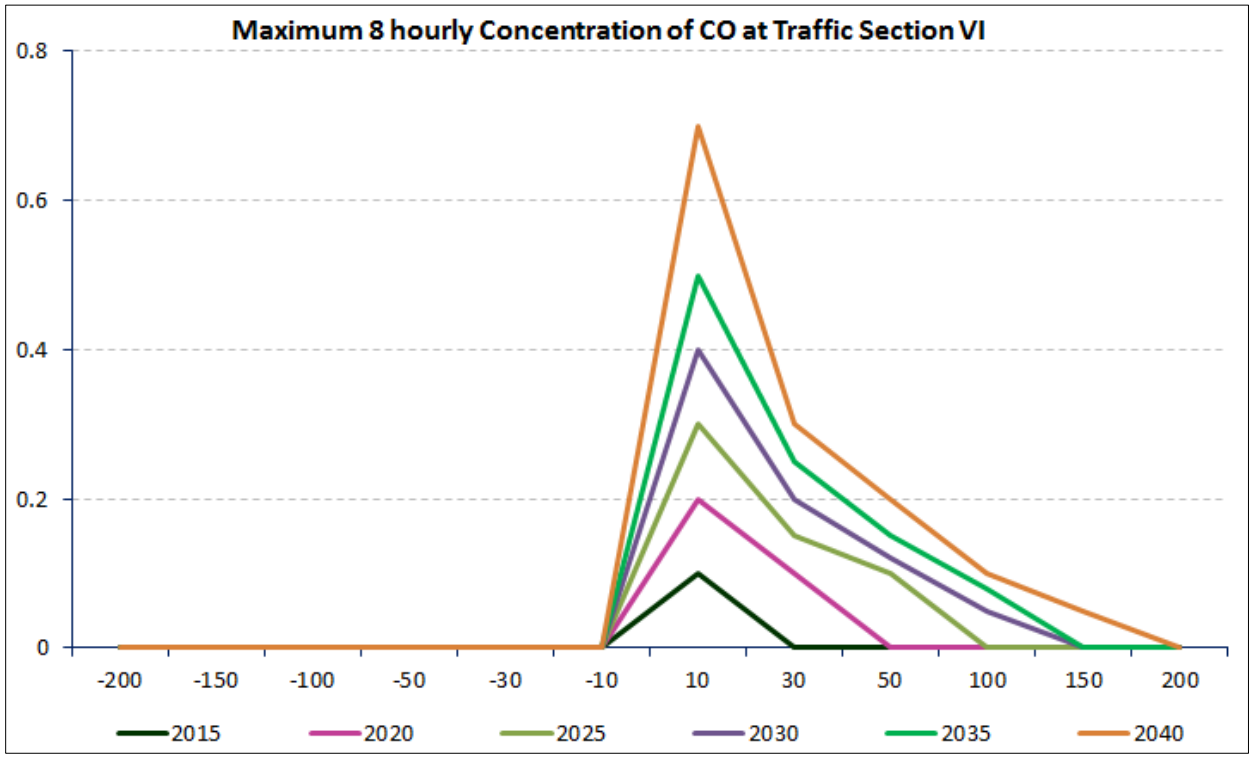


Figure 50: Maximum 24 Hourly CO Concentration at Traffic Section-V and VI

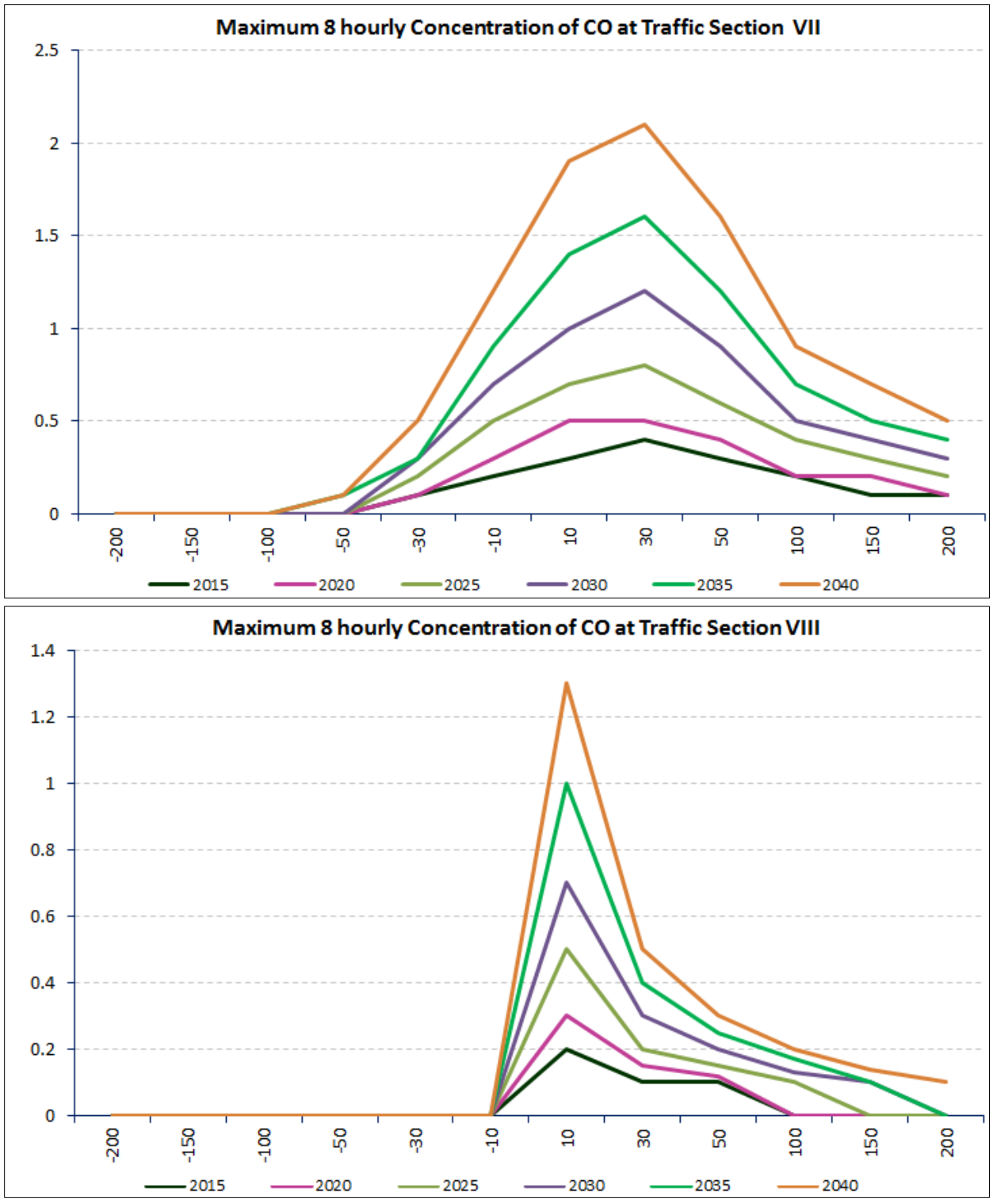


Figure 51: Maximum 24 Hourly CO Concentration at Traffic Section-VII and VIII

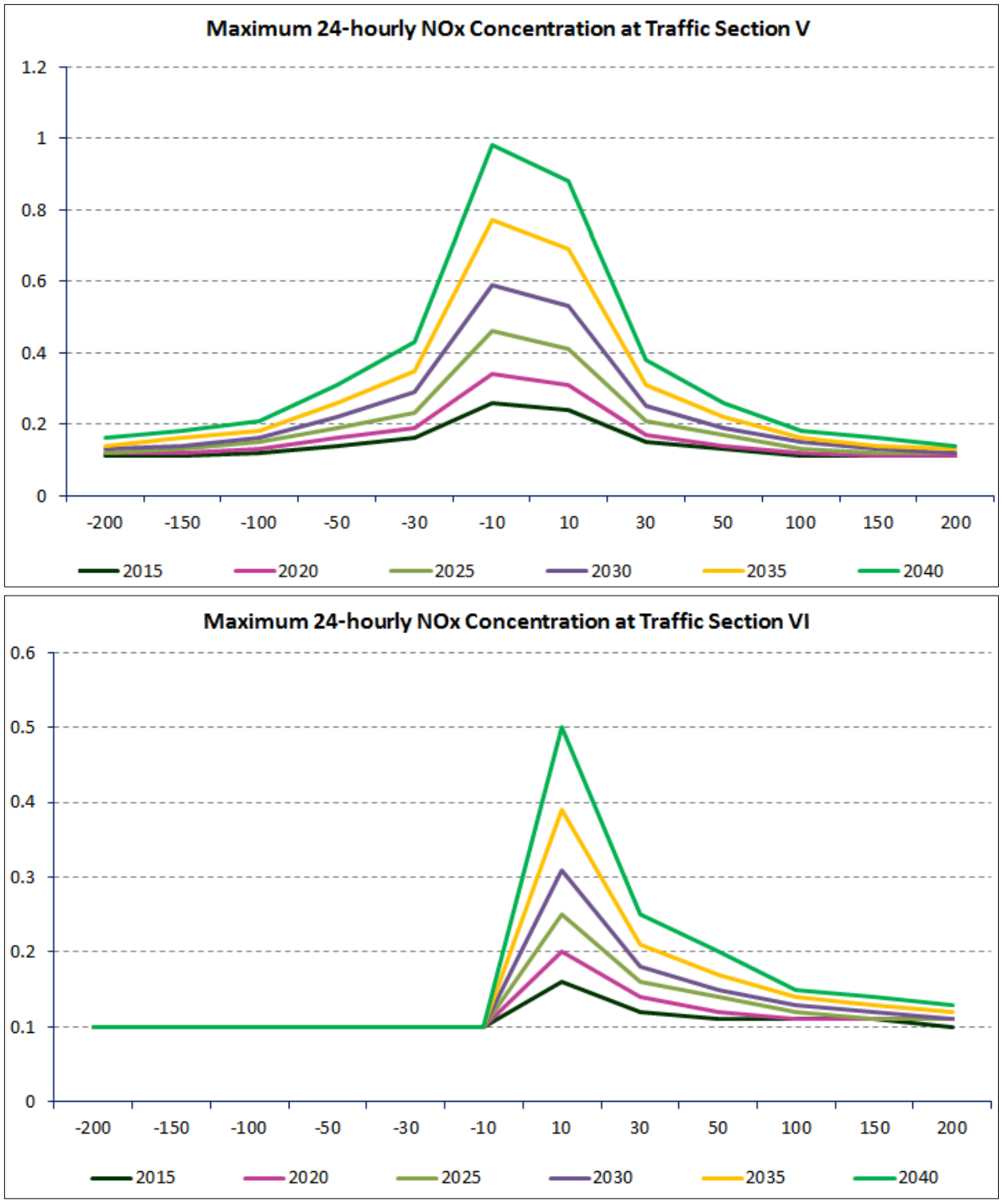


Figure 52: Maximum 24 Hourly NOX Concentrations at Traffic Section-V and VI

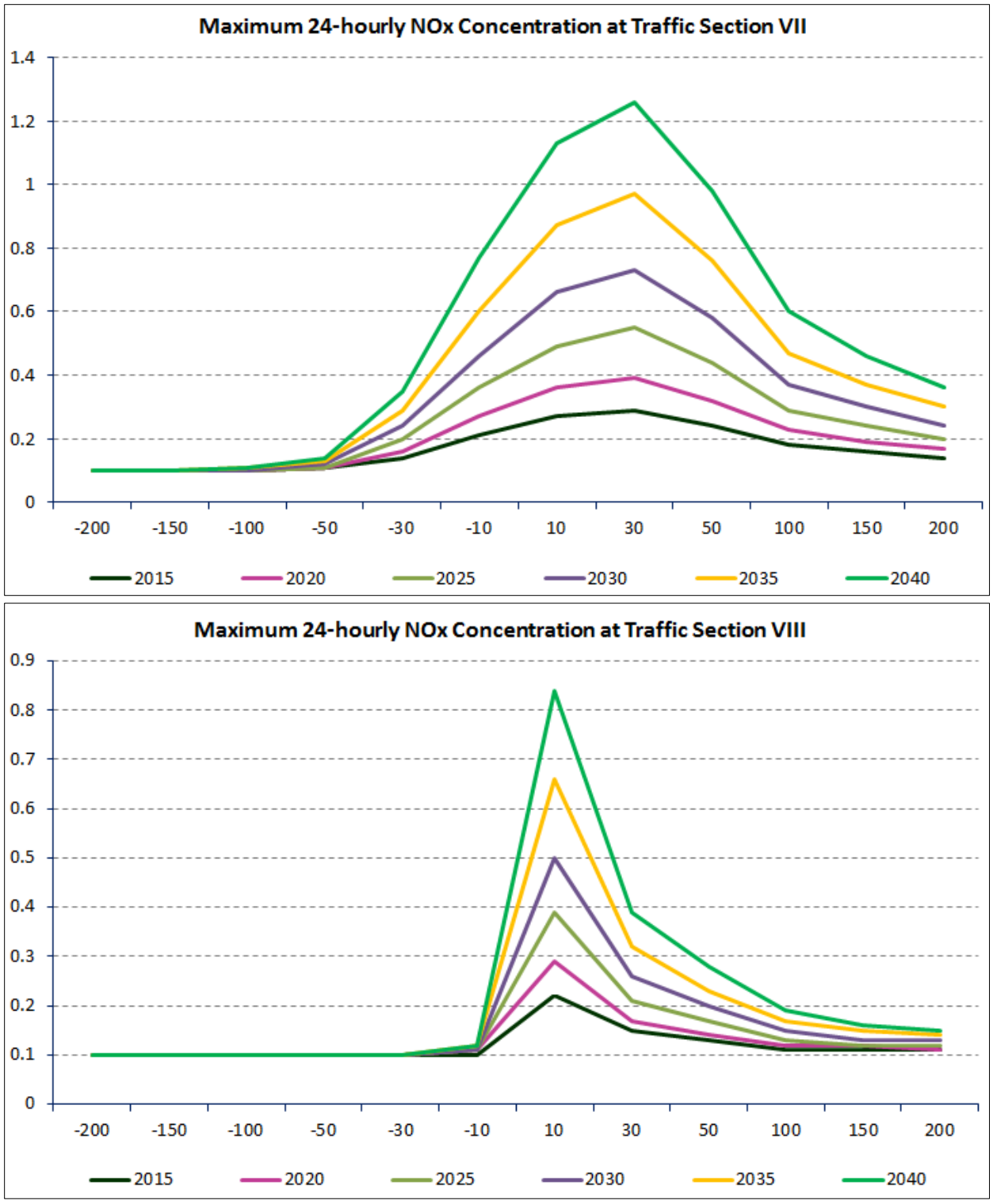


Figure 53: Maximum 24 Hourly NOX Concentrations at Traffic Section-VII and VIII

374. **Mitigation Measures:**

- Vehicular emission will be controlled through enforcement of laws and public awareness. It will be ensured that all the vehicles have vehicular emission within the permissible limits.
- Truck parking lay-byes and bus bays will be provided at required locations to facilitate smooth traffic flow vis a vis reduce air pollution.
- Regular monitoring of ambient air quality at specified representative locations will be conducted at fixed interval.
- Road side plantation along the road will act as sink of air pollutants. Pollution resistant species, which can grow in high pollutants concentrations and absorb pollutants will be planted as proposed under Greenbelt Development Plan
- The designed road surface will generate lesser dust due to the paved shoulders in settlement areas.
- Improvement in road surface condition and traffic capacity will reduce the local congestion in the built up areas and provide a smooth traffic flow.
- The net air quality impacts during the operation phase would be reduced after widening and improvement of the project.

E. Noise Environment

1. Construction Phase

375. During the construction phase, noise will be generated due to movement of vehicles, and operation of light & heavy construction machineries including pneumatic tools (hot-mixer, dozer, tipper, loader, excavator, grader, scraper, roller, concrete mixer, generator, pump, vibrator, crane, compressor etc.) that are known to emit sounds with moderate to high decibel value.

376. Noise generated from sources mentioned above will be intermittent and mostly during daytime. Moreover, villages / settlements being mostly away from the road, no significant impact on local people is apprehended, as the noise will generally die down by the time it reaches them. However, the workers are likely to be exposed to high noise levels that may affect them.

377. **Impacts:**

- Increase in noise level due to construction activities like operation of construction equipment & vehicular traffic.

378. Operation of construction machinery will lead to rise in noise level to the range between 80-95 dB(A). The magnitude of impact from noise will depend upon types of equipment to be used, construction methods and also on work scheduling. Typical noise level of various activities *associated* with highway projects is presented below.

Table 97: Typical Noise Level of various activities associated with Highway Projects

Sl. No.	Construction Activity	Noise Level dB(A)
1.	Grading & Clearing	84
2.	Excavation	89
3.	Foundations	88
4.	Erection	79
5.	Finishing	84

Note: Measured at Leq assuming 70 dB(A) ambient noise level

379. General conclusion can be based on the types of construction work anticipated, the likely equipment required and their associated range of noise levels. Typical noise level of principal construction equipment is presented below.

Table 98: Typical Noise Level of Principal Construction Equipment

Clearing		**Structure Construction**	
Equipment	**Noise Level dB(A)**	**Equipment**	**Noise Level dB(A)**
Bulldozer	80	Crane	75-77
Front end loader	72-84	Welding generator	71-82
Jack hammer	81-98	Concrete mixer	74-88
Crane with ball	75-87	Concrete pump	81-84
		Concrete vibrator	76
Excavation & Earth Moving		Air compressor	74-87
Bulldozer	80	Pneumatic tools	81-98
Backhoe	72-93	Bulldozer	80
Front end loader	72-84	Cement & dump trucks	83-94
Dump truck	83-94	Front end loader	72-84
Jack hammer	81-98	Dump truck	83-94
Scraper	80-93	Paver	86-88
Grading & Compaction		**Landscaping and Cleanup**	
Grader	80-93	Bulldozer	80
Roller	73-75	Backhoe	72-93
Paving		Truck	83-94
Paver	86-88	Front end loader	72-84
Truck	83-94	Dump truck	83-94
Tamper	74-77	Paver	86-88

Source: U.S. Environmental Protection Agency, Noise from Construction Equipment and Operations. Building Equipment and Home Appliance. NJID.300.1. December 31, 1971

380. The construction noise is generally intermittent and depends on the type of operations, location and function *of* the equipment and the equipment usage cycle, it attenuates quickly with increases in distance. The noise level generated from a source will decrease with distance as per the following empirical formula (inverse square law).

$$SPL2 = SPL1 - 20Log_{10}(r_2/r_1)$$

Where, SPL1 and SPL2 are the sound pressure levels at distance r_1 and r_2 respectively.

381. Considering the stationary construction equipment as a point source generating 90 dB(A) at a reference distance of 2 m, computed minimum distance required from the stationery source to meet the permissible noise limits during day time for different land use categories are given in **Table-99**.

Table 99: Minimum Distance Required from Stationary Noise Source

Category	**Permissible Limits in Day Time (CPCB)**	**Distance Required (m)**
Silence zone	50 dB(A)	200
Residential	55 dB(A)	113
Commercial	65 dB(A)	36
Industrial	75 dB(A)	11

382. From the above table it may be noted that residence within 113m from the road will be exposed to a noise higher than the permissible limit. The impacts will be significant on construction workers, working close to the machinery.

383. **Mitigation Measures:**

- Construction camp and temporary labour sheds will be located away from the immediate vicinity of the construction sites and major road traffic.
- Protective gears such as ear plugs or ear muffs will be provided to construction personnel exposed to high noise levels as preventive measure (Annex-8.10).
- Low noise construction equipment will be used.
- It will be ensured that all the construction equipment & vehicles used are in good working condition, properly lubricated & maintained to keep noise within the permissible limits and engines turned off when not in use to reduce noise.
- Stationary construction equipment will be placed 113 m away from inhabited areas.
- Stationary construction equipment will be placed 200 m away from the silence zones i.e. educational institutions, medical amenities and religious places
- Construction activities carried out near residential area will be scheduled to the daytime only so that minimum disturbances are caused to people.
- "Silence zones will be demarcated and road signs prohibiting the use of horns (No Honk Zone) will be displayed at residential areas, sensitive locations and silence zones
- Noise barrier will be constructed in all educational institutions to minimize the impact of traffic noise.
- Noise Monitoring: The effectiveness of mitigation measures and further improvement in designs to reduce the noise level due to construction and operation activity shall be monitored. The frequency, duration and monitoring plan shall be functional in construction as well as in operation stages as per the Environmental Monitoring Plan (Table-8.3 of Chapter-8). Ambient Air Quality Standards with respect of Noise are given in Annex-3.1 and the monitored values should correspond with the table. All deviated results shall be reported to IE, for remedial measures.

2. Operation Phase

384. The significance of operational noise impacts commensurate with the number of sensitive structures and sensitive areas that exist along the project roads. As stated in chapter IV, the project road is *mainly* passes through agricultural land (80.1%) followed by residential cum commercial area (16.1*%) and forest (3.8%). The sensitive structures comprising schools, temples, mosques and h*ealth centers located along the project road has been discussed in Section-4.15 of Chapter-IV. After removal and shifting of the directly impacted sensitive structures, the sensitive structures that will be remaining on either side of the road which will be exposed to noise generated by future traffic plying on the improved road.

385. ***Source of Noise.*** During the operational phase, movement of traffic, traffic congestion, pedestrian interferences and increase in use of horns will be the prime source of noise. The noise levels at nearby schools, religious *place* may cause nuisance and irritation.

386. ***Vehicle Noise and Road Surface Influence on Tire/Road Noise***[6] . There are many sources of noise when a vehicle travels down a roadway. Vehicle manufactures have made efforts to reduce tire/road noise and drive train noise. If a vehicle is in a good operating *condition* and has a reasonably good exhaust system, then the effect that power and drive train noise has on the overall noise level will be negligible at moderate to high speeds. There is a "cross-over speed" where tire / road noise begins to dominate the overall noise level of a vehicle. This speed lies in the range of 30-50 km/h for automobiles and 40-70 km/h for trucks [Sandberg 1992]. It has been found that the noise level increases with the increase in the speed (**Figure-54**).

387. There are several pavement parameters, which affect the amount that the road surface contributes to the generation of tire / road noise. These parameters include the texture, age, thickness, and binder material of the pavement. The overall texture of the pavement has a significant impact on tire / road noise levels. Studies performed by the Washington State Department of *Transportation* to evaluate how tire / road noise changes with pavement age. These studies have shown that asphalt pavements start out quieter than cement concrete pavements, but the asphalt pavements exhibit an increase in noise levels over time [Chalupnik and Anderson 1992]. Another reason for the increase in noise levels is due to an increase in stiffness from traffic loading. Finally, as the asphalt surface wears over time, the coarse aggregate becomes exposed which causes an increase in noise.

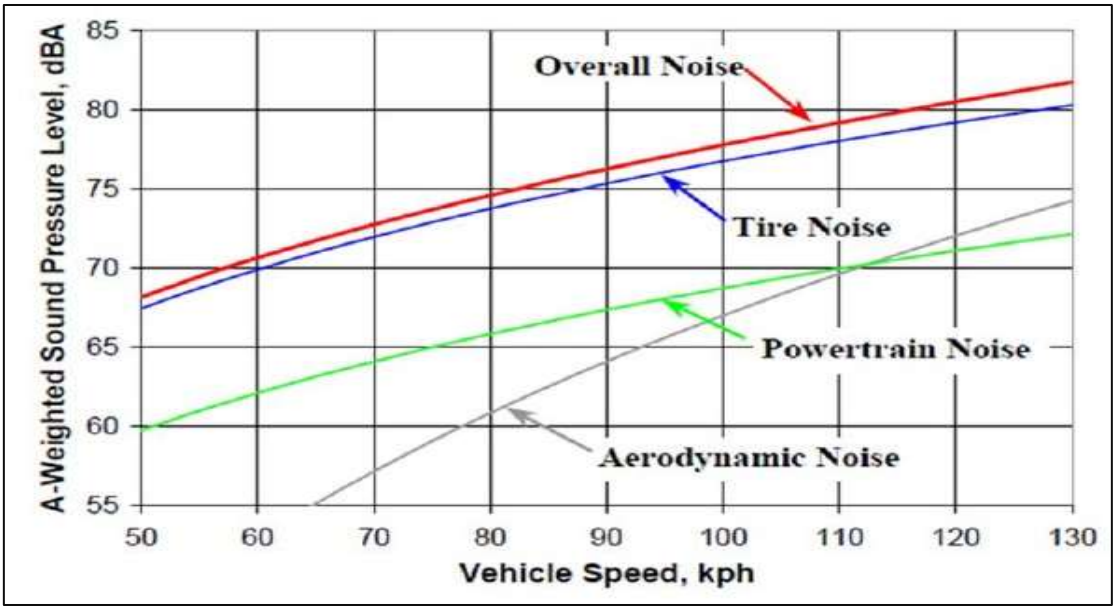


Figure 54: Comparison of Noise Level Separated by Component [Donovan, 2007]

388. **Prediction of Impacts**. Long-term noise level increase was assessed with respect to the sensitive receptors for the years 2015, 2020 and 2040 using the CRTN Model.[7] Noise

[6] U.S. Department of Transportation, Federal Highway Administration

[7] CRTN predicts noise in terms of the L_{10} index, for the 18 hours between 06:00 and 24:00. The equation $LA_{eq,\ 1h} = 0.94 \times L_{A10,1h} + 0.77$ dB was used to convert L_{10} to L_{Aeq} (*Abbot, P. G. and Nelson, P. M. Converting the UK Traffic Noise Index LA10,18h to EU Noise Indices for Noise Mapping. Project Report PR/SE/451/02).*

barrier has been proposed in 23 educational institutions. List of sensitive receptors where noise barrier has been proposed is tabulated below:

Table 100: Location of Sensitive Receptors where Noise Barrier proposed

Sl. No.	Particulars	Village	Design Ch.	Dist. (m)	Height of Noise Barrier (m)	Length of Noise Barrier (m)
1	Mothoshre Gurumma Shoratti Preprimary and Primary Convent School	Gadag	106+950	19.00	3.0	74.0
4	Anjuman-E-Islam ITI	Gadag	108+200	34.00	3.0	100.0
5	Govt. Higher Primary School,	Chabbi	135+500	14.50	3.0	116.0
6	Govt. Lower Primary School	Chabbi	136+450	10.00	3.0	120.0
11	Govt. Lower Primary School	Devihala	142+310	9.00	3.0	43.0
12	Govt. Primary School,	Madurayarapura	187+000	12.0	3.0	100.0
13	Govt. Higher Primary School	Honnatti	190+100	10.80	3.0	50.0
14	Govt. High School	Honnatti	190+400	10.00	3.0	116.0
15	Govt. Higher Primary School	Kerimallapur	191+200	12.40	3.0	50.0
16	Govt. Higher Primary School	Guddada Anveri	199+300	9.00	3.0	51.0
17	Govt. Urdu Lower Primary School	Halageri	216+040	40.00	3.0	105.0
18	Govt. Higher Primary School	Halageri	216+040	42.00		
19	SGK Pvt. ITI	Halageri	216+200	15.00	3.0	68.0
20	Govt. Lower Primary School	Thimmenahalli	230+440	13.50	3.0	99.0
21	Govt. Lower and Higher Primary School	Hanumasagara	247+840	17.20	3.0	43.0
22	Govt. Lower Primary School	Hanumasagara	248+465	9.50	3.0	60.0
23	Swami Vivekananda English Medium School	Honnali	252+950	22.5	3.0	45.0
			Total length of Noise Barrier (m)			**1240**

389. **Input Parameters:** Total vehicle flow for the projected period is obtained from the traffic projections. Minimum design speed of 80 *km*/hr is considered for operation phase. Apart from that, year-wise % of heavy vehicle, gradient, road surface, absorbent ground cover, distance from edge of the carriageway and source / receiver height difference are the other input parameters.

390. **Output:** To reduce traffic induced noise, noise barrier in the form of solid boundary wall is proposed. Height and length of the noise barrier and estimated reduction in noise level after construction of the noise barrier is given in **Table-101** and results of CRTN model is graphically presented (**Figure-55 to Figure-58**) and Noise *Contours* near the sensitive receptors is shown (**Figure-59 to Figure-62**) for 4 sensitive receptors for the year 2015, 2020 and 2040.

Table 101: Sensitive Receptor Wise Predicted Noise Levels[8]

Year →	2015	2020	2025	2030	2035	2040
Mothoshre Gurumma Shoratti Preprimary and Primary Convent School, Gadag						
Traffic Noise in dB(A)	64	68.4	70.2	71.4	72.5	73.7

[8] Since CRTN Model predicts noise in terms of L_{10} index, the corresponding equation $LA_{eq,\ 1h} = 0.94 \times L_{A10,1h} + 0.77$ dB to convert L_{10} to L_{Aeq} will result to lower values of noise. For example, instead of the 77.6 dB (A) predicted traffic noise (L_{10}) in Mothoshre Gurumma Shoratti Preprimary and Primary Convent School, Gadag in 2040, the $LA_{eq,\ 1h}$ is only equivalent to 70.0 dB (A).

Year →	2015	2020	2025	2030	2035	2040
Noise at Receptor w/o Noise Barrier dB(A)	61.1	65.6	67.4	68.6	69.7	70.9
Noise at Receptor with Noise Barrier dB(A)	46.6	51.1	52.9	54.1	55.2	56.4
Reduction (dBA)	-14.5	-14.5	-14.5	-14.5	-14.5	-14.5
Anjuman-E-Islam ITI, Gadag						
Traffic Noise in dB(A)	64	68.4	70.2	71.4	72.5	73.7
Noise at Receptor w/o Noise Barrier dB(A)	58.6	63	64.8	66	67.1	68.3
Noise at Receptor with Noise Barrier dB(A)	46.4	50.8	52.6	53.8	54.9	56.1
Reduction (dBA)	-12.2	-12.2	-12.2	-12.2	-12.2	-12.2
Govt. Higher Primary School, Chabbi						
Traffic Noise in dB(A)	59.8	65.2	67.1	68.6	69.8	71.1
Noise at Receptor w/o Noise Barrier dB(A)	52.7	58.1	60	61.5	62.7	64
Noise at Receptor with Noise Barrier dB(A)	41.8	47.2	49.1	50.6	51.8	53.1
Reduction (dBA)	-10.9	-10.9	-10.9	-10.9	-10.9	-10.9
Govt. Lower Primary School, Chabbi						
Traffic Noise in dB(A)	59.8	65.2	67.1	68.6	69.6	71.1
Noise at Receptor w/o Noise Barrier dB(A)	56.2	62	64	65.5	66.7	68
Noise at Receptor with Noise Barrier dB(A)	43.2	49	51	52.5	53.7	55
Reduction (dBA)	-13	-13	-13	-13	-13	-13
Govt. Lower Primary School, Devihala						
Traffic Noise in dB(A)	59.8	65.2	67.1	68.6	69.8	71.1
Noise at Receptor w/o Noise Barrier dB(A)	58.1	64.3	66.5	68	69.2	70.5
Noise at Receptor with Noise Barrier dB(A)	41.8	48	50.2	51.7	52.9	54.2
Reduction (dBA)	-16.3	-16.3	-16.3	-16.3	-16.3	-16.3
Govt. Primary School, Madurayarapura						
Traffic Noise in dB(A)	64.8	69.3	71.2	72.5	73.7	74.9
Noise at Receptor w/o Noise Barrier dB(A)	55.9	60.4	62.3	63.6	64.8	66
Noise at Receptor with Noise Barrier dB(A)	46.4	50.9	52.8	54.1	55.3	56.5
Reduction (dBA)	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5
Govt. Higher Primary School, Honnatti						
Traffic Noise in dB(A)	64.8	69.3	71.2	72.5	73.7	74.9
Noise at Receptor w/o Noise Barrier dB(A)	57.8	62.3	64.2	65.5	66.7	67.9
Noise at Receptor with Noise Barrier dB(A)	46.2	50.7	52.6	53.9	55.1	56.3
Reduction (dBA)	-11.6	-11.6	-11.6	-11.6	-11.6	-11.6
Govt. High School, Honnatti						
Traffic Noise in dB(A)	64.8	69.3	71.2	72.5	73.7	74.9
Noise at Receptor w/o Noise Barrier dB(A)	57.6	62.1	64	65.3	66.5	67.7
Noise at Receptor with Noise Barrier dB(A)	46.2	50.7	52.6	53.9	55.1	56.3
Reduction (dBA)	-11.4	-11.4	-11.4	-11.4	-11.4	-11.4
Govt. Higher Primary School, Kerimallapur						
Traffic Noise in dB(A)	64.8	69.3	71.2	72.5	73.7	74.9
Noise at Receptor w/o Noise Barrier dB(A)	63.8	68.3	70.2	71.5	72.7	73.9
Noise at Receptor with Noise Barrier dB(A)	44.6	49.1	51	52.3	53.5	54.7
Reduction (dBA)	-19.2	-19.2	-19.2	-19.2	-19.2	-19.2
Govt. Higher Primary School, Guddada Anveri						
Traffic Noise in dB(A)	64.8	69.3	71.2	72.5	73.7	74.9
Noise at Receptor w/o Noise Barrier dB(A)	63.2	67.7	69.6	70.9	72.1	73.3
Noise at Receptor with Noise Barrier dB(A)	45.9	50.4	52.3	53.6	54.8	56
Reduction (dBA)	-17.3	-17.3	-17.3	-17.3	-17.3	-17.3
Govt Urdu Lower Primary School, Halageri						
Traffic Noise in dB(A)	64.4	68.8	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	58.6	63	64.9	66.2	67.5	68.7
Noise at Receptor with Noise Barrier dB(A)	47	51.4	53.3	54.6	55.9	57.1
Reduction (dBA)	-11.6	-11.6	-11.6	-11.6	-11.6	-11.6

Year →	2015	2020	2025	2030	2035	2040
Govt. Higher Primary School, Halageri						
Traffic Noise in dB(A)	64.4	68.8	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	58.3	62.7	64.6	65.9	67.2	68.4
Noise at Receptor with Noise Barrier dB(A)	46.8	51.2	53.1	54.4	55.7	56.9
Reduction (dBA)	-11.5	-11.5	-11.5	-11.5	-11.5	-11.5
SGK Pvt ITI, Halageri						
Traffic Noise in dB(A)	64.4	68.8	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	65	69.6	71.5	72.8	74.1	75.3
Noise at Receptor with Noise Barrier dB(A)	49.8	54.4	56.3	57.6	58.9	60.1
Reduction (dBA)	-15.2	-15.2	-15.2	-15.2	-15.2	-15.2
Govt. Lower Primary School, Thimmenahalli						
Traffic Noise in dB(A)	64.4	68.8	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	56.6	61	62.9	64.2	65.5	66.7
Noise at Receptor with Noise Barrier dB(A)	45.8	50.2	52.1	53.4	54.7	55.9
Reduction (dBA)	-10.8	-10.8	-10.8	-10.8	-10.8	-10.8
Govt. Lower and Higher Primary School, Hanumasagara						
Traffic Noise in dB(A)	64.4	68.8	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	61.6	66.1	68	69.3	70.6	71.8
Noise at Receptor with Noise Barrier dB(A)	47.9	52.4	54.3	55.6	56.9	58.1
Reduction (dBA)	-13.7	-13.7	-13.7	-13.7	-13.7	-13.7
Govt. Lower Primary School, Hanumasagara						
Traffic Noise in dB(A)	64.4	68.8	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	60.8	65.2	67.1	68.4	69.7	70.9
Noise at Receptor with Noise Barrier dB(A)	48.1	52.5	54.4	55.7	57	58.2
Reduction (dBA)	-12.7	-12.7	-12.7	-12.7	-12.7	-12.7
Swami Vivekananda English Medium School						
Traffic Noise in dB(A)	64.4	68.8	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	62.2	66.7	68.6	69.9	71.2	72.4
Noise at Receptor with Noise Barrier dB(A)	48.4	52.9	54.8	56.1	57.4	58.6
Reduction (dBA)	-13.8	-13.8	-13.8	-13.8	-13.8	-13.8

391. Height of noise barrier has been proposed 3 m. It has been observed that, in the year 2040, the value of noise at the receptor will increase substantially from the base year (2015). However, to maintain the noise level at the receptors, the barrier height should be increased by 0.5 m in the year 2040 (height 3.5 m) It is recommended that the foundation of the noise barrier should be made in such a way that it can bear the load of incremental heights in future, if required.

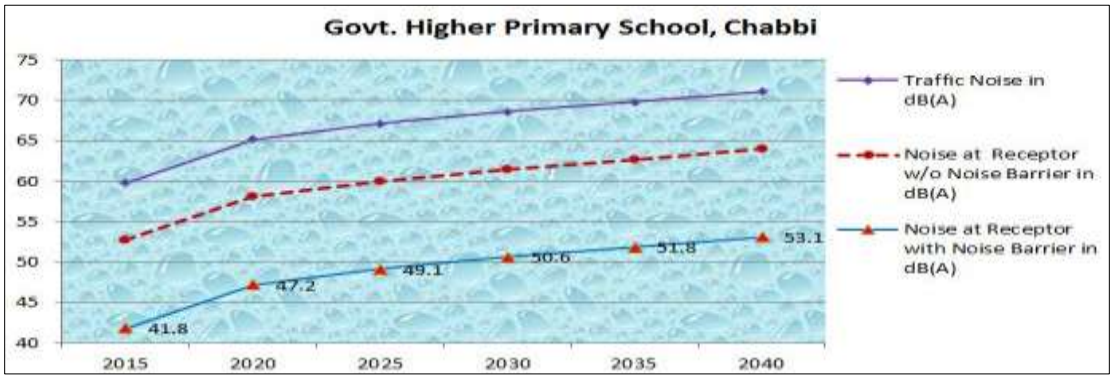


Figure 55: Noise Level at Govt. Higher Primary School, Chabbi- with & without Noise Barrier

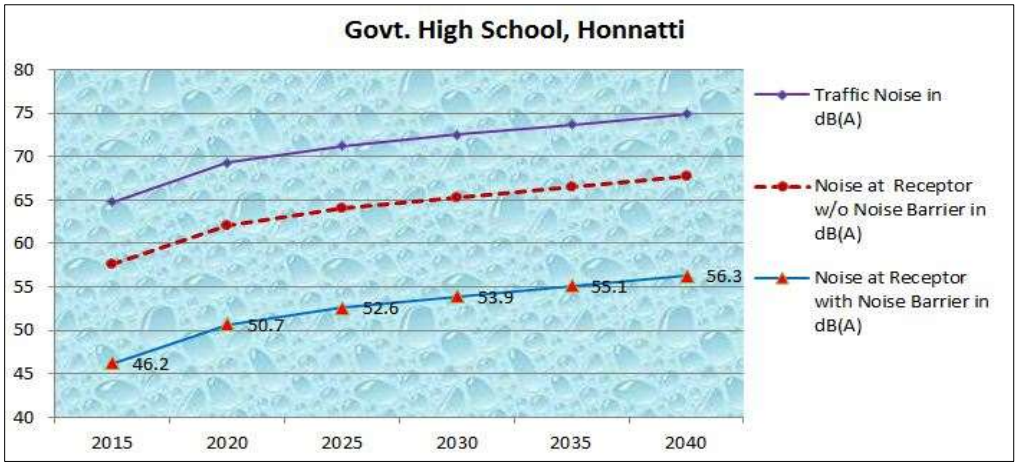


Figure 56: Noise Level at Govt. High School, Honnatti - with & without Noise Barrier

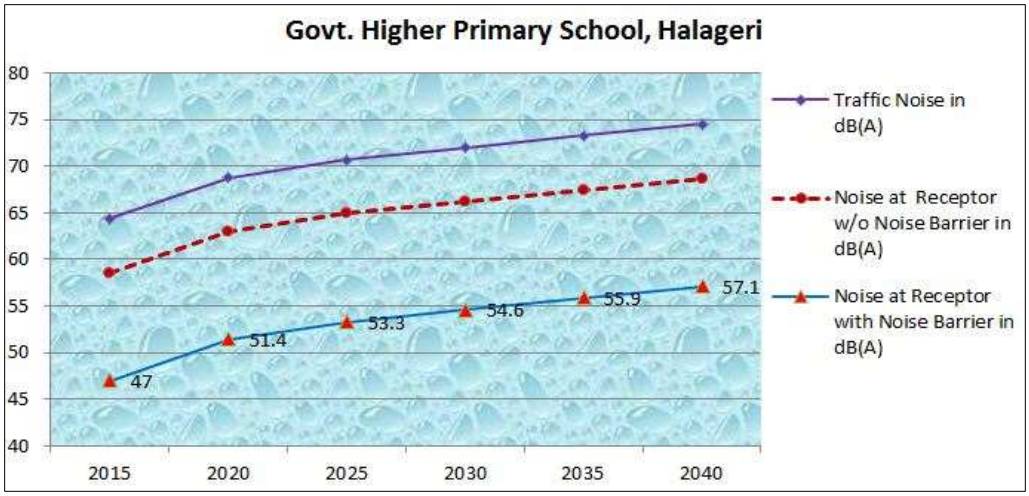


Figure 57: Noise Level Govt. Higher Primary School, Halageri - with & without Noise Barrier

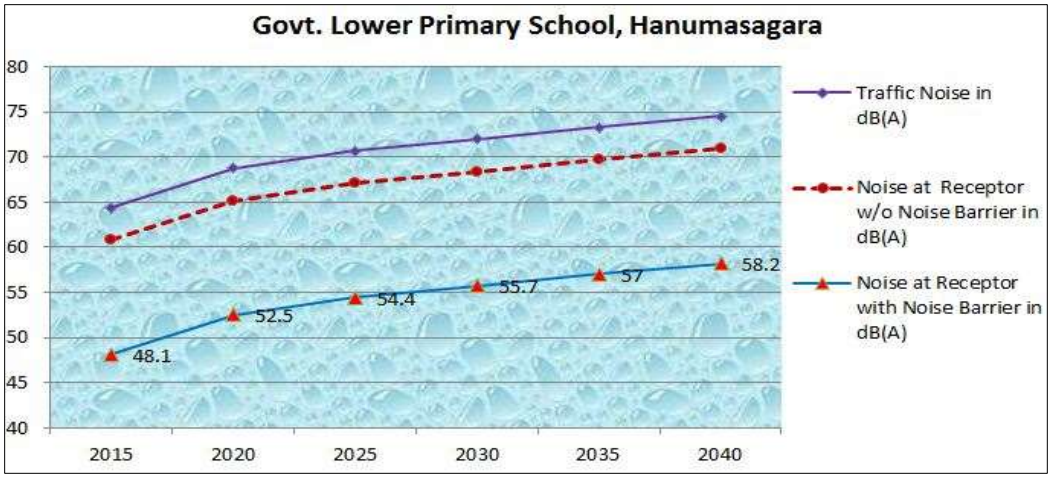


Figure 58: Noise Level at Govt. Lower Primary School, Hanumasagara - with & without Noise Barrier

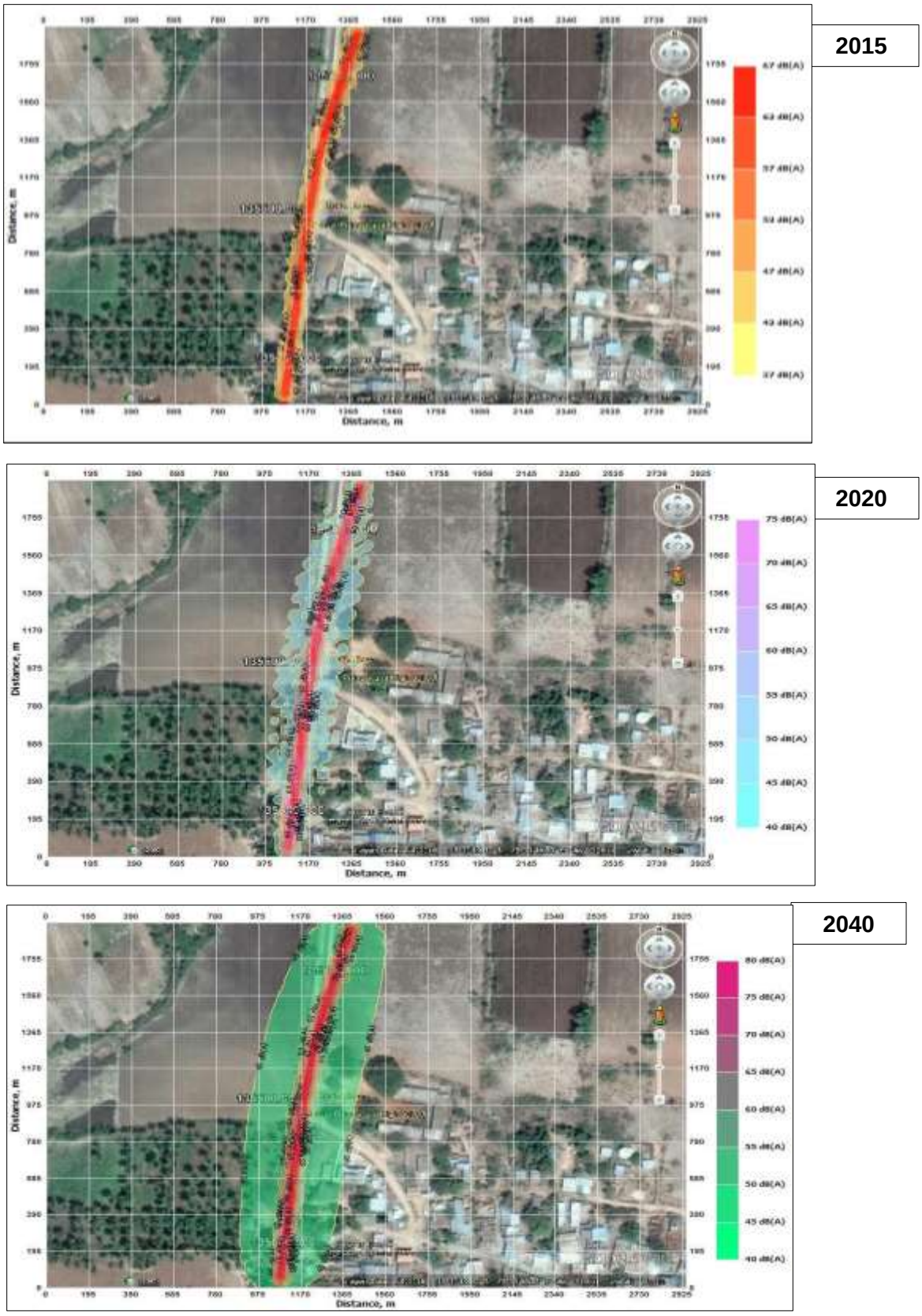


Figure 59: Noise Contour at Govt. Higher Primary School, Chabbi

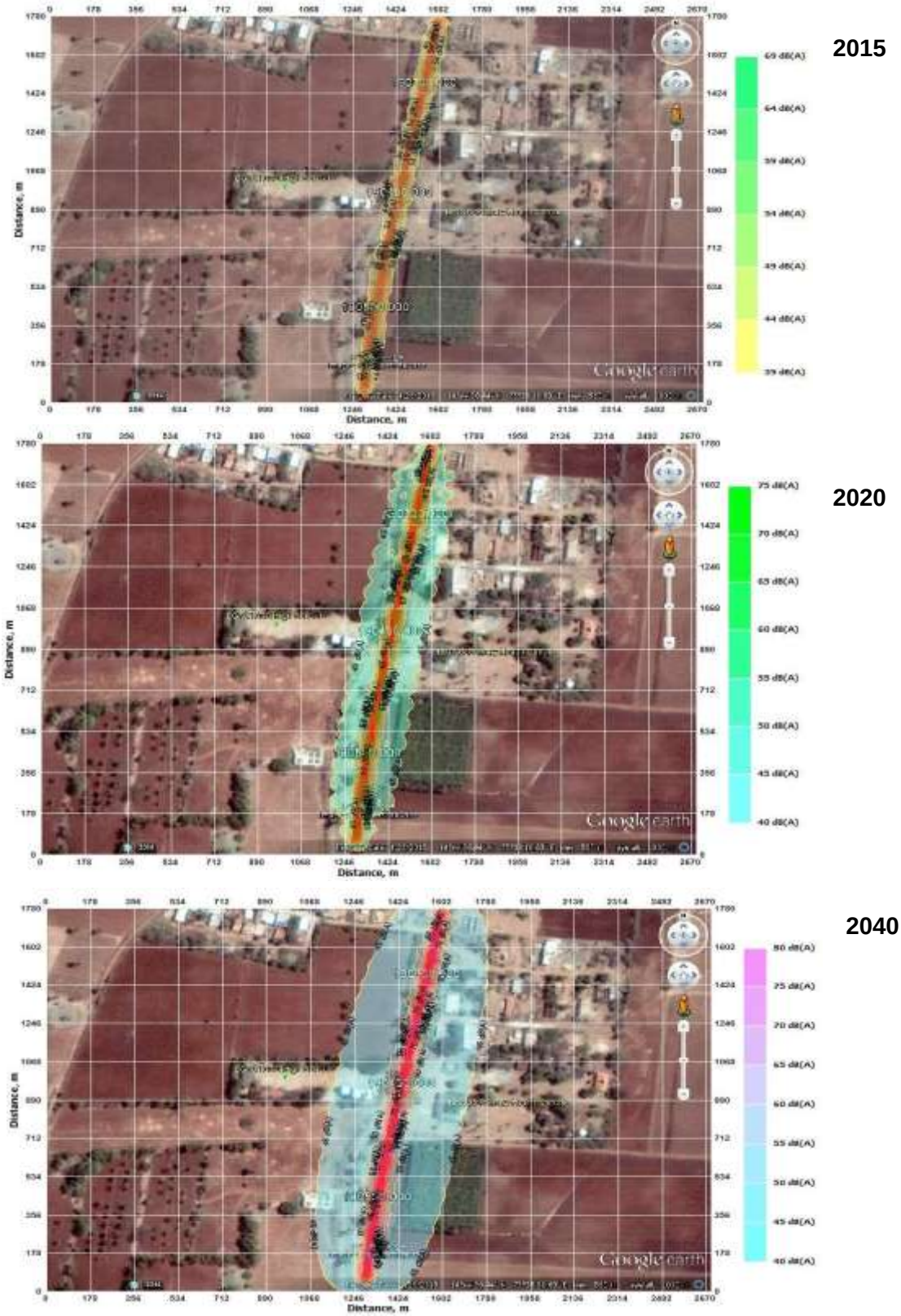


Figure 60: Noise Contour at Govt. High School, Honnatti

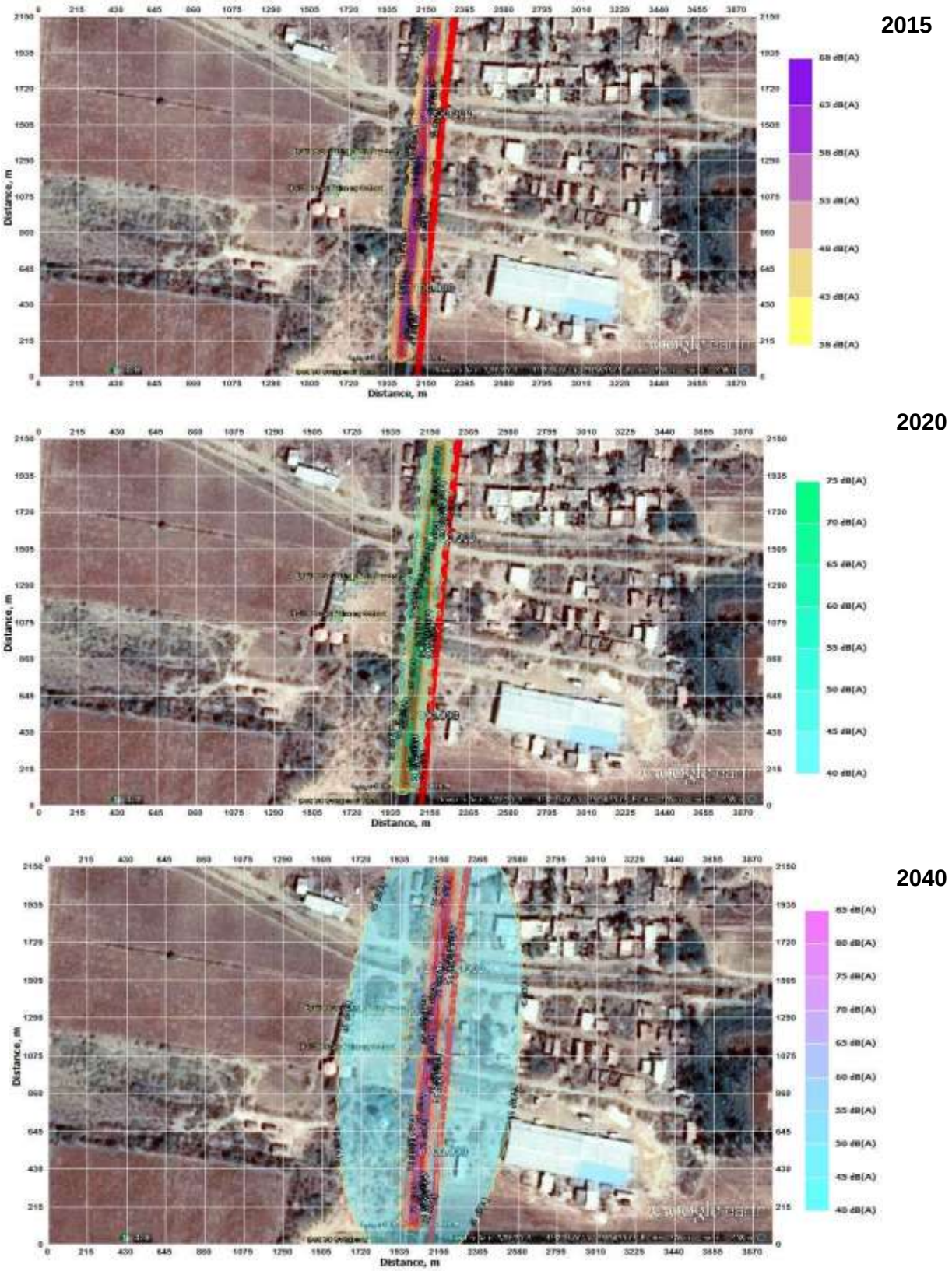


Figure 61 Noise Contour at Govt. Higher Primary School, Halageri

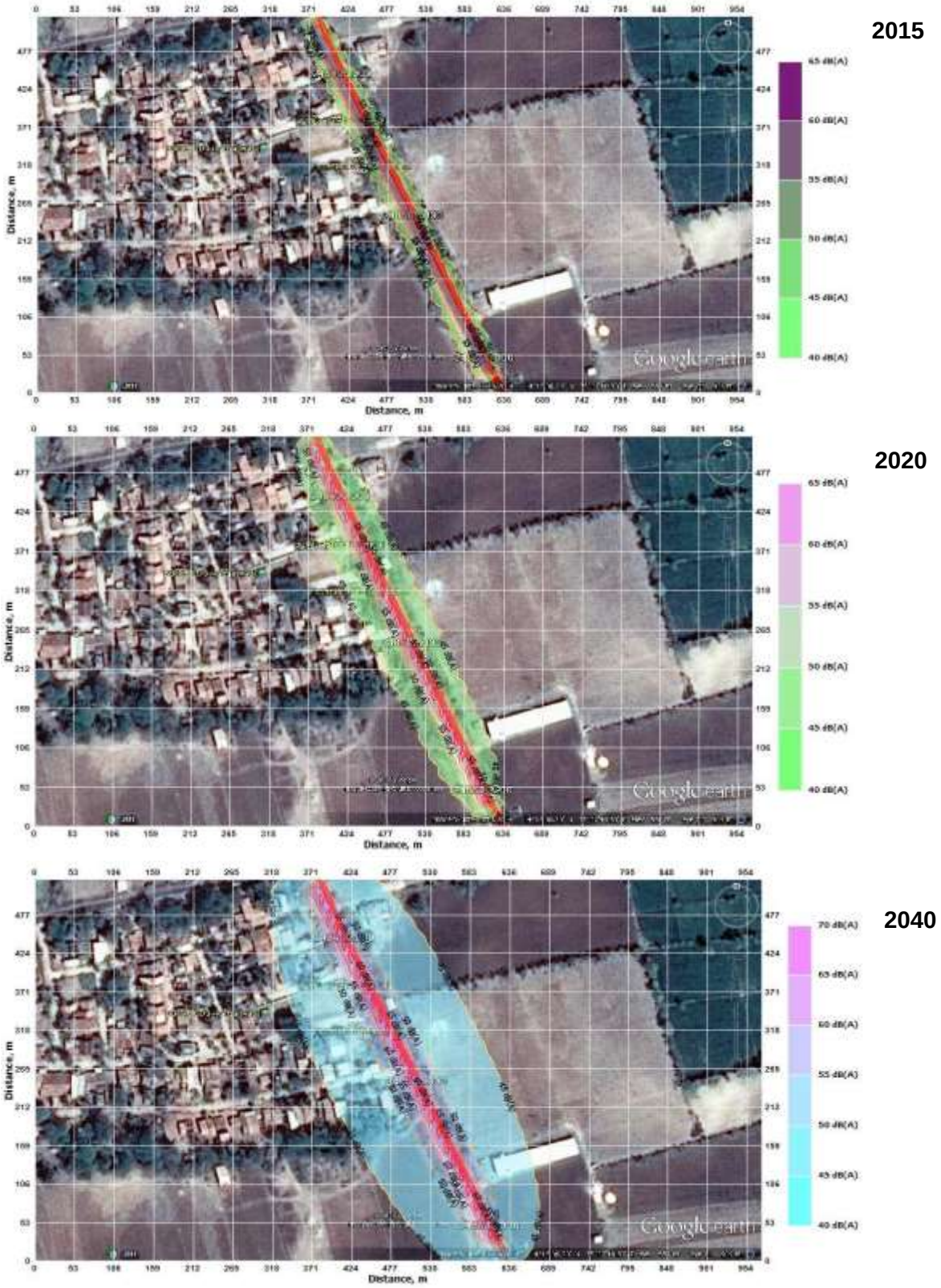


Figure 62: Noise Contour at Govt. Lower Primary School, Hanumasagara

3. Noise Barrier

392. To reduce traffic induced noise, noise barrier in the form of solid boundary wall is proposed for sensitive receptors. The noise barrier wall shall be constructed by excavation of foundation, laying of brick masonry wall, plastering and painting. It is also proposed to plant shade *and* flowering trees within the boundary of the sensitive receptors, between the building line and the compound wall (**Figure-63**). Creepers may be planted in consultation with the local forest officials to give an aesthetic look. Drawing of typical noise barrier is given in **Annex-8.25**.

Figure 63: View of Solid Boundary Wall with Trees and Creepers

393. **Various Noise Barrier Materials:** Noise barriers are a necessary structure along the highway to protect the sensitive receptors from excessive road noise. There are many different materials from which noise *barriers* can be constructed such as brick, concrete, plastic, wood, mixed type (existing wall, top up with dense fibre/polyethylene wall) high density fibre/polyethylene etc. Each of the materials used to construct noise barrier has advantages and disadvantages both acoustically and aesthetically. Several studies have been conducted to identify the noise barrier material that produced the greatest noise reduction. It can be concluded from literature review that:

- Absorptive wall materials absorbed more sound energy than a standard reflective material
- Concrete noise abatement walls yields a mean insertion loss of 18.54 dB, which is maximum in comparison to the other materials such as Fiberglass (17.35 dB), Wood (13.60 dB) Acoustic Fabric Fence materials (11.62 dB), Earthen Berms (12.93 dB) etc.

394. However, keeping in view the policy of KSHIP and cost effectiveness, brick has been proposed as a material for construction of noise barrier. In KSHIP – II, brick wall has been constructed as *noise* barrier and effectiveness of the barrier is discussed in ***Section 4***. In the year 2035, the noise level at the receptor will increase more than 4 dB(A) from the base year (2015). Therefore, to maintain the noise level at the receptors, construction of concrete wall may be considered in the year 2035.

395. **Mitigation Measures**

- Vehicular noise & use of horns will be controlled through enforcement of laws

and public awareness. It will be ensured that all the vehicles are using proper horn as per norms to keep noise within the permissible limits.

- Silence zones will be demarcated and road signs prohibiting the use of horns will be displayed at residential areas, sensitive locations and silence zones.
- Regular monitoring of noise level at specified representative locations will be conducted at fixed interval.
- Roadside plantation with suitable species near sensitive receptors and inhabited areas will result in partial noise attenuation.
- Maintenance of noise barrier

4. Experience on Noise Barrier installed under KSHIP-II

396. The Karnataka State Highways Improvement Project has taken up improvements of 831 km of State Highways in the state with *financial* assistance from the World Bank under the Second Karnataka State Highways Improvement Project (KSHIP–II) at a cost of US$ 350 Million. Under the project, the existing single / intermittent roads are to be strengthened and widened to 2 way carriage way with paved / unpaved shoulders on either side. The civil works were taken up under (i) Engineering Procurement Construction (EPC) contract in five packages for 268.9 Kms of roads and (ii) Engineering Procurement Annuity (EPA) contract in four packages for 562 Kms of roads.

397. As part of the road up-gradation / improvements, KSHIP had constructed noise barriers at selected sensitive receptor locations like schools, colleges, hospitals, temples among others at various chainage along roads under EPC packages.

398. A study was conducted by KSHIP to assess the effectiveness of such constructed noise barriers and accordingly 8 selected sensitive receptor locations, which are either on almost road side or very close to road and have maximum exposure to traffic of the road for most hours of the day were selected.

399. In order to determine the effectiveness of noise barriers, ambient noise levels were recorded on either side of the noise barrier i.e. at the edge of noise barrier towards roadside and at the nearest wall of the *sensitive* receptor, but away from noise barrier, falling in the same straight line and perpendicular to road. The noise levels monitored at these noise barrier locations were carried out over 8 hours during the daytime (6 a.m. to 10 p.m.) as per the stipulated guidelines. The test results of the ambient noise levels monitored at these noise barrier locations along with the minimum, maximum and mean values recorded during the monitoring period are summarized in **Table-102**.

Table 102: Summary of Noise Level Monitoring Results at selected Noise Barriers

Name of Link & Link No	Monitoring Date	Sampling Location	Monitoring Duration	Monitoring in front of Barrier (Road Side)	Monitoring behind Noise Barrier	% Reduction
				Leq* dB (A) (Mean)	Leq* dB (A) (Mean)	
Hangal-Tadasa, M7D	13.03.2012	Govt. School	2.00 to 10.00 p.m.	67.06	**55.05**	17.91
Haveri(NH4) - Hangal, T8	14.03.2012	Govt. School, Aladakatti	10.00 a.m. to 7.00 p.m.	70.41	**62.51**	11.22

Name of Link & Link No	Monitoring Date	Sampling Location	Monitoring Duration	Monitoring in front of Barrier (Road Side)	Monitoring behind Noise Barrier	% Reduction
				Leq* dB (A) (Mean)	Leq* dB (A) (Mean)	
Dharwad-Saundatti, 21B	16.03.2012	Govt. School, Heriahulligere	9.00 a.m. to 5.00 p.m.	65.64	**59.18**	9.84
Devadurga-Kalmala, 13B	20.03.2012	Govt. Primary School, Kakaragal	9.00 a.m. to 5.00 p.m.	60.31	**56.78**	5.85
Thinthini-Devadurga, 13A	21.03.2012	Govt. Higher Primary School, Yaragudda	9.00 a.m. to 5.00 p.m.	61.34	**58.22**	5.09
Chowdapur-Gulbarga, 6C	22.03.2012	Govt. Urdu Higher Primary School, Gubbur	10.00 to 6.00 p.m.	63.36	**58.2**	8.14
Hindgnala cross-Chintamani By pass, 67B	09.04.2012	Govt. Higher Primary School, & High School, Talagavara	9.00 a.m. to 5.00 p.m.	72.64	**57.3**	21.12
Hoskote - Hindgnala Cross,67A	11.04.2012	Govt. High School, Dodda Hulluru	9.00 a.m. to 5.00 p.m.	68.34	**59.6**	12.79

*dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

400. An assessment of the recorded noise levels given in Table 6-8, monitored on either side of the noise barriers as mentioned above indicate a reduction in noise levels up to 21%, which can be *attributed* to the effectiveness of noise barrier. The histograms depicting the ambient noise levels on either side of the noise barriers, monitored along selected roads under EPC packages receptors along with percentage reduction in noise levels due to noise barriers are presented in **Figure 64**.

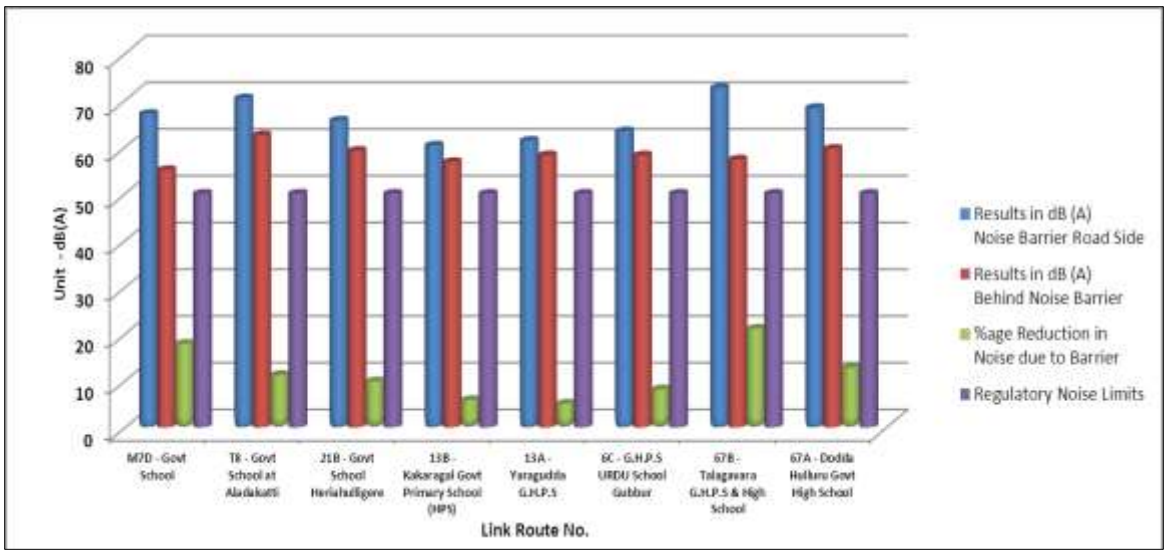


Figure 64: Noise Level Monitoring Results at Selected Noise Barrier Locations

F. Flora

1. Construction Phase

401. **Impacts:**

- Loss of flora due to felling of trees along the ROW
- No threatened species of flora is falling in the ROW of the project road
- Deposition of fugitive dust on pubescent leaves of nearby vegetation may lead to temporary reduction of photosynthesis. Such impacts will, however, be confined mostly to the initial periods of the construction phase and in the immediate vicinity of the construction area.
- In the long term, compensatory afforestation and Green belt development will enhance environment of the project area.

402. **Felling of Roadside Trees:**

- Efforts were made to minimize the number of trees to be felled in other locations also. Approximately 3,173 trees are required to be felled for the improvement of the road out of total 3,865 existing trees.
- However, this number may change and actual number of trees to be felled can be determined only after the completion of joint inspection with the Forest Department. Trees species abutting the project road mainly comprise Ficus benghalensis (Banyan), Ficus religiosa, (Peepal), Delonix regia (Gulmohar), Mangifera indica (Mango), Azadirachta indica (Neem), Tamarindus indica (Tamarind), Eucalyptus teriticornis (Eucalyptus) etc. Girth-size wise distribution of trees to be felled along both side of the road is presented in Table-103.

Table 103: Girth Size wise Distribution of Trees to be felled

Side	No of Trees in Girth Class (in cm)					Total
	<30	31-59	60-119	120-180	>180	
RHS	369	421	678	149	56	1,673
LHS	390	350	258	223	279	1,500
	759	**771**	**936**	**372**	**335**	**3,173**

403. **Green Tunnel:** Efforts were made to save green tunnel along the project road and this issue was also discussed during public consultation. To minimise the impacts on residential, commercial, religious and educational structures as well as to minimise the acquisition of fertile agricultural land, concentric widening has been proposed. Further, efforts were made to restrict the widening within the existing ROW. Most of the trees along with project road are located within 1-1.5 m from the existing blacktop.

404. Green tunnel is located at 5 locations along the project road, out of which at one location (design Ch. km 109+625 to 109+*770*) green tunnel has been saved on RHS. To minimise the social impacts, in remaining locations green tunnel could not be saved in Gadag to Honnali Border road but most of the giant trees will be saved.

405. **Mitigation Measures**

- Avoid cutting the giant trees to the extent possible
- The proposed improvement as far as possible is within the existing (ROW) avoiding land acquisition except for locations having inadequate width, bypass,

realignments with geometric improvements and provisions of highway facilities. Out of the total 138.168 km length of project road 82.828 km involves concentric widening, so the land acquisition is minimized and it will require limited vegetation clearing within the ROW only.

- It shall be ensured that trees located outside ROW shall not be felled.
- The trees required to be felled shall be identified, marked and verified by Forest department. Felling of trees shall be done only after obtaining Tree Felling Permission from competent authority. No threatened species of flora is reported in the ROW. The trees planted along the roads are common in distribution and found throughout the region.

406. **Roadside Plantations:** To mitigate the adverse impact due to the felling of the roadside trees plantations shall be done. One row of tree shall be planted on both sides of the project road outside drain line where space is available. In urban sections, **16 m to 20 m ROW** has been proposed to minimize social impact, where no space is available for plantation.

407. Total length of the project road is **138.168 km** out of which in 13.768 km stretch, there is no space available for plantation. Therefore, effective length available for plantation is **124.4 km (≅124 km)**. PIU-KSHIP has an arrangement with the Forest Department to plant the trees. In KSHIP-II, per km 200 trees (10 m interval on either side) were planted and the same system will be followed in KSHIP-III. Therefore, in 124 km stretch, **24,800 trees** shall be planted on both sides of the project road. Detail of plantation provided in Tree Plantation Strategy (**Annex-8.12**).

408. **310 trees** will be planted along the boundary of noise barrier at 4 m interval (total length of noise barrier is 1.240 km)

409. **Compensatory afforestation** shall be carried out in the ratio of 1:3. Compensatory Afforestation shall be provided as per the Forest Conservation Act, 1980 and amendment. The amount required for tree cutting and Net Present Value (NPV) for Forest land shall be provided by KSHIP to Forest Department.

410. The Karnataka Preservation of Trees Act, 1976 shall be abided. Trees in non-forest/ agriculture land shall be felled only after obtaining permission from competent authority.

411. Therefore, **Total Compensatory Plantation will be more than 1:8** for Gadag to Honnali section.

412. Species suggested for plantation are provided in the **Table-104.**

Table 104: Tree Species suggested for Plantation near Forest

S. No	Species	Value	Visitors*
1.	Chloroxylon swietenia**	Nectar , Fruit	I,B,M
2.	Mangifera indica	Nectar, Fruits & Pollution Control	I,B,M
3.	Pongamia pinnata	Nectar, Dust & Pollution Control	I,M
4.	Syzigium cumini	Nectar, Fruits	I,B,M
5.	Tamarindus indica	Nectar, Fruits	I,B,M
6.	Ziziphus mauritiana	Fruit	B,M

** I – Insects, B – Birds, M – Mammals*

*** - Vulnerable Tree species*

- The plantation shall be maintained for **5 years**. Dead saplings shall be replaced to maintain the survival percentage of 90%.
- To enhance the visual and landscape near water bodies, plantation is suggested. Species such *Terminalia arjuna, Syzigium cumini etc.* and flowering plants such as Champa, Jasmine etc. can be planted.
- Oil seed species / Bio fuel trees species such as *Pongamia Pinnata*, *Azadirachta Indica*, *Simarouba Glauca*, *Madhuca Indica / Latifolia*, *Calophyllum Inophyllum* also suggested for Plantation
- Native indigenous trees species shall be used as far as practicable, strictly avoiding any exotic (but popular) species like *Eucalyptus sp.* that can have far-reaching adverse effects on the ecology and water regime of the area.
- Soil erosion shall be checked by adopting bio-engineering measures.
- Construction camps shall be located away from Forest areas and movement of labours shall be monitored by Construction Supervision Consultant and Contractor.
- LPG/ Kerosene shall be provided by the Contractor for cooking.
- The impact on flora will be concentrated within the ROW of the road and cutting of trees or clearing of vegetation outside ROW shall be strictly prohibited.

2. Operation Phase

413. **Impacts:** Illegal felling of road side plantation

414. **Mitigation Measures:**
- Plantation along the ROW will be maintained properly
- Plantation along the ROW will be protected from illegal felling

G. Fauna

1. Construction Phase

415. **Impacts:**
- The clearing of land and felling of trees will directly cause loss of habitat to avifauna and wildlife dwelling in the area.
- There are no National Parks or Wildlife Sanctuaries within 10 km radius of the proposed road. There will be no direct impact on Protected Areas or wildlife habitat due to the project.
- The project alignment traverses through Reserve Forest & Protected Forest for **4.848 km** (as per design ch, 4.886 km). The wildlife mostly avifauna dwelling in the area shall be impacted due to project activities.
- The construction activities and noise will cause disturbance to wildlife in their movement, feeding, breeding and resting, which is short term reversible impact.
- The labour population may enter Forest area for collecting fire wood.
- The domestic fauna in the area will also face problem in movement due to

416. **Mitigation Measures**
- Reserve Forest / State Forest is located on either side of the project road at 13 locations. Avian species *Accipiter badius* (Shikra) and *Ictinaetus malayensis* (Black

Eagle), are Schedule-I as per Wildlife Protection Act, are dwelling in the project area. All the species in schedule-I category are under Least Concern as per IUCN red list. These species have an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion.

- Poaching shall be strictly prohibited in project area.
- The workers and staff at site shall be given training /awareness on sensitivity and importance of environmental protection and wildlife dwelling in the area.
- The Concessionaire shall ensure that all the people at construction site abide by the law prohibiting hunting of wildlife. Poaching will be strictly banned and any incidence of poaching of wildlife by workforce shall be reported to the Forest / Wildlife Department
- All the construction workers and staff of the project unit will be made aware and educated about the presence of the Wildlife in the area. Environmental awareness program will be provided to the Contractor, labours and all staff deployed at the site
- All staff / workers will be instructed not to chase or disturb if any wildlife seen near the project area. The incidence of sighting wildlife near project site should be reported to Forest Department.
- The Concessionaire shall ensure that no open fire is done in construction camp as it may lead to fire to surrounding forest causing injury to wildlife
- Noise will be kept under control by regular maintenance of equipment and vehicles. No honking board shall be placed near Forest. Noisy activity shall be prohibited during night time.
- Construction camps shall be located away from Forest areas.
- Trees located outside ROW will not be felled. The construction workers will be strictly prohibited from entering Forest Areas.
- Prohibitory Sign boards shall be placed to prevent trespassing in the Forest area.
- Construction debris shall not be allowed to dispose in the Forest areas
- Implementing sediment and erosion controls during construction will minimize adverse Impacts of water bodies. Construction activity will be avoided near water bodies during rainy season.
- Existing and proposed culverts and minor bridges along the project stretch will facilitate the movement / crossing of wildlife in the area.
- Plantation of fruit bearing species will support the future demand of the fauna dwelling in the project area. It will provide additional habitats to avifauna dwelling in the area.
- Impact on availability of fodder due to loss of trees and agricultural area shall be negligible on domestic fauna.
- **Overall the impact will be insignificant** on fauna of the project area.

2. Operation Phase

417. **Impacts:**

- Effect on aquatic fauna in case of accidental oil spill & toxic chemical release find its way into the water bodies.
- Illegal felling of road side plantation

418. **Mitigation Measures:**

- Contingent actions will be taken for speedy cleaning up of oil spills, fuel and toxic chemicals in the event of accidents
- Plantation along the ROW will be protected from illegal felling

H. Protected Area

419. The project road does not pass through any Wildlife Sanctuary/ National Park / Biosphere *Reserve*. **Ranebennur Wildlife Sanctuary** is located within 10 km radius of the project area and the nearest distance of the WLS from project road is 2.3 km. The sanctuary is far away from the project road. Therefore, **no impact** is envisaged on the sanctuary due to the proposed development.

I. Reserved Forest

420. The project road is passing through *Reserved* Forests /Protected Forest at various locations. **Total 4.848 Km** stretch of the project road is passing through the forest. Details are presented in **Table-105.**

Table 105: Location of Reserved Forest along the project Road

SN	Design Chainage Km		Length (Km)	Side	Existing Chainage km		Length (Km)	Forest Type
	From	To			From	To		
1	139+950	140+800	0.850	Both	142+140	142+990	0.850	RF
2	152+100	152+170	0.070	LHS	154+160	154+230	0.070	RF
3	152+900	153+115	0.215	LHS	154+970	155+185	0.215	RF
4	153+115	153+153	0.038	Both	155+185	155+223	0.038	RF
5	155+400	155+600	0.200	RHS	157+500	157+820	0.320	RF
6	160+500	161+100	0.600	RHS	162+935	163+535	0.600	RF
7	161+100	161+600	0.500	Both	163+535	164+035	0.500	RF
8	192+050	194+050	2.00	LHS	202+775	204+775	2.000	Gudgure RF
9	235+747	235+852	0.105	Both	21+000	21+100	0	RF[1]
10	236+750	236+900	0	RHS	22+100	22+300	0	RF[2]
11	241+667	241+830	0.163	RHS	27+025	27+200	0.175	PF
12	241+830	242+130	0	RHS	27+200	27+575	0	PF
13	242+130	242+275	0.145	RHS	27+575	27+655	0.080	PF
	Total		**4.886**		**Total**		**4.848**	

Source: Field Survey conducted by ICT Pvt. Ltd.

421. Minimum reserved *forest* land has been proposed for diversion **(3.4225 ha).** The area required is for curve improvement only for the sake of road safety. The acquisition of forest land will be taken up in accordance to the requirements of Government of India.

422. **Mitigation Measures.** For stretches of the corridor through the forest areas, the contractor and the IE shall ensure that the construction activities shall be limited to the proposed ROW, so as to avoid any impacts on the *vegetation* within the forest areas. The measures for avoiding / mitigating adverse impacts on the reserve forest stretches are given below:

- No construction camp shall be allowed within the designate limits of the forest areas and within 1km from their boundaries.
- No earthworks or surfacing will be permitted along stretches of road passing through the reserved forest area after 6:30 p.m.
- No workmen shall be allowed to stay within the areas after sundown except with adequate supervision.
- No disposal of debris shall be allowed within these areas except at locations identified during project preparation.

J. Induced and Cumulative Impact

423. According to the ADB Environment Safeguards Sourcebook *cumulative* impact is described as: “The combination of multiple impacts from existing projects, the proposed project and anticipated future projects that may result in significant adverse and / or beneficial impacts that cannot be expected in the case of a stand-alone project.” The sourcebook also describes induced impacts as: “Adverse and / or beneficial impacts on areas and communities from unintended but predictable developments caused by a project, which may occur at later or at a different location.

424. Economic activities supporting transport like fuel stations, automotive repair shops, lodging, and restaurants are expected to increase with increase of traffic and induce development in the project area. Increase in agro-industrial activities are also expected to take advantage of improved access to urban centers where there are higher demand and better prices for agricultural products. The project area has good infrastructure for industrialization. Hence the project will accelerate industrial activities and induce development significantly. Further the increased industrial activities will significantly reduce migration. The improved road will provide better *connectivity* and result in (i) Reduction in travel time (ii) better mode and frequency of transport (iii) access to quality health care facilities, educational and other infrastructural facilities (iv) enhanced tourism activities in the area and state which in many terms will boost the local economy (v) better investment climate for industries creating more employment opportunities to local people.

425. In terms of environment safeguard issues the improved road surface is expected to result in less dust and noise due to traffic plying on the damaged roads. However, the increased traffic due to the improved road will generate more air pollution due to vehicle exhaust and noise. The smoother road conditions will also result in increase of traffic speeds, hence creating more risks for accidents amongst traffic users as well as the local communities in the project area. Improvement in local economic conditions can also result in unorganized and illegal establishment of settlements and businesses along the roads creating new problems of waste and pollution. To address these potential problems relevant local authorities will have to monitor developments and strictly enforce rules.

426. For addressing the impacts of air pollution and noise, regular maintenance of the road surface, maintenance and monitoring of newly planted trees, noise barriers have been included in the EMP for implementation during operation stage. For addressing safety related impacts, regular maintenance of the road furniture including safety related furniture, has been included in the EMP for implementation during operation stage. Relevant local authorities will need to monitor developments locally and strict enforce rules on location for establishment of new business and houses along the improved road.

427. Information on other development projects in and around the project area was not available. Hence, it is difficult to assess cumulative impacts from other projects which may get implemented in the project area.

K. Climate Change Impacts and Risks

1. Climate Change Mitigation

428. The Transport Emissions *Evaluation* Model for Projects (TEEMP)[9] developed by Clean Air Asia[10] was utilized to assess the CO_2 gross emissions with and without the project improvements. The main improvement from the project that was considered for the model are better surface roughness with initially 2.5 m/km which may deteriorate over a period but not less than 3.1 m/km and widening of roads from 2 lane to 4 lane divided highway with paved shoulder configuration. These were translated into impacts on traffic speed and hence fuel consumption. The model also allows for the inclusion of impacts related to traffic congestion with and without project through provisions for inserting data on the traffic numbers, lane width, number of lanes and volume / capacity saturation limit.

429. Information that was fed into the model for projecting the CO_2 emissions were:

i) The project will rehabilitate and widen 138.168 km of the SH-57 & 26 from Gadag to Honnali, which will have four different Homogeneous sections: HS-V, HS-VI, HS-VII and HS-VIII.
ii) The road configuration will change from 2 lane to 2.0 lane with paved shoulder with carriageway width of 7.0 m and will have an asphalt bituminous surface.
iii) Existing road roughness varies from 5.0 m/km to 7.0 m/km and will be improved to 2.5 m/km, which may further reach up to 3.1 m/km during 5 years of road operations and hence will be resurfaced after every 5 years.
iv) Construction will take place over a period of 30 months in 2017-19 and road operations will begin in 2020.
v) The design life of the road is 20 years (2020 to 2039)
vi) Other improvements include the repair or reconstruction of damaged culverts, introduction of lined longitudinal and cross drains for the road and removal of irregularities on the existing vertical profile and road safety appurtenances.

430. Traffic forecasts were taken from the detailed project report. Maximum PCU for 2.0 lane highway with paved shoulder were considered as 36,000 in consistent to IRC guidelines. The volume / capacity saturation limit was taken at 2.0 for optimum travel speed and fuel consumption. Emission factors were mostly taken from the CBCP / MOEF (2007) Draft Report on Emission Factor Development for Indian Vehicles, the Automotive Research Association of India, and C. Reynolds et.al (2011) Climate and Health Relevant Emissions from in-Use Indian for three-wheelers rickshaw as follows:

Table 106: CO2 Emission Factors

Vehicle Type	Gasoline	Diesel
2-Wheel	2.28 kg/l	
3-Wheel		2.63 kg/l
Cars/ Jeeps	2.59 kg/l	2.68 kg/l
LCV		3.21 kg/l
Bus		3.61 kg/l
HCV		3.50 kg/l

[9] TEEMP is an excel-based, free-of-charge spreadsheet models to evaluate emissions impacts of transport projects.

[10] A network of 250 organizations in 31 countries established by the Asian Development Bank, World Bank, and USAID to promote better air quality and livable cities by translating knowledge to policies and actions that reduce air pollution and greenhouse gas emissions from transport, energy and other sectors.

431. It was assumed that in Section-V, Section-VI, Section-VIII, and Section-VIII, 2-wheelers and 3-wheelers have average trip distance of 1/3rd of the total road length and all other vehicles do use the entire length as average trip distance. Furthermore, 2-wheelers and 3-wheelers constitute 100% and 90%, respectively of the total local traffic.

432. It has also been *assumed* that over the time, the fleet composition will change and the assumptions taken for the same are as follows:

Table 107: Emission Standards of Fleet (%)

Vehicle Type	Current Scenario				Year 2039		
	Pre-Euro	Euro I	Euro II	Euro III	Euro I	Euro II	Euro III
2-Wheel		50%	50%		30%	70%	-
3-Wheel	80%	20%			40%	60%	
Cars/ Jeeps		40%	40%	20%		40%	60%
LCV/Bus/HCV		70%	20%	10%	10%	40%	50%

433. Emissions from road construction were estimated by using the emission factor for rural/ urban roads, by using ADB - Carbon footprint 4 (http://www.adb.org/documents/reports/estimating-carbon-footprints-road-projects/default.asp), which is equivalent to 109,600 kg CO2/km of road construction.

2. Estimated Carbon Emissions

434. The proposed road upgrading resulting to surface roughness and road capacity improvements have implications in CO_2 emissions. *Improved* roughness results to higher speed and lesser emissions while increase road users increases emissions. These factors are further affected by traffic congestion once the volume/capacity saturation limit.

435. CO_2 emissions will also result from the processing and manufacturing of raw materials needed to upgrade the project road and in the case of project, to upgrade and strengthen the road length of 148.0 km (as per existing Ch), total CO_2 emissions will be of the order of **16,220.8 tons** (**Table-108**).

Table 108: Estimated Total CO2 Emissions during Road Construction

Road Section	Length (km)	Emission Factor (ton CO2/km)	CO2 Emission (tons)
HS-III	24.8	109.6	2,718.1
HS-IV	51.0		5,589.6
HS-V	28.0		3,068.8
HS-VI	44.2		4,844.3
Total	**148**		**16,220.8**

436. The design life of roads is 20 years. Total CO_2 emission at Business-As-Usual scenario was estimated at **7,577.77** tons/year, without and with-induced traffic are **7,886.64** tons / year and **7,886.64** tons / year *respectively* (**Table-109**). These values are below the 100,000 tons per year threshold[11] set in the ADB SPS 2009. Therefore it is not necessary to implement options to reduce or offset CO_2 emissions under the project. The project's section-wise CO_2 emission intensity indicators are provided below:

[11] Page 38, Appendix I, footnote 10 of SPS 2009

Table 109: Section-wise Project CO2 Emissions Intensity Indicators

Road Sections	Particular	CO2 emission		
		Business-As-Usual	Project (without Induced Traffic)	Project (with Induced Traffic)
HS-V	tons/km	364.55	409.71	409.71
	tons/year	1,381.64	1,552.80	1,552.80
	tons/km/year	18.23	20.49	20.49
	g/t km	48.21	54.19	54.19
	g/tkm	120.20	135.09	135.09
HS-VI	tons/km	304.37	350.56	350.56
	tons/year	1,153.57	1,328.62	1,328.62
	tons/km/year	15.22	17.53	17.53
	g/pkm	52.75	60.75	60.75
	g/tkm	125.03	144.01	144.01
HS-VII	tons/km	474.15	520.04	520.04
	tons/year	1,711.68	1,877.33	1,877.33
	tons/km/year	23.71	26.00	26.00
	g/t km	55.54	60.91	60.91
	g/tkm	78.08	85.64	85.64
HS-VIII	tons/km	922.68	974.76	974.76
	tons/year	3,330.88	3,518.88	3,518.88
	tons/km/year	46.13	48.74	48.74
	g/t km	75.08	79.31	79.31
	g/tkm	54.52	57.60	57.60

437. Overall Project's CO2 emission intensity indicators are provided below:

Table 110: Project CO2 Emissions Intensity Indicators

Particular	CO2		
	Business-As-Usual	Project (without Induced Traffic)	Project (with Induced Traffic)
tons/km	2,065.75	2,149.33	2,149.33
tons/year	**7,577.77**	**7,886.64**	**7,886.64**
tons/km/year	103.29	107.47	107.47
g/t km	117.24	122.33	122.33
g/tkm	183.09	192.27	192.27

438. The with-project scenarios will be have higher CO_2 emissions. Furthermore, with project scenarios (both without and with induced traffic), there will be increase in the CO_2 emission levels over the time due to *the* increase in the traffic volume, however, the emissions will be controlled by maintaining the road roughness below 3.0 m/km during the entire project life as well as enhanced capacity of the road. This will result in annual CO_2 emissions of the project road much below the threshold limit of 100,000 tons/year.

3. Climate Risks and Adaptation needs

439. In today's world, *climate* change is considered the most serious global challenge. Changes in the atmosphere have been detected that could drastically alter the climate system and the balance of ecosystems. Atmospheric changes are linked to an increase in greenhouse gases (GHGs), chiefly on account of anthropogenic releases attributed to fossil fuel consumption, land use changes, deforestation etc. Research has established that carbon dioxide (CO2) levels in the atmosphere have risen by 35% since the pre-industrial era. Rising

CO2 concentrations increase the energy retention of Earth's atmosphere, leading to a gradual rise of average temperatures and global warming.

440. Sector specific climate risks screening has been done based on secondary sources to analyze impact on road components due to likely change in climatic variables, mainly temperature and precipitation.

441. **Temperature:** A warming trend in Karnataka for the period June to September was observed by Bangalore Climate Change Initiative – Karnataka (BCCI-K) (2011). As per Karnataka State Action Plan on Climate Change (KSAPCC), districts of northern interior Karnataka (Bidar, Bijapur, Gulbarga, Yadgir and Raichur) experienced an increase of both the minimum and the maximum temperature by ≥ 0.6°C over the last 100 years. In terms of magnitude this finding is 0.1°C higher than the 0.5°C annual increase IMD observed over the past 100 years for most parts of the country. The study also projects further warming: 1.7°C to 2.2°C by the 2030s. The projected increase of annual average temperatures for the northern districts is higher than the southern districts.

442. The project road is located in Gadag, Haveri and Davangere districts. As per the KSAPCC, projected minimum temperature increases are slightly above those of the maximum temperatures (**Table-111**).

Table 111: Projected change in annual temperature for 2021-50 compared to 1961-90

Districts	Projected change tAVG in °C	Projected change tMIN in °C	Projected change tMAX in °C
Gadag	2.08	2.15	2.05
Haveri	1.97	2.04	1.97
Davangere	1.98	2.05	1.98

Source: Karnataka State Action Plan on Climate Change, March 2012

443. **Precipitation:** Out of the average annual rainfall in Karnataka, the state receives 80% during the southwest monsoon period, 12% in the post-monsoon period, 7% in summer and only 1% in winter. The windward side of the Western Ghats, which is the coastal region, records 3,350 mm of rainfall during the south*w*est monsoon while on the leeward side rainfall drops to 600- 700 mm. BCCI-K (2011) assessed trends based on daily weather data from Indian Meteorology Department (IMD) for the period 1901 to 2008. The study observed a decline in annual rainfall from 1,204 mm during 1901-1950 to 1,140 during 1951-2008. however that IMD Bangalore, who provided the baseline data for the BCCI-K study, disagrees with the conclusion that rainfall in Karnataka has been declining.

444. Increased temperature and *precipitation* will have following impacts:

445. **High Precipitation Impacting Roads /Bridge /Embankment:** Heavy rains can cause disruption of the road networks, decreased accessibility, erosion of roads and embankments, surface water drainage problems, slope failures, landslides, among others. Increased river flow resulting from precipitation and storminess may result in damages to bridges, pavements, *and* other road structures. Bridge / culvert capacities are reduced or exceeded, causing upstream flooding to occur.

446. **High Temperature Impacting Road Stability**: Extreme heat, combined with traffic loading, speed and density can soften asphalt roads, leading to increased wear and tear. It is

likely that there would be concerns regarding pavement integrity such as softening, traffic-related rutting, *embrittlement*, migration of liquid asphalt. Additionally, thermal expansion in bridge expansion joints and paved surfaces may be experienced.

447. **Earthquake:** The project road is situated in the Zone II (having low seismic intensity) of the Seismic Map of India (as per IS: 1893, Part I, 2002) and therefore has a low risk of potential damage due to earthquake. Relevant IS codes have been adopted in designing the structures to sustain the magnitude of *earthquake* corresponding to Seismic zone II.

448. **Forest Fire:** As per "Karnataka State Action Plan on Climate Change (KSAPCC)", vast tracts of forest fall victim to forest *fires* every year. Rising temperatures and reduced top soil moisture due to increased evapotranspiration, the forest fire risk will escalate in the future.

449. **Drought**: As per KSAPCC, Karnataka ranks second in India after Rajasthan. 54% of the geographical area is drought prone, affecting 88 of 176 taluks and 18 of the 30 districts. The taluks of the northern drought-prone districts have in general, more years of moderate and severe drought than the taluks in the southern districts. Study of BCCI-K (2011) indicates that most northern districts of Karnataka would have 10-80% increased drought incidences. Increased drought frequency may lead *to* increased susceptibility to consolidation of the substructure with (unequal) settlement, more generation of smog, and unavailability of water for compaction work.

450. **Cyclone:** It can be *concluded* from the analysis of past meteorological data that cyclone, dust storms are extreme rare in the study area. Impact of cyclone is likely to be low.

451. **Flood:** The study area does not have flood problem. CWC in association with IMD and Ministry of Surface Transport (MOST) has prepared Flood Estimation Reports for small and medium catchments *for* each hydro meteorologically homogeneous 26 sub-zones. The project area is falling in sub zones 3(h) and 3(i). All structure have been designed for 50 year return period with anticipated risk of rarer flood generally of next higher frequency i.e. 100 year return period flood on the designed structures. Roadside toe drains shall be provided to receive discharge from embankment surface and countryside runoff and carry it safely to the nearest outfall point ensuring safety to the embankment toe, which is the area most vulnerable to erosion / failure.

452. Key engineering measures taken to address flood risks in the design are: i) increase in embankment height, ii) construction of new side and lead away drains, iii) construction of new culverts and widening of existing *ones* and iv) widening of bridges. As shown in Table-112, costs for taking these measures add up to a total of **Rs. 24.48 crores**. This is approximately 5% of the total civil works costs. It must be pointed out that these measures would have been considered anyway in the conventional design as the issue of flooding is a threat to the sustainability of the road. However, these measures also contribute to adaptation of the roads for future increases in precipitation. This risk screening and risk identification exercise has helped to ensure that the project road with climate risks have adequate risk mitigation or adaptation measures. The detailed list of road with climate risks, specific engineering measures taken and the costs of those measures are provided in **Table-112** Provisions have also been made in the bidding documents for the contractor to prepare contract package specific EMP's based on the final detailed design to address a range of issues including climate related risks and vulnerabilities and accordingly incorporate required costs in the BOQ.

Table 112: Details of Climate Adaptation Measures with Cost Implications

Roads/Details	Gadag-Honnali
Cross Drainage Structures	
Increase in Length in proposed culverts (in meter)	69.7
Cost Impact (Rs. Crore)	***6.91***
Increase in Length of Bridges (in meter)	153.9
Cost Implication (Rs. Crore)	***9.49***
Embankment	
Total Length of Embankment (in meter)	124400
Increase in Height (in meter)	0.6-1 m
Cost Implication for increasi (Rs. Crore)	***8.02***
Roadside drains	
Lined built-up (m)	24,936
Unlined open (m)	2,17,910
Cost Implication increasing depth (Rs. Crore)	**4.06**
Total Cost (Rs. Crore)	**28.48**

L. Social Impacts

1. Educational, Medical and Religious Properties

453. **Impacts**: Roadside amenities, religious and *cultural* properties generally include:

- Educational institutions (schools & colleges)
- Medical amenities (hospitals & health centers)
- Religious properties (temples, mosques, Church etc.)

454. Due to additional land acquisition & widening of the road, there will be some impact on the roadside educational, *medical* and religious places. In few cases the impacts will be total (e.g. the main structure has to be demolished), and in few cases the impacts will be partial (e.g. only boundary wall and/or part of the structure has to be demolished) depending on the distance of the structure from the road. The impacts on roadside amenities, religious and cultural properties are summarized in **Table-113**.

Table 113: Number of Roadside Educational, Medical and Religious Properties Affected

Items	Number of Educational, Medical and Religious Properties			
	Fully Affected	**Partly Affected**	**Not Affected**	**Total**
Educational Institutions	0	0	64	64
Medical Amenities	0	0	15	15
Religious Places	15	0	80	95

- None of the educational institutions along the project road will be affected
- None of the medical amenities will be affected
- Out of 95 religious structures along the project road, 15 will be fully affected. There will be no impact on remaining 80 religious places. Details of affected properties are presented in **Table-114.**

Table 114: List of affected Religious Properties

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance # (m)	Affected Status
1.	Mini Worship Place (Durga)	Kalasapura	108+550	108+060	Left	8.95	Affected
2.	Mini Worship Place (Siddhi Lingeshwara)	Gadag	109+635	109+150	Right	14.74	Affected
3.	Mini Worship Place	Itagi	171+500	165+200	Left	3.98	Affected
4.	Mini Worship Place	Teredahalli	171+580	165+300	Right	9.02	Affected
5.	Mini Worship Place (Hanuman)	Belavegi	180+600	170+525	Right	6.49	Affected
6.	Small Basuveshwara Temple	Guttal	187+650	177+550	Right	7.34	Affected
7.	Mini Worship Place (Mylara Lingeshwara)	Thimmapur	195+260	184+665	Left	4.30	Affected
8.	Mini Worship Place (Nag Dev)	Kerimallapur	202+975	192+055	Right	6.00	Affected
9.	Chouramma Temple	Guddada Anveri	208+460	197+510	Right	4.55	Affected
10.	Mini Worship Place (Hanuman)	Guddada Anveri	209+780	198+800	Right	6.88	Affected
11.	Mini Worship Place (Kalamma Devi)	Puradakeri	249+915	239+580	Right	13.63	Affected
12.	Mini Worship Place (Bhutnath)	Puradakeri	250+120	239+780	Right	5.83	Affected
13.	Mini Worship Place (Hanuman)	Hanumasagara	259+035	248+460	Left	9.47	Affected
14.	Hanuman Temple	Anjanapura	263+270	252+560	Right	8.67	Affected
15.	Durgamma Temple	Honnali	263+400	252+700	Right	11.00	Affected

Distance in meter from existing centerline

455. **Mitigation Measures:**

- Fully affected structures will be relocated
- Affected utilities like electrical transmission lines, telephone lines, water pipelines, petrol pumps etc. will be suitably shifted by the concerned departments.

2. Impact on Land

456. According to the Land Acquisition Plan (LAP) **240.4263 Ha** of land will be acquired for the project, out of which *230*.7330 Ha. is private land. These lands are a source of livelihood. The major findings and magnitude of impacts on land is further discussed in this chapter. The details of land acquisition requirement are summarized in the **Table-115.**

Table 115: Type of Land Affected

Sl. No.	Land Details	Acquisition of Land Area (Ha.)	Percentage
1	Forest Land	3.4225	1.4
2	Govt. Land / Waste Land	6.2708	2.6
3	Private Land	230.7330	96.0
Total		**240.4263**	**100**

Source: Land acquisition Plan, ICT Pvt. Ltd 2015

3. Impacts on Structure in the Project Area

457. After considering the mitigation measures, 417 assets including government and common property resources (CPRs) are likely to be affected. Out of total 417 affected properties, 310 (74.34%) are private structures owned by 48 titleholders and 262 non-titleholder households, while 77 structures are government properties, out of which 30 are mini water tanks and 26 are bus shelters, 11 hand pump .There are 8 borewell and 2 water tap. There are 15 religious structures in the form of temples, and 15 structures are common properties. The details of affected properties are presented in the **Table-116**.

Table 116: Details of Affected Structures

Sl. No.	Structure/ properties in the Affected Area	Number of Affected Properties	Fully affected	Percentage
1	Private Structures	310	167	74.34
2	Government Structures	77	75	18.46
3	Community Structures	15	13	3.6
4	Religious structures	15	15	3.6
	Total	**417**	**270**	**100**

Source: Census Survey 2015-16

4. Impacts on Private Structures

458. As per the census survey, 310 private properties are likely to be affected due to the road improvement project. These private properties are residential, commercial and residential-cum-commercial. 167 private structures are fully affected and rest 143 private structures will be partially affected and will remain viable for use. This has been assessed during the survey based on whether 25% or more of the structure is affected, in which case, it was considered as fully affected. During the RP implementation, if the affected household or KSHIP can demonstrate that a structure that is impacted less than 25% remains unviable, it will be considered as fully affected. This would be calculated or considered on case to case basis as necessary. Both partially and fully affected structures are owned by 48 title-holders and 262 non-titled holders. Details on the loss of private assets are given in **Table-117**.

Table 117: Impact on Private Structures

Sl. No.	Type of Private Property	Total No. of Structures	Partially affected Structures	Fully affected Structures	Total affected HHs (including Tenants & Employees)	Total no. of affected Families* (including Tenants & Employees	No. of affected Persons (including Tenants & Employees)
1	Residential	132	79	53	133	202	481
2	Commercial	136	38	98	138	196	446
3	Res-Cum-Commercial	25	9	16	26	59	144
4	Boundary wall	17	17	0	18	29	59
	Total	**310**	**143**	**167**	**315**	**486**	**1130**

Source: Census Survey 2015-16

**Family here refers to the "Family" as defined in RFCTLARR Act, 2013. "Family" includes a person, his or her spouse, minor children, minor brothers and minor sisters dependent on him; and*

An adult (18years and above) of either gender with or without spouse or children or dependents shall be considered as a separate family for the purpose of this Act.

5. Legal Ownership of the Properties/ Structures

459. The improvement of the existing road is proposed within proposed COI of minimum 26 m in open section, whereas in 2 lane rural section the CoI is customized to 16 m. The likely impact on Titleholders and Non-Titleholders were assessed through the census survey undertaken within COI of the project road. The details of ownership of properties are presented in **Table-118.**

Table 118: Details of Ownership of Properties

Sl. No.	Type of Properties	No. of Households		Total	Percentage
		Titleholder	Non-Titleholder		
1	Residential	23	110	133	42.22
2	Commercial	16	122	138	43.81
3	Res-cum-commercial	3	23	26	8.25
4	Boundary Wall	6	12	18	5.72
Total		**48**	**267**	**315**	**100**

Source: Census Survey 2015-16

6. Severity of Impact on Households Losing Structures

460. The analysis of impact on the scale of severity reveals that out of 315 private households, 144 households are moderately affected (up to 25%), while 171 households are significantly affected, leading to physical displacement. The intensity of impact is further classified in the **Table-119.**

Table 119: Intensity of Impact on Structures

Sl. No.	Scale of Impact	To the scale of 25 %	No. of Household	No. of Families	Percentage
1	Fully Impacted	(More than 25%)	171	242	54.29
2	Partially Impacted	(Less than 25%)	144	244	45.71
		Total	**315**	**486**	**100**

Source: Census Survey 2015-16

7. Loss of Livelihoods

461. Out of 218 total households losing their livelihood, 89 are fully affected and 35 are partially affected commercial households. Majority of them are owners and conducting commercial activities in these structures (95.04%) but some of them are tenants who have taken the premises on rent for commercial purpose (2.48%). The details of economic impact as per the category of affected households are presented in **Table-120.**

Table 120: Loss of Livelihoods

Sl. No.	Loss	Partially affected Households	Fully affected Households	Total affected Households	Total affected Families	Percentage
1	Owners of Shop	32	86	115	210	95.04
2	Artisans	3	0	3	3	2.48
3	Tenants	0	3	3	5	2.48
4	Employees	0	0	0	0	0
Total		**35**	**89**	**121**	**218**	**100**

Source: Census Survey 2015-16

8. Impacts on Common Property Resources

462. The summary list of CPRs affected along the project is presented in **Table-121.**

Table 121: Types of CPRs and Government Properties likely to be affected

Sl. No.	Types of Properties	Items	Total
1	A. The Other Community Properties (CPRs)	Aralikatte	9
2		Arch	1
3		Cloth Washing Place	1
4		Flag Hosting	2
5		Open Well	2
		Sub-total	**15**
6	B. Religious Properties	Temple	15
		Sub-total	**15**
7	C. Government Properties	Bus Shelter (BS)	26
8		Hand Pump (HP)	11
9		Mini water tank	30
10		Borewell	8
11		Water Tap	2
		Sub-total	**77**
		Total	**107**

Source: Census Survey 2015-16

9. Key Effects on Assets and Displaced Persons

463. A summary of the impacts based on the Census survey of likely to be impacted structures and Land owners is provided in **Table-122**.

Table 122: Summary of Impact on Structures and Displaced Persons

Sl. No.	Type of APs	Impact category	Number
1.	Titleholders	Land only	1203
		Land & Structure	48
		Physically displaced	25
2.	Non-Titleholders	Structure	262
		Physically displaced	142
3.	Tenants	Structure only	5
4.	Employees	Strcuture only	0
5.	Other economically affected (excluding owners physically displaced and tenants)	Structure only	35
6.	Total number Project Affected Persons (PAPs)	Land only	6029
		Structure only	1130
7.	Total Households Affected including (Structures, Land,Tenants and Employees)	Land only	1203
		Structure	310
		Tenant	5
		Employee	0
8.	Total Vulnerable Households Affected	Land	941
		Structure	211
9.	Moderately Affected Households (Title-Holder & Non-Title Holders)	Titleholders	1226
10.	Marginally Affected Households (Tenant & Employee)	Structure Only	5

Sl. No.	Type of APs	Impact category	Number
11.	Physically Displaced Households (Title-Holders)	Structure only	25
12.	Physically Displaced Households (Non-titleholders)	Structure only	142
13.	Physically Displaced Affected Families (Title-Holders)	Structure only	30
14.	Physically Displaced Affected Familes (Non-titleholders)	Structure only	206
15.	Moderately Affected Households (Title-Holders)	Structure only	23
16.	Moderately Affected Families (Title-Holders)	Structure only	37
17.	Marginally Affected Families (Tenant & Employee)	Structure only	8
18.	Households Affected by loss of income (Shop owner, Artisans Tenants & Employees)	Structure only	89
19.	Households Affected by Land Acquisition	Land only	1203
20.	Households Affected by Impact on Private Structures (Structures, Tenants & Employees)	Structure only	315
21.	Number of trees likely to be affected including (both)	Land and Structure	1271
22.	CPR affected		15
23.	Religious structures affected		15
24.	Government structures affected		77

M. Steps for Minimizing Adverse Impacts

464. Social impacts, in particular impacts on very congested areas and sensitive structures (i.e. clusters, community and religious structures), were minimized to the extent possiblethrough the following steps:

465. The CoI was reduced to 16 meters for 2-lane in open areas and 20 meters in 4 lane buit-up areas, instead of following codal provisions 45 mtrs in open areas and 30 mtrs. in buit-up areas respectively. The social team weighed up the alternative alignment options proposed by the design team through field visits and consultations and discussed with design team best options to avoid or minimize adverse impact on large number of households and sensitive sites. Suggestions offered by road residents were considered. These minimization efforts resulted in:

- Avoiding sensitive/religious sites by adjusting the alignment
- Minimizing impacts on structures by using realignments/bypasses;
- Fixing the speed in the built up areas including schools and hospitals as per local needs and problems of the people;
- Deciding the rural and settlement location road cross-sections based on field surveys and likely impact on the people; and

466. At some instance, the alignment has been modified to avoid certain sensitive structures. Few key examples are at Mallasamudra (km.108.100) and Betegeri villages (Km 112.000) were saved. At Chabbi, Mallasamudra village one Temple and Government high school structure were saved by shifting the alignment or by doing the eccentric widening

N. Rehabilitation and Resettlement

467. The resettlement cost estimate for the RP includes compensation for structure at replacement cost without depreciation, compensation for livelihood loss, resettlement assistances and cost of RP implementation. The total resettlement cost for the project is **INR**

119.87 Crores. The EA will provide the necessary funds for compensation for land and structures and R&R assistance. The EA will ensure timely availability of funds for smooth implementation of the RP

O. Employment and Trading Opportunities

468. It is estimated that a substantial construction personnel including skilled, semi-skilled and unskilled laborers employed by various contractors will work at site during the peak period of construction phase. Since most of sizeable labour force will be drawn from neighborhood, no change in demographic profile is anticipated. Only for a few skilled personnel, brought to site from outside the locality, proper housing/ accommodation would be provided in the construction camps. Due to employment opportunities, some competition for workers during construction phase is therefore anticipated.

469. The construction materials like stone chips and sand will be procured locally from identified quarry sites. The other important materials like cement, steel will be procured through various local sources. Thus there is a possibility of generation of local trading opportunities, though temporary.

470. **Mitigation Measures:**

- Most of the unskilled construction laborers will be recruited from the local areas to create some employment opportunities and sense of wellbeing among local people. This will also reduce social tension of migration.
- Some of the construction materials like stone chips & sand will be procured locally. Thus there is a possibility of generation of local trading opportunities, though temporary.

P. Migration

471. From the view point of employment of migrant skilled workers the project is small. Therefore no social tension is expected due to very small number migrant skilled workers. As the construction phase has a very short time span in comparison to the operation phase, it would not have any long term effect. Moreover the different groups of people engaged in different construction activities will leave the place after specified time span.

Q. Construction Camp

472. **Impacts:**

- Influx of construction work-force & supplier who are likely to construct temporary tents in the vicinity
- Likely sanitation & health hazards & other impacts on the surrounding environment due to inflow of construction labourers
- Generation of solid and liquid waste from construction camp

473. **Mitigation Measures:**

- Temporary construction camps at designated & demarcated sites with adequate sanitation, drinking water supply & primary health facilities.
- Proper accommodation will be provided in the locality for the migrant construction engineers & officers.
- Most of the construction work is labour intensive. As most of the job will be done

by contractors, it will be ensured that the contractor's workers are provided with adequate amenities, health & sanitation facilities in the camp by the contractor. Such facilities shall include potable water supply, sanitary facilities, solid waste collection & disposal system, primary health facilities, day care facilities and temporary electrification (if possible). (Annex-8.2)

- It will be ensured through contract agreement that the construction workers are provided fuel for cooking to avoid cutting of trees for fuel wood from the adjoining areas.
- Domestic as well as the sanitary wastes from construction camp will be cleared regularly

R. Waste Management

- The Contractor should provide separate garbage bins in the camps for bio-degradable, non-biodegradable waste and ensure that these are regularly emptied and disposed-off in safe and scientific manner.
- The disposal of kitchen waste and other biodegradable matter will be disposed in approved landfills through arrangement with local civic bodies
- Noon-biodegradable waste like discarded plastic bags, paper and paper products, bottles, packaging material, gunny bags, metal containers, strips and scraps of metal etc. and other such materials will be sold /given out for recycling or disposed in approved landfills through arrangement with local civic bodies.
- No incineration or burning of wastes should be carried out.
- Effluent treatment system like septic tank with soak pits provided for toilets should be sited, designed, built and operated in such a way that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place.
- Soak pits must be provided to collect waste water from bathrooms and kitchen.
- Septic tank must be provided for toilets and the sludge should be cleared by municipal exhausters.

S. Occupational Health and Safety

474. **Impacts:**

- Health & safety related problems to construction workers due to inadequate health & safety measures

475. **Mitigation Measures:**

- Adequate safety measures complying with the occupational safety manuals will be adopted by the contractor to prevent accidents/hazards to the construction workers
- A road safety, traffic management and accident management plan is to be prepared by the Contractor prior to the start of the construction activity
- Periodic health check-up of construction workers will be done by the contractor
- Personal protective equipment will be provided to the construction workers (Annex-8.10)

T. Road Safety

1. Construction Phase

476. **Impacts:**

- Increase on incidence of road accidents due to disruptions caused in existing traffic movements

477. **Mitigation Measures:**

- Proper traffic diversion and management will be ensured during construction at the intersections and construction areas. Proper warning signs will be displayed at the construction sites (Annex-8.9)
- Reduction of speed through construction zones

2. Operation Phase

478. **Impacts:**

- Impacts on human health due to accidents
- Damage of road due to wear & tear

479. **Mitigation Measures:**

- 150 nos. of Bus Shelters shall be provided along the project road conforming to design standards.
- Semi-rigid type / rigid type / flexible type safety barriers shall be provided on the high Embankment Section (where the height of embankment is more than 3.0 m) and along the horizontal curve having radius up to 450m for complete length including transition and 20m further before and after.
- Rigid Type such as Concrete Crash Barriers shall be provided on the bridges, isolated structures and its approaches.
- Three types of Road signs shall generally be provided (such as Mandatory / Regulatory, Cautionary / Warnings, and informatory signs.
- Locations of Signs shall conform to IRC:67-2012 and Section 800 of MoRT&H Specifications.
- Periodical inspection of the road will be conducted to detect anomalies in pavement
- Disposal of solid waste/ municipal waste along the side of the road should be avoided. The accumulated wastes should be disposed at approved landfill sites. Where such sites are not available within reasonable lead distance, KSHIP should encourage the local municipal / panchayat authorities to identify and develop new landfill sites away from the project for disposal of solid wastes
- The ambulance services to transport serious cases to the district hospital will be introduced and maintained so that serious accident cases can be transported immediately to the nearest district hospital
-

U. Positive & Beneficial Impacts

1. Construction Phase

- Employment opportunities due to recruitment of local labourers
- Trading opportunities due to procurement of some construction materials locally
- Clean up operations, landscaping and plantations

2. Operation Phase

- Increase in road traffic & transportation activities due to faster accessibility
- Time saving due to faster movement of traffic
- Fuel saving due to faster movement of traffic
- Reduction of air pollution
- Reduction of number of accidents
- Reduction of vehicle operating cost
- Better facilities to road users e.g. bus bay, truck lay-byes etc.

VII. PUBLIC CONSULTATION

A. Approach of Public Consultation Meeting

480. Well planned public consultation meeting can lead to reduced financial risks of time and cost over-run, legal disputes, and negative publicity, direct cost savings, increased market share through good public image, and enhanced social benefits to the affected local communities. Public Consultation Meeting (PCM) provides an opportunity for the general public, private and community bodies to know the environmental and social impacts as a result of project implementation. Thus, the meeting is held open to all general public who are concerned with the project during the initial stage.

481. Major purpose of the public consultation of environmental issues in the IEE study is to appraise the stakeholders on potential environmental impacts and collect their feedback so that adequate safeguards can be considered during the planning phases.

B. Methodology

482. **Arrangement:** Major settlements located close to project roads were selected for conducting public consultation. Venue for the meeting was fixed at local schools in agreement with the school administration. Affected communities and potential stakeholders such as local residents, panchayat members, school teachers etc. were invited to attend the meeting. Effort was made to make the gathering representative of the local population directly or indirectly affected by the potential impacts. During the meetings, no person is prevented from entering and /or leaving the PCM as he / she shall so desire.

483. **Discussions, Questions and Answers:** In the meeting, the participants were explained the proposed improvement proposal and potential environmental impacts due to the project. Thereafter, a session for question and answer was kept to facilitate interaction with the stakeholders, exchange of information, & direct communication and collect their opinion on the environmental issues.

484. **Collection of Feedback:** A feedback questionnaire in local language (Kanada) has been prepared and distributed among the participants at the end of the meetings (Annex-7.1). Participants were encouraged to provide their opinion through the feedback questionnaire, however it was kept voluntary. Some of the participants could not fill the form as they could not read or write. The issues broadly covered in questionnaire included the following topics

- Disturbance due to present traffic scenario with respect to environmental pollution and road safety
- Anticipation of disturbance due to the improvement proposal with respect to environmental pollution and road safety
- Expectation on road safety measures in the improvement proposal
- Accidents and conflicts involving wildlife, if any
- Preference of avenue trees, if any

485. **Record of the Meeting:** General information of the participants such as Name, gender, and name of the village the participant belongs to along with their signature was recorded during the public consultation meetings and is attached in the report as **Annex 7.2**. Registration was

kept voluntary. With exception of few isolated cases, almost all of the participants registered themselves.

C. Meeting Schedules and Venue

486. The public consultation meeting schedule for the project road in provided in **Table-123**.

Table 123: Public Consultation Meeting Schedule

Sl	Date	Time	Venue	Location Coordinates
PCM-1	03-02-2016	10.30 a.m.	Govt. Higher Primary School, Rannebennur	14°36'32.79"N 75°37'29.76"E
PCM-2	03-02-2016	3.00 p.m.	Govt. Lower Primary School, Thimmenahalli	14°25'32.82"N 75°37'16.26"E
PCM-3	04-02-2016	10.30 a.m.	Govt. Higher and Lower Primary School, Hanumasagara	14°16'37.42"N 75°37'41.59"E
PCM-4	06-02-2016	09.30 a.m.	Govt. Higher Primary School, Guddi Honnati	14°44'46.52"N 75°38'19.31"E
PCM-5	06-02-2016	11.30 a.m.	Govt. Higher Primary School, Guddada Hanveri	14°40'17.01"N 75°36'58.71"E
PCM-6	08-02-2016	10.30 a.m.	Govt. Urdu Lower Primary and Govt. Higher Primary School, Halageri	14°32'48.84"N 75°36'36.95"E
PCM-7	27-02-2016	10.30 a.m.	Govt. Higher Primary School, Chabbi	15°10'18.86"N 75°35'46.37"E
PCM-8	01-03-2016	3.30 p.m.	Govt. High School, Guddi Honnati	14°44'37.01"N 75°38'16.19"E

Photographs of Public Consultation

Photographs of Public Consultation

D. Analysis of Collected Feedback

1. Stakeholders and women participants

487. A total of 341 stakeholders participated in 8 public consultation meetings. Meeting at Govt. Higher Primary School at Chhabi village had the highest number of participants but women participation was highest Ranebennur. The percentage of women participation varied between 14%-70% in these public meetings, with over participation percentage being 35%. Gender-wise distribution of participants is provided in **Table-124.**

Table 124: Gender wise Distribution of Participants in PCMs

SL	Location	Female	Male	Total
PCM-1	Govt. Higher Primary School, Ranebennur	33	14	47
PCM-2	Govt. Lower Primary School, Thimmenahalli	4	17	21
PCM-3	Govt. Higher and Lower Primary School, Hanumasagara	10	32	42
PCM-4	Govt. Higher Primary School, Guddi Honnati	13	21	34
PCM-5	Govt. Higher Primary School, Guddada Hanveri	6	37	43
PCM-6	Govt. Urdu Lower Primary and Govt. Higher Primary School, Halageri	13	26	39

SL	Location	Female	Male	Total
PCM-7	Govt. Higher Primary School, Chabbi	9	52	61
PCM-8	Govt. High School, Guddi Honnati	32	22	54
	Total	**120**	**221**	**341**

488. Providing written opinion on environmental issues was kept voluntary in the public consultation meetings. Responses of the participants, who volunteered to provide written feedback, have been analyzed in subsequent sections and distributions of respondents in various PCMS are summarized in **Table-125**. Overall, 73% of women and men responded with written response.

Table 125: Gender wise Distribution of Respondents given written feedback

SL	Location	No of responses			% of response w.r.t. total participants		
		Female	Male	Total	Female	Male	Total
PCM-1	Govt. Higher Primary School, Rannebennur	17	10	27	51.5%	71.4%	57.4%
PCM-2	Govt. Lower Primary School, Thimmenahalli	3	13	16	75.0%	76.5%	76.2%
PCM-3	Govt. Higher and Lower Primary School, Hanumasagara	8	25	33	80.0%	78.1%	78.6%
PCM-4	Govt. Higher Primary School, Guddi Honnati	8	17	25	61.5%	81.0%	73.5%
PCM-5	Govt. Higher Primary School, Guddada Hanveri	6	22	28	100.0%	59.5%	65.1%
PCM-6	Govt. Urdu Lower Primary and Govt. Higher Primary School, Halageri	13	21	34	100.0%	80.8%	87.2%
PCM-7	Govt. Higher Primary School, Chabbi	1	35	36	11.1%	67.3%	59.0%
PCM-8	Govt. High School, Guddi Honnati	32	19	51	100.0%	86.4%	94.4%
Total		**88**	**162**	**250**	73.3%	73.3%	73.3%

2. Perception on Noise Pollution Issues

489. About 93% respondents felt that traffic induced noise pollution could be disturbing. About 56% respondents scaled present traffic noise as highly disturbing while another 27% viewed it as moderately disturbing. About 63% of the respondents expected the traffic volume to increase after project implementation.

490. Only 31% respondents anticipated increased noise level in post project scenario. Out of them, about 20% expected it to be high or moderate, while 68% of the total respondents expect reduction in traffic noise due to smooth traffic flow in improved road conditions. It may be interesting to note that considerable majority of respondents anticipated that noise menace due to honking will be reduced after the project implementation. The perception of the respondents with respect to noise pollution is detailed in **Table-126.**

Table 126: Perception of Respondents on Noise Pollution due to Traffic

1 Do you feel disturbed due to traffic noise	**Yes**	**92.8%**			No	**7.2%**
If yes, then Degree of Impact	*High*	*Moderate*	*Low*	*Insignificant*	*Can't Say*	*Not Applicable*
Disturbance from Noise of present traffic	56.0%	27.2%	4.8%	2.0%	2.8%	*7.2%*
Disturbance from Honking of present traffic	65.2%	12.8%	6.8%	1.6%	6.4%	*7.2%*
2 Increase in traffic volume after project implementation	62.8%	8.0%	3.6%	0.4%	25.2%	-
3 Do you anticipate change in	**Increase**	30.8%	Decrease	68.0%	No	1.2%

noise level due to the project?					Change	
If anticipated increase, then Degree of Impact	*High*	*Moderate*	*Low*	*Insignificant*	*Can't Say*	*Not Applicable*
Increase in noise after project implementation	15.6%	4.4%	4.8%	0.8%	5.2%	*69.2%*
Disturbance due to honking after project implementation	16.8%	3.2%	6.0%	2.0%	2.8%	*69.2%*
Disturbance due to construction machinery & vehicles	15.6%	4.8%	2.4%	1.6%	6.4%	*69.2%*

491. PCM wise variation of response on noise pollution is presented in **Table-127**. It may be observed that about high disturbance due to traffic noise of Guddi Honatti Village (PCM-8). The respondents at large, has also expressed concern on the honking noise of the vehicles.

Table 127: PCM wise Variation of Response on Noise Pollution

Parameters➢	**Disturbance from traffic noise**	**Annoyance from existing traffic noise**	**Annoyance due to honking**	**Anticipated increase in Traffic Volume**	**Anticipated annoyance from future traffic noise**
Category➢	Disturbed	High	High	High	High
PCM-1	10.8	8.4	8.8	7.6	2.8
PCM-2	6.0	4.8	5.6	4.8	0.0
PCM-3	13.2	8.4	10.0	8.8	0.0
PCM-4	9.2	3.2	5.6	2.8	0.8
PCM-5	9.2	6.4	5.6	2.8	2.4
PCM-6	12.4	7.6	6.8	8.0	4.0
PCM-7	11.6	10.8	10.0	10.4	5.6
PCM-8	20.4	6.4	12.8	17.6	0.0
Overall	**92.8**	**56.0**	**65.2**	**62.8**	**15.6**

3. Perception on Air Pollution Issues

492. About 84% of the respondents felt that traffic induced air pollution could be disturbing. Further, about 52% respondents scaled present air pollution and dust levels due to traffic as highly disturbing while other 18% and 12% respondents viewed the same as moderately and low disturbing respectively. Respondents could not identify any other sources of air pollution in vicinity.

493. It is noteworthy that about 42% of the respondents anticipated improved air quality after project implementation due to better road conditions while about 8% of them could not anticipate any change in air quality in future with respect to the present condition. However, majority (55%) of the respondents anticipated air quality to deteriorate due to increased traffic flow in post project scenario. The respondents by large perceived that the dust pollution will be reduced in operation stage due to improved road conditions. The perception of the respondents with respect to air pollution is detailed in **Table128.**

Table 128: Perception of Respondents on Air Pollution due to Traffic

4 Do you feel disturbed due to air pollution	**Yes**	**84.4%**			**No**	**15.6%**
If yes, then Degree of Impact	*High*	*Moderate*	*Low*	*Insignificant*	*Can't Say*	*Not Applicable*
Disturbance due to air emissions from present traffic	51.6%	18.0%	11.6%	0.4%	2.8%	*15.6%*
Disturbance due to dust due to	56.4%	18.0%	5.2%	1.6%	3.2%	*15.6%*

present traffic						
5 Any other sources of Air Pollution other than traffic	-	-	-	-	100.0%	-
6 Change in air quality due to the project?	Deteriorate	54.8%	Improve	42.0%	No Change	3.2%
If anticipated increase, then Degree of Impact Ø	*High*	*Moderate*	*Low*	*Insignificant*	*Can't Say*	*Not Applicable*
Increase in air pollution due to increased traffic	36.0%	7.6%	5.6%	2.4%	3.2%	*45.2%*
Increase in dust due to increased traffic	37.2%	7.2%	6.0%	1.2%	3.2%	*45.2%*
Increase in dust due to construction activity	36.0%	4.8%	6.0%	2.4%	5.6%	*45.2%*

494. PCM wise variation of response on air pollution is presented in **Table-129**. Highest disturbance (by %) due to present traffic emission has been reported by about 10% of the respondents in PCM 7 at Chhabi village. As evident from the table below, the anticipated air emission and dust pollution in the construction and operation phase has moderate variations among respondents across all PCMs.

Table 129: PCM wise Variation of Response on Air Pollution

Parameters➢	**Emission from present Traffic**	**Dust from Traffic Movement**	**Emission from Future Traffic**	**Dust due Future Traffic Movement**	**Emission from Construction machinery**
Category➢	High	High	High	High	High
PCM-1	8.8%	9.2%	8.4%	8.4%	8.0%
PCM-2	6.0%	6.0%	6.0%	6.0%	6.0%
PCM-3	6.4%	6.0%	1.6%	2.8%	1.6%
PCM-4	3.2%	5.2%	3.2%	2.0%	2.0%
PCM-5	7.6%	6.8%	3.6%	4.8%	4.4%
PCM-6	6.0%	6.8%	4.8%	4.8%	5.2%
PCM-7	9.6%	10.4%	8.4%	8.4%	8.4%
PCM-8	4.0%	6.0%	0.0%	0.0%	0.4%
Overall	**51.6**%	**56.4**%	**36.0**%	**37.2**%	**36.0**%

4. Perception on Road Safety Issues

495. About 80% of the respondents opined that the road at the present condition is accident prone and requested to take immediate steps for its improvement. 27% of the respondents feared that construction period may lead to further increase of accidents and adequate safety measures must be enforced.

496. About 82% of the respondents wanted pedestrian crossings at important junctions and popular movement locations like schools, hospitals and temples etc., while 84% of them felt speed breakers are required at these locations to avoid accidents. The respondents shared their concern that the present road signage is insufficient and the proposed improvement proposal should provide proper road signage (83%). 78% respondents viewed regular police patrol can also curb the accident rate while 23% of them were of the opinion that speed cameras should be installed at important junctions and considered it as the most effective tool to nab the offenders responsible for over speeding causing fatal accidents. About 82% of the respondents opined that regular road safety education camps and Driver Awareness Programs can also bring down accident rates. The perception of the respondents regarding safety issues is detailed

in **Table-130**. Overall, the respondents were unanimous over the requirement of road safety features and demanded for its implementation at the earliest.

Table 130: Perception of Respondents on Road Safety Issues

Perception on Road Accidents	%
Is the road accident prone?	80.0
Anticipation of increased road accidents in construction phase?	27.2
Choice of People on Road Safety Measures	
Speed Breaker	83.6
Pedestrian crossing	81.6
Road signage	82.8
Improved emergency services	79.6
Police Patrol	78.0
Speed Cameras	22.8
Road safety education camps	82.0
Driver Awareness Programs	80.4

5. Perception on Ecology and Biodiversity Issues

497. About 18% respondents reported sighting of wild animals in the project area. However, only 3.6% of them opined that sighting of animals are of high prevalence, while 6.8% respondents ranked the sighting prevalence as moderate. 13% of the respondents reported that they experienced crop damage by some time or other by wild animals. Accidents involving wildlife is reported by only 2% respondents while injury to human life by wild animals are reported to be very rare event. No wildlife accident spots were identified by the respondents.

498. Respondents reported that major wildlife observed in the project area involves fox, deer, wolf and wild boars. Respondents opined that flowering and fruit being trees like mango and tamarind should be selected for median plantations. The perception of the respondents regarding ecology and biodiversity issues is detailed in **Table-131**.

Table 131: Perception of Respondents on Ecology & Biodiversity Issues

Indicators	**%**
Are wild animals sighted in your area?	17.6%
Frequency of Sighting wild animals	*High – 3.6%* *Moderate – 6.8%* *Low - 5.2%* *Insignificant – 2.0%*
Crop damage by wild animals	13.2%
Accident involving wildlife	2.0%
Incident on man wildlife conflict	1.2%
Poaching / wildlife trafficking incident in nearby locality	Not reported
Frequently sighted wild animals	Deer, Fox, Wolf & Wild Boar
Frequent Wildlife accident spots, if any	Nil
Preferred tree species in agricultural land boundaries	Teak, Neem & Mango
Preferred species for roadside plantation	Tamarind, Neem & Mango

E. Outcome of the Public Consultation Meeting

499. The following are the major points of concern of the participants of PCM:

- Stakeholders are concerned about the existing traffic noise and anticipate that

increase of traffic flow may lead to increased noise level after project implementation.

- Majority of the stakeholder are concerned with the existing air emission by the present traffic but their opinion in post project scenario is fragmented to a considerable extent.
- Stakeholders viewed the road as moderately accident prone and requested to take possible measures to further minimize the accidents.
- Pedestrian crossing, proper road signage and speed control measures are the most sought after road safety measures by the stakeholders.
- Accident involving wildlife and man-animal conflicts are reported to be rare and incidents of crop damage by wild boars and deer are limitedly reported.
- School authorities and citizens at large are in favour of introducing speed restriction near the schools.
- Boundary wall acting as noise barriers along the school premises are welcomed by all of the participants. The stakeholders felt construction of boundary will also provide the security to the students and should be implemented before the start of construction activity to safeguard the students from construction noise.
- Participants requested for trees with large crown areas such as Banyan (Ficus Sp.) and Neem should be planted as Avenue plantation.
- Participants at large requested for up-gradation of existing bus shelters and installation of water tank near bus shelters. The maintenance of these assets should be vested with the project implementing authorities as panchayats often does not have enough resources all the times for its up-keepment.

F. Consultation in Religious Places

500. To assess the requirement of noise barrier in the religious places along the project road, consultations with stakeholders were carried out. Local devotees, temple owner or trustees and devotees visiting the temples were informed about the impending development.

501. Three temples, as detailed in **Table-132** were selected for such consultation based on its local importance and relative proximity with the proposed alignment.

Table 132: List of Temples Identified for Consultation

S.N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1.	Chouramma Temple	Guddada Anveri	208+460	197+510	Right	4.55
2.	Hanuman Temple	Hanumasagara	258+425	247+860	Left	9.71
3.	Durga Temple	Hanumasagara	258+440	247+900	Left	22.59

Distance in meter from existing centerline

Location of Consultations at Religious Places along Gadag-Honali Road

1. Outcome of Consultation at Religious Places

502. The response of the participants varied regarding installation of noise barrier, as detailed in **Table-133** below. While participants at Durga temple of Hanumasagara village unanimously (100%) ruled out any requirement of boundary wall for mitigating traffic noise, but 10% stakeholders at the same village welcomed the move. This divided opinion was again observed at Guddada Anveri village as evident from the Table. Overall **85.7%** participants showed reservation against construction of boundary wall due to temple aesthetics and accessibility; while those supported the concept (**14.3%**) were delighted to get a wall constructed around the property at government's expenses as a part of big ticket public expenditure.

Table 133: Outcome of the Consultation at Religious Places

S. N.	Description	No. of participants	Type of Participants	Response of Participants regarding Noise Barrier			
				Yes	%	No	%
1.	Chouramma Temple	8	Devotees	3	37.5%	5	62.5
2.	Hanuman Temple	10	Devotees	1	10%	9	90%
3.	Durga Temple	10	Devotees and Trustee	0	0%	10	100%
			Overall Response	**4**	**14.3**	**24**	**85.7**

VIII. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

503. Environmental Management Plan (EMP) is the key to ensure a safe and clean environment. The desired results from the environmental mitigation measures proposed in the project may not be obtained without a management plan to assure its proper implementation & function. The EMP envisages the plans for the proper implementation of management measures to reduce the adverse impacts arising out of the project activities.

B. Stage Wise Environmental Management Measures

504. The EMP includes a list of all project-related activities at different stages of project (design & pre-construction stage, construction stage and operation & maintenance stage), remedial measures, reference to laws/ guidelines, monitoring indicators & performance target and a clear reporting schedule. The EMP sets a time frame to all proposed mitigation and monitoring actions with specific responsibility assigned to the proponents, the contractors and the regulatory agencies to implement the project and follow-up actions defined. Stage wise management measures are tabulated below:

Table 134: Stage Wise Environmental Management Plan

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
A. DESIGN AND PRE-CONSTRUCTION STAGE							
1. Alignment							
1.1 Pavement damage and inadequate drainage provisions in habitat areas	▪ Strength of borrow soil is generally good except at 4 locations where the soaked CBR is less than 8%. Of the total borrow area soils sample, about 75% borrow area soil soaked CBR (97% compaction) is in the range from 10% to 20%. Thus the soil is suitable for construction of subgrade and embankment. ▪ Overloading to be checked ▪ Raised embankment and provision of roadside drainage to prevent damage to pavement due to water logging on the road	Design requirement IRC:37-2012 IRC: 58-2015	Throughout the stretch, Embankment raised for a length of **124.4 km** **Roadside drains** Roadside drains shall be provided on both sides of the embankment. In urban sections lined drains with footpath has been proposed for	MI: Design and number of cross and side drains, slab/box culverts, and Hume pipes PT: Design and numbers are in accordance with site needs	Review of detail design documents & drawings and comparison with site conditions	Design Consultant	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	and also inconvenience caused to ▪ Provision of adequate no. of cross drainage structures. ▪ Increase (vent and height) in waterway of existing structures ▪ Roadside drains have been proposed with suitable outfalls. ▪ The Length of lined drain along the project is 24.936 Km and the length of unlined drain is 217.910 km ▪ Considering the adequacy and hydrological requirements, some additional culverts and replacement of some culverts have been proposed. Considering the adequacy and hydrological requirements, some additional culverts and replacement of some culverts have been proposed. A total of **250 culverts** have been proposed along the project Road. Overall width of all culverts shall be equal to the roadway width of the approaches		safety reasons. For rural areas, the drains have been proposed as open and trapezoidal with 2(H):1(V) side slope as per IRC: SP: 73-2015 (Clause 6.2.4). The minimum bed width and depth of flow at starting section shall be 500 mm and 300 mm respectively. For list of bridges, **Please refer Table-18 to Table-23** of Chapter-2 of IEE Report				
1.2 Safety along the proposed alignment	▪ The project road is having substandard horizontal geometry in some sections. There are about **280** nos. Horizontal curves having radius less than 150 m with a design speed of less than the minimum 80 kmph stipulated in code along the project road. To improve safety of road users, realignment have been considered at five locations as part of geometric improvement ▪ Safety barriers shall be provided on the high Embankment Section	Design requirement Vertical geometry will be based on IRC-SP:73-2015 IRC:SP:84-2014 IRC SP 87 2013 IRC: 37-2012	Entire stretch At embankment height >3.0 m total length = **16.745 km** <u>Horizontal Curve:</u> Please refer Annexure-1.2 of Volume-II Design Report <u>Vertical</u>	<u>MI</u>: number and location of Semi-rigid type / rigid type / flexible type safety barriers, warning sign boards <u>PT</u>: numbers and location are in accordance with site needs	Review of design documents and drawings and comparison with site conditions	Design Consultant	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	(where the height of embankment is more than 3.0 m) ▪ Provision of retro-reflective warning sign boards near school, hospital, religious places and forests ▪ Highway lightings including high masts will be provided at intersections in order to improve the night time visibility. ▪ Signs and marking viz., cat's eyes, delineators, object markers, hazard markers, safety barriers at hazardous locations ▪ Horizontal and vertical geometry as per IRC Specification		Alignment: Please refer Annexure-1.3 of Volume-II Design Report				
2. Natural Hazards							
2.1 Flooding / Water-Logging	▪ Provision of adequate number of CD structures. Additional culverts have been proposed. ▪ All CD structures designed for 50 year HFL return period and bridges designed for 100 year HFL return period ▪ Water ways of bridges and culverts have been increased. ▪ Roadside drains also provided ▪ Embankment height raised along low lying/ potential water logged areas ▪ Improvement in existing culverts/ Bridges to increase their carrying capacity.	Design requirement	Entire stretch	MI: Design and numbers of cross & side drains, slab / box culverts Hume pipes, road embankment height, design and number of bridges PT: Design and numbers are in accordance with site needs	Review of design documents and drawings and comparison with site conditions	Design Consultant	KSHIP
3. Loss of Land and Assets							
3.1 livelihood loss to affected persons	▪ Road improvement work to be accommodated within available ROW to the extent possible. ▪ Social Impact Assessment and	The Right to Fair Compensation and Transparency in Land Acquisition,	Throughout the corridor	MI: Payment of compensation and assistance to PAFs as per RAP	Check LA records; design drawings vs land plans;	KSHIP & implementing NGO	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	Resettlement Plan to be undertaken as per National Policy and ADB' guidelines. ▪ Complete all necessary land and property acquisition procedures prior to the commencement of civil work. ▪ Adhere to the Land Acquisition procedures in accordance to Entitlement Framework. ▪ Compensation and assistance as per project Resettlement Action Plan (RAP) ▪ Income restoration as per RAP ▪ Preference in employment and petty contracts during construction to affected persons ▪ Constitute Grievance Redressal Cell (GRC) as per RAP	Rehabilitation and Resettlement Act, 2013. and ADB's Involuntary Resettlement Policy. Contract Clause for preference to local people during employment.		Number of complaints / grievances related to compensation and resettlement PT: Minimal number of complaints / grievances. All cases of resettlement and rehabilitation if any are resolved at GRC level. No case referred to arbitrator or court.	Interview with affected persons Check status of employment given to local people during construction		
4. Felling of Trees and Diversion of Forest Land							
4.1 Loss of trees 4.2 Loss of habitat of avifauna	▪ Geometric adjustments made to minimize tree felling ▪ Tree clearing within ROW would be only those required for enabling construction or to reduce accident. Trees to be felled shall be clearly marked. ▪ Obtain tree felling permission from State Forest Department ▪ Provision of mandatory compensatory afforestation through Forest Department ▪ Tree felling is to proceed only after all the legal requirements including attaining of In-principle and Formal Clearances from the State Forest Department are completed and subsequently a written order is issued to the Contractor.	▪ Forest Conservation Act, 1980 ▪ The Karnataka Preservation of Trees Act, 1976 ▪ Environmental Policy of KSHIP	Throughout the corridor Total number of affected trees=**3173** LHS: **1,500** RHS: **1,673**	MI: Number and location of geometric adjustments made to avoid forestland and tree cutting, budget amount allocated for compensatory afforestation and additional plantation PT: Unnecessary tree felling along the project road avoided; Budget allocation is adequate	Review final design. Check budget provision for compensatory afforestation and additional plantation.	- Design Consultant (incorporated in DPR), - Contractor (joint inspection, marking of trees, follow up for clearance) - KSHIP & - Forest Department	KSHIP & Forest Department

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	▪ Stacking, transport and storage of the wood will be done as per the relevant norms. Systematic corridor level documentation for the trees to be felled and those saved will be maintained by the PIU.						
4.3 Diversion of Forest Land	▪ Diversion of forest land has minimized to the extent possible by Geometric adjustments and reducing the RoW or by adopting eccentric widening where forest land is located only on one side of the road. ▪ Forest area to be diverted is to be marked on ground through a joint inspection with Forest Officials. ▪ NoC is to be obtained (FRA Certificate) under the Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006.	Forest Conservation Act, 1980; Environmental Policy of KSHIP	Reserved Forest is located on either side of the project road. For location of Reserved forest along the project road, please refer **Table No.-74** of Chapter-4 of IEE Forest land to be diverted: **3.4225 ha**	MI: Geometric adjustments made to avoid forestland, budget amount for diversion of forest land PT: Unnecessary tree felling on forest land avoided. Budget allocation is adequate,	Review final design. Check budget provision for compensatory afforestation and additional plantation.	- Design Consultant (incorporated in DPR, Preparation of Application for Forest Clearance), - Contractor (follow up for Forest clearance) - KSHIP & - Forest Department	KSHIP & Forest Department
5. Shifting of Utilities							
5.1 Disruption of utility services to local community	▪ All telephone and electrical poles/wires and underground cables should be shifted before start of construction in any construction zone ▪ Bore wells, water supply pipelines and hand pumps located within the proposed RoW should be shifted before start of construction in any construction zone ▪ Necessary permission and payments should be made to relevant utility service agencies	Project requirement	Throughout the corridor	MI: Number of complaints from local people, number, timing and type of notifications issued to local people, time taken to shift utilities PT: No. of complaints should be 0. Effective and timely notification.	Interaction with concerned utility authorities and local public	Contractor/ KSHIP / Utility company	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	to allow quick shifting and restoration of utility services ▪ Local people must be informed through appropriate means about the time of shifting of utility structures and potential disruption of services if any			Minimal time for utility shifting			
B. CONSTRUCTION STAGE							
1. Air Quality							
1.1 Dust Generation due to construction activities and transport, storage and handling of construction materials	▪ Transport, loading and unloading of loose and fine materials through covered vehicles. ▪ Paved approach roads. ▪ Storage areas to be located downwind of the habitation area. ▪ Water spraying on the unpaved haulage roads and other dust prone areas. ▪ Provision of PPEs to workers.	- MORT&H Specifications for Road and Bridge works - The Air (Prevention and Control of Pollution) Act, 1981 and - Central Motor and Vehicle Act 1988 - Environmental Policy of KSHIP	Throughout project corridor	MI: PM10 level measurements Complaints from locals due to dust PT: PM10 level< 100 µg/m^3; Number of complaints should be 0.	Standards CPCB methods; Observations; Public consultation; Review of monitoring data maintained by contractor	Contractor	KSHIP / IE
1.2 Emission of air pollutants (HC, SO_2, NO_2, CO etc,) from vehicles and use of equipment and machinery	▪ Regular maintenance of machinery and equipment. ▪ Contractor to submit PUC certificates for all vehicles / equipment / machinery used for the project and maintain a record of the same during the contract period. ▪ Batching, WMM, HMP and crushers at downwind (1km) direction from the nearest settlement. ▪ These plants shall be used after obtaining consent to establish & consent to operate from SPCB ▪ Only Crushers licensed by the	- The Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules 1982; - Environmental Policy of KSHIP	Batching & Asphalt Mixing Plants, Hot Mix Plant, Crushers, DG sets locations	MI: Levels of HC, SO_2, NO_2, and CO. Status of PUC certificates PT: To keep SO2 and NO2 levels less than 80ug/m^3. PUC certificate of equipment and machinery is up to date	Standards CPCB methods Review of monitoring data maintained by the Contractor	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	SPCB shall be used ▪ Hot mix plant should be fitted with dust extraction unit ▪ SPM value at a distance of 40m from a unit located in a cluster should be less than 500 g/m^3. The monitoring is to be conducted as per the monitoring plan. ▪ DG sets with stacks of adequate height and use of low sulphur diesel as fuel. ▪ LPG should be used as fuel source in construction camps instead of wood ▪ Air quality monitoring as per Environmental Monitoring Program ▪ Contractor to prepare traffic management and dust suppression plan duly approved by IE & KSHIP						
2. Noise							
2.1 Disturbance to local residents and sensitive receptors due to excessive noise from construction activities and operation of equipment and machinery	▪ All equipment to be timely serviced and properly maintained. ▪ Construction equipment and machinery to be fitted with silencers and maintained properly. ▪ Only IS approved equipment shall be used for construction activities. ▪ Near school, noisy construction activities shall be carried out after closing of school and in the weekends / holidays only ▪ Carry out noisy operations intermittently to reduce the total	- Legal requirement 508. - Noise Pollution (Regulation and Control) Rules, 2000 and amendments thereof; 509. - Environmental Policy of KSHIP	Throughout project section especially at construction sites, residential and identified sensitive locations. **Refer Table No. - 75, to 77 of Chapter-4 of IEE** for information on sensitive receptors.	MI: day and night Noise levels. Number of complaints from local people PT: Zero complaints or no repeated complaints by local people. Average day and night time noise levels are within permissible limits for work zone areas	As per Noise rule, 2000 Consultation with local people Review of noise level monitoring data maintained by contractor Observation of construction	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	noise generated ▪ Manage smooth traffic flow to avoid traffic jams and honking. ▪ Restrict construction near residential, built up and forest areas to daylight hours. ▪ Construction of noise barrier at sensitive receptors ▪ Initiation of multi-layered plantation, to serve as mitigation option for operation phase ▪ Honking restrictions near sensitive areas ▪ Noise limits for construction equipment such as compactors, rollers, front loaders, concrete mixers, cranes (moveable) etc. shall not exceed 75 dB(A) at a distance of 11 m from its source ▪ PPEs to workers ▪ Noise monitoring as per Environmental Monitoring Program				site		
3. Land & Soil							
3.1 Land use Change and Loss of productive / topsoil	▪ Non-agricultural areas to be used as borrow areas to the extent possible. ▪ If using agricultural land, top soil to be preserved and laid over either on the embankment slope for growing vegetation to protect soil erosion. ▪ **Guideline on Top Soil Conservation** and Reuse is given in **Annex-8.1** ▪ Hot-mix plants, batching plants, construction camps shall be located at least 500m away from habitation and 1000 m away from	Project requirement Annex-8.1 Guidelines on Top Soil Conservation and Reuse Annex-8.2 Guidelines for Siting and Layout of Construction Camp	Throughout the project section Land identified for construction camp, storage areas, hot-mix plant, batching plant etc.	MI: Location of Construction Camp, Storage Areas, Hot-mix Plant, Batching Plant Top soil storage area PT: Zero complaints or disputes registered against contractor by land owner	Visit of construction camp, plant sites; review of the reports submitted by the contractor	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	forest & wildlife area ▪ Land for temporary facilities like construction camp, storage areas etc. shall be brought back to its original land use ▪ Detailed site selection criteria for **Construction Camp** given in **Annex-8.2** should be followed. ▪ Details of sites identified for Construction Camp should be reported to the Sr. Environmental Specialist of IE for approval in the format as given in **Annex-8.13** and format for setting up Construction Camp is given in **Annex-8.14** ▪ Details of sites identified for establishment of Hot-mix/ Batch mix Plants should be reported to the Sr. Environmental Specialist of IE for approval in the format as given in **Annex-8.15**						
3.2 Slope failure and Soil erosion due to Construction activities, earthwork, and cut and fill, stockpiles etc.	▪ Bio-turfing of embankments to protect slopes. ▪ Slope protection by providing frames, dry stone pitching, masonry retaining walls, planting of grass and trees. ▪ Side slopes of all cut and fill areas will be graded and covered with stone pitching, **Coir Geo-Textile, grass (Vetiver grass)**. Care should be taken that the slope gradient shall not be greater than 2:1. ▪ The earth stock piles to be provided with gentle slopes to soil erosion. ▪ Please refer **Annex-8.3**	IRC: 56 -1974 recommended practice for treatment of embankment slopes for erosion control Clause No. 306 and 305.2.2 MORT&H Annex-8.3 Guidelines on Soil Stabilization	Throughout the project road	MI: Occurrence of slope failure or erosion issues PT: No slope failures. Minimal erosion issues	Review of design documents and site observation	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	regarding **Guideline on Soil Stabilization**						
3.3 Borrow Area Management	▪ Obtain EC from SEIAA before opening any new borrow area. ▪ Comply to EC conditions ▪ Non-productive, barren lands, upland shall be used for borrowing earth with the necessary permissions/consents. ▪ Follow IRC recommended practice for borrow area (IRC:SP:108:2015) for identification of location, its operation and rehabilitation ▪ Borrow areas not to be dug continuously. ▪ To the extent borrow areas shall be sited away from habitated areas. ▪ Depths of borrow pits to be regulated and sides not steeper than 25%. ▪ Topsoil to be stockpiled and protected for use at the rehabilitation stage. ▪ At least 10% of the acquired area shall be kept for stockpiling of fertile topsoil. The piles shall be covered with gunny bags / tarpaulin. ▪ Slope of stockpile shall not exceed 1:2 (V:H) and edge of pile shall be protected by silt fencing ▪ Transportation of earth materials through covered vehicles. ▪ Borrow areas shall be leveled with salvaged material or other filling materials which do not pose contamination of soil. Else,	IRC Guidelines on Borrow Areas; Environmental Protection Act and Rules,1986; Water Act 1974; Air Act 1981 Annex-8.4 Guidelines on Siting, Operation and Re-development of Borrow Area Environmental Policy of KSHIP	Borrow sites location	MI: Existence of borrow areas in inappropriate unauthorized locations. Poor borrow area management practices. Number of accidents. Complaints from local people. PT: No case of non-compliance to conditions stipulated by SEIAA in clearance letter. Zero accidents. Zero complaints.	Review of design documents and site observations Compare site conditions with EC conditions by SEIAA	Design Consultant and Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	it shall be converted into fish pond. ▪ Detailed site selection criteria, operation of borrow area and redevelopment plan given in **Annex-8.4**. ▪ Details of identified sites should be reported to the Sr. Environmental Specialist of IE for approval in the **Format** given in **Annex-8.16** and reporting format for establishment of borrow area given in **Annex-8.17**						
3.4 Quarry Operations	▪ Aggregates will be sourced from existing licensed quarries. ▪ Copies of consent / approval / rehabilitation plan for a new quarry or use of existing source will be submitted to IE & KSHIP. ▪ The contractor will develop a Quarry Redevelopment plan, as per the Mining Rules of the state and submit a copy of the approval to EA. ▪ Obtain environmental clearance from SEIAA in case of opening new quarry ▪ Quarrying shall be done only after obtaining proper permit or license from the Department of Mining and quarrying operation shall comply with the requirements of the State Pollution Control Board. ▪ Detailed site selection criteria, operation of quarry area and redevelopment plan given in **Annex-8.5**. ▪ Details of identified sites should be reported to the IE for approval	IRC Guidelines on Quarry Areas; Environmental Protection Act and Rules,1986; Water Act 1974; Air Act 1981 Annex-8.5 Guidelines on Siting, Operation and Re-development of Quarry Area Environmental Policy of KSHIP	Quarry area locations	MI: Existence of licenses for all quarry areas from which materials are being sourced Existence of a Quarry Redevelopment Plan PT: Quarry license is valid; No case of non-compliance to consent /permit conditions and \ Air quality meets the prescribed limit	Review of design documents, contractor documents and site observation; Compliance to EC conditions in case of opening new quarries	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	in the **Format** given in **Annex-8.18**						
3.5 Compaction of soil and impact on quarry haul roads due to movement of vehicles and equipment	▪ Construction vehicles, machinery, and equipment to be stationed in the designated ROW to avoid compaction. ▪ Approach roads / haulage roads shall be designed along the barren and hard soil area to reduce the compaction. ▪ Transportation of quarry material to the dumping site through heavy vehicles shall be done through existing major roads to the extent possible to restrict wear and tear to the village /minor roads. ▪ Land taken for construction camp and other temporary facility shall be restored to its original conditions	Design requirement	Parking areas, Haulage roads and construction yards.	MI: Location of approach and haulage roads; Presence of destroyed / compacted agricultural land or land which has not be restored to its original condition PT: Zero occurrence of destroyed / compacted land and undestroyed land	Site observation	Contractor	KSHIP / IE
3.6 Contamination of soil due to leakage / spillage of oil, bituminous and non-bituminous debris generated from demolition and road construction	▪ Construction vehicles and equipment will be maintained and refueled in such a fashion that oil / diesel spillage does not contaminate the soil. ▪ Fuel storage and refueling sites to be kept away from drainage channels. ▪ To avoid soil contamination **Oil-Interceptors** shall be provided at wash down and refueling areas. ▪ Waste oil and oil soaked cotton / cloth shall be stored in containers labeled 'Waste Oil' and 'Hazardous' sold off to MoEF / SPCB authorized vendors ▪ Non-bituminous wastes to be dumped in borrow pits with the	Design requirement	Fuelling station, construction sites, and construction camps and disposal location.	MI: Quality of soil near storage area Presence of spilled oil or bitumen in project area PT: Soil test conforming to no – contamination; No sighting of spilled oil or bitumen in construction site or camp site	Site observation	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	concurrence of landowner and covered with a layer of topsoil conserved from opening the pit. ▪ Bituminous wastes will be disposed-off in the bitumen disposal pit						
4. Water Resources							
4.1 Sourcing of water during Construction	▪ Requisite permission shall be obtained for abstraction of groundwater from Central Groundwater Authority. ▪ Where surface water sources are to be tapped, arrangements shall be made by contractor that the water availability and supply to nearby communities remain unaffected. ▪ The possible sources could be abandoned ponds, tanks or wells, specially created tanks or ponds, nearby perennial rivers subject to approval of village & local administration. ▪ Water intensive activities not to be undertaken during summer season. ▪ Provision of water harvesting structure to augment groundwater condition in the area	CGWA Guidelines	Throughout the Project section	MI: Approval from competent authority; Complaints from local people on water availability PT: Valid approval from Competent Authority. Zero complaints from local people.	Checking of documentation; Talk to local people	Contractor	KSHIP / IE
4.2 Disposal of water during construction	▪ Provisions shall be made to connect roadside drains with existing nearby natural drains.	Design requirement	Throughout the Project section	MI: Condition of drainage system in construction site; Presence / absence of water logging in project area.	Standards methods; Site observation and review of documents	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
				PT: Existence of proper drainage system. No water logging in project area			
4.3 Alteration in Surface Water Hydrology	▪ Existing drainage system to be maintained and further enhanced. ▪ Provision shall be made for adequate size and number of cross drainage structures especially in the areas where land is sloping towards road alignment. ▪ Road level shall be raised above HFL level wherever road level is lesser than HFL. ▪ Culverts reconstruction shall be done during lean flow period. In some cases these minor channels may be diverted for a very short period (15-30 days) and will be bring back to its original course immediately after construction.	Design requirement,	Near all drainage channels, River / Stream / Causeway crossings etc.	MI: Proper flow of water in existing streams and rivers PT: No complain of water shortage by downstream communities. No record of overtopping / water logging	Review of design documents Site observation	Contractor	KSHIP / IE
4.4 Siltation in Water Bodies due to construction activities / earthwork	▪ Embankment slopes to be modified suitably to restrict the soil debris entering water bodies. ▪ Silt fencing shall be provided along ponds within the direct impact zone intercepting highway to prevent siltation in water bodies. ▪ Sediment / silt should be collected and stockpiled for possible reuse as surfacing of slopes where they have to be re-vegetated.	Design requirement; Worldwide Best Practices; Annex-8.6 Guideline for Sediment Control	Near all water bodies/ waterway Refer **Table No. 59 of Chapter-4 of IEE** for information on Water Bodies along the project road	MI: Presence/absence of siltation in rivers, streams, nala, ponds and other water bodies in project area; water quality monitoring PT: No records of siltation due to project activities.	Field observation	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	▪ Earthworks and stone works to be prevented from impeding natural flow of rivers, streams and water canals or existing drainage system. ▪ **Guideline for Sediment Control** is given in **Annex-8.6**).			Surface water quality tests confirm to turbidity and TSS limit			
4.5 Deterioration in Surface water quality due to leakage from vehicles and equipment and waste from construction camps.	▪ No vehicles or equipment should be parked or refueled near water-bodies, so as to avoid contamination from fuel and lubricants. ▪ Oil and grease traps and fuelling platforms to be provided at re-fuelling locations. ▪ All chemicals and oil shall be stored away from water and concreted platform with catchment pit for spills collection. ▪ All equipment operators, drivers, and warehouse personnel will be trained in immediate response for spill containment and eventual clean-up. Readily available, simple to understand and preferably written in the local language emergency response procedure, including reporting, will be provided by the contractors ▪ Construction camp to be sited away from water bodies. ▪ Wastes must be collected, stored and taken to approve disposal site only. ▪ Water quality shall be monitored	The Water (Prevention and Control of Pollution) Act, 1974 and amendments thereof; Environmental Policy of KSHIP	Water bodies**;** refueling stations; construction camps.	MI: Water quality of ponds, streams, rivers and other water bodies in project Presence of oil floating in water bodies in project area PT: Surface water quality meets freshwater quality standards (IS:2296)	Conduction of water quality tests as per the Environmental Monitoring Plan Field observation	Contractor	KSHIP / IE
5. Flora and Fauna							
5.1 Vegetation loss	▪ Restrict tree cutting up to toe line	Forest Conservation	Throughout	MI: ROW width;	Review of	Contractor / KSHIP	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
due to site preparation and construction activities	considering safety to road users. ▪ Roadside trees to be removed with prior approval of competent authority. ▪ KSHIP will be responsible for plantation of trees along the side of the road as per the arrangement of KSHIP with the Forest Department ▪ Tree Plantation Strategy given in **Annex-8.12** ▪ Mandatory compensatory plantation is to be done by Forestry Department ▪ Regular maintenance of all trees planted. ▪ Provision of LPG in construction camp as fuel source to avoid tree cutting. ▪ Plantation of trees on both sides of the road where technically feasible. ▪ Integrate vegetation management (IVM) with the carriage way completely clear of vegetation. ▪ Additional plantation near sensitive receptors, river banks to minimize noise & air pollution and to check erosion.	Act 1980; IRCSP:21and IRCSP:66 Environmental Policy of KSHIP	project corridor Estimated No. of affected tree= **3,173** Additional Plantation at Sensitive receptors (school), borrow areas, quarry area etc.	Number of trees for felling; Compensatory plantation plan and Number of trees replanted. PT: Additional compensatory afforestation done by contractor. Number of trees planted. Tree survival rate is at least 70%.	relevant documents; Tree cutting permit; Compensatory plantation plan; Meeting with villagers; Field Observations		
6. Construction Camp							
6.1 Impact associated with location	All camps should be established with prior permission from SPCB. Camps to maintain minimum distance from following: # 1,000 m from habitation # 1,000 m from forest areas where possible # 500 m from water bodies where	Design Requirement The Water (Prevention and Control of Pollution) Act,1974and its amendments thereof	All construction camps	MI: Location of camp sites and distance from habitation, forest areas, water bodies and through traffic	On site observation Interaction with workers and local community	Contractor and EO	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	possible # 500 m from through traffic route	**Annex-8.2** Guidelines for Siting and Layout of Construction Camp		PT: Distance of camp site is less than 500m from listed locations			
6.2 Worker's Health in construction camp	▪ The location, layout and basic facility provision of each labor camp will be submitted to IE and approved by EA. The contractor will maintain necessary living accommodation and ancillary facilities in functional and hygienic manner. ▪ Adequate water and sanitary latrines with septic tanks with soak pits shall be provided. ▪ Contractor to provide a full-fledged dispensary. The number of beds shall be as per the requirement of the labour license ▪ Contractor to conduct workshop on HIV / AIDS for all his laborers at all his camps at least once in a quarter ▪ Contractor shall conduct monthly health check-ups of all his laborers in his camps through registered medical practitiioner ▪ Waste disposal facilities such as dust bins must be provided in the camps and regular disposal of waste must be carried out. ▪ The Contractor will take all precautions to protect the workers from insect and pest to reduce the risk to health. This includes the use of insecticides which should comply with local regulations. ▪ No alcoholic liquor or prohibited drugs will be imported to,	The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 and The Contract Labour (Regulation & Abolition) Act, 1970 The Water (Prevention and Control of Pollution) Act,1974 and amendments thereof Environmental Policy of KSHIP and provision of ISO:14001:2004	All construction camps	MI: Camp health records. Existence of proper first aid kit in camp site. Complaints from workers. PT: No record of illness due to unhygienic conditions or vectors. Zero cases of STD. Clean and tidy camp site conditions.	Camp records Site observation Consultation with contractor workers and local people living nearby	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
7. Management of Construction Waste / Debris							
7.1 Selection of Debris Disposal Sites	▪ Unproductive / wastelands shall be selected for dumping sites away from residential areas and water bodies ▪ Dumping sites must be having adequate capacity equal to the amount of debris generated. ▪ Public perception and consent from the village Panchayats has to be obtained before finalizing the location. ▪ **Guideline for Siting and Management of Debris Disposal Site** is given in **Annex-8.7** ▪ Details of identified debris disposal site should be reported to the IE for approval in the **Format** given in **Annex-8.19**	Design Requirement; Annex-8.7: Guideline for Siting and Management of Debris Disposal Site, Environmental Policy of KSHIP	At all Dumping Sites	MI: Location of dumping sites Number of public complaints. PT: No public complaints. Consent letters for all dumping sites available with contractor	Field survey and interaction with local people. Review of consent letter	Contractor	KSHIP / IE
7.2 Reuse and disposal of construction and dismantled waste	▪ The existing bitumen surface shall be utilized for paving of cross roads, access roads, and paving works in construction sites and camps, temporary traffic diversions and haulage routes. ▪ All excavated materials from roadway, shoulders, verges, drains, cross drainage will be used for backfilling embankments, filling pits, and landscaping. ▪ Unusable and non-bituminous debris materials should be suitably disposed-off at pre-designated disposal locations, with approval of the concerned authority. The bituminous wastes	Design Requirement; Annex-8.8: Guideline for Preparing Comprehensive Waste Management Plan	Throughout the project corridor	MI: Percentage of reuse of existing surface material Method and location of disposal site of construction debris PT: No public complaint and consent letters for all dumping sites available with contractor or IE	Contractor records Field observation Interaction with local people	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	shall be disposed in secure landfill sites only in environmentally accepted manner. ▪ Unusable and surplus materials, as determined by the Project Engineer, will be removed and disposed off-site. ▪ Guideline for Preparing **Comprehensive Waste Management Plan** is given in **Annex-8.8**						
8. Traffic Management and Safety							
8.1 Management of existing traffic and safety	▪ Temporary traffic diversion shall be planned by the contractor and approved by the 'Engineer'. ▪ The traffic control plans shall contain details of diversions; traffic safety arrangements during construction; safety measures for night time traffic and precautions for transportation of hazardous materials. Traffic control plans shall be prepared in line with requirements of IRC's SP 55 document'. ▪ The Contractor will ensure that the diversion / detour are always maintained in running condition, particularly during the monsoon to avoid disruption to traffic flow. ▪ On stretches where it is not possible to pass the traffic on the part width of existing carriageway, temporary paved diversions will be constructed. ▪ Restriction of construction activity to only one side of the existing road.	Design requirement and IRC: SP: 27 -1984; IRC:SP: 32 -1988 Road Safety for Children (5-12 Years Old); IRC:SP: 44 -1994 Highway Safety Code IRC: SP: 55 -2001; Guidelines for Safety in Construction Zones; IRC:53:2012 Road Accident recording The Building and other Construction workers Act 1996 and Factories Act 1948	Throughout the project corridor especially at intersections.	MI: Traffic Management Plan. Presence/ absence of safety signs, clear traffic demarcations, flag men etc. on site. Complaints from road users. Number of traffic accidents PT: No complaints. No accidents due to poor traffic management. Traffic signs, demarcation lines etc. present in appropriate locations on site	Review Traffic Management Plan; Field observation of traffic management and safety system Interaction with people in vehicles using the road	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	▪ The contractor shall inform local community of changes to traffic routes, and pedestrian access arrangements with assistance from "Engineer". ▪ Use of adequate signage to ensure traffic management and safety. Conduct of regular safety audit on safety measures. ▪ Guideline for Preparing **of Traffic Management Plan** is given in **Annex-8.9**	Annex-8.9 Guideline for Preparing of Traffic Management Plan					
8.2 Pedestrians, animal movement	▪ Temporary access and diversion, with proper drainage facilities. ▪ Access to the schools, temples and other public places must be maintained when construction takes place near them. ▪ All structures having vertical clearance above 3m and not catering to perennial flow of water may serve as underpass for animals	Same as above	Near habitation on both sides of schools, temples, hospitals, graveyards, Construction Sites, Haulage roads and diversion sites.	MI: Presence/ absence of access routes for pedestrians. Road signage. Number of complaints from local people PT: Easy access to schools, temples and public places. Zero complaints	Field observation Interaction with local people	Contractor	KSHIP / IE
8.3 Safety of Workers and accident risk from construction activities	▪ Contractors to adopt and maintain safe working practices. ▪ Usage of fluorescent and retro refectory signage, in local language at the construction sites ▪ Training to workers on safety procedures and precautions. ▪ Mandatory appointment of safety officer. ▪ All regulations regarding safe scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and safe	Same as above Annex-8.10 Guideline to Ensure Worker's Safety during Construction Environmental Policy of KSHIP and provision of ISO:14001:2004	Construction sites	MI: Availability of Safety gears to workers Safety signage Training records on safety Number of safety related accidents PT: Zero fatal accidents. Zero or minor non-fatal accidents.	Site observation Review records on safety training and accidents Interact with construction workers	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	means of entry and egress shall be complied with. ▪ Provision of PPEs to workers. ▪ Provision of a readily available first aid unit including an adequate supply of dressing materials. ▪ The contractor will not employ any person below the age of 18 years ▪ Use of hazardous material should be minimized and/or restricted. ▪ Emergency plan (to be approved by engineer) shall be prepared to respond to any accidents or ▪ Accident Prevention Officer must be appointed by the contractor. ▪ Other provisions to ensure **Worker's Safety during Construction** should be followed as per **Annex-8.10.** ▪ Guidelines for **Storage, Handling**, Use and Emergency Response for **Hazardous Substances** is given in **Annex-8.11.** ▪ The Safety Checklist given in **Annex-8.20** should be submitted to IE on monthly basis ▪ Reporting format for road safety measures during Construction given in **Annex-8.21** should be submitted to IE before start of construction. ▪ On occurrence of any accident or injury, the safety officer should submit an accident report to the IE as per the format given in IRC:53-2012 "Road Accident Reporting"						

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
8.4 Accident risk to local community	▪ Restrict access to construction sites only to authorized personnel. ▪ Physical separation must be provided for movement of vehicular and human traffic. ▪ Adequate signage must be provided for safe traffic movement ▪ Provision of temporary diversions and awareness to locals before opening new construction fronts.	Same as above	Construction sites	MI: Safety signs and their location; Incidents of accidents; Complaints from local people PT: Zero incident of accidents. Zero complaints.	Site inspection Consultation with local people	Contractor	KSHIP / IE
9. Site Restoration and Rehabilitation							
9.1 Clean-up Operations, Restoration and Rehabilitation	▪ Contractor will prepare site restoration plans, which will be approved by the 'Engineer'. ▪ The clean-up and restoration operations are to be implemented by the contractor prior to demobilization. ▪ All construction zones including river-beds, culverts, road-side areas, camps, hot mix plant sites, crushers, batching plant sites and any other area used/affected by the project will be left clean and tidy, to the satisfaction of the Environmental officer. ▪ All the opened borrow areas will be rehabilitated and 'Engineer' will certify	Project requirement Annex-8.2 Annex-8.4 Annex-8.5 Annex-8.7 Environmental Policy of KSHIP and provision of ISO:14001:2004	Throughout the project corridor, construction camp sites and borrow areas	MI: Condition of camp sites, construction sites and borrow areas. Presence / absence of construction material / debris after completion of construction works on construction site. PT: Clean and tidy sites. No trash or debris left on site. Site restored and leveled.	Site observation Interaction with locals; Issue completion certificate after restoration of all sites are found satisfactory	Contractor	KSHIP / IE
C. OPERATION AND MAINTENANCE STAGE							
1. Air Quality							
2.1 Air pollution due to due to vehicular movement	▪ Roadside tree plantations shall be maintained. ▪ Regular maintenance of the road will be done to ensure good	Environmental Protection Act, 1986; The Air (Prevention and	Throughout the Corridor	MI: Air quality monitoring as per post project Environmental	As per CPCB requirements	PIU / Pollution Monitoring Agency	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	surface condition ▪ Air quality monitoring. If monitored parameters exceeds prescribed limit, suitable control measures must be taken. ▪ Signages shall be provided reminding them to properly maintain their vehicles to economize on fuel consumption. ▪ Enforcement of vehicle emission rules in coordination with transport department or installing emission checking equipment	Control of Pollution) Act, 1981 Environmental Policy of KSHIP		Monitoring Program PT: Levels are equal to or below baseline levels given in the IEE report	Site inspection		
2. Noise							
2.1 Noise due to movement of traffic	▪ Effective traffic management and good riding conditions shall be maintained ▪ Speed limitation to 20 km/hour and honking restrictions near sensitive receptors ▪ HORN PROHIBITED sign to be placed near educational institutions and medical facilities ▪ Noise monitoring. If monitored value exceeds prescribed limit, suitable control measures must be taken. ▪ Maintenance of noise barriers near sensitive receptors with the help of local community ▪ The effectiveness of multilayered plantation should be monitored. ▪ Create awareness amongst the residents about likely noise levels from road operation at different distances, the safe noise limits and easy to implement noise reduction	Noise Pollution (Regulation and Control) Rules, 2000 and amendments thereof Environmental Policy of KSHIP	Sensitive receptors as identified in the IEE Report	MI: Noise monitoring as per post project Environmental Monitoring Program PT: Levels are equal to or below baseline levels given in the IEE report	Noise monitoring as per noise rules , 2000 Discussion with people at sensitive receptor sites	PIU / Pollution Monitoring Agency	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	measures while constructing a building near road						
3. Land & Soil							
3.1 Soil erosion at embankment during heavy rainfall.	▪ Periodic checking to be carried to assess the effectiveness of the stabilization measures viz. turfing, stone pitching etc. ▪ Necessary measures to be followed wherever there are failures	Project requirement	At bridge locations and embankment slopes and other probable soil erosion areas.	MI: Existence of soil erosion sites; Number of soil erosion sites PT: Zero or minimal occurrences of soil erosion	On site observation	PIU	KSHIP
4. Water Resources / Flooding and Inundation							
4.1 Siltation	▪ Regular checks shall be made for soil erosion and turfing conditions for its effective maintenance.	Project requirement	Near surface Water bodies	MI: Water quality monitoring as per post project Environmental Monitoring Program PT: No turbidity of surface water bodies due to the road	Site observation	PIU	KSHIP
4.2 Water logging due to blockage of drains, culverts or streams	▪ Regular visual checks and cleaning of drains shall be done along the alignment to ensure that flow of water is maintained through cross drains and other channels / streams. ▪ Monitoring of water borne diseases due to stagnant water bodies	Project requirement	Near surface Water bodies	MI: Presence/ absence of water logging along the road PT: No record of overtopping/ Water logging	Site observation	PIU	KSHIP
5. Flora							
5.1 Vegetation	▪ Planted trees, shrubs and grasses to be properly maintained.	Forest Conservation Act 1980	Project tree plantation sites	MI: Tree/plants survival rate	Records and field observations.	Forest Department / PIU	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	▪ The tree survival audit to be conducted at least once in a year to assess the effectiveness	Environmental Policy of KSHIP		PT: Minimum rate of 70% tree survival	Information from Forestry Department		
6. Maintenance of Right of Way and Safety							
6.1 Accident Risk due to uncontrolled growth of vegetation	▪ Efforts shall be made to make shoulder completely clear of vegetation. ▪ Regular maintenance of plantation along the roadside ▪ No invasive plantation near the road.	Project requirement	Throughout the Project route	MI: Presence and extent of vegetation growth on either side of road. Number of accidents. PT: No accidents due to vegetation growth	Visual inspection Check accident records	PIU	KSHIP
6.2 Accident risks associated with traffic movement.	▪ Traffic control measures, including speed limits, will be forced strictly. ▪ Further encroachment of squatters within the ROW will be prevented. ▪ No school or hospital will be allowed to be established beyond the stipulated planning line as per relevant local law ▪ Monitor / ensure that all safety provisions included in design and construction phase are properly maintained ▪ Highway patrol unit (s) for round the clock patrolling. Phone booth for accidental reporting and ambulance services with minimum response time for rescue of any accident victims, if possible. ▪ Tow-way facility for the breakdown vehicles if possible	IRC:SP:55	Throughout the Project route	MI: Number of accidents Conditions and existence of safety signs, rumble strips etc. on the road Presence/absence of sensitive receptor structures inside the stipulated planning line as per relevant local law PT: Fatal and non-fatal accident rate is reduced after improvement	Review accident records Site observations	PIU	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
6.3.Transport of Dangerous Goods	▪ Existence of spill prevention and control and emergency responsive system ▪ Emergency plan for vehicles carrying hazardous material	-	Throughout the project stretch	MI: Status of emergency system – whether operational or not PT: Fully functional emergency system	Review of spill prevention and emergency response plan Spill accident records	PIU	KSHIP

EA: Executing Agency, KSHIP: Karnataka State Highways Improvement Authority, EO: Environmental Officer, IRC: Indian Road Congress, IE: Independent Engineer, SPCB: State Pollution Control Board,

The “Project engineer” or “the engineer” is the team of Independent Engineer (IE) responsible for approving the plans, engineering drawing, release of payments to contractor etc. on behalf of the employer (KSHIP). It is usually the team leader of the IE that takes the responsibility of signing approval documents on behalf of the IE team. The “environmental officer” is the environmental specialist under the IE who is responsible for providing recommendations to the IE team leader for approving activities specific to environment safeguards on behalf of “the engineer”.

C. Environmental Policy of KSHIP

511. **The Karnataka State Highways Improvement Project** (KSHIP), a unit of KPWD, Government of Karnataka, implements improvement in the State's road network to provide safe and efficient road access, that will enhance community livelihood and support economic prosperity in the State.

512. KSHIP seeks to achieve balanced and sustainable outcomes with responsible environmental leadership in all the projects it implements. For achieving the above, KSHIP aims to:

- Comply with all applicable environmental legislation and other requirements
- Protecting & conserving natural resources and enhancing the environmental values while preventing pollution and minimizing the impact on the natural environment
- Implement, maintain and continually improve an effective environmental management system
- Apply an approach of "avoid, minimize and mitigate", to the management of environmental impacts associated with road improvement for its Stakeholders
- Develop awareness of environmental management processes, standards and responsibilities among KSHIP employees, consultants, contractor partners etc.
- Be responsive to community and stakeholder views on environmental issues
- Set specific environmental objectives and targets relating to the key environmental aspects of KSHIP activities; measure and report progress in achieving these targets

513. This policy is established in line with the Vision and Environmental Policy of the KPWD, Government of Karnataka.

D. Emergency Response Plan

514. Project Proponents shall prepare site specific Emergency Response Plans to face and address any emergency situation with respect to vehicular accidents, heavy floods and spillage of oil or other hazardous materials. Copy of emergency plan may be circulated in local language to affected villages. A consultation may also be formed regarding discussion on Emergency Response Plan with local populace. A communication flow chart may also be drafted for easy understanding of information flow during emergency situation. It requires establishing and developing a communication and response system to minimize the impacts of these situations and also minimize the time required to respond to these situations in order to safeguard people, property and environmental resources. Contractor shall submit approved Accident Safety and Hazardous Chemical Spill Management Plan. The plan should also have details of detours in case of emergency. The Emergency Contact Information of concerned local authorities should be displayed at suitable locations along the road particularly in accident prone zones and sensitive locations

E. Grievance Redressal Mechanism

515. A project-specific grievance redress mechanism (GRM) will be established to receive, evaluate, and facilitate the resolution of affected person's (AP's) concerns, complaints, and grievances about the social and environmental performance at the level of the project. The

GRM will aim to provide a time-bound and transparent mechanism to voice and resolve environmental concerns linked to the project. The GRM will provide an accessible and trusted platform for receiving and facilitating the resolution of APs' grievances related to the project. The multi-tier GRM for the project is outlined below, each tier having time-bound schedules and with responsible persons identified to address grievances and seek appropriate persons' advice at each stage as required.

516. Project area-wide public awareness campaigns will ensure that knowledge of the grievance redress procedures is generated. The PIU, with the assistance of RP Implementation NGO will conduct awareness campaigns to ensure that general public, including poor and vulnerable households are made aware of the grievance redress procedures.

517. **Grievance Redress Process:** KSHIP PIU has a well-established and functioning grievance redress system. The same system will be followed for this project.

518. **Registering complaints:** Complainants will have the flexibility of conveying grievances/suggestions by registering in the compliant registers placed at contract site offices, SDO & DO offices or by e-mail, or by post, or by registering online of KSHIP website. PIU established a public response centre (PRC) helpline specifically addresses the issues arising out of project implementation. Compliant can be registered via any of the following means:

- Through Public Response Center Help Line 24/7: ◦
  - Land Line Number: 080-23205995
  - Cell No: 9482079947
  - Skype ID: Kshipprc
  - WhatsApp: 9482079947
  - Email: kshipprc@vindhyainfo.com
- Through Facebook: www.facebook.com/pwd.KSHIP
- register online at (http://www.kship.in/pms/Pub/CHM/frmComplaintNewEn.aspx)

519. The complaint received at PRC helpline is recorded and transferred to concerned official based on the nature of complaint. Environmental related complaints/grievances are forwarded to the Environmental Specialist of the PIU. ES will review the complaint and forward to the concerned DO for redress. DO will take necessary action on the complaint and if the corrective action is to be taken by the contractor, DO will instruct the contractor to do so. It is required to address the complaint in 28 days, and inform the compliant about redress and the action taken.

520. Following process is followed for the complaints received at the site offices. Careful documentation of the name of the complainant, date of receipt of the complaint, address/contact details of the person, location and nature of the problem will be undertaken. In case of grievances that are immediate and urgent in the perception of the complainant, the contractor's EHS officer and the Project Manager, and personnel from the PIU engineers on-site will provide the most easily accessible or first level of contact for the quick resolution of grievances. Contact information of responsible officers and contractor staff will be posted at all construction sites in visible locations. The grievance redress process will have following levels:

- **1st Level Grievance:** The complaint will be reviewed by concerned AEE and forwarded to the contractor for immediate resolution of the issue on-site and will be required resolve the issue within 7 days of receipt of a complaint/grievance.

IEs Environmental Management Specialist (EMS) will provide guidance as required by site staff.

- **2nd Level Grievance:** All grievances that cannot be redressed within 7 days at the 1st level will be dealt by at Executive Engineer, DO, with the assistance of IE EMS. If the issue is not resolved in 7 days at EE level, will be brought to the notice of the PIU head office. The Environmental Specialist of PIU will resolve the grievance within 14 days of receipt of a complaint/grievance.

- **3rd Level Grievance:** If the grievance is not resolved at above two levels within 28 days will be referred to the District Grievance Redress Committee (DGRC) headed by the Deputy Commissioner. DGRC will have following members: Assistant Commissioner, independent member from any reputed institution appointed by DC and EE of concerned DO (as member secretary). DGRC meets at the district headquarter as required, and resolve the matter within 30 days of receipt at DGRC.

521. The PIU Environmental Officer (SO) will have the overall responsibility for timely grievance redressal on environmental issues and for registration of grievances, related disclosure, and communication with the aggrieved party.

522. The project GRM notwithstanding, an aggrieved person shall have access to the country's legal system at any stage. That is the choice of the complainant, and can run parallel to accessing the GRM and is not dependent on the negative outcome of the GRM

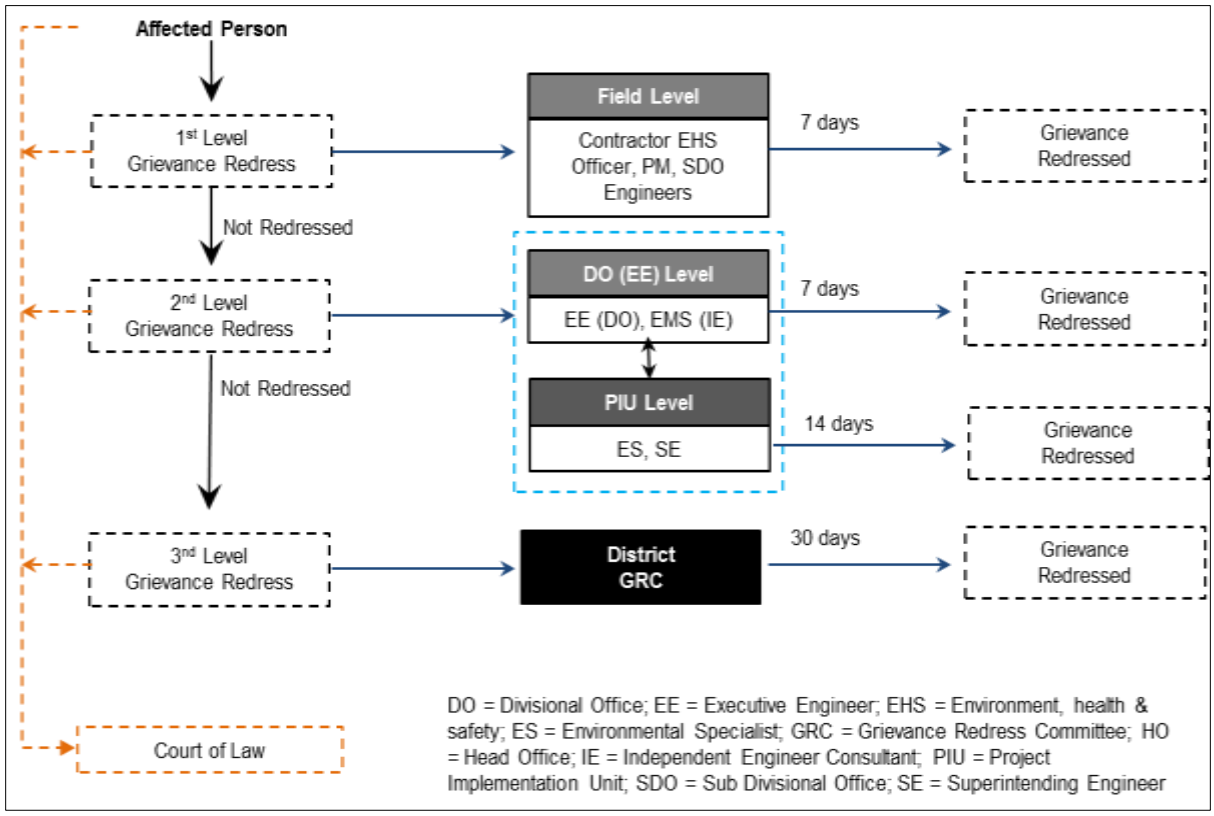


Figure 65: Grievance Redress Process

523. In the event that the established GRM is not in a position to resolve the issue, the affected persons can also use the ADB Accountability Mechanism through directly contacting (in writing) the Complaint Receiving Officer at ADB headquarters or the ADB India Resident Mission. The complaint can be submitted in any of the official languages of ADB's Developing Member Countries. The ADB Accountability Mechanism information will be included in the Project Information Document to be distributed to the affected communities, as part of the project GRM.

524. **Record-keeping:** The PIU will keep records of grievances received, including contact details of the complainant, the date the complaint was received, the nature of the grievance, agreed corrective actions and the date these were affected and the final outcome. The number of grievances recorded and resolved and the outcomes will be displayed/disclosed on PIU website, as well as reported in monitoring reports submitted to ADB on a semi-annual basis.

525. **Periodic Review and Documentation of Lessons Learned:** The Project Director will periodically review the functioning of the GRM and record information on the effectiveness of the mechanism, especially on the project's ability to prevent and address grievances.

526. **Costs:** All costs involved in resolving the complaints (meetings, consultations, communication and reporting/information dissemination) will be borne by the PIU.

F. Environmental Monitoring Program

527. The purpose of the environmental monitoring program is to ensure that the envisaged purpose of the project is achieved and results in desired benefits to the target population. To ensure the effective implementation of the EMP, it is essential that an effective monitoring program be designed and carried out. The broad objectives are:

- To evaluate the performance of mitigation measures proposed in the EMP
- To evaluate the adequacy of Environmental Impact Assessment
- To suggest improvements in management plan, if required
- To enhance environmental quality
- To satisfy the legal and community obligations

528. The environmental monitoring plan contains:

- Performance Indicators
- Environmental Monitoring Program
- Reporting Formats
- Necessary Budgetary Provisions

1. Performance Indicators

529. The physical, biological and social components identified to be particularly significant in affecting the environment at critical locations have been suggested as Performance Indicators. The Performance Indicators shall be evaluated under three heads as:

a) Environmental condition indicators to determine efficiency of environmental management measures in control of air, noise, water and soil pollution.
b) Environmental management indicators to determine compliance with the suggested environmental management measures

c) Operational performance indicators that have been devised to determine efficiency and utility of the proposed mitigation measures

530. The Performance Indicators and monitoring plans prepared are presented in **Table-135**.

Table 135: Performance Indicators

S.N.	Details	Indicators	Stage	Responsibility
A.	**Pre-Construction Stage: Environmental Management Indicators and Monitoring Plan**			
1.	Location of construction camps have to be identified and parameters indicative of environment in the area has to be reported. Reporting format is given in Annex-8.13	Construction camp	Pre-construction	Contractor
2.	Location of borrow areas have to be finalized and parameters indicative of environment in the area has to be reported. Reporting format is given in Annex-8.16	Borrow areas	Pre-construction	Contractor
3.	Location of Quarry and Stone Crusher sites have to be finalized and parameters indicative of environment in the area has to be reported. Reporting format is given in Annex-8.18	Quarry and Stone Crusher sites	Pre-construction	Contractor
4.	Locations for Debris Disposal Site have to be identified and parameters indicative of environment in the area has to be reported. Reporting format is given in Annex-8.19	Debris Disposal Site	Pre-construction	Contractor
5.	Progress of tree removal marked for cutting is to be reported	Site clearing	Pre-construction	Contractor
B.	**Construction Stage: Environmental Condition Indicators and Monitoring Plan**			
1.	The parameters to be monitored as per frequency, duration & locations of monitoring specified in the Environmental Monitoring Program prepared (Refer **Table-136**)	Air quality	Construction	Contractor through NABL approved monitoring agency
		Noise level	Construction	Contractor through NABL approved monitoring agency
		Ground Water quality	Construction	Contractor through NABL approved monitoring agency
		Surface Water quality	Construction	Contractor through NABL approved monitoring agency
		Soil quality	Construction	Contractor through NABL approved monitoring agency
2.	Progress of measures suggested as part of the strategy is to be reported	Tree plantation	Construction	Contractor
3.	Contractor shall report implementation of the measures suggested for topsoil conservation to Sr. Environmental Specialist of IE	Top Soil Conservation	Construction	Contractor
4.	Contractor shall report implementation of the measures	Slope Stabilization	Construction	Contractor

S.N.	Details	Indicators	Stage	Responsibility
	suggested for slope stabilization and sediment control to Sr. Environmental Specialist of IE	and Sediment Control		
5.	Contractor shall report implementation of the measures suggested for waste management to Sr. Environmental Specialist of IE	Waste Management Plan	Construction	Contractor
6.	Contractor shall report implementation of the guideline to ensure worker's safety during construction to Sr. Environmental Specialist of IE	Worker's Safety during Construction	Construction	Contractor
C.	**Operation Stage: Management & Operational Performance Indicators**			
1.	The number of trees surviving during each visit will be compared with the number of saplings planted	Survival rates of trees	Operation	Sr. Environmental Specialist of IE up to construction period, and then Environmental Cell of PIU, KSHIP over a period of 5 years
2.	Sr. Environmental Specialist of IE and PIU will undertake joint site visit with the Contractor to determine whether the Borrow areas, Quarry areas, Debris disposal site have been rehabilitated in line with Guidelines	Rehabilitation of Borrow areas, Quarry area, Debris Disposal site	Operation	Sr. Environmental Specialist of IE and PIU / KSHIP
3.	The PIU will visit sensitive locations along with the environmental monitoring agency (responsible for monitoring of noise levels during operation stage) to check the efficiency of the noise barriers	Utility of noise barriers for sensitive receptors	Operation	PIU / KSHIP

2. Monitoring Schedule

531. The detail monitoring schedule during construction and operation stages are presented in **Table-136.** For each of the environmental condition indicator, the monitoring program specifies:

- Parameters to be monitored
- Location of the monitoring sites
- Frequency and duration of monitoring
- Institutional responsibilities for implementation and supervision

Table 136: Environmental Monitoring Program

Environment Component	Project Stage	Environmental Monitoring Program			Institutional Responsibility	
		Parameters	Location	Frequency	Implementation	Supervision
Air Quality	Construction[12]	PM_{10}, $PM_{2.5}$, SO_2, NOx, CO, HC	At 2 locations: Wherever the contractor decides to locate the Batching & Asphalt Mixing Plants, Hot Mix Plant, Crushers, DG sets locations	Twice in a season at one day interval for 3 seasons (except monsoon) Construction work should be in full swing during monitoring Duration: 24 hours	Contractor through NABL approved monitoring agency	IE / PIU
		PM_{10}, $PM_{2.5}$, SO_2, NOx, CO,	At 8 locations: - Gadag - Chabbi - Alagilawad - Guttal - Ranebennur - Halageri - Hallur - Honnali	Twice in a season at one day interval for 3 seasons (except monsoon) Construction work should be in full swing during monitoring Duration: 24 hours	Contractor through NABL approved monitoring agency	IE / PIU
	Operation[13]	PM_{10}, $PM_{2.5}$, SO_2, NOx, CO,	At 6 locations: - Gadag - Chabbi - Guttal - Ranebennur - Halageri - Honnali	Once in a season for 3 seasons (except monsoon) Duration: 24 hours	PIU through NABL approved monitoring agency	PIU/KSHIP
Noise Level	Construction	Noise level in dB(A)	At equipment yard and Stone Crusher Unit	4 times a year (in each season) Duration: 24 hours	Contractor through NABL approved monitoring agency	IE / PIU
		Noise level in dB(A)	At 6 locations: - Gadag - Chabbi - Ranebeenur - Halagiri - Hallur - Honnali	4 times a year (in each season) Duration: 24 hours	Contractor through NABL approved monitoring agency	IE / PIU
	Operation	Noise level in dB(A)	At 6 locations: - Gadag - Chabbi - Ranebeenur	Once in every three years Duration:	PIU through NABL approved monitoring agency	PIU/KSHIP

[12] Construction period is 30 months
[13] Monitoring in Operation Phase will be conducted in every 3 years for 10 years

<table>
<tr><th rowspan="2">Environment Component</th><th rowspan="2">Project Stage</th><th colspan="3">Environmental Monitoring Program</th><th colspan="2">Institutional Responsibility</th></tr>
<tr><th>Parameters</th><th>Location</th><th>Frequency</th><th>Implementation</th><th>Supervision</th></tr>
<tr><td></td><td></td><td></td><td>- Halagiri
- Hallur
- Honnali</td><td>24 hours</td><td></td><td></td></tr>
<tr><td>Ground Water Quality</td><td>Construction</td><td>Physical, Chemical & Biological parameters as per IS 10500:2012

However, IE may include additional parameters</td><td>At 5 locations:

- Gadag
- Chabbi
- Guttal
- Ranebennur
- Honnali</td><td>4 times a year (in each season)</td><td>Contractor through NABL approved monitoring agency</td><td>IE / PIU</td></tr>
<tr><td></td><td>Operation</td><td>Physical, Chemical & Biological parameters as per IS 10500:2012</td><td>At 5 locations:

- Gadag
- Chabbi
- Guttal
- Ranebennur
- Honnali</td><td>Twice in every three years (Pre-monsoon & post-monsoon)</td><td>PIU through NABL approved monitoring agency</td><td>PIU / KSHIP</td></tr>
<tr><td>Surface Water Quality</td><td>Construction</td><td>Physical, Chemical & Biological parameters as per IS:2296</td><td>At 7 locations:
<table><tr><th>Design Ch. Km</th><th>Description</th></tr><tr><td>142+800</td><td>Pond -Devilhal Village</td></tr><tr><td>158+600</td><td>Dodda Halla River</td></tr><tr><td>168+200</td><td>Varada River</td></tr><tr><td>200+300</td><td>Canal Crossing-Guddad Anveri Village</td></tr><tr><td>221+750</td><td>Kusaguru Halla River</td></tr><tr><td>222+700</td><td>Kumadvati River</td></tr><tr><td>235+700</td><td>Tungabhadra River</td></tr></table></td><td>4 times a year (in each season)</td><td>Contractor through NABL approved monitoring agency</td><td>IE / PIU</td></tr>
<tr><td></td><td>Operation</td><td>Physical, Chemical & Biological parameters as per IS:2296</td><td>At 4 locations:
<table><tr><th>Design Ch. Km</th><th>Description</th></tr><tr><td>158+600</td><td>Dodda Halla River</td></tr><tr><td>168+200</td><td>Varada River</td></tr><tr><td>221+750</td><td>Kusaguru Halla River</td></tr><tr><td>222+700</td><td>Kumadvati River</td></tr></table></td><td>Twice in every three years (Pre-monsoon & post-monsoon)</td><td>PIU through NABL approved monitoring agency</td><td>PIU / KSHIP</td></tr>
<tr><td>Soil</td><td>Construction</td><td>pH, Conductivity, Organic matter, N, P, Na, K, Pb</td><td>Total 6 locations:

2 locations, wherever the contractor will decides to locate the Hot Mix Plant & construction camp;
Remaining 4 will be from different land use area along the project road such</td><td>Once in a year</td><td>Contractor through NABL approved monitoring agency</td><td>IE / PIU</td></tr>
</table>

Environment Component	Project Stage	Environmental Monitoring Program			Institutional Responsibility	
		Parameters	**Location**	**Frequency**	**Implementation**	**Supervision**
			as agricultural area, residential area, forest land and river bed			
Soil	Operation	pH, Conductivity, Organic matter, N, P, Na, K, Pb	4 will be from different land use area along the project road such as agricultural area, residential area, forest land and low lying areas	Once in every three years	PIU through NABL approved monitoring agency	PIU / KSHIP
Soil Erosion	Construction	Visual observation & turbidity test	Visual observation at high embankments sites such as bridge location, culvert locations, embankment area etc.	Pre-monsoon and post-monsoon season	Environmental Specialist, Hydrologist, and Material Specialist of Construction Supervision Consultants & Contractor	IE / PIU
Haul Road	Construction	Maintenance of haul roads, generation of dust.	Haul roads & hauling mode	At least twice a day i.e. midday and evening	Contractor	IE / PIU
Plantation	Construction	Plantation	- Side of the carriageway - Along boundary wall of the schools – Noise Barrier	Once in fortnightly; Comparison should be done for every six months	State Forest Department / PIU	PIU / KSHIP
	Operation	Growth of plantation	- Side of the carriageway - Along boundary wall of the schools – Noise Barrier	Assess growth every year for initial five years	PIU	PIU / KSHIP

Note: 1) Construction period is 30 months
2) Monitoring in Operation Phase will be conducted every 3 years for 10 years.

Note: Karnataka has the following four seasons in the year:

Winter Season : January to February
Summer Season : March to May
Monsoon Season : May to September
Post-monsoon : October to December

3. Reporting System

532. Reporting system for the suggested monitoring program operates at two levels:

- Reporting of environmental management indicators
- Reporting for operational performance indicators at the PIU level

533. Environmental monitoring involves regular checking of the environmental management issues detailed in the EMP and to ascertain whether the mitigation measures are achieving their objectives, according to the EMP, with the progress of the works. It provides the necessary feedback for project management to keep the program on schedule will still achieving the expected outcomes.

534. The contractor, IE and PIU are three components of the reporting system for environmental conditions and management indicators. The reporting system to be followed in **construction phase** is presented in **Table-137.**

- The reporting system will start with the Contractor who is the main executor of the implementation activities. The contractor will report to the Sr. Environmental Specialist of IE who in turn shall report to the PIU. The Contractor will submit monthly and quarterly environmental compliance reports along with formal monthly and quarterly reporting to the IE.
- The IE will submit separate quarterly environmental monitoring reports to PIU in addition to submission of the summary of the activities of the month in the formal monthly report including any deviations and corrective actions.
- PIU will be responsible for preparation of the targets for identified non-compliances
- A full record of construction activities will be kept as a part of normal contract monitoring system. Reporting and Monitoring Systems for various stages of construction and related activities have been proposed are to ensure timely and effective implementation of the EMP.

535. During the operation phase, the supervision as well as reporting responsibilities will lie with the KSHIP site offices and overall supervision will be the responsibility of Environmental Specialist at KSHIP head office in Bengaluru.

Table 137: Reporting System during Construction Phase

Item	Contractor	Independent Engineer		PIU to oversee compliance monitoring
		Supervision	Reporting to PIU	
Construction Stage				
Monitoring of construction site and construction camp	Before start of Work	Regular	Quarterly	Regular
Pollution Monitoring	As per Environmental Monitoring Program	As per the Schedule	Quarterly	Quarterly
Debris Disposal Area	Weekly	As required	Quarterly	Quarterly
Monitoring of Enhancement Activities	Regular	Regular	Quarterly	Quarterly
Top Soil Conservation & Slope Stabilization	Weekly	Weekly	Monthly	Quarterly
Borrow Area /Quarry Area / Debris Disposal Area	Regular	Weekly	Monthly	Quarterly
Tree felling	Weekly	Weekly	Monthly	Quarterly
Tree Plantation	Monthly	Monthly	Monthly	Quarterly

G. Institutional/Implementation Arrangements

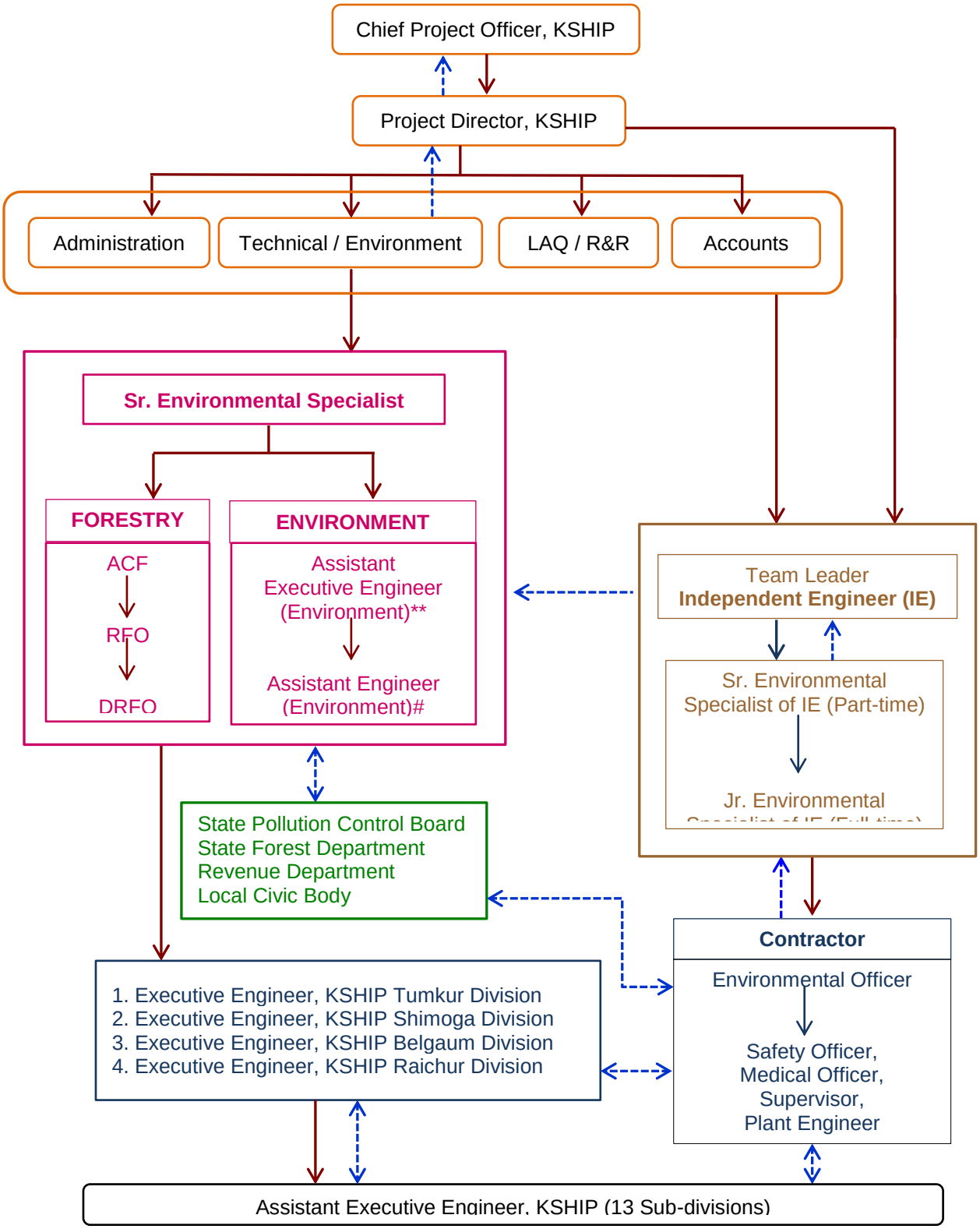
1. Institutional Arrangement

536. Project Implementation Unit (PIU) is responsible for implementation of all the mitigation and management measures suggested in EMP and also make sure that the statutory requirements are not violated during the pre-construction, construction and operation stages of the project.

537. The Chief Project Officer (CPO) heads KSHIP. He will be responsible for the successful implementation of the Project. The Chief Engineer is also the Project Director (PD) in the KSHIP set up for the implementation of the project. The PD is assisted by PIU, Technical / Environment and LAQ / R&R wings at the head office. Various wings are functioning under PIU such as Technical, Environment, LAQ, Administration and Accounts.

538. An Environmental Management Plan Implementation Unit (EMPIU) has been created in Project Implementation Unit (PIU) and a Sr. Environmental Specialist Environment has been positioned for the overall functioning of the EMPIU. The main activities of the EMPIU can be divided into two categories i.e. forestry and environment. Forestry related activities include diversion of forest land, compensatory afforestation, avenue plantation, plantation in oxbow land etc. while environment related activities include statutory clearances, implementation of EMP through Contractor, Grievance Redress, training etc. An Assistant Conservator of Forest (ACF), Range Forest Officer (RFO) and Deputy RFO, assist the Sr. Environmental Specialist for forestry related activities. For environment related activities, 2 Assistant Executive Engineer (AEE) and 2 Assistant Engineer (AE) has been proposed for KSHIP-III. Position of one AEE and one AE are already sanctioned while another position of AEE and EE are to be sanctioned.

539. Project Director will be heading the overall functioning of the PIU. The Executive Engineers (EEs) and supporting staff as employer's representatives nominated for the project will be responsible for the implementation of the project under the divisions. The Sr. Environmental Specialist of the EMPIU will look after the forestry and environmental issues during the project preparation, implementation and operation with the assistance of the Sr. Environmental Specialist of the Independent Engineer (IE). The contractor will be responsible for implementation of the EMP in the field. The "Contractors" herein mean the agency hired for execution of the construction works for the respective packages. Organizational setup of for PIU is illustrated in the **Figure-66.**



Note: **Assistant Executive Engineer (2 positions): 1 position already sanctioned, 1 position to be sanctioned
Assistant Engineer (2 positions): 1 position already sanctioned, 1 position to be sanctioned

Figure 66: Implementation Arrangement

2. Implementation Arrangements

540. The KSHIP is responsible for the implementation of the provisions made within the EMP through Independent Engineer (IE) with the help of project offices. The services of Independent Engineer will be procured to assist the site offices for monitoring the environmental aspects of the project during implementation. The IE will have a multi-disciplinary team and will also have an environmental management team having intermittent input of a senior level Environmental Specialist supported by middle level full time Environmental Specialists (one for each package). This team will ensure compliances of mitigation measures and all statutory requirements during implementation and operation of project.

541. **Independent Engineer (IE):** The Independent Engineer, to be procured through ICB shall assist the KSHIP with the implementation of project, once the project documents are ready. The Environmental Specialist of the IE shall be the key personnel to ensure the successful implementation of EMP provisions. Since ICB procurement is envisaged, the selected IEs are expected to have the necessary professional(s) to tackle the issues that the project is likely to bring up. The Environmental Specialist of the Independent Engineer will be a key position, which can be leveraged to ensure that the Contractor complies with the various EMP requirements.

542. The EMP prepared for the Project road, needs to be followed during the implementation of the civil works. The EMP is integrated in the technical specification and contract documents.

543. Qualification and Responsibilities of Senior Environmental Specialist of IE:

a. Qualifications & Experience

- Postgraduate in Environmental Management / Environmental Science / Ecology / Environmental Planning / degree in Civil Engineering with PG / specialisation in environment.
- 15 years of total experience with a minimum of 10 years in the preparation and implementation of EMP of highway projects and an understanding of environmental, health and safety issues.
- Prior practical experience in Highways projects funded by Multilateral Agencies

b. Roles & Responsibilities

- The key responsibility of the Environmental Specialist will be the successful implementation of the EMP
- In addition, he / she will update KSHIP on the progress of environmental protection and / or enhancement works as envisaged in the EMP
- Supervise and monitor the implementation of EMP by the Contractor
- Review and approve site-specific environmental mitigation / enhancement designs worked out by the Contractor based on the EMP prepared during project preparation
- Review and recommend the Contractors' Implementation Plans for approval (with any changes that may be necessary) to ensure compliance with the environmental provisions of the Contract
- Monitor tree plantation programs and the periodic Environmental Monitoring (air, noise, water, soil and biodiversity) programs to ensure compliance with the statutory requirements and the EMP
- Hold regular meetings with Contractor and provide update to KSHIP regarding

the progress of environmental works
- Prepare and submit Monthly, Quarterly, Semi-annual and Annual Environmental report to KSHIP
- Develop and organise environmental training programmes to upgrade the skills within the staff of the environmental cell and the Contractors
- Document and develop good practices during project implementation for wider dissemination

544. The project will require continuous environmental supervision from the IE's side. Since **the Sr. Environmental Specialist for IE projects are to be deployed on intermittent basis**, it is required to have **fulltime Jr. Environmental Specialist** to assist the key professional. Field Engineers supervising the construction works also needs to be trained on environmental aspects, who then shall apprise the Team Leader and the Sr. Environmental Specialist of any significant development on environment

545. Qualification and Responsibilities of Junior Environmental Specialist of IE (Sub Professional):

a. Qualifications & Experience
- Postgraduate in Environmental Management / Environmental Science / Ecology / Environmental Planning / Environmental Engineering
- 7 years of experience with a minimum of 3 years in the preparation and or implementation of EMP of highway projects and an understanding of environmental, health and safety issues
- Prior practical experience in multilateral funded projects in highways sector would be an advantage

b. Roles & Responsibilities
- The key responsibility of the Environmental Specialist will be the successful implementation of the EMP
- In addition, he / she will update the Key Environmental Specialist & the TL of IE on the progress of environmental protection and / or enhancement works as envisaged in the EMP
- Regularly supervise and monitor the implementation of EMP by the Contractor
- Verify the extent of environmental compliance of the Contractor regularly
- Monitor tree plantation programs and the periodic Environmental Monitoring (air, water, noise, soil & biodiversity) Programs to ensure compliance with the statutory requirements and the EMP
- Interact & hold regular meetings with Contractor Environmental Officers in implementation of the EMP
- Assist the Key Environmental Specialist in preparation of monthly, Quarterly, Semi-annual and Annual Environmental reports
- Assist the Key Environmental Specialist in documenting good practices during project implementation for wider dissemination
- Regularly monitor the approved site-specific environmental mitigation / enhancement designs based on the EMP prepared

546. **Contractor:** Execution of works will be the responsibility of the PBDPS Contractor (Performance based Deferred Payment System Contractor). The Contractor may himself be the executioner of the project or might decide to sublet some part to petty contractor. The contractor

shall be responsible for both the jobs done by the petty contactor (if Sublet) as well by him. In both the cases the Contractor will implement the environmental measures. This has been done with a view to ensure that road construction and environmental management go together. The Contractors shall employ a **full time Environmental Officer** whose qualification and responsibilities shall be as stated below:

547. Qualification and Responsibilities of Environmental Officer (EO) of Contractor:

a. Qualifications & Experience

- Postgraduate in Environmental Management / Environmental Science / Zoology / Botany / Ecology / Environmental Planning / Environmental Engineering
- 5 years of experience with a minimum of 2 years in the implementation of EMP of highway projects and an understanding of environmental, health and safety issues
- Prior practical experience in multilateral funded projects in highways sector would be an advantage

b. Roles & Responsibilities

- The Environmental Officer shall report directly to the Resident Construction Manager / Project Manager of the Contractor so that the pertinent environmental issues that he raises are promptly dealt with.
- He shall also have a direct interaction with the Environmental Specialist of the IE.
- Monitor / implement measures laid out in the EMP and or as directed by the IE for the work executed both by petty contractors and the contractor.
- Implement tree plantation programs (if under Contractor's scope) and conduct periodic Environmental Monitoring (air, water, noise, soil & biodiversity) Programs to ensure compliance with the statutory requirements and the EMP
- Provide key inputs in the development of the Contractors' implementation plan for all construction activities, including haulage of material to site, adhering to the requirements of the EMP and getting approval of the IE on the same before start of works.
- Ensure that the regulatory permissions required for the construction equipment, vehicles and machinery (given in the EMP) have been obtained and are valid at all times during the execution of the project.
- Prepare / fill up the environmental and safety related compliances as per daily, weekly, fortnightly, monthly, quarterly, semi-annual checklists in the EMP
- Prepare Safety Plans, Debris & Waste disposal Plan, Emergency Response Plans and Quarry Management and other safety, health and environment related Plans for approval of the IE.
- Identify locations for siting construction camps and other plants, machinery, vehicles and equipment, as well as locations for storage and disposal of wastes, both from the construction camps and from the site and obtain approval for the same from the IE.
- Detail out site-specific environmental mitigation and enhancement measures and obtain approval of the IE for the same
- Carry out the measurements of environmental mitigation and / or enhancement works and prepares bills for the same for approval and payment through the IE.
- Ensure that the safety of the workers and other site users is not compromised during construction
- Ensure that adequate monitoring facilities are available for collecting samples of

all discharges from the Contractor's plants, equipment and camps

- Verify the extent of environmental compliance at sites from where the Contractor is procuring the material – Borrow Area, Quarries, Crushers or even sand and suggest appropriate mitigation measures, if required

c. Penalty Clause:

- For not employing a full time Environmental Officer (EO), the contractor shall be levied a fine of Rs. 2,000/ every day from his invoice
- The EO shall be approved by the Client
- In case of non-notified absence of the EO (absence to be notified to the authority in writing) for more than 15 days from site, a fine of Rs. 2,000 per day to be levied on the contractor. Eligibility of leave due to the EO shall be as per standard guidelines of the organization.

548. The environmental officer shall have an environmental, health and safety team to help him in implementing the EMP. These team members may / may not report to him / her directly but shall apprise him of all the incidents and mark a formal report of any incident having an impact on the Health, Environment and Safety issues.

549. **Safety Officer (SO):** The safety officer shall on day to day basis interact and assist the EO in implementation of the safety features mentioned in the EMP. He shall also assist the EO in the preparation & submission of safety plans.

550. **First Aider / Medical Officer (MO):** The first aider / medical officer shall interact and assist the EO in implementation of the health features mentioned in the EMP

551. **Duty Officers (DO) /Supervisors:** The Duty Officers shall on day to day basis, take the necessary mitigation measures as per the directions of the EO, SO & MO and monitor the project facilities and report to the EO on activities that adversely affect the environment in the vicinity.

552. **Plant Engineer:** The Plant Engineer has the responsibility of managing and controlling the hot mix plant, crusher unit and fleet of vehicles. He shall ensure that the environment is not degraded at his plant site. Even though the EO shall routinely monitor to detect any negative issues due to operations and bring it to the knowledge of Plant manager for taking rectification works. In case of emergency the Plant Engineer shall immediately notify the EO for necessary actions.

H. Institutional Capacity Building

553. Construction industry of India is an important indicator of the development as it creates investment opportunities across various related sectors. The industry is fragmented, with a handful of major companies involved in the construction activities across all segments; medium sized companies specializing in niche activities; and small and medium contractors who work on the subcontractor basis and carry out the work in the field. In the absence of any institutional mechanism for skill formation, construction workers continue to be trained by the traditional master craftsmen. Apart from its inadequacy in quantitative terms, the traditional system neither utilizes new technologies and work methods, nor does it absorb the benefits of research and development.

554. Therefore, for successful implementation of EMP it is important to orient contractor's supervisory staff as well as key field staff towards environmental issues of highway project, implementation of mitigation measures, green construction technology and sustainable environment to safeguard natural resources and environment. The Environmental Specialist / Engineers at PIU and Independent Engineer are also responsible for the implementation of the EMP, need to be trained. To ensure the success of the proposed implementation set up, there is need for training and skill up-gradation. Hence, considering the requirement, the following training program is suggested.

1. Training Components

555. The environmental training should encompass the following:

- Understanding of the relevant environmental regulations and their application to the project;
- Environmental & Social Issues in Highway Projects
- Road Safety and Road Safety Audit for Highways
- Mainstreaming Biodiversity in Road Transportation Projects for Promoting Smart Green Infrastructure
- Mitigation measures of noise generated from construction equipment
- Environmental Monitoring during Construction stage and Operation stage
- Green Highways & Green Infrastructure
- Use of Waste Plastic in Road Construction
- ISO 14001:2004 Environmental Management System

2. Training Program

556. A training program needs to be worked out incorporating the project needs as well as the intermediate-term capacity building needs of the PIU, IE and Contractor. The program should consist of a number of training modules specific to target groups. The training would cover the basic principles and postulates of environmental assessment, mitigation plans and program implementation techniques, monitoring and management methods and tools. Looking into the potential requirements of each of the target groups, several training component has been suggested.

557. Given below is a list of Training Institutes (**Table-138**) which can be contacted for providing training in various issues related to environmental management as identified in Training Components.

Table 138: List of Training Institutes

Sl. No.	Name of Training Institute
1.	Indian Academy of Highway Engineers (IAHE) (Ministry of Road Transport & Highways, Govt. of India) A-5, Institutional Area, Sector-62, NH-24 Bypass, NOIDA-201301 (UP) Telephone: 0120-2400085 - 86, 2405006 - 09, Course Coordinator: Shri. M. Riten Kumar Singh(JointDirector) Email: iahe.training@gmail.com
2.	Wildlife Institute of India Post Box # 18, Chandrabani, Dehadun 248 001 Uttarakhand Email: dwii@wii.gov.in

Sl. No.	Name of Training Institute
	Phone: 0135-2640910, 0135-2640114, 0135 2646102 Fax: 0135-2640117
3.	Central Road Research Institute (CRRI) P.O. CRRI, Delhi-Mathura Institute, New Delhi – 110 025 Shri. T. K. Amla, Chief Scientist, Head & Course Organizer Phone: 011 26921939 Email: tkamla.crri@nic.in
4.	**Centre for Innovations in Public Systems (CIPS)** Administrative Staff College of India, College Park Campus Road No. 3, Banjara Hills, Hyderabad – 500 034 Phone: 040 667 20720 Fax: 040 667 20721 E-mail: chakrapani@cips.org.in
5.	Kerala Forest Research Institute An Institute of Kerala State Council for Science, Technology and Environment Peechi P.O, Thrissur District - 680653 Kerala Phone: 0487 2690100; Fax: 0487-2690111
6.	National Environmental Engineering Research Institute (NEERI) Nehru Marg, Nagpur – 440020, Maharashtra Phone: 0712 2249885-88; 2249970-72 URL: http://www.neeri.res.in
7.	Envirotech Instruments Pvt. Ltd. Manufacturers of Air Pollution Monitoring Instruments A-271,Okhla Industrial Area, Phase-1, New Delhi-110020 Phones: 011 26813887, 26814139 Fax: 011 26811833 Email: envirotech@vsnl.com
8.	Centre for Science and Environment 41, Tughlakabad Institutional Area, New Delhi-110062 Phone: 011 29955124, 29956110, 29956394, 29956399 Fax: 011 29955879 Email: cse@cseindia.org
9.	TUV India PVT Ltd 801, Raheja Plaza 1, L.B.S. Marg, Ghatkopar (West) Mumbai – 400086 Phone: +91 22 66477096/ 98, +91 22 66477009 Email: infoindia@tuv-nord.com
10.	SGS India - South 28B/1, 28B/2, 2nd Main Road, Ambattur Industrial Estate Chennai, Tamil Nadu, 600 058 Phone: +91 (0) 44 6608 1600 /1700 / 1800, +91 (0) 87 54 44 6594 (Regional Branch Manager)

I. Environmental Budget

558. The budgetary provision for the implementation of the environmental management plan of the project road can be categorized in to two types and is presented below:

- Environmental Management Plan Works to be implemented by the contractor under civil works contracts
- Environmental Management Plan Works to be implemented by the KHSIP

559. A capital cost provision of about **Rs. 7.94 Crore** has been kept towards implementation of environmental management plan. Summary of environmental budget is presented in **Table-139.**

Environmental Management Plan
Works to be implemented by the Contractor under Civil Works Contracts (Bill of Quantities)

A. Mitigation / Enhancement Budget

Component	Stage	Item	Unit	Quantity	Cost# (Rs.)	Total Cost (Rs.)
Topography & Land Use	Construction	Establishment of Construction Camp	Sq. ft	Area required 100 Sq.ft/ labour; No. of labours: 150 Total area required = (150 x 100) = 15,000 sq.ft	300	4,500,000
Soil	Construction	Slope stabilization	Covered under Engineering Cost			
Air	Construction	Dust suppression with sprinkling of water;	Trip	6 trips per day x 300 days in a year for 2.5 years = 4,500 trips	500	2,250,000
Water	Construction	Provision of water supply facilities for the construction camps	Month	30	15,000	450,000
Water	Construction	Provision of sewage and sanitation facilities for the construction camps, including maintenance for 2.5 years	Month	30	15,000	450,000
Water	Construction	Provision for Oil Interception Chambers in construction yard near to 1) vehicle parking, fueling and washing area and 2) Hot Mix Plant	No.	1 units in a construction yard x 4 locations = 4	10,000	40,000
Water	Construction	Construction of Sedimentation Tanks in construction yard near to 1) Concrete mix plant and 2) Hot mix plant	No.	1 units in a construction yard x 4 locations = 4	50,000	200,000
Water	Construction	Silt fencing near water bodies, low lying areas	Meter	1,200	850	1,020,000

Component	Stage	Item	Unit	Quantity	Cost# (Rs.)	Total Cost (Rs.)
		and areas identified by the IE				
Water	Construction	Ground Water Recharge Pit / Rainwater Harvesting Structures	No.	13	62,800	816,400
Water	Construction	Enhancement of water body at 1 location as per specification given in the Pond Enhancement Plan (Annex-8.27) and described in Section-6.3.5.1 of Chapter-6	No.	1	3,411,000	3,411,000
Water	Construction	Phyco-Remediation of water body using NUALGI as per details provided in Annex-8.26	Liter	22.5	9,000	202,500
Noise	Construction	Construction of noise barrier at sensitive receptors along the project road (for details please refer Section 6.5.2 of Chapter-6)	Meter	1,240	7,500	9,300,000
Vegetation loss	Construction	Provision of fuel in the construction camp	No.	6 commercial LPG Cylinder per month x 30 months = 180 cylinders	1,500	270,000
Solid Waste Management	Construction	Clearing garbage from construction camp and construction site	Month	30	8,000	240,000
Safety of Workers	Construction	Providing PPE to the labours during the construction	Cost/ person	100	1,200	120,000
Health Checkup	Construction	Provision for biannual health checkups	No.	150 persons x 4 checkups = 600	2,000	1,200,000
Resettlement & Rehabilitation	Construction	Compensation for structure including affected religious structures, livelihood loss, resettlement assistances & RP implementation	Covered under Engineering Cost			
					Total	**24,469,900**

Note: 1) Construction period is 30 months

basis of unit cost is the Consultant's past experience in similar projects

B. Environmental Monitoring Budget

Parameters	Stage	Frequency	No. of Locations	No. of Samples	Unit Cost/ Sample# (Rs.)	Total Cost (Rs.)
Ambient Air Quality	Construction	Twice in a season for 3 seasons (except monsoon)	10	150	4,000	600,000
	Operation	Once in a season for 3 seasons (except monsoon)	6	54	4,000	216,000
Noise Level	Construction	4 times a year (in each season)	8	80	2,000	160,000
	Operation	Once in every three years	6	18	2,000	36,000
Ground Water Quality	Construction	4 times a year (in each season)	5	50	7,000	350,000
	Operation	Twice in every three years (Pre-monsoon & post-monsoon	5	30	7,000	210,000
Surface Water Quality	Construction	4 times a year (in each season)	7	70	7,000	490,000
	Operation	Twice in every three years (Pre-monsoon & post-monsoon	4	24	7,000	168,000
Soil Quality	Construction	Once in a year	6	18	5,000	90,000
	Operation	once in every three years	4	12	5,000	60,000
Transportation of samples to the laboratory	Construction	Immediately after sampling	-	-	Lump sum	200,000
	Operation	Immediately after sampling	-	-	Lump sum	300,000
					Grand Total	**2,880,000**

Note: 1) Construction period is 30 months

2) Monitoring in Operation Phase will be conducted every 3 years for 10 years.

basis of unit cost is the Consultant's past experience in similar projects

Environmental Management Plan
Works to be implemented by the KHSIP

C. Forestry Budget

Component	Stage	Item	Unit	Quantity	Cost# (Rs.)	Total Cost (Rs.)
Net Present Value (NPV)	Pre-construction	Diversion of Reserved Forest Land	Ha	3.4225	626,000	2,142,485
Compensatory Afforestation	Pre-construction	Mandatory Compensatory Afforestation for diversion of forest land	Ha	3.4225	234,000	800,865
Avenue Plantation	Construction	Plantation of trees (one row) on either side of the project road at 10 m interval & its maintenance for 5 years (200 trees / km on both sides)	Nos.	24,800	1,911	47,392,800
Noise barrier	Construction	Plantation of trees (one row)	No	310	1,911	592,410

Component	Stage	Item	Unit	Quantity	Cost# (Rs.)	Total Cost (Rs.)
		along the boundary wall, which will act as noise barrier at 4 m interval & its maintenance for 5 years. (250 trees / 1,000m) Length of noise barrier – 1,240 m				
					Total	**50,928,560**

D. Training & Mobilization Budget

Component	Stage	Item	Unit	Quantity	Cost# (Rs.)	Total Cost (Rs.)
Training and Mobilization	Construction & Operation	Training of Environmental staff of KSHIP involved in the project, staff of IE, contractor, and collaborating Government agencies	Training cost per person	4 persons @ 2 trainings per year	40,000 per training	640,000
Facilities and Equipment	Construction & Operation	Infrastructure facility (such as computer, printer, scanner, internet etc.) for the team at PIU who will be responsible for monitoring of the implementation of EMP	Set	2	200,000	400,000
					Total	**1,040,000**

basis of unit cost is the Consultant's past experience in similar projects

Table 139: Summary of Environmental Budget

Component	Description	To be implemented by	Amount (Rs.)
A.	Mitigation / Enhancement	Contractor	24,469,900
B.	Environmental Monitoring		2,880,000
		Subtotal	***27,349,900***
C.	Forestry	KSHIP	50,928,560
D.	Training & Mobilization		1,040,000
		Subtotal	***51,968,560***
		Grand Total	**79,318,460**

X. CONCLUSION & RECOMMENDATIONS

A. Conclusion

560. The proposed project (**Gadag to Honnali**) includes strengthening and widening of existing State Highway (SH-57 & 26). Five new bypasses (14.215 km) and realignments are proposed at twelve locations (total 18.225 km) for improving the road geometrics and meet the project objectives. The length of the project road is **138.168 km**. Project road traverses mainly through plain terrain.

561. The existing road is to be widened to standard 2-lane with paved shoulder configuration based on the traffic projection. A 2-lane section with 7 m wide carriageway and 1.5 m wide paved shoulder and 1m earthen shoulder on both sides with proposed ROW of minimum 26 m has been proposed for all the bypasses & realignments.

562. As per ADB Safeguard Policy Statement 2009, proposed project is **"Category B"** project. The Initial Environmental Examination (IEE) Report attempts to identify significant potential environmental impacts associated with the construction and operational phases of the proposed road project. Apart from positive impacts road projects could also generate some adverse direct and indirect environmental impacts. Direct environmental impacts are usually due to construction activities, while indirect environmental impacts are usually related to the operation of improved roads.

563. Most of the adverse impacts of road project during construction period are temporary in nature. These impacts can be minimized through specific engineering solutions. Environment friendly construction methodology has been incorporated into the project design and Environment Management Plan has been prepared to minimize the overall impact on environmental attributes by the proposed project works. Therefore, it is **unlikely to cause any significant adverse environmental impacts** and no further detailed study is required.

564. As per the Government of India regulation, Environmental Clearance is not required for the proposed project. However, Forest Clearance & Tree Felling Permission from State Forest Department will be required before start of construction.

B. Recommendations

565. Conservation and **Ecosystem Management** has vital role to minimize the impact of highway construction. Maintaining natural flows of rivers, streams etc. without changing the gorge of flow at highway site also contribute to conservation of ecosystem.

566. The use of **Recycled Asphalt Cold Mix** in lieu of Hot Mix Asphalt (HMA) is one of the practices to reduce the lifecycle energy in highway construction. Recycled Asphalt Pavement (RAP) materials generated out of the existing distressed bituminous layers are proposed to be used as the base layer. The single most important justification for use of this technology is that it reduces the emission of greenhouse gases and controls thereby global warming. This would earn tradable carbon credit. Secondly, the technology is quite compatible with Reclaimed Asphalt Pavement technology, which saves the requirement of fresh aggregates and reduces the environmental hazard associated with dumping of damaged pavement materials. The fumes from Hot Mix Asphalt are known to be potential health hazards, especially for the construction workers. Construction at normal air temperature of the mix avoids this health hazard.

567. **Bio-engineering** is the technique of utilizing vegetation in addressing geotechnical problems, which is the only environment friendly and sustainable technology to control soil erosion and slope stabilization in highway project.

568. **Waste plastic** creates problem to the environment. The best way of disposal of waste plastic is its recycling to the maximum extent and waste plastic has great potential for use in bituminous construction. Plastics increase the melting point of the bitumen as well as its addition in small dose helps in substantially improving Marshall Properties, fatigue life and other properties. Use of this technology can not only strengthens the road construction but also increases the road life, and also help to improve the environment.

569. As discussed above, the Environmental Management Plan has been prepared incorporating various modern technologies and guidelines to reduce the environmental impacts of highway construction to make it a Green Highway. Therefore, it is recommended to strictly follow the EMP and associated Guidelines during construction phase and operation phase of the project.

Green Highway considerations at Construction Stage

- Use of Waste Plastic in Road Construction
- Use of Recycled Asphalt Cold Mix Technology
- Slope stabilization using Coir Geotextile and Vetiver Grass
- Phyco-Remediation of water using NUALGI
- Native indigenous trees species with large canopy cover shall be planted. One sq. m. of green canopy absorb 0.2 kg of CO2 and other waste gases.
- Preservation of fertile top soil
- Adequate number to cross drainage structures proposed to maintain natural flows of streams without changing the gorge of flow at highway site
- Rainwater Harvesting Structures to improve ground water level
- Provision of LPG in construction camp as fuel source
- Utilization of low electrical equipment viz. CFL, LED etc. in construction camp
- Utilization of solar panels in camps, offices and execution sites
- Disposal of hazardous and non-hazardous waste from construction site and reporting its environmental compliances to concerned authorities
- Use of CNG vehicles
- Reduction in fuel consumption & lower down fuel demand in machinery & vehicles