Initial Environmental Examination

January 2017

IND: Karnataka State Highways Improvement III Project

Magadi to Somwarpet

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

CURRENCY EQUIVALENTS

(as on 17 January 2017)

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

LIST OF ABBREVIATION

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

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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".

B. Objectives of the IEE

3. Following are the objectives of the Environmental Study:

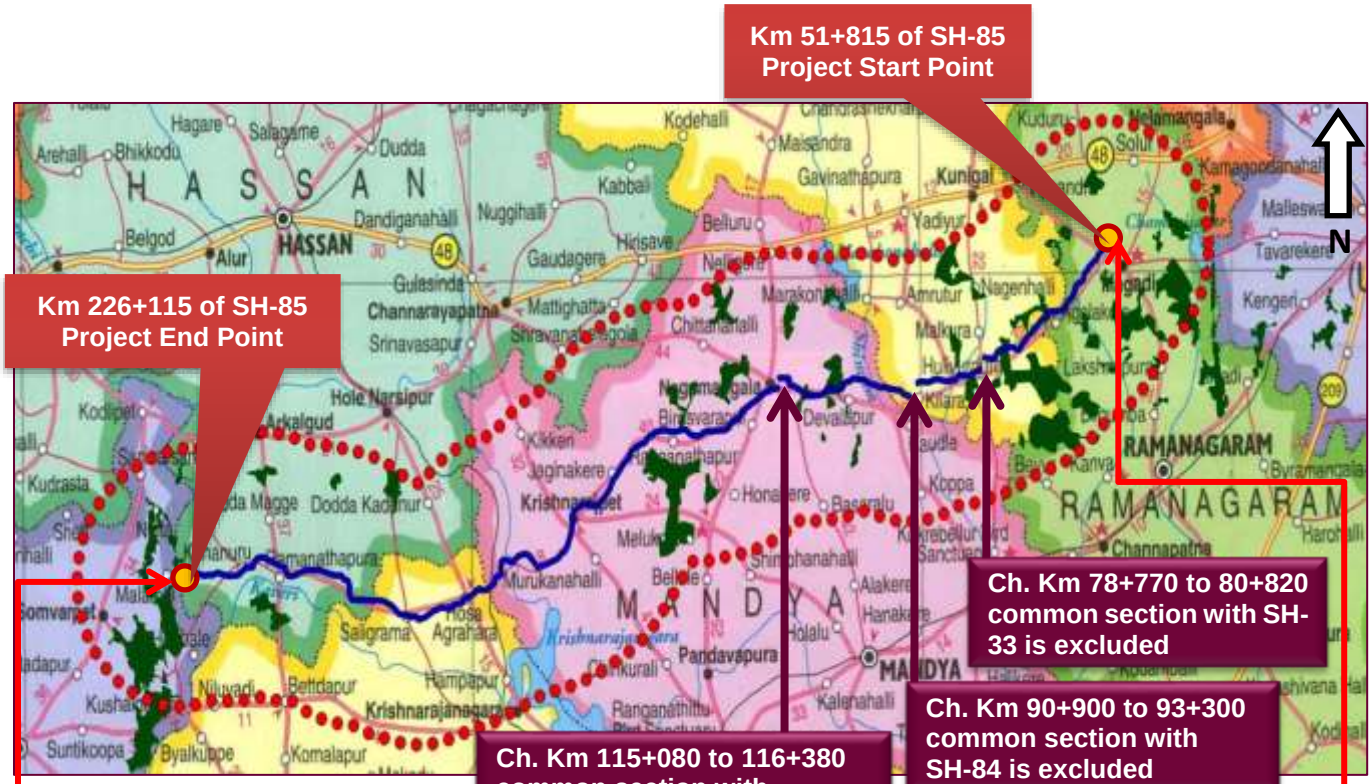
- Determine the category of the project depending on improvement proposal, environmental sensitivity and magnitude of impacts, i.e. screening as per Government of India's regulations and ADB's Safeguard Policy Statement 2009;
- Determine the appropriate extent and type of EA required (IEE or EIA), i.e 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.

C. Description of the Project

4. The Project road is a part of SH 85 (Bangalore to Jalsoor). The proposed improvement starts in Ramanagara district from the junction of Magadi-Kunigal Road near Magadi (existing Ch. Km 51+815) traverses through Ramnagar, Tumkur, Mandya, Mysore, and ends in Hassan district near Somwarpet (existing Ch. Km 226+115). The latitude & longitude of start and end points are $12^0\,57'\,51.98''$ N & $77^0\,12'\,26.26''$ E and $12^0\,36'\,13.636''$ N & $75^0\,56'\,33.044''$ E respectively.

5. Project road predominately traverse through plain and rolling terrain. The existing length of the project road is about 169.495 Km, excluding the common section with State & National Highways. Some of the common sections with SH-33 (2.05 km), SH-84 (2.4 km) have already been implemented for improvement under separate packages and NH-150A (1.3 km) in Nagamangala is taken up by NHAI for improvement and DPR is under preparation by an appointed consultant.

6. Length of the existing road is **169.495 km.** After the proposed improvement (realignment, curve improvement), length of the project road will be 165.47 km.



Project Road Forest Area 15 km radius of Project Road

Map Showing location of the Project Road

1. Project Highlights

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

Road stretch	Magadi to Somwarpet
Road length (Existing)	**169.495 Km**
Start point	Magadi in Ramanagara district at Ch. Km 51+815 of SH-85
End point	At Ch. Km 226+115 of SH-85 in Hasan district
Districts en-route	Ramnagar, Tumkur, Mandya, Mysore and Hassan
Important settlements /villages	Magadi, Nagamangala, K. R. Pet, Bheriya, Saligram, Keralapura, Basavapatna, Ramanathpura and Kananur
Existing carriageway	Majority section of the project is of single to intermediate lane i.e. carriageway width varies from 3.75 m to 5.5 m. However in small stretches is 4 lane divided carriage when passing through built up area.
Terrain	Plain and rolling
Land Use	Mainly agricultural followed by built-up area and forest land
Major Bridges	1
Minor Bridges	34
Causeways	4 vented causeways
Culverts	427 culverts
ROB & RUB	Nil
Railway Crossing	one existing railway level crossing (single track) at Ch. Km 169+000
Flyover	Nil
Road Intersections:	29 major junctions and 268 minor junctions

2. Annual Average Daily Traffic (AADT)

7. 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-01	Km 99+000	iDeCK'2015	1,200	1,092
MCC-02	Km 128+000	ICT 2015	3,057	2,440
	Km 128+000	iDeCK'2015	1,933	1,654
MCC-03	Km 206+000	ICT 2015	4,594	3,993
	Km 174+500	iDeCK'2015	3,182	2,453
MCC-04	Km 215+700	iDeCK'2015	1,586	1,159
MCC-05	Km 54+000	ICT 2015	14,079	20,760

Source: Survey conducted by iDeCK & ICT

3. Identification of Homogeneous Sections

8. The homogeneous section wise traffic projections have been given in **Table-E.3**.

Table-E.3 Homogeneous Sections of of the Project Road

Section No.	Sections	Existing Chainage (km)		Design Chainage (km)		Distance (Km)	Traffic Volume AADT (PCU)
		Start	End	Start	End		
HS-III	Magadi to Nagamangala	51+815	114+500	51+000	113+370	62.37	1,176
HS-IV	Nagamangala to K.R.Pet	114+500	151+800	113+370	150+250	36.88	2,440
HS-V	K.R Pet to Ramanathpura	151+800	206+400	150+250	204+780	53.195*	3,993
HS-VI	Ramanathpura to Somwarpet (excluding forest area)	206+400	226+800	204+780	221+833	17.05	1,253

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

4. Traffic Forecast

9. 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 likely induced and generated traffic has been added to arrive at the future traffic for each of the homogeneous sections. The projected traffic for each of the homogeneous sections is presented in Table-E.4.

10. Based on the observations and turning movement the project road (SH-85) from Magadi to Somwarpete has been divided four homogeneous section. Homogenous Sections III, IV, V and VI would be required to be widened to two-lane with paved shoulder configuration from the year 2015.

Table-E.4 Projected Annual Average Daily Traffic on Various Homogenous Sections of SH-85 (Magadi to Somwarpet Section)

Vehicle Type	Year								
	2015	2019	2020	2022	2025	2030	2035	2040	2050
Homogenous Section III-Magadi to Nagamangala [km 51+815 to Km 114+500 (existing) / Km 51+000 to km 113+370 (Design)]									
Total PCUs	1176	1497	3182	4756	5826	7882	10469	13533	21311
Total Vehicles	1250	1665	2862	4100	5165	7186	9701	12706	20372
Homogenous Section IV-Nagamangala to K.R. Pet [km 114+500 to km 151+800 (existing) / Km 113+370 to km 150+250 (Design)]									
Total PCUs	2440	3148	4215	5439	6735	9126	12039	15535	24593
Total Vehicles	3057	4100	5016	6305	8027	11157	14918	19459	31387
Homogenous Section V - K.R Pet to Ramanathpura [Km 151+800 to km 206+400 (existing) / Km 150+250 to km 204+780 (Design)]									
Total PCUs	3993	5228	5650	6606	8301	11464	15298	19907	32323
Total Vehicles	4594	6214	6775	8061	10365	14539	19501	25525	41781
Homogenous Section VI-Ramanathpura to Somwarpet [Km 206+400 to Km 226+800 (existing) / Km 204+780 to km 221+833 (Design)]									
Total PCUs	1253	1561	1685	1960	2438	3317	4340	5542	8791
Total Vehicles	1654	2083	2265	2681	3423	4754	6310	8176	13199

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 32 m depending on the height of embankment</td></tr>
<tr><td>Widening Scheme</td><td>2-lane with paved shoulder configuration except in the built up sections en-route, 11.7 km length of 4-lane with paved shoulder has been proposed.
▪ Concentric Widening : 85.474 km
▪ Eccentric Widening : 25.460 km
▪ Bypass / Realignment : 27.652 km
▪ Curve Improvement (Km) Concentric : 26.892 km</td></tr>
<tr><td>Bypass</td><td>At two locations:
<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>Krishna Raj Pete Bypass</td><td>149+690</td><td>158+515</td><td>146+080</td><td>155+300</td><td>9.220</td></tr>
</table></td></tr>
<tr><td>Realignment</td><td>At fourteen (14) locations, total length is 18.432 km</td></tr>
<tr><td>Bridge</td><td>▪ Existing Minor bridges Proposed to be Widened with Repair: 14
▪ Existing Minor bridges to be retain with repair : 6
▪ New bridges under construction by PWD : 1
▪ New Major Bridge in place of existing bridge : 1
▪ New Minor Bridge in place of existing bridge : 15
▪ New Minor Bridge on proposed K. R. Pet bypass : 3</td></tr>
<tr><td>ROB</td><td>There is one level crossing on the project road at Ch. 167+705. An ROB is proposed to be provided at this location</td></tr>
<tr><td>Overpass</td><td>One overpass at Ch. 122+380 is proposed on the project road</td></tr>
<tr><td>Culverts</td><td>▪ Reconstruction of existing culverts : 180
▪ Widening & repair : 91
▪ Construction of new culverts : 144
▪ Additional culverts for junctions : 326</td></tr>
<tr><td>Pedestrian Subway</td><td>Nil</td></tr>
<tr><td>Road Side Drains</td><td>▪ 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</td></tr>
<tr><td>Bus Bays</td><td>150 bus bays at 75 locations</td></tr>
<tr><td>Truck Lay Byes</td><td>Truck Lay Bye proposed on both sides of the carriageway at 3 different locations</td></tr>
<tr><td>Toll Plaza</td><td>Considering traffic flow and Homogeneous section, three toll plazas have been proposed along the project road at Ch. Km 93+700, Km 128+300 and Km 197+020. 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</td></tr>
<tr><td>Design Speed</td><td>of 100 kmph in plain/rolling terrain and with 80 kmph as the minimum design speed</td></tr>
<tr><td>Road Safety Devices</td><td>▪ Road Markings
▪ Road Signs
▪ Roadside Safety Barriers
▪ Pavement Marking and Lighting
▪ Many other safety features as prescribed in applicable codes and standards</td></tr>
<tr><td>Project Cost</td><td>Civil Cost : Rs. 702.69 Crore
EMP Cost : Rs. 11.4 Cror</td></tr>
<tr><td>Project Completion Period</td><td>30 months</td></tr>
</table>

D. Policy, Legal and Administrative Framework

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

12. **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-85 from Magadi to Somwarpet (169.495 km) in the State of Karnataka**.

13. 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
Permissions under AMASR Act 2010	Archaeological Survey of India (ASI)	Before Construction

14. 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
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 (DEIAA)	▪ Environment (Protection) Act, 1986
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

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
			▪ 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 ▪ The Inter-State Migrant Workmen (Regulation of

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
			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

15. 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)

E. Description of the Environment

16. 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

17. 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

18. The land use pattern in most of the stretch along the project road is agricultural (60.7%) followed by residential cum commercial area (19.6%), mixed land use (15.6%) and forest (4.1%).

3. Soil Quality

19. Four (4) 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 61-67% sand content and about 12-15% clay content. The pH of the all samples are around 7.6 indicating slightly alkaline soil which can hold excess calcium and molybdenum salts and are generally low in iron and boron nutrients. The organic matter was observed to sufficient and varying in the range of 1.7-2.1%. The sodium absorption ratio is low (1.0 to 1.2%), 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

20. An automatic weather station was established at Nagamagala 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 (°C)	33.4
Minimum Temperature (°C)	12.4
Maximum Relative Humidity (%)	99.0
Minimum Relative Humidity (%)	43.8
Total Rainfall (mm)	2
Average Wind Speed (m/sec)	2.1
Calm condition	1.34
Predominant wind direction (blowing from)	South
Dry hours (%)	99.8%

Source: On-site Monitoring during Dec15-Jan16

5. Ambient Air Quality

21. 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.

22. 24-hourly monitoring results of $PM_{2.5}$, PM_{10}, SO_2, NO_2 and 1-hourly CO corresponding to air quality stations AQ1 to AQ8 are presented in **Table-E.9.** 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	PT V^{IND}	PTV^{WB}	Indian Standard
$PM_{2.5}$ ($\mu g/m^3$)	AQ1	Kenkere	4	12.00	17.00	1.87	16.94	0	0	60
	AQ2	Devalapura	4	11.60	16.40	1.75	16.32	0	0	
	AQ3	Nagamangala	8	12.00	22.00	3.16	21.72	0	0	
	AQ4	Kommenahalli	8	12.00	18.00	1.92	17.72	0	0	
	AQ5	Ramanathapura	4	9.50	14.00	1.78	13.88	0	0	
	AQ6	Bheriya	4	11.00	16.00	1.87	15.82	0	0	
	AQ7	Siddapura	4	10.00	17.00	2.74	16.82	0	0	
	AQ8	Konanur	4	11.00	18.00	2.55	17.76	0	0	
	Overall 8 Locations		**40**	**9.50**	**22.00**	**2.79**	**20.44**	**0**	**0**	
PM_{10} ($\mu g/m^3$)	AQ1	Kenkere	4	56.00	66.00	3.74	65.64	0	0	100
	AQ2	Devalapura	4	56.00	66.00	3.74	65.64	0	0	
	AQ3	Nagamangala	8	66.00	80.00	5.21	79.72	0	0	
	AQ4	Kommenahalli	8	42.00	60.00	5.54	59.44	0	0	
	AQ5	Ramanathapura	4	38.00	46.00	3.16	45.88	0	0	
	AQ6	Bheriya	4	48.00	56.00	3.16	55.88	0	0	
	AQ7	Siddapura	4	40.00	60.00	7.62	59.64	0	0	
	AQ8	Konanur	4	36.00	50.00	5.48	49.88	0	0	
	Overall 8 Locations		**40**	**36.00**	**80.00**	**11.12**	**78.44**	**0**	**0**	

Pollutant	AAQMS	Location	Mes	Min	Max	SD	p98	PTV^{IND}	PTV^{WB}	Indian Standard
SO_2 ($\mu g/m^3$)	AQ1	Kenkere	4	6.50	10.20	1.53	10.18	0	0	80
	AQ2	Devalapura	4	10.60	15.40	1.90	15.21	0	0	
	AQ3	Nagamangala	8	8.80	13.80	1.54	13.62	0	0	
	AQ4	Kommenahalli	8	8.20	12.60	1.47	12.42	0	0	
	AQ5	Ramanathapura	4	6.00	8.50	0.94	8.42	0	0	
	AQ6	Bheriya	4	7.40	11.80	1.61	11.64	0	0	
	AQ7	Siddapura	4	6.20	9.80	1.55	9.75	0	0	
	AQ8	Konanur	4	8.20	11.40	1.18	11.35	0	0	
	Overall 8 Locations		**40**	**6.00**	**15.40**	**2.16**	**14.15**	**0**	**0**	
NO_2 ($\mu g/m^3$)	AQ1	Kenkere	4	14.00	20.00	2.38	19.88	0	0	80
	AQ2	Devalapura	4	22.00	30.00	3.16	29.88	0	0	
	AQ3	Nagamangala	8	22.00	32.00	3.12	31.72	0	0	
	AQ4	Kommenahalli	8	22.00	32.00	3.03	31.72	0	0	
	AQ5	Ramanathapura	4	16.00	24.00	2.96	23.76	0	0	
	AQ6	Bheriya	4	12.00	22.00	3.84	21.88	0	0	
	AQ7	Siddapura	4	12.00	22.00	3.70	21.82	0	0	
	AQ8	Konanur	4	12.00	20.00	3.16	19.88	0	0	
	Overall 8 Locations		**40**	**12.00**	**32.00**	**5.61**	**32.00**	**0**	**0**	
CO (mg/m^3)	AQ1	Kenkere	4	0.60	0.70	0.04	0.70	0	0	4
	AQ2	Devalapura	4	0.37	0.45	0.04	0.45	0	0	
	AQ3	Nagamangala	8	0.53	0.68	0.04	0.67	0	0	
	AQ4	Kommenahalli	8	0.32	0.45	0.04	0.45	0	0	
	AQ5	Ramanathapura	4	0.39	0.44	0.02	0.44	0	0	
	AQ6	Bheriya	4	0.32	0.46	0.06	0.46	0	0	
	AQ7	Siddapura	4	0.33	0.40	0.03	0.40	0	0	
	AQ8	Konanur	4	0.31	0.39	0.03	0.39	0	0	
	Overall 8 Locations		**40**	**0.31**	**0.70**	**0.12**	**0.68**	**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

23. To assess the background noise levels, ambient noise monitoring was conducted at 8 locations, three in residential areas and five 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	Navagraha Temple, Kenkere	82+380	RHS	20	Silence
NQ2	Nagamangala	115+000	LHS	35	Residential
NQ3	Govt Primary School, Bommenahalli	161+400	RHS	22	Silence
NQ4	Bheriya	174+750	RHS	25	Residential
NQ5	Govt. Degree College, Shaligram	186+250	LHS	40	Silence
NQ6	Ramanathapura, near the ASI Site	207+950	LHS	40	Residential
NQ7	Pattabirama Govt. Girls PU College, Ramanathapura	209+000	LHS	50	Silence
NQ8	MKS Lions Vidhyaniketahan, Konanur	212+950	LHS	18	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)

24. 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 65.1 dB(A) in NQ4 and 66.8 dB(A) in NQ8 respectively.

25. Ld10 values (highest among the monitored values) are found to be 68.2 dB(A) and 69.0 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

26. 7 surface water (River, Lake and Pond) 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	Depambudhai Lake	72+400	RHS	20	Irrigation
2	SW2	Ammana Katte	113+300	LHS	12	Irrigation
3	SW3	Sule Kere	117+800	RHS	15	Drinking, Irrigation
4	SW4	Canal Crossing near Jaginakere Village	144+119	LHS	36	Irrigation
5	SW5	Hemavati River Crossing	164+830	LHS	35	Irrigation, domestic
6	SW6	Shaligrama Lake	184+800	RHS	20	No use
7	SW7	Cauvery River (at Ramanathapura)	207+600	LHS	216	Irrigation, domestic
Ground Water						
1	GW1	Malenahalli	115+500	RHS	15	Drinking
2	GW2	Kommenahalli	159+100	LHS	13	Drinking
3	GW3	Haradanahalli	191+900	LHS	10	Drinking
4	GW4	Konanur	212+850	RHS	11	Drinking

Distance in meter from existing centerline

Source: On-site Water Quality Monitoring in December 2015

27. The water quality results shows the surface waters in the study area are devoid of any extraneous chemical contamination; there is 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.

28. Ground water, in general, is hard in nature and the physico-chemical quality, at large (except hardness in GW2) satisfies the permissible limit as stipulated in Drinking Water Standards.

8. Ecology and Biodiversity

29. **Road side Trees:** The number of roadside trees existing within the row is estimated to be 7,488, out of which, 3,797 trees are located in left side and 3,691 trees are located in right side.

30. **Giant Trees:** Field survey was conducted to identify the location of giant trees. **520** giant trees are found along the project road, out of which 245 trees are on the left side and 275 trees are on the right side.

31. **Biodiversity Study:** The biodiversity study for **Magadi to Somwarpet** was carried in the month of December, 2015. Total of nine 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 15 -20km 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	12˚ 36' 34"	75˚ 58' 23"	871	Fallow agriculture land
2	12˚ 36' 49.1"	75˚ 8' 02"	818	Shrubby vegetation
3	12˚ 33' 59.4"	75˚ 16' 54.4"	793	Shrubby vegetation
4	12˚ 37' 4"	75˚ 26' 2.8"	779	Shrubby vegetation
5	12˚ 43' 13.5"	75˚ 32' 21.6"	836	*Acacia* and *Eucalyptus* Plantation
6	12˚ 44' 59.0"	75˚ 34' 19.0"	811	*Acacia* and *Eucalyptus* Plantation
7	12˚ 50' 7"	75˚ 44' 2.0"	760	*Acacia* and *Eucalyptus* Plantation
8	12˚ 48' 18"	75˚ 49' 9.0"	780	Shrubby vegetation
9	12˚ 52' 16"	75˚ 59' 27"	688	Shrubby vegetation

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

32. **82 floral species** were identified, out of which, 31 were trees, 29 shrubs and 22 herb species. In the present assessment, the Shannon's diversity index for tree species was 3.34, for shrubs 3.21 and for herbs 2.86. Shannon's diversity index values obtained 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).

33. 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	3.34	0.04
Shrub	3.20	0.05
Herb	2.86	0.07

Source: Bio-diversity Study conducted by ICT

34. Total **77 faunal** species were identified in the project area during field survey out of which 44 are avian species, 29 insects, 3 (three) reptiles and 1 (one) mammal.

35. Avian species *Accipiter badius* (Shikra), *Haliastur indus* (Bhramini Kite), *Ictinaetus malayensis* (Black Eagle), *Pavo cristatus* (Indian Peafowl) and *Ocyceros birostris* (Indian Gray Hornbill) are Schedule-I as per Wildlife Protection Act, are dwelling in the project area. The Act

provides protection to listed species of flora and fauna, prohibits hunting of any wild animal specified in Schedule. All the species in schedule-I are under Least Concern as per IUCN red list. The species have an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion. *Threskiornis melanocephalus* (Oriental white ibis) and *Mycteria leucocephala* (Painted stork) are two avian species which fall in near Threatened category as per IUCN red list.

36. None of the species found in the project area fall under the threatened category as per IUCN red list.

Table-E-14 Shannon and Simpson Index

Shannon's Diversity Index (H)	Simpson's Index (D)
3.60	0.04

Source: Bio-diversity Study conducted by ICT

37. **Protected Areas:** There is no Wildlife Sanctuary / National Park / Biosphere Reserve/ Tiger Reserve / Elephant Reserve in the project area.

38. **Forests:** Forests of the project area falls under Tropical Dry Deciduous and Dry Thorn scrub type These forests do not have any potential for timber production. Most of the activities are in the form of artificial regeneration with focus on urban forestry.

39. Tropical Dry Deciduous forests are characterized by stunted growth of trees with open canopy. The vegetation comprise of *Acacia sps.*, *Albizia sps*, *Wrightia tinctoria*, *Zizyphus sps*, *Dendrocalamus strictus etc.* Forest department have raised plantations, species such as *Eucalyptus sps*. *Acacia auriculiformis, Pongamia pinnata (Honge), Cassia siamea* (Seemethamgadi), *Albizia lebbeck* (Bage) *etc* have been planted. These plantations are raised either on notified Forests or on other Government lands that are under the control of the Forest department.

40. The project road is passing through Reserved Forests /and State Forest at various locations. Total **16.23 km** stretch of the project road is passing through the reserved forest / state forest. Details are presented in **Table-E.15.**

Table-E.15 Location of Forest along Project Alignment

Sl. No.	Ex. Chainage (Km)		Side	Name of the Forest	Length (km)
	From	To			
1	64+830	64+880	LHS	Ippadi Reserved Forest	0.050
2	64+880	66+730	Both	Ippadi Reserved Forest	1.850
3	73+850	76+110	Both	Huliyurdurga Reserved Forest	2.260
4	76+110	76+755	RHS	Huliyurdurga Reserved Forest	0.645
5	81+640	82+670	Both	Kamalapura Reserved Forest	1.030
6	103+660	104+460	RHS	State Forest, Nagamangala	0.800
7	104+460	105+500	Both	State Forest, Nagamangala	1.04
8	105+500	105+830	RHS	State Forest, Nagamangala	0.330
9	105+830	107+280	Both	State Forest, Nagamangala	1.450
10	109+550	109+900	RHS	State Forest, Nagamangala	0.350
11	109+900	110+170	Both	State Forest, Nagamangala	0.270
12	110+170	110+500	RHS	State Forest, Nagamangala	0.330
13	110+500	110+710	Both	State Forest, Nagamangala	0.210
14	110+710	111+020	RHS	State Forest, Nagamangala	0.310

Sl. No.	Ex. Chainage (Km)		Side	Name of the Forest	Length (km)
	From	To			
15	117+575	117+975	RHS	State Forest, Nagamangala	0.400
16	125+270	125+440	RHS	State Forest, Nagamangala	0.170
17	131+965	132+230	LHS	State Forest, Nagamangala	0.265
18	132+230	132+530	Both	State Forest, Nagamangala	0.300
19	132+530	132+660	RHS	State Forest, Nagamangala	0.130
20	134+260	134+600	LHS	State Forest, Nagamangala	0.340
21	134+600	135+500	Both	State Forest, Nagamangala	0.900
22	135+500	135+835	Both	State Forest, K. R. Pet	0.335
23	135+835	137+200	RHS	State Forest, K. R. Pet	1.365
24	139+780	140+310	RHS	State Forest, K. R. Pet	0.530
25	159+450	160+020	RHS	State Forest, K. R. Pet	0.570
Total length of project road abutting the Forests on LHS (km)					*0.655*
Total length of project road abutting the Forests on RHS (km)					*5.930*
Total length of project road abutting the Forests on Both sides (km)					*9.645*
Total Length					**16.23**

9. Educational, Medical and Religious Properties

41. 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	117
Medical Amenities	22
Religious Places	133

Source: Field Study conducted by ICT in December 2015

10. Archaeological Sites

42. Two ASI protected monuments are located within 300 m from the proposed project road at Ramanathapura in Hasan district as tabulated below:

Description	Design Ch. Km	Side	Dist. between centre line of the project road and boundary wall of the monument	Protection Status
Rameshwara Temple	203+900	LHS	132 m	Protected by the State Government
Agasthyeshwara Temple	204+300	LHS	172 m	

11. Demographic details of Affected Population

- The socio-economic information of affected persons (APs) has been collected from the census survey (100%). As per census survey, 2,251 households are likely to be affected due to the up-gradation of the existing road.
- There are a total of 8,913 APs being affected which includes 4,559 (51.15%) males and 4,354 (48.85%) females. The average household size is 3.9 and the sex ratio among APs is 955.
- The majority of the PAHs belong to the Hindu religion 79.92%, 1.87% is Muslims

and 0.13% belong to the Christian religion. However, nearly 18.08% of households did not respond to the question related to religion.

- Out of 2,251 affected households, 224 households (9.95%) are from general category, 1,245 households (55.31%) are from other backward class (OBC), 6.57% are from scheduled caste (SC), and 2.53% are from scheduled tribe (ST) category.
- 191 affected households (8.49%) earn Rs. 30,000 per annum while 884 affected households (39.27%) earn above Rs.1,00,000 annually.
- 33.32% affected households are illiterate, 7.60% are up to middle school, 8.09% are below matric, 14.62% APs are Matric (10th standard), 5.55% are up to graduate level.
- 41.58% households are engaged in agriculture, 1.91% are agriculture labour, 4.31% are daily wage earner and 15.06% households are doing business as their main occupation.

F. Analysis of Alternatives

43. The project road throughout length has substandard geometry for both horizontal and vertical. The project road also passes through several congested settlements which include Nagamangala, K.R. Pet, Berya, Basvanpatnna and etc. where it is noted highway traffic is impeded by local traffic and improvement of project road through some of these settlements would lead to R&R impact. There are about 561 Nos. Horizontal curves having radius less than 150 m with a design speed of less than the minimum 80 kmph stipulated in code and 370 vertical curves. Hence to minimize R&R (Rehabilitation and resettlement) impact and to provide safety to road users, one bypass (9.220 km) & fourteen realignments (18.432 km) have been proposed in this section of SH-85 with a total length of 27.652 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 two options of the proposed bypass.

G. Anticipated Impacts and Mitigation Measures

1. Environmental Impacts

44. 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	▪ Adequate measures like drainage, embankment consolidation & slope stabilization will be taken

Area	Impacts	Mitigation Measures
	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.	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 varies from 16 m to 20 m and in rural area it varies from 26 m to 32 m depending on the height of embankment	▪ 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 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 23 locations near water bodies, river crossing, canal 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	▪ 31 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 6 road side ditches. These are small depression (natural or manmade) along the road where water stored during rainy seasons. Water of these ditches is of no use.

Area	Impacts	Mitigation Measures
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 emission from asphalt and hot mix plants.	▪ 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 receptors and 300 m from the road. ▪ 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 **5,406** trees are required to be felled for the improvement of the road out of total **7,488** existing trees ▪ No threatened species of flora is falling in the ROW of the project road	▪ **Green tunnel has been saved at 4 locations** by modifying engineering design and **323 trees** have been saved. ▪ **19,000 trees** shall be planted along the road ▪ **1,044 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

Area	Impacts	Mitigation Measures
		honking board shall be placed near Forest. Noisy activity shall be prohibited during night time
Forest	▪ Reserved forest land is to be diverted **(21.3872 ha)**	▪ Net Present Value will be provided to Forest 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	▪ Out of 117 educational institutions along the project road, 10 will be partially affected, i.e., boundary wall will be affected. There will be no impact on school building. ▪ 1 Veterinary Hospital at Keralapura will be fully affected and boundary wall of 1 Veterinary Dispensary at Saligrama will be affected. There will be no impact on remaining 20 medical amenities ▪ Out of 133 religious structures along the project road, 25 will be fully affected, 1 partially affected. There will be no impact on remaining 107 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	▪ Proper traffic diversion and management will be ensured during construction at the interactions and construction areas.

Area	Impacts	Mitigation Measures
	movements.	▪ 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.
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.	▪ 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.

2. Social Impacts

45. According to the Land Acquisition Plan (LAP) **178.7472 Ha** of land will be acquired for the project, out of which 134.58 Ha. is private land. A summary of the impacts is provided in **Table-E.18**.

Table-E.18: Summary of Impacts

Type of Impact	No.
▪ Persons affected	8913
▪ Households affected (Land, Structure, Tenant and Employee)	2251
▪ Titled holders affected (Land & Structure)	1866
▪ Non-titled holders affected	385
▪ Households affected by land acquisition	1357
▪ Households who have to physically relocate	231
▪ Households affected by loss of income	339
▪ Vulnerable families affected	1615
▪ Severely affected households	231
▪ CPR affected (including government structures)	264
▪ Employee Affected Household	2
▪ Renters affected Household	153

H. Public Consultation

46. 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 nil 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.

47. **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 6 religious places along the project road. Overall **77.78%** participants showed reservation against construction of boundary wall due to temple aesthetics and accessibility; while **22.22%** supported the concept.

I. Environmental Management Plan

48. 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.

1. 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

2. Environmental Budget

49. 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

50. A capital cost provision of about **Rs. 11.4 Crore** has been kept towards implementation of environmental management plan. Summary of environmental budget is presented in **Table-E.19.**

Table-E.19 Summary of Environmental Budget

Component	Description	To be implemented by	Amount (Rs.)
A.	Mitigation / Enhancement	Contractor	62,057,500
B.	Environmental Monitoring		3,515,000
		Subtotal	***65,572,500***
C.	Forestry	KSHIP	48,262,884
D.	Training & Mobilization		1,040,000
		Subtotal	***49,302,884***
		Grand Total	**114,875,384**

J. Conclusion and Recommendations

51. 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.

52. 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-2 "Magadi to near Somwarpet"** 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).

A. Approach & 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.

C. 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 **Magadi to near Somwarpet** Project Road under the corridor CEW 28.

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

Volume A IEE Report and EMP

Executive Summary
Chapter-1 : Introduction
Chapter-2 : Description of the Project
Chapter-3 : Policy, Legal and Administrative Framework
Chapter-4 : Description of the Environment
Chapter-5 : Analysis of Alternatives
Chapter-6 : Anticipated Environmental Impacts and Mitigation Measures
Chapter-7 : Public Consultation
Chapter-8 : Environmental Management Plan
Chapter-9 : Conclusion and Recommendations

Volume B Annexures

II. DESCRIPTION OF THE PROJECT

A. Project Location

9. The Project road is a part of SH 85 (Bangalore to Jalsoor). The proposed improvement starts in Ramanagara district from the junction of Magadi - Kunigal Road near Magadi (existing Ch. Km 51+815) traverses through Ramnagar, Tumkur, Mandya, Mysore, and ends in Hassan district near Somwarpet (existing Ch. Km 226+115). The latitude & longitude of start and end points are $12^0\,57'\,51.98''$ N & $77^0\,12'\,26.26''$ E and $12^0\,36'\,13.636''$ N & $75^0\,56'\,33.044''$ E respectively.

Figure 2: Map Showing Location of Project Road

10. Project road predominately traverse through plain/rolling terrain and rolling terrain. The existing length of the project road is about **169.495 Km**, excluding the common section with State & National Highways. Some of the common sections with SH-33, SH-84 have already been implemented for improvement under separate packages and NH-150A in Nagamangala is taken up by NHAI for improvement and DPR is under preparation by an appointed consultant. Details of such common sections are given in **Table 2** below:

Table 2: Details of common Section of KSHIP II

Sl. No.	Existing Chainage (Km)		Design Chainage (Km)		Design Length (Km)	Remarks
	From	To	From	To		
1	78+770	80+820	76+480	78+530	2.050	Common section (SH 33)
2	90+900	93+300	88+100	90+500	2.400	Common section (SH 84)
3	115+080	116+380	112+070	113+370	1.300	Common section (NH 150A)

B. Description of the Project Road

11. Project road has connectivity to a National Highway and State highway as such improvement of project road would benefit and improve network mobility in the region. The project road passes through five districts of Karnataka. Two National Highways NH 75 and newly declared NH 275 (Bengaluru-Mysuru-Puttur) almost run parallel to project road both at a perpendicular distance of 15 to 25 Km. The project road forms shortest connectivity between Bengaluru to Somwarpet and also the proposed improvement proposal would help decongest traffic on both existing NH connectives. There are about 5 State Highways crossing the SH 85. There are 2 SH which has already been proposed/ under improvement program of KSHIP II. With available network of NH and SH highways the proposed improvement proposal of SH 85 would further provide quick connectivity to market places and also various tourist destinations in the region and would bring economic development within these districts

12. Project road predominately traverse through plain/rolling terrain and rolling terrain. The project road passes through rural area except small stretch of built up congested town like Nagamangala, K. R. Pet, Saligram, Ramanathpura and Kananur. Based on the field observations and traffic, project road can be divided into four sections as described below.

13. **Magadi (Km 51+815) to Nagamangala Junction:** After the junction with SH-94 (known as Kunigal Road) near Magadi in Ramanagara District, the SH-85 turns towards south westward and passes through Tumkur District. SH-111 take off from SH-85 near Chowdanakuppe near km 70 in Tumkur District. Further SH-85 connects SH-33 near Huliyurudurga at Km 78+750 and both SH is having a common section for a length of about 1.20 Km. A bypass of Huliyurudurga has been proposed and is under construction for SH 33 under KSHIP II. The improvement proposal for SH-85 will include to use the bypass under construction as part of its alignment.

Project Road passing through Nagamangala Forest

Take off point of Huliyurudurga Bypass currently under construction in separate Package by KSHIP II

14. Further the road traverses Westward in Tumkur District and connects SH-84 near Yedvani village. In this section SH-85 and SH-84 is having a common section for a length of about 2.40 km. Improvement of SH-84 is under execution, hence improvement of SH-85 from Km 90+900 to Km 93+300 has not been considered under KSHIP-III. Further project road traverse westwards through Mandya District and connects NH-150A near Nagamangala.

15. **Nagamangala Junction to Krishnarajpet (K. R. Pet):** The SH-85 connects NH-150A near Nagamangala at Km 115. In Nagamangala, the project road is having common section with NH 150A for a length of about 1.30 Km as such this section of road is not considered under improvement for SH-85. The SH-85 take off from NH-150A near Mallenaalli Circle (Km 58+200 of NH 150A) and traverses Westward. SH-47 connects near Tiruganahalli with staggered junction at Km 134 and Km 137. Further the project road traverses towards southwest and crosses SH-7 near K. P. Pet at Km 154. Project road when passing through K. R. Pet town is having 3 right angle turns with heavily built up area and congested due to local traffic. There is a short length about 2.4 km having 4 lane divided carriageway within the city area.

Junction of SH 85 with NH 150 A in Nagamangala Town

Project Road passing through Krishnarajapete Town

16. **K. R. Pet to Ramanathpura:** After crossing SH-7 in K. R. Pet, alignment passes through Hosaholalu settlement which is congested with structures very close to carriageway and the building to building distance as 10 to 12 m. Further the project road traverses towards southwest and crosses Hemavati River at Km 165. Then the project road crosses South Western Railways line at km 172 with a level crossing and enters in Mysore District. Then SH-85 crosses SH-57 near Bherya at Km 175. The project passes through the congested built up area of Bherya town and the available building to building distance is about 10 m. Then the alignment further traverses towards west and has junction with SH-108 / SH-120 near Saligram town. Further the alignment enters in Hassan District and SH-102 and SH-86 connects the project road near Keralapura on the bank of Kaveri River at km 195+800 and Km 196+400. Then the project road moves towards Westside along River Kaveri and crosses SH-21 near Ramanathpura at Km 208.

Junction of Project road in Bherya with SH 57

Bus Stand in Saligrama Settlement

17. **Ramanathpura to Somwarpet (Km 226+800):** After crossing Ramanathpura town area the project road, runs along River Kaveri for a length of about 5 Km little beyond Kananur settlement. SH-91 takes up from SH-85 near village Sidhapura at km 217. Further the project road moves westward and reaches the boundary of Nitha forest range near village Bettalagalle. The improvement proposal for the project road is proposed to be terminated at the boundary with Nitha forest.

Project Road passing through Kannanur Settlement

Project road badly damaged without pavement surface near Project Termination Point

18. **Other Features:** There are many substandard horizontal as well as vertical curves. As part of improvement proposal 29 major road and 268 minor village road / ODR crossings have been identified to be improved for better cross movement of traffic at these junction locations. The alignment includes 39 bridge structures over exiting stream crossings. The section of project road includes 427 Nos. of Culvert structures.

19. **Carriageway:** Majority section of the project is of single to intermediate lane i.e. carriageway width varies from 3.75 m to 5.5 m. However in small stretches the existing road is 4 lane divided carriage when passing through built up area. The summary of lane configuration of the existing road is given in **Table-3** below:

Table 3 Summary of Existing Lane Configuration

Sl. No.	Lane Configuration	Length (Km)
1	Single lane	48.815
2	Intermediate Lane	93.335
3	2 lane	22.430
4	2 Lane with Paved Shoulder	1.200
5	4 lane (2x5.5m/2x7.0m)	3.715
	Total Length	**169.495**

20. **Terrain:** The project road traverses through both plain and rolling terrain.

21. **Road Intersections:** There are 29 major roads and 268 minor village road / ODR crossings. All the junctions have been proposed for improvement.

22. **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 20 mm to 380 mm and the Granular Base/sub base layer varies from 50 to 460mm.

23. **Existing Bridges & Culverts:** There are 34 minor bridges, 4 causeways, 1 major bridge and 427 culverts (2 Box Culverts, 199 Slab Culverts, 222 Pipe Culverts, 1 BS Slab/Arch Culverts, 2 Box / Pipe Culverts and 1 Slab / Pipe Culverts) along the project road. One minor bridge is under construction by state PWD.

Table 4 Location of Major Bridges along the Project Road

Sl. No.	Existing Ch. Km	Type of Structure		Overall Length (m)	Span arrangement (m)	Overall Width (m)
		Sub-structure	Super Structure			
1	164+830	Stone Masonry Arch (in Lime Mortar)		222.620	21 x 10.6	1 x 6.90

Table 5 Location of Minor Bridges along the Project Road

Sl. No.	Existing Chainage (Km)	Type of Structure		Overall length (m)	Span Arrangement (m)	Overall Width (m)
		Super Structure	Sub structure			
1	57+401	RCC Solid Slab	RCC Wall type with open footing	9.22	1 x 9.20	8.15

Sl. No.	Existing Chainage (Km)	Type of Structure		Overall length (m)	Span Arrangement (m)	Overall Width (m)
		Super Structure	Sub structure			
2	72+330	RCC Girder and Slab	RCC Column type with open footing	20.020	2 x 10.0	8.90
3	73+220	RCC Girder and Slab	RCC Wall type with open footing	10.020	1 X 10.0	8.70
4	83+283	RCC Solid Slab	RCC Wall type with open footing	43.020	4 X 10.75	11.40
5	86+880	RCC Solid Slab	RCC Wall type with open footing	33.520	5 X 6.70	8.00
6	98+280	RCC Solid Slab	SM Wall type with open footing	18.620	6 X 3.10	7.30
7	112+266	RCC Solid Slab	RCC Wall type with open footing	12.820	2 x 6.40	12.00
8	123+527	RCC Solid Slab	SM Wall type with open footing	8.40	4 x 2.1	13.00
9	127+088	RCC Solid Slab	RCC Wall type with open footing	48.00	5 x 9.60	8.50
10	140+363	RCC Solid Slab	SM Wall type with open footing	6.720	1 x 6.70	8.80
11	142+846	RCC Solid Slab	RCC Wall type with open footing	43.22	4 x 10.80	8.50
12	144+119	Stone Masonry Arch		8.62	1 x 8.60	8.50
13	146+305	RCC Solid Slab	RCC Wall type with open footing	12.62	3 x 4.20	8.50
14	148+310	RCC Solid Slab	SM Wall type with open footing	9.020	1 x 9.00	8.50
15	151+900	RCC Solid Slab	RCC Wall type with open footing	53.52	5 x 10.70	8.50
16	155+470	RCC Solid Slab	RCC Wall type with open footing	48.020	4 x 12.00	16.30
17	163+415	RCC Solid Slab	RCC Wall type with open footing	6.62	1 x 6.60	10.95
18	164+375	RCC Solid Slab	RCC Wall type with open footing	7.82	1 x 7.80	11.00
19	167+059	RCC Solid Slab	RCC Wall type with open footing	12.020	2 x 6.00	8.60
20	173+990	RCC Solid Slab	RCC Wall type with open footing	8.40	1 x 8.40	11.70
21	174+535	Stone Slab	SM Wall type with open footing	25.62	2x3.80 + 6x3.0	8.50
22	179+037	RCC Solid Slab	RCC Wall type with open footing	9.42	2 x 4.70	8.30
23	184+779	RCC Solid Slab	RCC Wall type with open footing	22.02	2 x 11.0	8.80
24	193+007	RCC Solid Slab	SM Wall type with open footing	6.72	1 x 6.70	8.40
25	195+065	RCC Solid Slab	RCC Wall type with open footing	28.22	3 x 9.40	12.20
26	196+542	RCC Solid Slab	RCC Wall type with open footing	9.421	1 x 9.40	11.90
27	198+900	RCC Solid Slab	RCC Wall type with open footing	12.020	4 x 3.00	6.50

Sl. No.	Existing Chainage (Km)	Type of Structure		Overall length (m)	Span Arrangement (m)	Overall Width (m)
		Super Structure	Sub structure			
28	203+048	RCC Solid Slab	RCC Wall type with open footing	12.928	1 x 12.90	12.50
29	203+469	Stone Slab	SM Wall type with open footing	7.82	3 x 2.60	7.75
30	206+197	RCC Solid Slab	RCC Wall type with open footing	8.22	1 x 8.20	11.70
31	207+286	RCC Solid Slab	RCC Wall type with open footing	8.52	1 x 8.50	12.30
32	209+765	RCC Solid Slab	SM Wall type with open footing	14.020	2 x 7.00	7.55
33	212+802	RCC Solid Slab	RCC Wall type with open footing	28.220	3 x 9.40	12.00
34	221+336	RCC Girder and Slab	RCC Wall type with open footing	16.220	1 x 16.200	5.90

Table 6 Location of Causeways along the Project Road

Sl. No.	Existing Chainage (Km)	Remarks
1	57+146	10 Pipes of 1.2m Dia.
2	71+180	12 Pipes of 2.0m Dia.
3	80+980	10 Pipes of 1.2m Dia.
4	88+480	12 Pipes of 2.4m Dia.

24. **Railway level Crossing:** There is one existing railway level crossing (single track) at Ch. Km 169+000.

C. Traffic Study

25. During the pre-feasibility study, traffic surveys were conducted by iDeCK in 2014. As per the iDeCK Traffic Report, the entire SH 85 from Bengaluru to Somwarpet was divided into five sections. Apart from the data validation, ICT has conducted Manual Classified Counts (MCC) on two more locations on the project road and one on NH-75 (competing road) to assess the divertible traffic.

1. Composition of Traffic

26. The composition of traffic was worked out from the traffic volume count data. Along the project road, the share of passenger traffic varies from 72.9 % to 87.4%, whereas goods traffic varies from 9.8 % to 24.2 %. The share of trucks is varying from 1.0% to 10.6% of total traffic. The share of car and taxi varies from 5.2% to 34.5% of total traffic along the project road. It is also observed that the share of non-motorized traffic consists of mainly bicycles and varies from 0.1% to 14.3% along the project road.

27. **Hourly Variation of Traffic:** Peak hour traffic for all the locations on SH-85 is found to be between 7.3% and 11.0% of the ADT, which is normal for intercity and rural roads. Similarly, peak hour traffic data is found to be varying from 9% to 11% of the ADT by iDeCK study. OnNH-75, peak hour proportion is 6.5%.

2. Identification of Homogeneous Sections

28. As per the iDeCK Traffic Report 2014, the project road CEW 28 (SH-85) from Bengaluru to Somwarpet has been divided into five sections. In the current study for Bengaluru to Somwarpet, the project road from Km 15+200 to Km 226+800 (existing), has been divided into six homogeneous sections on the basis of the observed traffic flows. Bengaluru to Magadi comprise Homogenous section I & II and **Magadi to Somwarpet** (from existing Km 51+815 to Km 226+115) comprise Homogenous section III, IV, V & VI. For the purpose of this Report (Magadi to Somwarpet) four homogeneous sections have been discussed (**Table-7**).

Table 7 Homogeneous Sections of Traffic on Project Highway by ICT

Section No.	Sections	Existing Chainage (km)		Design Chainage (km)		Distance (Km)	Traffic Volume AADT (PCU)
		Start	End	Start	End		
HS-III	Magadi to Nagamangala	51+815	114+500	51+000	113+370	62.37	1,176
HS-IV	Nagamangala to K.R.Pet	114+500	151+800	113+370	150+250	36.88	2,440
HS-V	K.R Pet to Ramanathpura	151+800	206+400	150+250	204+780	53.195*	3,993
HS-VI	Ramanathpura to Somwarpet (excluding forest area)	206+400	226+800	204+780	221+833	17.05	1,253

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

3. Annual Average Daily Traffic (AADT)

29. 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 pattern of traffic volume on various sections of the project road over different months or seasons of the year.

30. In this study, the seasonality factor has been derived from the monthly variation of petrol and diesel sale data collected from seven fuel stations along the stretch of SH-85 and one fuel station on surrounding network (NH-75). This data was collected during both iDeCK and ICT study and all the collected data have been utilised to find the seasonal variation for the various survey locations on the project road. The diesel sale data has been used to find the seasonality factor for the freight vehicles, whereas the petrol sale data has been used to calculate seasonality factor for passenger vehicles based on the fuel used by the vehicles in the two categories. The seasonality factors thus obtained are used to convert Average Daily Traffic (ADT) to Annual Average Daily Traffic (AADT) for various survey locations of the project road. Section-wise AADT thus obtained is shown in **Table-8**, which gives the mode-wise AADT for all the survey locations.

Table 8 Annual Average Daily Traffic at Various Surveyed Location

Location	Description	Survey conducted by	Total Traffic	
			Vehicles	PCUs
MCC-01	Km 99+000	iDeCK'2015	1,200	1,092
MCC-02	Km 128+000	ICT 2015	3,057	2,440
	Km 128+000	iDeCK'2015	1,933	1,654
MCC-03	Km 206+000	ICT 2015	4,594	3,993

	Km 174+500	iDeCK'2015	3,182	2,453
MCC-04	Km 215+700	iDeCK'2015	1,586	1,159
MCC-05	Km 54+000	ICT 2015	14,079	20,760

Source: Survey conducted by iDeCK & ICT

4. Turning Movement Survey

31. The total Turning Movement surveys were carried out at 13 locations both by iDeCK and ICT. It is observed that, the total approach volumes during peak hour, varies from 89 PCUs (Yedavani Junction) to 1770 PCUs (Nagamangala Junction) which is about 7 to 9% of the traffic.

5. Axle Load Survey

32. The axle load survey has been carried out to work out the Vehicle Damage Factor (VDF) and the axle load spectrum for design of pavement. Based on the survey the VDF for 2-axle trucks has been computed in the range 1.11-9.02 while the VDF for 3-axle truck lies in the range 0.23 - 6.20. The VDF for multi- axle vehicle has been calculated to be in the range 0.26-7.99. The results indicate low VDF values in down direction (i.e. towards Bengaluru).

6. Traffic Forecast

33. 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 likely induced and generated traffic has been added to arrive at the future traffic for each of the homogeneous sections. The projected traffic for each of the homogeneous sections is presented in **Table-9**. Based on the observations and turning movement the project road (SH-85) from Magadi to Somwarpete has been divided four homogeneous section. Homogenous Sections III, IV, V and VI would be required to be widened to two-lane with paved shoulder configuration from the year 2015.

Table 9: Projected Annual Average Daily Traffic

Vehicle Type	Year								
	2015	**2019**	**2020**	**2022**	**2025**	**2030**	**2035**	**2040**	**2050**
Homogenous Section III-Magadi to Nagamangala [km 51+815 to Km 114+500 (existing) / Km 51+000 to km 113+370 (Design)]									
Car	104	140	796	1390	1772	2574	3631	4877	7795
Total Jeep/ Van	0	0	0	0	0	0	0	0	0
Mini Bus	5	5	11	15	17	22	27	32	42
Bus	45	55	256	424	500	638	811	1011	1536
Tempo LGV - Freight (3,4 Axle)	116	147	282	410	494	641	828	1052	1644
Tempo LGV - Freight (6 Axle)	0	0	0	0	0	0	0	0	0
2 Axle Truck	32	36	67	93	107	135	170	212	324
3Axle Truck	3	3	11	17	20	25	30	35	46
MAV	1	1	3	3	3	3	3	3	3
Three Wheeler	102	134	149	178	221	310	424	567	1015
Two Wheeler	782	1079	1222	1502	1961	2763	3697	4832	7872
Tractor	5	5	5	5	5	5	5	5	5
Tractor With Trailer	16	20	21	23	25	30	35	40	50
Cycle	28	29	29	29	29	29	29	29	29
Cycle Ricks	1	1	1	1	1	1	1	1	1
Hand Cart	0	0	0	0	0	0	0	0	0

Vehicle Type	Year								
	2015	**2019**	**2020**	**2022**	**2025**	**2030**	**2035**	**2040**	**2050**
Animal Drawn	9	9	9	9	9	9	9	9	9
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	**1176**	**1497**	**3182**	**4756**	**5826**	**7882**	**10469**	**13533**	**21311**
Total Vehicles	**1250**	**1665**	**2862**	**4100**	**5165**	**7186**	**9701**	**12706**	**20372**
Homogenous Section IV-Nagamangala to K.R. Pet [km 114+500 to km 151+800 (existing) / Km 113+370 to km 150+250 (Design)]									
Car	187	253	595	918	1172	1708	2416	3261	5246
Total Jeep/ Van	56	70	131	187	224	290	366	452	664
Mini Bus	11	15	19	23	27	32	39	49	70
Bus	47	54	155	239	281	355	445	553	830
Tempo LGV - Freight (3,4 Axle)	167	210	284	362	436	562	713	890	1337
Tempo LGV - Freight (6 Axle)	33	39	41	45	52	65	81	100	147
2 Axle Truck	40	47	63	80	91	112	139	170	246
3Axle Truck	10	10	14	18	21	26	31	36	51
MAV	2	1	2	3	3	3	3	3	3
Three Wheeler	211	277	299	349	433	607	832	1113	1993
Two Wheeler	2153	2973	3259	3921	5121	7216	9657	12621	20559
Tractor	40	44	45	47	49	54	59	64	74
Tractor With Trailer	32	36	37	39	41	46	51	56	66
Cycle	66	69	70	72	74	79	84	89	99
Cycle Ricks	0	0	0	0	0	0	0	0	0
Hand Cart	0	0	0	0	0	0	0	0	0
Animal Drawn	1	1	1	1	1	1	1	1	1
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	**2440**	**3148**	**4215**	**5439**	**6735**	**9126**	**12039**	**15535**	**24593**
Total Vehicles	**3057**	**4100**	**5016**	**6305**	**8027**	**11157**	**14918**	**19459**	**31387**
Homogenous Section V - K.R Pet to Ramanathpura [Km 151+800 to km 206+400 (existing) / Km 150+250 to km 204+780 (Design)]									
Car	480	664	727	868	1122	1643	2302	3128	5413
Total Jeep/ Van	65	84	91	104	124	162	203	249	368
Mini Bus	57	65	69	80	97	128	162	197	265
Bus	122	149	159	180	215	279	353	430	595
Tempo LGV - Freight (3,4 Axle)	339	439	474	548	674	926	1239	1614	2645
Tempo LGV - Freight (6 Axle)	47	55	58	64	79	106	141	183	298
2 Axle Truck	117	147	155	174	207	275	370	481	791
3Axle Truck	36	45	47	51	60	77	100	128	209
MAV	8	7	7	7	7	7	7	7	7
Three Wheeler	129	169	183	214	266	373	510	682	1222
Two Wheeler	3128	4319	4734	5696	7438	10482	14028	18335	29867
Tractor	13	13	13	13	13	13	13	13	13
Tractor With Trailer	25	29	30	32	34	39	44	49	59
Cycle	26	26	26	26	26	26	26	26	26
Cycle Ricks	0	0	0	0	0	0	0	0	0
Hand Cart	0	0	0	0	0	0	0	0	0
Animal Drawn	2	2	2	2	2	2	2	2	2
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	**3993**	**5228**	**5650**	**6606**	**8301**	**11464**	**15298**	**19907**	**32323**
Total Vehicles	**4594**	**6214**	**6775**	**8061**	**10365**	**14539**	**19501**	**25525**	**41781**
Homogenous Section VI-Ramanathpura to Somwarpet									

Vehicle Type	Year								
	2015	2019	2020	2022	2025	2030	2035	2040	2050
[Km 206+400 to Km 226+800 (existing) / Km 204+780 to km 221+833 (Design)]									
Car	115	156	170	200	254	359	484	628	993
Total Jeep/ Van	0	0	0	0	0	0	0	0	0
Mini Bus	5	6	6	6	6	6	6	6	6
Bus	17	21	22	24	27	32	37	42	60
Tempo LGV - Freight (3,4 Axle)	117	147	158	180	219	295	381	469	692
Tempo LGV - Freight (6 Axle)	0	0	0	0	0	0	0	0	0
2 Axle Truck	15	18	19	21	24	29	34	39	57
3Axle Truck	1	1	1	1	1	1	1	1	1
MAV	1	1	1	1	1	1	1	1	1
Three Wheeler	103	126	137	159	198	278	380	509	912
Two Wheeler	1169	1488	1631	1963	2564	3614	4837	6322	10298
Tractor	2	2	2	2	2	2	2	2	2
Tractor With Trailer	24	27	28	30	32	37	42	47	57
Cycle	83	87	88	90	92	97	102	107	117
Cycle Ricks	0	0	0	0	0	0	0	0	0
Hand Cart	0	0	0	0	0	0	0	0	0
Animal Drawn	2	2	2	2	2	2	2	2	2
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	**1253**	**1561**	**1685**	**1960**	**2438**	**3317**	**4340**	**5542**	**8791**
Total Vehicles	**1654**	**2083**	**2265**	**2681**	**3423**	**4754**	**6310**	**8176**	**13199**

34. ***Capacity and Level of Service analysis (ICT Study):*** The following guidelines, which recommend 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-10**.

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 2 lane given in IRC code, it should be provided with granular or paved shoulder. Considering the above guidelines, the widening proposal for the project road sections of SH-85 has been formulated, and is given in **Table-11.** Homogenous Sections III, IV, V and VI would be required to be widened to two-lane with paved shoulder configuration from the year 2015.

Table 10 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		

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'
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.					

Table 11 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-III	51+815	114+500	Plain	2015	2034	2046	-
2	HS-IV	114+500	151+800	Plain	2015	2031	2042	-
3	HS-V	151+800	206+400	Plain	2015	2027	2037	-
4	HS-VI	206+400	226+800	Rolling	2015	2050	-	-

D. Improvement Proposal

1. Corridor of Impact

37. 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.

38. 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 32 m** in rural / open country areas. However, at one ROB location COI is **45m**.

2. Widening Scheme

39. Based on the traffic projection, the project road from Magadi to Somwarpet (design chainage **Km 51+000 to Km 221+833**) is proposed to be improved to 2 lane with Paved Shoulder standard except some urban sections. In selected urban sections, 4 lane divided carriageway has been considered. The lane configurations recommended for the project road is given in **Table-12.** Considering the need to minimize land acquisition, concentric widening of existing carriageway is adopted for majority of the section. The summary of widening is given in **Table-13.**

40. Length of the existing road is 169.495 km. After the proposed improvement (realignment, curve improvement), **length of the project road will be 165.47 km.**

Table 12 Recommended Lane Configuration

Sl. No.	Lane configuration	Length (km)
41. 1.	2 lane with Paved Shoulder	128.78
2.	2 lane with Paved Shoulder + Footpath	21.98
3.	2 lane with Paved Shoulder ROB approaches	1.16
4.	2 Lane with slip road	0.72
5.	2 lane with Paved Shoulder +Climbing Lane	1.13
6.	4 lane with Paved Shoulder	11.7
	Total Length (Km)	**165.47**

Table 13 Summary of Widening

Widening length in Km		Bypass/ Realignment (Km)	Curve Improvement (Km) Concentric
Concentric	Eccentric		
85.474	25.460	27.652	26.892

3. Typical Cross Sections

42. 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**. In addition to 2 lane with paved shoulder standard typical cross section, in small stretches having built up section, 4 lane divided carriageway with New Jersey type crash barrier and both side footpath has been proposed. Proposed Cross-sections have been customized to suit field conditions and minimize R&R impact and Land Acquisition. The cross-sections were developed within minimum Corridor of Impact (COI) of **16 m to 32 m**, without compromising on safety and capacity augmentation requirement of the project road.

43. 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	:	2 lane with Paved Shoulder Concentric Widening (Open Country)
TCS-1A	:	2 lane with Paved Shoulder Concentric Widening (Open Country), Embankment Height > 3 m
TCS-2	:	2 lane with Paved Shoulder Realignment / New Construction / Bypass (Open Country)
TCS-2a	:	2 lane with Paved Shoulder Realignment / New Construction / Bypass (Open Country) Embankment Height > 3 m
TCS-3	:	4 lane Divided Carriageway Concentric Widening (Urban Section)
TCS-4	:	2 lane with Paved Shoulder Concentric Widening (Urban Section)
TCS-5	:	2 lane with Paved Shoulder (Cut Section)
TCS-6	:	2 lane with Paved Shoulder (Half Cut Section)
TCS-7	:	Approaches to ROB with Slip Road (Open Country)
TCS-8	:	Approaches to ROB with Slip Road (Open Country)
TCS-9	:	Approaches to ROB without Slip Road (Open Country)
TCS-10	:	2 lane with Paved Shoulder Climbing Lane – Left (Open Country)
TCS-11	:	2 lane with Paved Shoulder Climbing Lane – Right (Open Country)
TCS-12	:	2 lane with Paved Shoulder with both side Slip Road (Cut Section)

TCS-13	:	4 lane Divided Carriageway with Retaining Wall on Right Side (Urban Section)

4. Bypasses and Realignments

44. The project road traverses through five districts of Karnataka. There are several highway crossings and mainly major urban development observed near the crossing locations. Due to congested market area and non-availability of adequate land width along existing road, development of the project road will involve demolition of structures. The existing road is also having substandard geometry which does not satisfy the codal provisions. Hence to provide safety and to reduce R&R impact, bypass and realignment have been explored. The details are presented in **Table-15**.

Table 15 Proposed Bypass of SH-85

Sl. No.	Name of Town / Village	Existing Chainage		Design Chainage		
		Start	End	Start	End	Length (km)
1	Krishna Raj Pete Bypass	149+690	158+515	146+080	155+300	9.220

45. Further small realignments have been provided to improve the horizontal alignment where sharp curves, S curves exist along the existing road. Majority of the following locations are of curve improvement of series of substandard curves. The details of the proposed major realignment are as given in **Table-16**.

Table 16 Proposed Realignment of SH-85

Sl. No.	Name of Town/Village	Chainage along existing alignment (km)			Chainage along Bypass / Realignment (km)		
		Start	End	Length	Start	End	Length
1.	Huliyurudurga	73+456	76+780	3.324	72+000	74+500	2.500
2.	Kenkeri	83+852	85+500	1.648	81+500	82+900	1.400
3.	Yadavani	90+306	90+928	0.622	87+700	88+100	0.400
4.	Devalapura	100+043	100+764	0.721	97+100	97+780	0.680
5.	Nagamangal rural	112+858	114+111	1.253	109+800	111+200	1.400
6.	Kunnakatte Mallenahalli	117+219	118+278	1.059	114+200	115+200	1.000
7.	Ayithanahalli	128+550	129+540	0.99	125+400	126+300	0.900
8.	Tiraganahalli	134+145	136+006	1.861	130+900	132+550	1.650
9.	Bommadihalli	137+971	138+900	0.929	134+508	135+400	0.892
10.	Komenahalli	158+700	159+788	1.088	155+100	156+100	1.000
11.	Lakshmipura	165+100	166+078	0.978	161+400	162+350	0.950
12.	Singanahalli-ROB approach	170+910	172+000	1.09	167+000	169+100	2.100
13.	Bherya Realignment	173+875	176+330	2.455	170+075	172+575	2.500
14.	Kurubara Abburu	221+600	222+688	1.088	217+550	218+610	1.060
Total Length (Km)				**19.106**			**18.432**

5. Improvement of the Existing Road Geometrics

46. In the following sections, 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:

Table 17 Location of Geometric Improvement

Sl. No.	Design Chainage		Length (Km)	Remarks
	From (Km)	To (Km)		
1	51+000	51+240	0.240	Geometric Improvement
2	52+390	52+595	0.205	Geometric Improvement
3	54+430	54+940	0.510	Geometric Improvement
4	55+100	55+430	0.330	Geometric Improvement
5	58+400	58+900	0.500	Geometric Improvement
6	59+000	60+000	1.000	Geometric Improvement
7	60+600	61+455	0.855	Geometric Improvement
8	62+045	62+635	0.590	Geometric Improvement
9	63+170	63+330	0.160	Geometric Improvement
10	63+700	64+540	0.840	Geometric Improvement
11	64+900	65+700	0.800	Geometric Improvement
12	70+200	70+825	0.625	Geometric Improvement
13	71+025	71+300	0.275	Geometric Improvement
14	71+500	71+700	0.200	Geometric Improvement
15	74+700	75+100	0.400	Geometric Improvement
16	78+595	78+930	0.335	Geometric Improvement
17	80+030	80+400	0.370	Geometric Improvement
18	80+700	81+000	0.300	Geometric Improvement
19	84+470	84+700	0.230	Geometric Improvement
20	85+900	86+600	0.700	Geometric Improvement
21	90+600	90+800	0.200	Geometric Improvement
22	91+000	91+200	0.200	Geometric Improvement
23	91+400	92+045	0.645	Geometric Improvement
24	94+100	94+520	0.420	Geometric Improvement
25	94+780	95+000	0.220	Geometric Improvement
26	95+200	95+520	0.320	Geometric Improvement
27	96+395	96+650	0.255	Geometric Improvement
28	98+900	99+330	0.430	Geometric Improvement
29	99+830	100+120	0.290	Geometric Improvement
30	100+330	100+700	0.370	Geometric Improvement
31	101+220	102+000	0.780	Geometric Improvement
32	103+180	103+600	0.420	Geometric Improvement
33	104+430	104+720	0.290	Geometric Improvement
34	107+000	107+300	0.300	Geometric Improvement
35	120+460	120+600	0.140	Geometric Improvement
36	121+205	121+620	0.415	Geometric Improvement
37	121+900	122+500	0.600	Geometric Improvement
38	122+950	123+220	0.270	Geometric Improvement
39	123+400	123+900	0.500	Geometric Improvement
40	132+800	132+900	0.100	Geometric Improvement
41	133+700	133+950	0.250	Geometric Improvement
42	134+150	134+400	0.250	Geometric Improvement
43	135+600	135+900	0.300	Geometric Improvement
44	136+700	137+000	0.300	Geometric Improvement
45	137+310	137+400	0.090	Geometric Improvement
46	137+700	138+060	0.360	Geometric Improvement
47	139+050	139+630	0.580	Geometric Improvement
48	142+690	142+980	0.290	Geometric Improvement

Sl. No.	Design Chainage		Length (Km)	Remarks
	From (Km)	To (Km)		
49	159+150	159+300	0.150	Geometric Improvement
50	162+800	163+000	0.200	Geometric Improvement
51	165+275	166+020	0.745	Geometric Improvement
52	166+200	166+500	0.300	Geometric Improvement
53	173+490	174+290	0.800	Geometric Improvement
54	175+900	176+030	0.130	Geometric Improvement
55	181+100	181+500	0.400	Geometric Improvement
56	184+313	184+660	0.347	Geometric Improvement
57	185+240	185+670	0.430	Geometric Improvement
58	185+920	186+370	0.450	Geometric Improvement
59	189+720	190+250	0.530	Geometric Improvement
60	190+860	191+020	0.160	Geometric Improvement
61	192+350	192+600	0.250	Geometric Improvement
62	194+150	194+520	0.370	Geometric Improvement
63	198+290	198+770	0.480	Geometric Improvement
64	203+400	203+550	0.150	Geometric Improvement
65	203+700	204+000	0.300	Geometric Improvement
66	211+320	211+770	0.450	Geometric Improvement
67	216+720	217+220	0.500	Geometric Improvement
68	219+900	220+300	0.400	Geometric Improvement
69	221+600	221+900	0.300	Geometric Improvement
Total Length (Km)			**26.892**	

6. Pavement Design

47. **Design of New Flexible Pavements:** Pavement for new construction in widening, bypass / realignment and reconstruction portion is designed based on subgrade strength, material characteristics and design traffic. Flexible pavement is designed for design life of 15 years as well as 20 years for project road section. 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

48. Pavement Composition of new construction for 15 years and 20 years design life is same as for both, minimum traffic of 20 msa is considered.

Table 18 Pavement Design for New / Widening Section

HS	Design Chainage		Design Period	Design Subgrade CBR (%)	Design Traffic (MSA)	Pavement Composition (mm)								Recommended Option
						Option 1 (Conventional)				Option 2 (RAP)				
	From Km	To Km				BC	DBM	WMM	GSB	BC	DBM	RAP	CTSB	
HS- III	51+000	113+370	2019-38	15	20	40	60	250	200	40	-	80	200	Option 2

HS-IV	113+370	150+250	2019-38	15	20	40	60	250	200	40	-	80	200	Option 2
HS-V	150+250	190.0	2019-38	15	20	40	60	250	200	40	-	80	200	Option 2
	190.0	204+780	2019-38	12	20	40	70	250	200	40	-	90	200	Option 2
HS-VI	204+780	221+833	2019-38	12	20	40	70	250	200	40	-	90	200	Option 2

49. **Rehabilitation Design of Flexible Pavements:** Rehabilitation (partial /full depth reconstruction and overlay) of pavement of project road are designed by consultant based on the following:

- Existing pavement condition
- Existing subgrade characteristics
- Deflection Survey
- Change in vertical alignment (raising of embankment)
- Economic lead of borrow soil and other construction material and
- Use of alternate material such as RAP, cement treated sub base

50. Various options are taken into consideration for rehabilitation design of flexible pavement which includes partial / full depth reconstruction and overlay design. Best alternative for pavement composition is selected based on availability of material, economic design and engineering judgment.

51. The field investigation of pavement composition and testing of existing pavement materials shows that granular layer thickness is inadequate at most of the places and GSB / WMM material contains more finer materials as specified in standards, hence in partial reconstruction after milling / scarifying existing bituminous layer, existing granular layer will be loosen, spread over proposed area and re-compacted. This will be treated as subgrade of design CBR. The Summary of Rehabilitation (partial / full depth reconstruction and overlay) of the project road is presented in **Table-19**. Pavement Composition for Rehabilitation for 15 years and 20 years design life will remain same as minimum traffic of 20 MSA is considered for both the years.

Table 19 Pavement Design for Rehabilitation (15 & 20 Years Design Life)

Homogenous Sections	Pavement Condition	Existing Pavement Composition Avg.		Existing Subgrade CBR at 97 % MDD	Borrow Soil CBR of Subgrade (%)	Design Traffic (MSA)	Rehabilitation (Reconstruction/Overlay) (mm)							Recommended Rehabilitation Option	
							Option 1				Option 2				
		Bituminous Layer	Granular Layer				BC	DBM	WMM	GSB	BC	DBM	RAP	CTSB	
HS- III	Fair	80	145	6.0-27.0	15	20	40	60	250	-	40	-	80	200	Option 2
	Good	180	245	9.0-26.0	15	20	40	60	250	100	40	-	80	200	Option 2
	Fair	190	275	17.0-19.0	15	20	40	60	250	-	40	-	80	200	Option 2
HS-IV	Fair	75	190	9.0-21.0	15	20	40	60	250	-	40	-	80	200	Option 2
HS-V	Fair	90	170	10.0-21.0	15	20	40	60	250	-	40	-	80	200	Option 2
	Fair	75	145	10.0-24.0	12	20	40	70	250	-	40	-	90	200	Option 2
HS-VI	Poor	75	165	10.0-24.0	12	20	40	70	250	-	40	-	90	200	Option 2

52. For **Option 1** Reconstruction starts from WMM onwards after milling / scarifying existing granular layer and **for option 2** existing bituminous layer is scarified and reconstruction start from CTSB, treating existing granular layer as Subgrade.

7. Bridges

53. Based on the present condition of existing bridges as assessed, from inventorisation and visual inspection, the feasibility of their retention after carrying out repair or complete replacement due to proposed realignment of road or hydraulic /structural inadequacies were studied in detail. Only **7 nos.** existing minor bridge are proposed to be retained after carrying out repair and rehabilitation measures and **14 nos.** existing bridges are proposed to be retained after widening and repair / rehabilitation. At **4 nos.** existing locations where there are Vented Causeways, new 2 lane bridges are proposed. Remaining **12 nos.** existing structures are also proposed to be replaced due to inadequate waterway, old stone slab bridges in poor condition or due to change in vertical profile / relocation and geometrics. Further **3 nos.** new bridges are proposed to be provided on K. R. Pet Bypass. Thus total number of new bridges will be 19 nos. Besides the above, 1 no. new bridge is already under construction. Improvement proposal of the bridges are summarized in **Table-20**.

Table 20 Summary of Bridge Improvement Proposal

S. No.	Particulars	No.
1.	Existing Minor bridges Proposed to be Widened with Repair (Table 2-17)	14
2.	Existing Minor bridges to be retain with repair (Table 2-18)	6
3.	New bridges under construction by PWD (Table 2-18)	1
4.	New Major Bridge in place of existing bridge (Table 2-19)	1
5.	New Minor Bridge in place of existing bridge (Table 2-19)	15
6.	New Minor Bridge on proposed K. R. Pet bypass (Table 2-19)	3
	Total	**40**

54. Details of existing minor bridges proposed to be retained after widening / repair and rehabilitation are given in **Table-21** below.

Table 21 Existing Minor bridges Proposed to be Widened with Repair

S. No.	Existing Ch. Km	Design Ch. Km.	Span Arrangement (m)	Total length (m)	Existing Deck Width (m)	Proposed Widening (m)	Total Deck Width (m)
1.	57+401	56+375	1 x 9.2	9.220	8.15	7.85	16.0
2.	86+880	84+230	5 x 6.7	33.520	8.00	8.00	16.0
3.	127+088	123+942	5 x 9.6	48.000	8.50	7.50	16.0
4.	142+846	139+317	4 10.80	43.220	8.50	7.50	16.0
5.	148+310	144+777	1 x 9	9.020	8.50	7.50	16.0
6.	163+415	159+722	1 x 6.6	6.620	10.95	5.05	16.0
7.	167+059	163+327	2 x 6	12.020	8.60	7.40	16.0
8.	193+007	189+122	1 x 6.7	6.720	8.40	7.60	16.0
9.	195+065	191+175	3 x 9.4	28.220	12.20	3.80	16.0
10.	196+542	192+637	1 x 9.4	9.420	11.90	4.10	16.0
11.	203+048	199+077	1 x 12.9	12.928	12.50	3.50	16.0
12.	206+197	203+207	1 x 8.2	8.220	11.70	4.30	16.0
13.	207+286	204+295	1 x 8.5	8.520	12.30	3.70	16.0
14.	212+802	209+807	3 x 9.4	28.220	12.00	4.00	16.0

55. Details of Major / Minor Bridges proposed to be retained after repairs are given in **Table-22** below.

Table 22 Details of Bridges Proposed to be Retained after Repairs

S. No.	Existing Ch. Km	Design Ch. Km.	Span Arrangement (m)	Total Length (m)	Overall deck Width (m)	Remarks
1.	72+330	70+950	2 x 10	20.020	8.90	Existing bridge with RCC T beam type superstructure
2.	73+220	71+780	1 x 10	10.020	8.70	Existing bridge with RCC T beam type superstructure
3.	83+283	81+050	4 x 10.75	43.020	11.40	Existing bridge with cantilever span at end
4.	112+266	109+207	2 x 6.4	12.82	12	New 2 lane bridge is **under construction** by PWD
5.	144+119	140+590	1 x 8.6	8.62	9.5	Stone arch superstructure
6.	179+037	175+237	2 x 4.7	9.42	8.30	Existing bridge with cantilever type pier cap
7.	184+779	180+953	2 x 11	22.02	8.80	Existing bridge with cantilever type pier cap

56. 19 nos. new 2 lane bridges are proposed as shown in **Table 23** below.

Table 23 New 2 lane Major & Minor Bridges on proposed alignment

S. No.	Existing Ch. Km	Design Ch. Km.	Span Arrangement (m)	Total Length (m)	Overall deck Width (m)	Remarks
Major Bridge						
1.	164+830	161+130	9 x 25.84	232.6	16.00	Replaced due to Inadequate deck width and lime stone arch superstructure
Minor Bridge						
2.	57+146	56+120	2 x 8 x 3.7	17.40	16.00	New 2 lane bridge on Causeway
3.	71+180	69+820	3 x 15.84	47.560	16.00	
4.	80+980	78+750	2 x 8 x 5.423	17.500	16.00	
5.	88+480	85+835	3 x 15.84	47.560	16.00	
6.	98+280	95+315	3 x 15.84	47.56	16.00	New 2 lane bridge due to inadequate waterway
7.	123+527	120+444	1x8.8	8.821	16.00	Replaced with new 2 lane bridge as per highway profile
8.	140+363	136+843	1 x 8	9.200	16.00	New 2 Lane bridge on Realignment
9.	146+305	142+775	2 x 8 x 6.5	17.5	16.00	New 2 lane bridge on realignment
10.	-	146+750	1 x 19.2	19.241	16.00	New 2 lane bridge on K. R. Pet Bypass
11.	-	146+980	1 x 25.84	25.844	16.00	
12.	-	149+107	1 x 10.8	10.82	16.00	
13.	164+375	160+675	1 x 10.8	10.822	16.00	Replaced due to highway profile
14.	173+990	170+190	1x8.8	8.821	16.00	

S. No.	Existing Ch. Km	Design Ch. Km.	Span Arrangement (m)	Total Length (m)	Overall deck Width (m)	Remarks
15.	174+535	170+735)	2x10.8	21.620	16.00	Replace with new 2 lane bridge due to realignment
16.	198+900	194+933	1x16.84	16.880	16.00	Replaced due to Inadequate Waterway
17.	203+469	199+498	1x8.8	8.82	16.00	Replaced with new 2 lane bridge due to old Stone slab superstructure
18.	209+765	206+772	2x15.84	31.720	16.00	New 2 lane bridge due to inadequate waterway
19.	221+336	217+277	2x15.84	31.720	16.00	New 2 lane bridge due to inadequate waterway

8. ROB and Overpass

57. **ROB:** There is one level crossing on the project road at Ch. 167+705. An ROB is proposed to be provided at this location. Details of the same are shown in **Table 24** below.

Table 24 Details of new ROB

Sl. No.	Existing Ch. Km	Design Ch. Km.	Span arrangement (m)	Total Length (m)	Type of Structure		Remarks
					Super Structure	Sub-Structure	
1	169+000	167+705	2 x 19.040 + 2 x 37.240 x 1 x 19.04	112.603	Steel Girder & RCC Slab	RCC Wall with open footing	New 2 lane ROB in place of existing level crossing

58. **Overpass:** One overpass at Ch. 122+380 is proposed on the project road. Details of the same are given in **Table 25** below.

Table 25 Details of New Overpass

Sl. No.	Existing Ch. Km	Design Ch. Km.	Carriageway Width (m)	Overall width (m)	Span Arrangement (m)	Type of Structure	
						Super Structure	Sub-Structure
1	122+370	122+370	10	13.80	1 x 13.00 (Clear opening)	RCC Single Cell Box Structure	

9. Culverts

59. As discussed above, there are 427 culverts along the project road. Considering the adequacy, hydrological requirements and curve improvements/ realignments, some additional culverts and replacement of some culverts has been proposed. The summary of the proposed culverts is given in **Table 26.** In addition to these culverts, 326 hume pipe have been proposed for cross drainage in proposed junctions.

Table 26 Summary of Proposed Culverts

Type	New Proposal	Replaced	Repair & Widened	Total
Hume Pipe	76	71	40	187

Slab	0	0	50	50
RCC Box	68	109	1	178
	144	**180**	**91**	**415**

10. At-Grade Intersection / Grade Separated Intersection

60. There are 29 major and 268 minor junctions have been identified and improvement has been proposed. High mask lighting system has been catered for in the design of major intersections. For smooth merging & diverging of cross road traffic, at grade intersections have been proposed at other location.

11. Service Road / Slip Road

61. **Slip Roads:** Considering the turning movement traffic on the project road, only at grade intersection has been proposed. But to reduce the existing gradient one overpass has been proposed at Km 122+370 near village Devara Hosuru. Hence to facilitate the local traffic, both side slip road of width 5.5m have been proposed for a length of about **720m.** In addition to above, **300m (**Both side) length of slip road has been proposed near ROB location.

62. **Climbing Lane:** Some section of the project area falls in rolling terrain and existing gradient is more than 5%. Since climbing uphill is difficult for vehicles such as large trucks or Semi-trailer trucks, ascending a steep grade, they can travel in the climbing lane without slowing traffic. Hence to allow slower travel for large vehicles, additional one lane as climbing lane has been proposed at three locations. The total length of climbing is 1.13 Km.

12. Road Side Drain

63. 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.

64. In rural 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. For rural areas, the drains have been proposed as open and trapezoidal with 1(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. The sections shall be gradually increased in terms of bed width and depth of flow up to the outfall point. The Length of lined drain along the project road is **67.36 Km** and the length of unlined drain is **207.456 km.**

13. Footpath

65. The project is passing through built up section. Considering the safety of pedestrian traffic, Drain cum footpath has been proposed on both side of the project road in the following location locations.

Table 27 Location of Drain cum Footpath along the Project Road

Sl. No.	Design Chainage (Km)		Fully paved shoulders/ footpaths (m)
	From	To	
1	51+845	52+000	2x2.5 (Covered Drain Cum Footpath)
2	52+595	53+100	2x2.5 (Covered Drain Cum Footpath)
3	58+100	58+500	2x2.25 (Covered Drain Cum Footpath)
4	60+300	60+670	2x2.5 (Covered Drain Cum Footpath)
5	63+000	63+595	2x2.5 (Covered Drain Cum Footpath)
6	65+995	66+400	2x2.5 (Covered Drain Cum Footpath)
7	67+245	67+600	2x2.5 (Covered Drain Cum Footpath)
8	68+615	69+300	2x2.5 (Covered Drain Cum Footpath)
9	70+110	70+510	2x2.5 (Covered Drain Cum Footpath)
10	80+275	80+500	2x2.5 (Covered Drain Cum Footpath)
11	86+660	87+050	2x2.5 (Covered Drain Cum Footpath)
12	92+045	92+600	2x2.5 (Covered Drain Cum Footpath)
13	94+645	94+950	2x2.5 (Covered Drain Cum Footpath)
14	95+800	96+095	2x2.5 (Covered Drain Cum Footpath)
15	97+800	98+500	2x2.25 (Covered Drain Cum Footpath)
16	109+680	110+080	2x2.5 (Covered Drain Cum Footpath)
17	111+150	112+070	2x2.25 (Covered Drain Cum Footpath)
18	113+370	113+400	2x2.5 (Covered Drain Cum Footpath)
19	113+400	113+870	2x2.25 (Covered Drain Cum Footpath)
20	126+200	127+200	2x2.5 (Covered Drain Cum Footpath)
21	138+060	138+550	2x2.5 (Covered Drain Cum Footpath)
22	143+000	144+850	2x2.5 (Covered Drain Cum Footpath)
23	157+300	158+100	2x2.5 (Covered Drain Cum Footpath)
24	158+610	159+620	2x2.5 (Covered Drain Cum Footpath)
25	163+360	164+000	2x2.5 (Covered Drain Cum Footpath)
26	164+000	165+275	2x2.25 (Covered Drain Cum Footpath)
27	171+000	172+150	2x2.5 (Covered Drain Cum Footpath)
28	175+100	175+900	2x2.5 (Covered Drain Cum Footpath)
29	176+400	176+900	2x2.5 (Covered Drain Cum Footpath)
30	179+640	181+150	2x2.5 (Covered Drain Cum Footpath)
31	181+150	181+390	2x2.25 (Covered Drain Cum Footpath)
32	181+390	181+500	2x2.25 (Covered Drain Cum Footpath)
33	181+500	183+040	2x2.25 (Covered Drain Cum Footpath)
34	187+370	189+020	2x2.25 (Covered Drain Cum Footpath)
35	191+620	192+900	2x2.5 (Covered Drain Cum Footpath)
36	193+370	194+070	2x2.5 (Covered Drain Cum Footpath)
37	195+320	195+820	2x2.5 (Covered Drain Cum Footpath)
38	199+510	201+040	2x2.5 (Covered Drain Cum Footpath)
39	201+040	201+580	2x2.25 (Covered Drain Cum Footpath)
40	202+320	202+920	2x2.5 (Covered Drain Cum Footpath)
41	203+370	204+020	2x2.5 (Covered Drain Cum Footpath)
42	204+375	206+530	2x2.25 (Covered Drain Cum Footpath)
43	207+780	209+480	2x2.25 (Covered Drain Cum Footpath)
44	209+980	210+480	2x2.5 (Covered Drain Cum Footpath)
45	218+680	219+480	2x2.5 (Covered Drain Cum Footpath)

66. **Utilities:** To facilitate utilities along the project road which may include Electric lines and poles, Fibre optics, Waterlines and 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

67. 150 Bus bays (75 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. To minimize additional Land Acquisition, the size of the Bus Bay in rural area has been followed as per IRC: 80 and for built up section as per IRC: 86.

15. Truck Lay Byes

68. To facilitate the truck traffic, Truck Lay Bye on both sides of the project roads have been proposed in the following locations.

Table 28 Location of Proposed Truck Lay Byes

Sl. No.	Truck Lay Bay Location	
	LHS	RHS
1	87+400	87+550
2	137+000	137+550
3	212+060	211+920

16. Toll Plaza

69. Considering traffic flow and Homogeneous section, three toll plazas have been proposed along the project road at Ch. Km 93+700, Km 128+300 and Km 197+020. 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

70. 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 kmph in plain/rolling terrain and with 80 kmph as the minimum design speed.

18. Additional Land Acquisition

71. According to the Land Acquisition Plan (LAP) **178.7472 Ha** of land will be acquired for the project, out of which 134.58 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-29.**

Table 29 Details of Land being acquired for the Project

Sl. No.	Land Details	Acquisition of Land Area (Ha.)	Percentage
1	Private Land	134.58	75.3
2	Forest Land	21.3872	12.0
3	Govt. Land / Waste Land	22.78	12.7
	Total	**178.7472**	**100**

Source: Land acquisition Plan, ICT Pvt. Ltd 2015

E. Road Safety Devices

72. 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

73. 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) and along all curves having radii up to 450m for complete length of curves including transitions and 20m further before and after the curve.
- 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

74. 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

75. 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. Highway lightings including high masts will be provided at intersections in order to improve the night time visibility. All the built up locations as well Underpasses has been proposed lighting arrangements.

F. Sources of Construction Materials

76. 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.

77. **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-30**.

Table 30 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)	Present Land Use
1.	47.700	LHS	Magadi	0.1	Barren Land
2.	54.900	LHS	Vishwanathpura	0.1	Barren Land
3.	57.350	RHS	Kempasagara	0.3	Barren Land
4.	63.300	RHS	Alesabela	0.2	Barren Land
5.	69.800	LHS	Byadarahalli	2	Barren Land
6.	75.000	LHS	K. G. Devapana	0.1	Barren Land
7.	79.600	LHS	Hulidurga	0.3	Barren Land
8.	83.300	LHS	Sugganahalli	0.5	Barren Land
9.	85.200	RHS	Pallarayahalli	0.8	Barren Land
10.	93.700	LHS	Kudugubalu	0.4	Barren Land
11.	98.200	LHS	Devalapura	0.5	Barren Land
12.	105.200	RHS	Tattahalli	0.3	Barren Land
13.	118.700	RHS	Sankanahalli	0.2	Barren Land
14.	121.900	RHS	Gangasamudra	0.5	Barren Land
15.	128.000	LHS	Sriramnahalli	2.3	Barren Land
16.	133.600	RHS	Giduvinahasahalli	0.5	Barren Land
17.	139.700	RHS	Chakkaharanahlli	1	Barren Land
18.	143.400	RHS	Kaigonahalli	0.5	Barren Land
19.	149.800	LHS	Guddenahalli	2.5	Barren Land
20.	156.200	RHS	Hosaholalu	0.2	Barren Land
21.	163.200	RHS	Dadahalli	0.5	Barren Land
22.	169.600	LHS	Jainahalli	1.6	Barren Land
23.	176.600	RHS	Somanahalli	0.2	Barren Land
24.	177.600	RHS	Somanahalli	1.4	Barren Land
25.	188.700	RHS	Haradanahalli	0.2	Barren Land
26.	192.250	RHS	Seegehol	1.1	Barren Land
27.	196.100	RHS	Bodanur	2	Barren Land
28.	202.100	RHS	Garudanahalli	1.5	Barren Land
29.	206.900	RHS	Shiradanahalli	0.6	Barren Land

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Location / Village Name	Lead From Nearest Point on Project Road (km)	Present Land Use
30.	212.800	RHS	Hirehalli	2.2	Barren Land
31.	219.000	RHS	Siddapura	0.1	Barren Land
32.	223.200	RHS	Vadenura	0.3	Barren Land
33.	225.200	RHS	Betkale	0.1	Barren Land

78. **Stone / Coarse Aggregate Material:** Eight Stone quarries were identified along the project road section and samples were collected and tested. Out of these, two quarries are near to project road and have small lead whereas other quarries are away from project road. It is therefore suggested to use aggregates of quarries with economical lead. The sampling locations, name of quarry /village and approximate lead distances from project site are given in **Table-31.**

Table 31 Location of Stone / Coarse Aggregate Material

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Source and Village Name	Lead From Nearest Point on Project Road (km)	Approx. Quantity
1	44.2	RHS	Panakanakallu	1.2	HUGE
2	80.2	RHS	Tharikare	17.0	HUGE
3	113.2	BHS	Maigonahalli	13.0	HUGE
4	114.4	LHS	A. Shyanabhoganahalli	11.0	HUGE
5	130.0	LHS	Thiruganahalli	0.2	HUGE
6	149.7	LHS	Haralahally	11.0	HUGE
7	152.2	LHS	Baby	28.0	HUGE
8	227.5	LHS	Banavara	0.3	HUGE

79. **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 four sources of manufactured sand were identified and representative samples were collected and tested from these sources. Details of these locations are presented in **Table-32.**

Table 32 Location of Fine Aggregate Material (Sand)

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Location / Village Name	Lead From Nearest Point on Project Road (km)
1	44+200	RHS	TJM-AIKYA-JV, Panakanakallu	1.2
2	80+200	RHS	Balaji Stone Crusher, Tharikare	17.0
3	130+000	LHS	Thiruganahalli	0.2
4	152+200	LHS	Baby	28.0

80. The manufactured sand at Chainage Km 80+200 is not conforming to any of the zones specified in IRC:383 and hence require adjustment in the crushing plant to obtain desired gradation.

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

82. **Bitumen:** Bitumen can be procured from oil refinery from Chennai, Tamil Naidu, with a lead of about 360 Km from Bengaluru or Mangalore Oil Refinery with a lead of about 350 Km. The Specification of Bitumen must comply with relevant IS/IRC codes.

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

84. **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. The reason behind extra durability and strength of “plastics roads” is due to the higher melting point of which is created from the plastic additives. Not only does it increase the melting point but also the elasticity of the road. In the turbulent climate of India, roads are severely treated and cause an extensively large drain on the natural resources to maintain. The higher elasticity of the “plastic roads” will be able to survive harsher treatment which will reduce the maintenance costs.

85. Consultant suggests using waste plastic in the bitumen intended for bituminous wearing course. During the course of investigation Consultant have identified one source of Waste plastic within the vicinity project influence area, the address of which is as follows:

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

G. Project Cost

86. The Project Cost for the project road from Magadi to Somwarpet is given as follows:

Table 33 Project Costs

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.)
165.4	702.69	4.25	976.74	5.90

III. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Introduction

87. 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

88. 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

89. 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

90. 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

91. 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*

92. **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;

93. **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-85 from Magadi to near Somwarpet (169.495 km) in the State of Karnataka**.

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

94. 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.

95. 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 85 (Magadi to Somwarpet).** 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

96. 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.

97. 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.

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 Air Act) from SPCB will not be required for improvement of existing State Highway 85 (Magadi to Somwarpet).** It has also been verified from the Karnataka State Pollution Control Board.

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

99. 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.

100. 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

101. 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

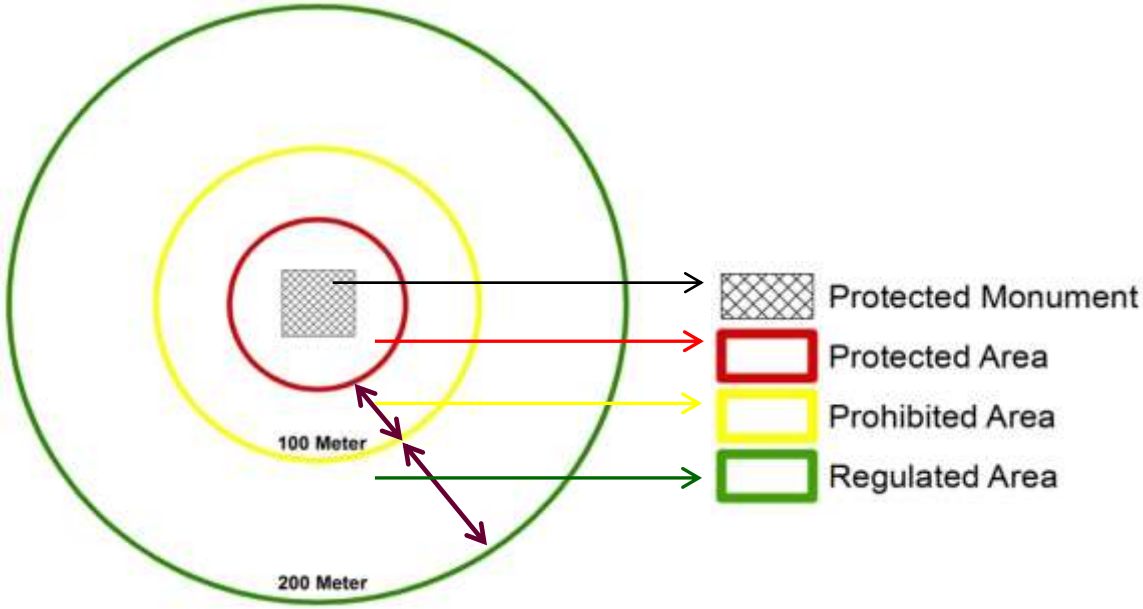
102. This Act empowers the Central and State Governments to establish National Parks and Sanctuaries; to formulate rules and designate authorities for the maintenance of National Parks, Sanctuaries and Zoos; to protect and conserve the flora and fauna. Vide Circular No. 11-9/98-FC dated 4-12-1998 issued 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

103. 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

104. 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.



105. 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.

106. Two ASI protected monuments (Rameshwara Temple & Agasthyeshwara Temple) are located within 300 m from the proposed project road at Ramanathapura in Hasan district. Rameshawara and Agashthyeshwara temples are 132 m and 172 m, respectively from the center line of the road to the boundary wall of main monument, and therefore, the road falls under the regulated area. Both the temples are protected by the Karnataka State Government. Therefore, **Archaeological Clearance will be required** for the proposed project road.

107. None of the notified monuments recognized by the UNESCO or World Heritage Monuments intercept with the road improvements.

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

108. 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.

109. 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).

110. 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.

111. **Udupi** Thermal Power Plant is 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

112. 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

113. 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 **Magadi to Somwarpet** Project corridor having length of **169.495 km** has been classified as **Category 'B'** project requiring Initial Environmental Examination (IEE).

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

114. 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.

a. 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;

b. 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

c. 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 34 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 Indin Road Congress (IRC) Codes

115. 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 are provided in **Table 35.**

Table 35 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

116. A summary of various statutory clearances required for the project road is presented in **Table 36**.

Table 36 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
Permissions under AMASR Act 2010	Archaeological Survey of India (ASI)	Before Construction

117. 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 37** for operating his equipment and carrying out construction work.

Table 37 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

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
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 (DEIAA)	▪ Environment (Protection) Act, 1986
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	▪ The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
		and Employment)	▪ 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 ▪ 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

118. 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

119. 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

120. 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

121. 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

122. 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

123. 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

124. 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

125. 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.

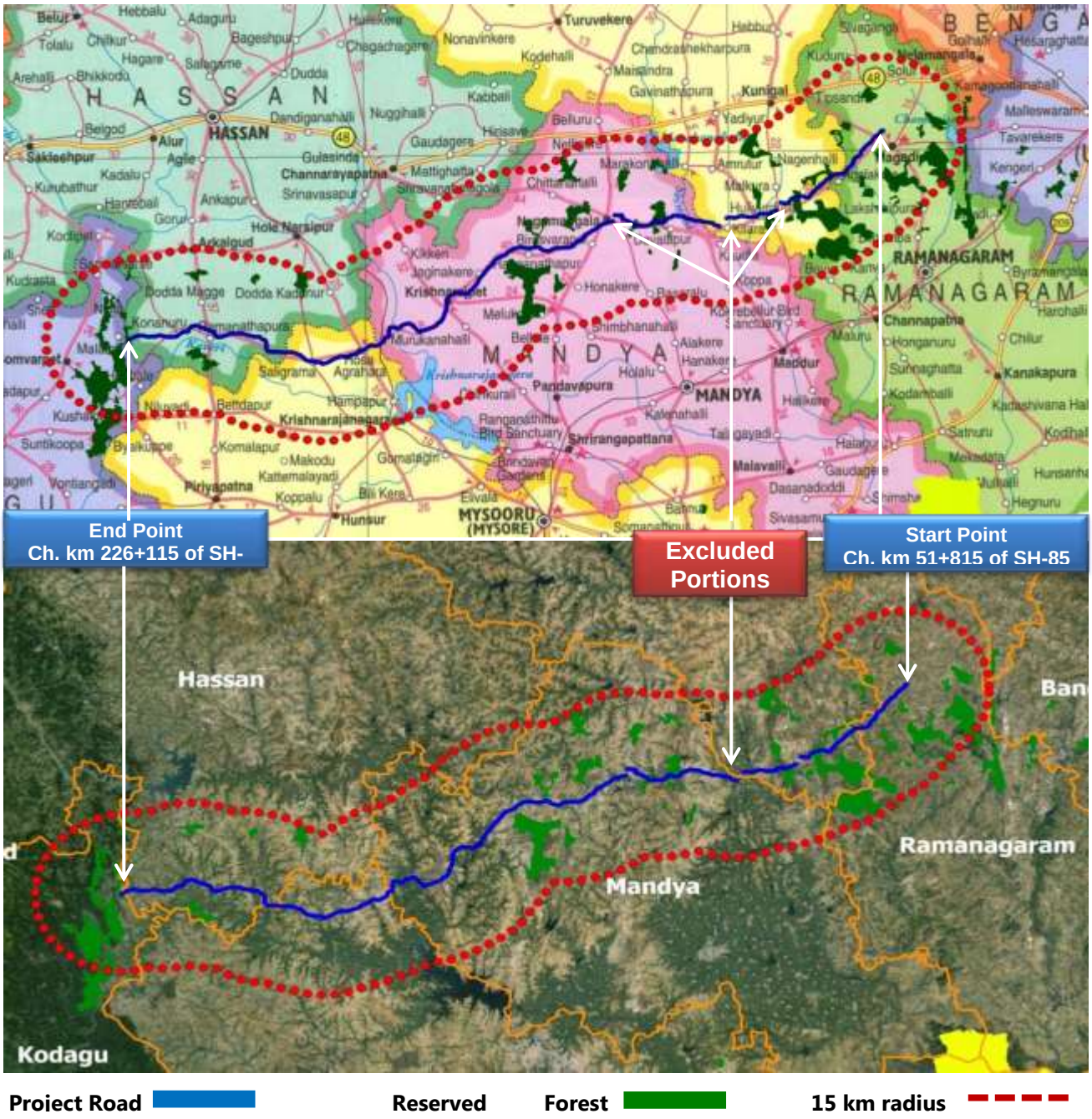


Figure 3 Map Showing Location of the Project Road

B. Location – Districts En-Route

126. The project road starts from Kunigal Road Junction near Magadi (existing Ch. Km 51+815) traverses through Ramnagara, Tumkur, Mandya, Mysore, and ends in Hassan district (existing Ch. Km 226+115). Project road predominately traverse through plain and rolling terrain. The existing length of the project road is about 169.495 Km, excluding the common section with State & National Highways. The location of the project road is shown on Index Map at **Figure 3.**

C. Geology, Topography and Soil

127. The project road is passing through Ramanagara, Tumkur, Mandya, Mysore and Hassan districts.

128. Geomorphologically the Ramanagara district can be divided into rocky upland, plateau and flat topped hills at an elevation of about 900 m amsl. The district with major part sloping towards south and south east forming pediplain interspersed with hills all along the western part with the elevation in the range of 996 m and 1467 m amsl mostly in the granitic terrain. The pediplain form major part of the district underlain by gneisses and granites with the highest pediplain in the range of 850 m to 950 m amsl. Rocky upland pediplain and plateau constitute erosional topography.

129. The majority parts of Tumkur district consist of mainly undulating plains interspersed with clumps of tall and well grown trees. Long ranges of hills running roughly south-south east direction occupy the western part of the district. The surface topography of Mandya district is in the form of undulating plain situated at an average elevation of 750-900m amsl. There are few sporadic out crops of rocks as hills and few fertile shallow valleys. The general elevation of Mysore district is in the ranges from 700-800 m amsl except for the denudational hills and ridges. Flat valleys are not very common except for isolated appearances. Geologically, Hasan district is divided into three distinct units i.e. the Western and north-eastern hilly terrains constituting part of the Western Ghats, the Central transition zone and the Eastern Maidan (plain) region. Geological Map of the study area is provided in **Figure 4**.

130. Major part of pediplain constitutes low relief area having matured dissected rolling topography with erosional landscape covered by layers of red soil of varied thickness. A major part of the Ramanagara district is occupied by red sandy soil (60%), and the remaining by red loamy soil. Red sandy soil mainly occurs in Channapatna, Kanakapura and Ramanagara taluks in undulating land slopes. These soils are derived from acidic rocks, granites and granitic gneiss. These soils occur on gently sloping pediplain. They are dark brown colour with loam to sandy loam composition on the surface and sandy clay loam to clayey soils in the sub surface horizons. They are neutral to alkaline in nature. Red loamy soils generally occur on hilly to undulating land slope on granite and granite gneisses. It is mainly covered in Magadi taluk and parts of Channapatna and Kanakapura taluks.

131. Soil types of Tumkur, Mandya & Mysore districts are also mainly red loamy, red sandy and red clay loam very. Red soils have good drainage but poor in lime and bases. The soils are having high permeability and neutral with a pH of 7. The thickness of the soil varies from less than a meter to 6 m. Deep Black soils occur in few parts of Mysore district and Hasan district. These soils are dark brown, dark greyish brown to very dark grey or black in colour. The texture is usually clayey throughout the profile. These soils are fertile and generally produce good yields.

Figure 4 Geological Map of Project Area

D. Seismicity

132. 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

133. Drainage is controlled by topography. The drainage pattern of the study area is dendritic to semi dendritic. The study area is part of the Cauvery basin. The major tributaries of the Cauvery River draining the study area are Arkavati, Shimsha & Hemavati Rivers. The rivers and streams originate from small watersheds of these tributaries and empty into number of tanks scattered in the district. Cauvery is an east flowing perennial river that joins directly Bay of Bengal. The drainage channels of the study area are mostly east flowing joining Cauvery River. The main Cauvery River flows from west to east parallel to the road from Chainage km 190+500 (Keralapura) to 212+500 (Siddapura) at varying distances before opening into K R Sagar reservoir.

F. Agriculture and Irrigation Practices

134. Agriculture is predominant occupation of the people in the area. However, irrigation in the study area is mostly rain fed. Hemavati reservoir is the major irrigation project in Hassan district, which also cater to the needs of Tumkur district partially. Tumkur and Ramangara districts have no completed irrigation projects, mainly due to absence of perennial rivers. Mandya district is comparatively well irrigated; having irrigation facility in 30% of net sown land.

135. The major crops grown in the study area are Paddy, Ragi, Jowar, Bajra, Maize and Wheat. Pulses like Gram, Tur are also cultivated along with oilseed like Groundnut, sunflower. Different varieties of fruits (Mango, Lime, Sapota, Grapes, Guava etc.), vegetables (Tomato, Brinjal, Carrot, Cabbage, Potato, Beans, Chillies etc.) are also produced.

G. Land Use

1. Method of Data Preparation

136. The land use/land cover has been presented in the form of a map prepared by using Survey of India Topographical sheet no. 48P/13 to 48P/15, 57D/2 to 57 D/10, 57D/14, 57H/1, 57H/5, 57H/957G/8 and 57G/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 5** 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

137. 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 Magadi, Nagamanagala, Huliyadurga, Krishanaraj pethe (KR Pet), Bhereya, Saligrama, Keralapura, Ramanathpura and Konnanur.

138. The land use pattern within 50 m on either side of the project road is mainly agricultural (60.7%) followed by residential cum commercial area (19.6%), mixed land use (15.6%) and forest (4.1%). Within ROW the land use is mainly open land with trees by the side of the earthen shoulder

3. Land Use within the Study Area

139. The land use classification within approximately 15 km area of the project site is summarized in **Table 38** and major land use types are graphically presented in **Figure 6.** Majority of the land is under agrarian use (67%), followed by vegetation (18%) and forests (7%).

Table 38 Area Statistics of Land Use Map

Land use Classes	Sq. km	Percentage
Agriculture	3631.97	66.7
Barren Rocky	299.42	5.5
Water Body/River/Canal	88.57	1.6
Builtup Area	56.33	1.0
Forest	386.42	7.1
Vegetation	986.37	18.1
Total	**5449.08**	100.0

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

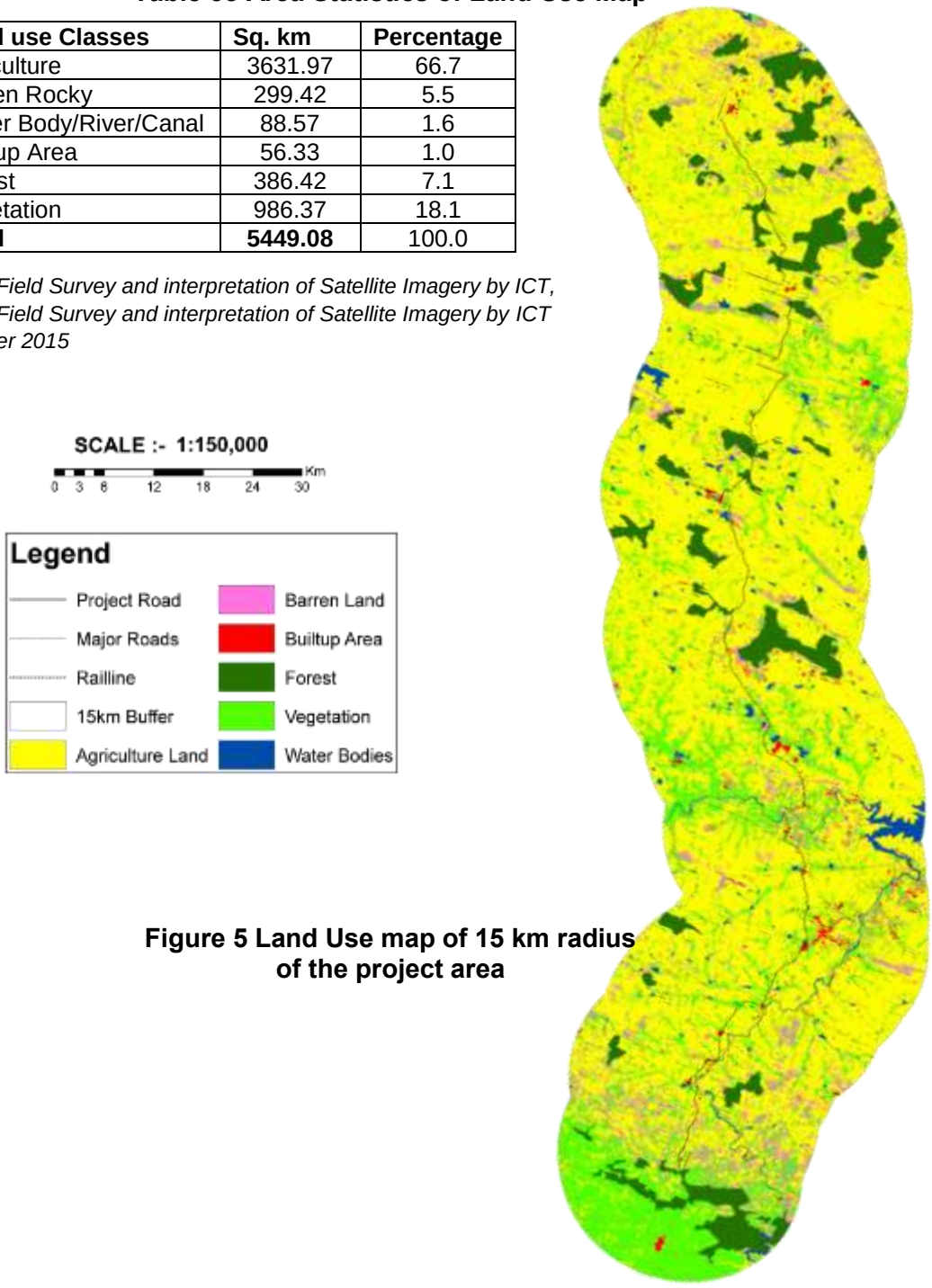


Figure 5 Land Use map of 15 km radius of the project area

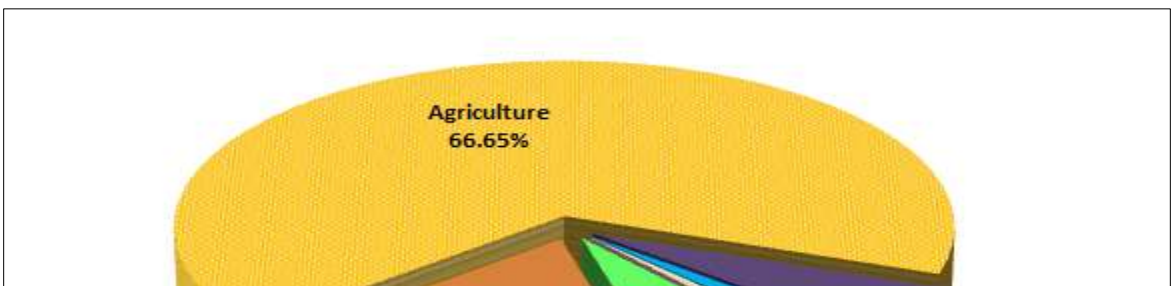


Figure 6 Major Land Use Types in the Study Area

H. Soil Quality

140. 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

141. 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 39.** 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.

Table 39 Details of Soil Monitoring Stations

SN	Place	Chainage (Km)	Side	Distance# (m)	Area category
SQ1	Hulurdurga	81+500	LHS	25	Agricultural
SQ2	Nagamangala	117+450	LHS	35	Agricultural
SQ3	Hosaholalu	157+800	RHS	40	Agricultural
SQ4	Ramanathapura	207+150	RHS	25	Agricultural

Source: Field Survey in December 2015

Distance in meter from existing centerline

2. Soil Characteristics of the Study Area

142. 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.

143. The physico-chemical characteristics of the soils in the study area, as obtained from the analysis of the soil samples, are presented in **Table 40** & **Table 41**. The results are compared with standard soil classification**.**

Table 40 Sand, Silt, Clay & Soil Porosity

Sl. No.	Location Code	Sand (%)	Silt (%)	Clay (%)	Porosity (%)	Soil Texture
1	SQ1	64	24	12	44.2	Sandy Loam
2	SQ2	67	20	13	44.9	Sandy Loam
3	SQ3	64	21	15	41.5	Sandy Loam
4	SQ4	61	25	14	43.0	Sandy Loam

Source: Field Survey in December 2015

Table 41 Physico-Chemical Characteristics of Soil in the Study Area

SN	Parameters	Unit	Location Code			
			SQ1	SQ2	SQ3	SQ4
1.	pH	-	7.6	7.64	7.57	7.54
2.	Colour		Brown	Brown	Brown	Brown
3.	Bulk Density	g/cm^3	1.48	1.46	1.55	1.51
4.	Electrical Conductivity	µs/cm	231	226	252	250
5.	Moisture	%	11	15	12	13
6.	Potassium as K	mg/100g	0.86	0.83	0.91	0.94
7.	Nitrogen as NO3-N	mg/100gm	40	38	42	34
8.	Phosphorous as P	mg/100gm	90	93	87	88
9.	Chloride (Cl–)	mg/kg	204	195	224	216
10.	Sodium	mg/kg	13	15	16	12
11.	SAR	-	1	1.2	1.2	1
12.	Lead	mg/Kg	5.8	7	6.2	6.8
13.	Sodium Sulphate	%	0.098	0.13	0.095	0.14
14.	Calcium Sulphate	%	0.004	0.007	0.006	0.005
15.	Organic Matter	%	2	1.9	2.1	1.7
16.	Iron as Fe	ppm	1.38	1.26	1.15	1.25
17.	Infiltration Rate	mm/hr.	1.16	1.07	1.14	1.1

Source: Field Survey in December 2015

144. It has been observed that the texture of soil is sandy loam with 61-67% sand content and about 12-15% clay content. The pH of the all samples are around 7.6 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. The Electrical conductivity was very low, varies between 226-252 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.

145. The organic matter was observed to sufficient and varying in the range of 1.7-2.1%. The sodium absorption ratio is low (1.0 to 1.2%), 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

146. The study area span east to west across 5 districts Ramanagara, Tumkur, Mandya, Mysuru and Hassan districts and have variation the climatic conditions. In general, humid to semi-arid climatic conditions prevail in Ramanagara district. The average temperature is around 25°C. Tumkur district falls in the eastern dry agro climatic zone. The temperatures start rising from January to peak in May, around 40° C is common. Thereafter it declines during the monsoon period. The humidity is lowest during the dry season and highest during the monsoon period. The annual potential evapotranspiration is over 1800mm with monthly rates less than 100mm during December and January and over 250 mm during May.

147. Sub-tropical climate is observed in Madya district with temperatures ranging between 16° and 35°C. The rainfall is generally uniform in the district except in the western sector where it is slightly higher. The normal rainfall of the district is 623 mm. The average minimum and maximum temperatures in Mysore district vary from 34° to 21.4°C in April to 16.4° to 28.5°C in January. Relative humidity ranges from 21 to 84%. The district receives an average rainfall of 776.7 mm. There are 53 rainy days in the district on an average about 50% of annual rainfall occurs during the southwest monsoon period.

148. Past meteorological data of three nearest IMD Observatories, namely **Mysore** (46 km), **Hassan** (43 km) and **Medikeri** (31 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 42** below.

Table 42 Summaries of Climatological Data (Based on IMD Records of 1951-80)

		Mysore		Hassan		Medikeri	
Parameter	**IST**	**Monthly[1]**	**Annual**	**Monthly**	**Annual**	**Monthly**	**Annual**
Mean daily max temperature (°C)		27.2 Jul – 34.3 Apr	29.5	24.6 Jul-33.3 Apr	28.3	20.8 Jul-29.1 Mar	24.7
Mean daily min temperature (°C)		16.4 Jan – 21.5 Apr	19.3	13.6 Jan-19.3 May	17.1	14.1 Jan-18.2 May	16.4
Relative humidity (%)	0830	67 Feb – 85 Jul	79	73 Feb -9 Aug	83	70 Mar-97 Jul	86
	1730	25 Mar – 71 Jul	51	35 Mar – 82 Jul	59	54 Feb-96 Jul	76
Total rainfall (mm)		1.9 Jan – 166.5Oct	788.9	0.7 Jan-170 Oct	899.4	2.1 Jan-1131.8 Jul	3311.1
Wind speed (km/h)		8.3 Oct - 14.4 Jul	11.1	4.8 Nov-11.9 Jun	7.7	7.6 Mar-16.2 Jul	10.6
Cloud cover (all cloud oktas)	0830	2.0 Mar-5.4 Jul	4.0	2.2 Mar – 7.1 Jul	4.7	1.4 Feb-7.5 Jul	4.2
	1730	2.6 Feb – 6.1 Jul	4.5	3.0 Feb – 7.0 Jul	5.0	1.9 Feb-7.6 Jul	4.7

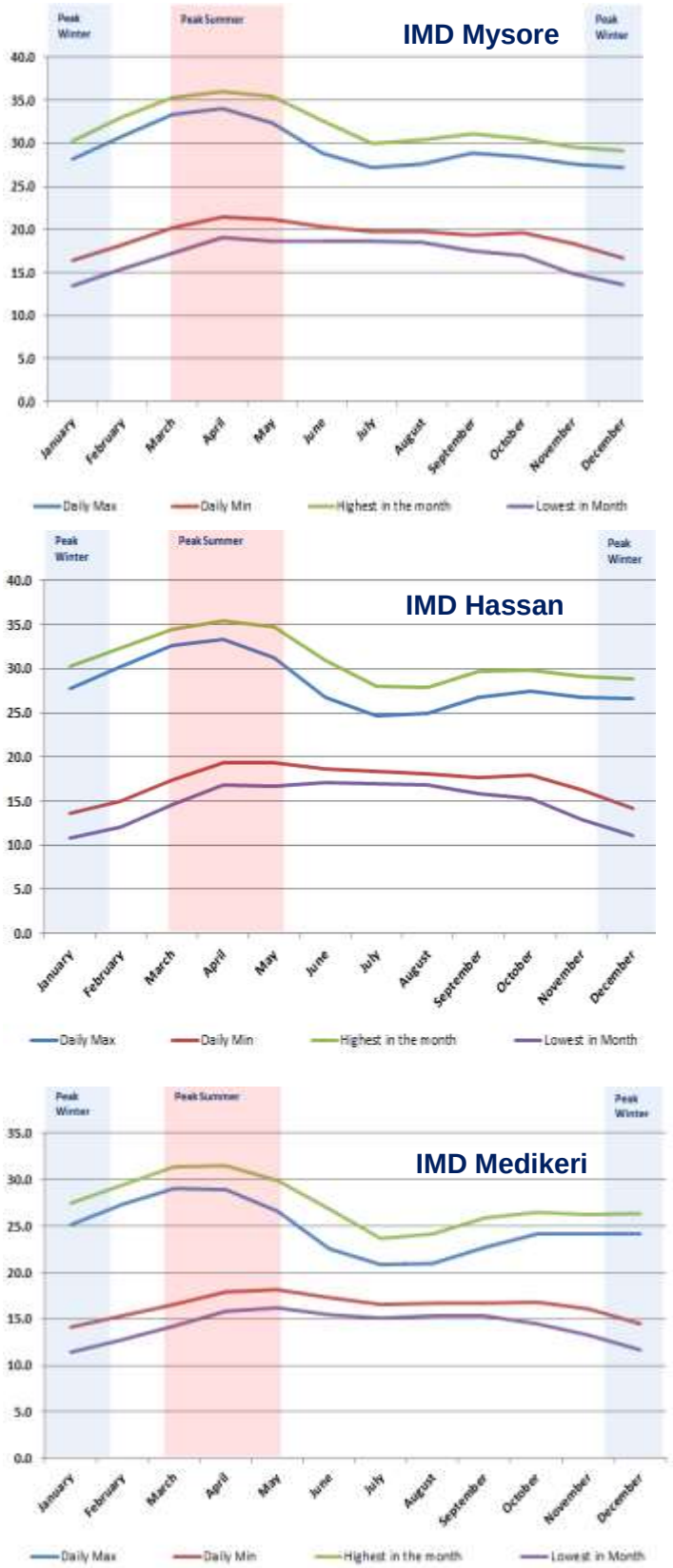
Source: Climatological Data of Hassan. Mysore & Medikeri, Indian Meteorological Department
1 Monthly Range; 2 Annual Mean/Total

a. Temperature

149. 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 that April & May are usually the hottest month with the mean daily maximum temperature around 29.5°C at Mysore, 28.3°C at Hassan and 24.7°C at Medikeri.

150. Mean daily minimum Temperature are also observed to be highest in Mysore, followed by Hassan and Medikeri. In the hot season the temperature sometimes goes above 35°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.

151. January is recorded to be the coldest month in all of the three stations, with the mean daily minimum temperature varying between 16.4°C at Mysore, 13.6°C at Hassan and 14.1°C at Medikeri. The monthly ambient temperature profile in the study area is presented in **Figure 7.**



b. Rainfall & Relative Humidity

152. **Mysore:** Normal annual rainfall is around 788 mm. Historical data shows that moderate rains occur in the month of November due to NE monsoon. The southeast monsoon contributes around 41 percent of the annual rainfall. The North East Monsoon yields around 29 percent and the balance of around 30 percent results from the pre-monsoon and winter.

Figure 7 Monthly Ambient Temperature Profiles

153. 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 and October are 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**.

Table 43 Monthly Rainfall, Wind Speed and Relative Humidity of Mysore

Months	Monthly Rainfall (mm)	No of Rainy Days	Mean Wind Speed (kmph)	Relative Humidity (%)	
				0830 Hours	1730 Hours
January	1.9	0.2	11	74	37
February	5.2	0.4	10.6	67	27
March	8.5	0.5	9.3	71	25
April	61.0	3.9	8.5	75	35
May	148.3	7.4	10.2	79	51
June	72.7	5.6	14.1	81	65
July	80.4	8.0	14.4	85	71
August	63.7	5.7	13.5	85	68
September	106.2	6.3	10.9	85	64
October	166.5	8.9	8.3	85	64
November	58.0	3.6	10.2	79	56
December	16.5	1.1	11.9	77	48
Total	**788.9**	**51.6**	**11.1**	**79**	**51**

154. **Hassan:** Normal annual rainfall is around 900 mm. The southeast monsoon contributes around 51 percent of the annual rainfall. The North East Monsoon yields around 27 percent and the balance of around 22 percent results from the pre-monsoon and winter. The average monthly rainfall, relative humidity and wind speed data for Hassan IMD are provided in **Table 44**. The rainfall profile in the study area is presented in **Figure 9**.

155. **Medikeri:** Normal annual rainfall is around 3311 mm. The southeast monsoon contributes around 83 percent of the annual rainfall. The North East Monsoon yields around 9 percent and the balance of around 8 percent results from the pre-monsoon and winter. The average monthly rainfall, relative humidity and wind speed data for Hassan IMD are provided in **Table 45**. The rainfall profile in the study area is presented in **Figure 10**.

Table 44: Monthly Rainfall, Wind Speed and Relative Humidity of Hassan

Months	Monthly Rainfall (mm)	No of Rainy Days	Mean Wind Speed (kmph)	Relative Humidity (%)	
				0830 Hours	1730 Hours
January	0.7	0.1	5	77	38
February	3.7	0.4	5.4	73	35
March	12.7	0.7	6.1	75	35

Source: Climatological Data of Hassan, Indian Meteorological Department

Table 45: Monthly Rainfall, Wind Speed and Relative Humidity of Medikeri

Months	Monthly Rainfall (mm)	No of Rainy Days	Mean Wind Speed (kmph)	Relative Humidity (%)	
				0830 Hours	1730 Hours
January	2.1	0.3	9.5	80	56
February	3.0	0.2	8.7	72	54
March	12.3	1.0	7.6	70	54
April	84.3	5.9	7.6	80	70
May	168.2	8.7	9.8	87	79
June	580.2	22.3	12.6	95	92
July	1131.8	28.1	16.2	97	96
August	764.0	26.5	15.4	97	95
September	278.7	17.3	11.1	93	90
October	206.4	12.4	7.6	90	86
November	69.1	4.6	9.6	84	76
December	11.0	1.1	10.9	85	67
Total	**3311.1**	**128.4**	**10.6**	**86**	**76**

Source: Climatological Data of Medikeri, Indian Meteorological Department

c. Wind Speed

156. Average winds speed is high in monsoon north east monsoon and winter months, while in March witness lowest wind speed. The wind speed profile in the study area is presented in **Figure 8** (Mysore), **Figure 9** (Hassan) and **Figure 10** (Medikeri).

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

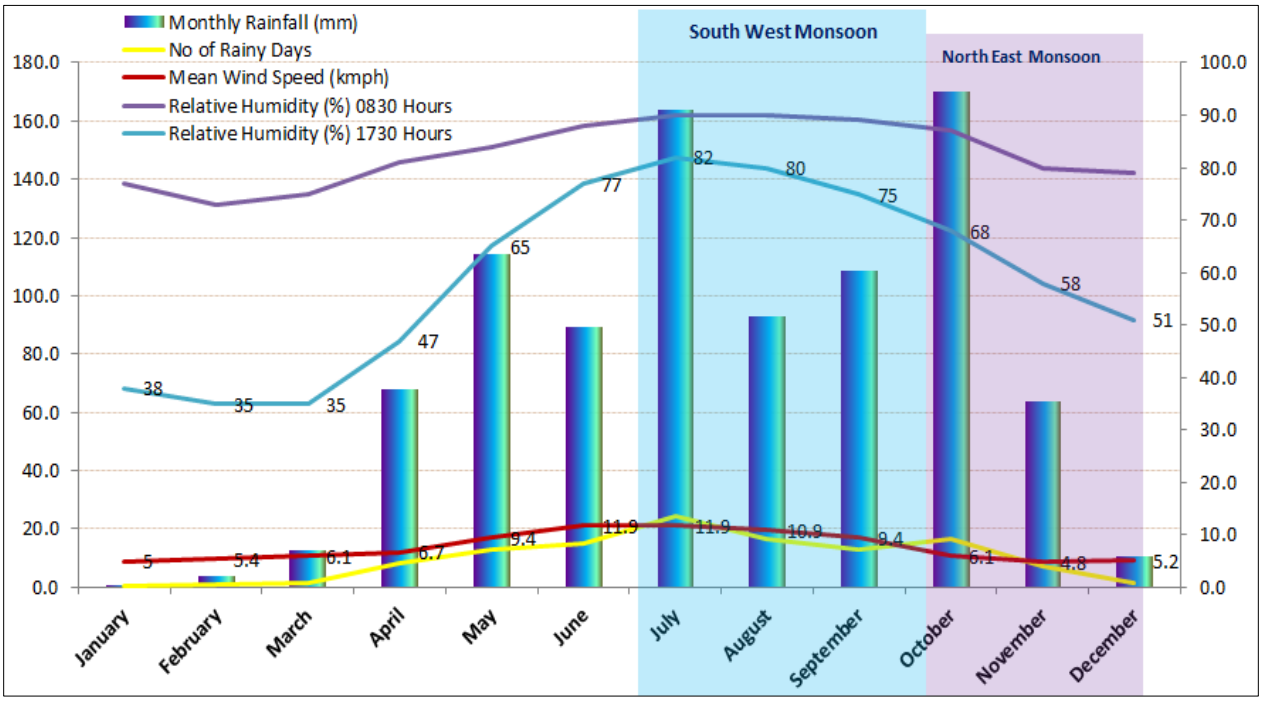


Figure 9 Monthly Rainfall, Rainy Days, Wind Speed and Relative Humidity of Hassan IMD

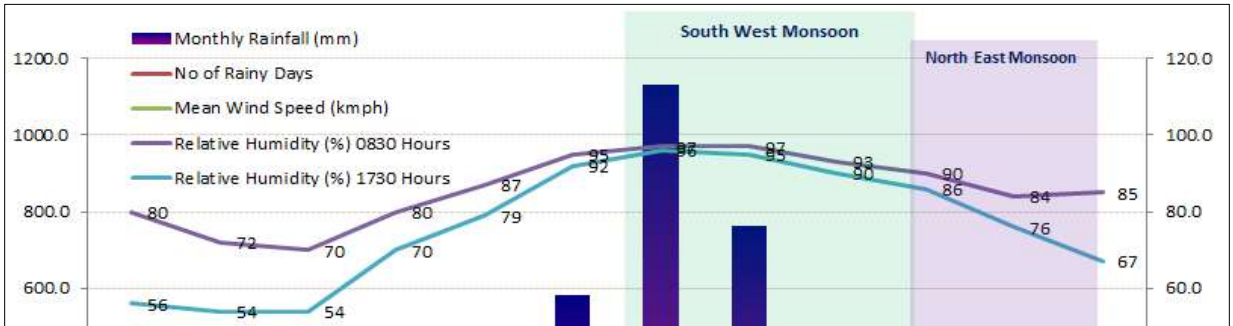


Figure 10: Monthly Rainfall, Rainy Days, Wind Speed and Relative Humidity of Medikeri IMD

d. Weather Extremes

157. **Mysore:** High summer temperature over 38°C occurs occasionally in the month of April. Highest temperature has been recorded to be 39.4°C in April 1917. Moderately low temperatures had been recorded during winter months, the lowest being 10.6°C in December 1945. Thunder storms occur in April-May and also in September-October but dust storm and hails have not been recorded.

Table 46 Numbers of days with Extreme Weather Condition- Mysore 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	0.5	0.0	0.0	0.3	0.0	0.2-0	4-0	21.7-2	2.2-22.5	2.9-6.5
February	0.6	0.0	0.1	0.4	0.0	0.4-0	4.8-0.4	19.8-3.3	1.9-18.9	1.1-5.4
March	1	0.0	0.7	0.4	0.0	0.3-0	3.8-0.5	19.8-1.2	4.2-22.6	2.9-6.7
April	5.9	0.0	3.1	0.0	0.0	0-0	1.7-0.4	24.4-1.2	3-21.9	0.9-6.5
May	10.1	0.0	5.7	0.0	0.0	0-0	2.8-1.3	23.2-3.8	3.4-21.3	1.6-4.6
June	10.3	0.0	0.9	0.0	0.0	0.2-0	2.2-2.6	23-3.2	2.4-21.4	2.2-2.8
July	14.9	0.0	0.2	0.0	0.0	0-0	1.8-2.2	24.6-4.6	2.4-21.4	2.2-2.8
August	13.3	0.0	0.2	0.0	0.0	0.1-0	1.1-1.5	23.7-3.1	4.2-23	1.9-3.4
September	10.3	0.0	1.3	0.0	0.0	0-0.1	1.5-0.4	23.8-2	2.9-23.8	1.8-3.7
October	12.2	0.0	2.5	0.1	0.0	0.2-0	2.4-1.3	21.4-1.7	4.4-23.8	2.6-4.2
November	5.4	0.0	0.7	0.5	0.0	0.3-0	3.6-1.3	22.5-1.3	1.9-23.1	1.7-4.3
December	2	0.0	0.2	0.5	0.0	0.1-0	3.3-0.3	21.6-3.4	3.7-22.4	2.3-4.9
Annual Mean	86.5	0.0	15.6	2.2	0.0	1.8-0.1	33-12.2	269.5-30.8	36.6-266.1	24.1-55.8

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

158. On an average, the study area received 0.3 mm or more rainfall in 86.5 days in a year. Occurrence of fog in winter is occasional. **Table 46** shows the extreme weather data with bar projections denoting incremental frequency.

159. **Hassan:** High summer temperature over 37°C occurs occasionally in the month of April. Highest temperature has been recorded to be 37.8°C in May 1906. Low temperatures had been recorded during winter months, the lowest being 6.7°C in December 1907. Thunder storms occur in April-May and also in September-October but dust storm and hails have not been recorded. On an average, the study area received 0.3 mm or more rainfall in 98.2 days in a year. Occurrence of fog in winter is occasional. **Table 47** shows the extreme weather data with bar projections denoting incremental frequency.

Table 47 Numbers of days with Extreme Weather Condition- Hassan 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	2.6	0.0	1.7-0	3.2-0	6-6	5.8-4.6	14.3-20.4
February	0.5	0.0	0.1	1.1	0.0	0.8-0	2.3-0.2	5.3-6.3	6.8-4.3	12.8-17.2
March	1	0.0	0.7	3.4	0.0	2-0	2.6-0.3	7.3-7.8	8.9-6.1	10.2-16.8
April	6.8	0.0	4.9	0.9	0.0	0.9-0	2.4-1.4	7.1-7.8	5.7-4.7	13.9-16.1
May	9.3	0.1	5.9	0.2	0.0	0-0.3	3.2-2.2	7.3-8.6	4.9-3.9	15.6-16
June	13.1	0.0	1.3	0.0	0.0	0.4-0.3	3.7-2.2	7.1-7.9	5.7-3.2	13.1-16.4
July	20	0.0	0.3	0.0	0.0	0.6-0.4	4.6-2.5	7.9-9.4	7-5.2	10.9-13.5
August	16.7	0.0	0.4	0.1	0.0	0.7-0.3	4.3-2.6	7-7.8	5.6-5.3	13.4-15
September	11.6	0.0	1.8	0.3	0.0	0.5-0.2	3.3-1.2	6.7-7.9	4.3-3.5	15.2-17.2
October	11.9	0.0	2.3	0.8	0.0	0.6-0	2.9-1.1	6.8-7.9	4.6-3.2	16.1-18.8
November	5.6	0.0	0.6	0.8	0.0	0.9-0.1	2.6-0.6	5.5-7.5	4.3-2.8	16.7-19
December	1.5	0.0	0.2	1.0	0.0	1.2-0	3.2-0.5	6.7-7.9	4.7-3.6	15.2-19
Annual Mean	98.2	0.1	18.5	11.2	0.0	10.3-1.6	38.3-14.8	80.7-92.8	68.3-50.4	167.4-205.4

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

Table 48 Numbers of days with Extreme Weather Condition- Medikeri 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	0.4	0.0	0.1	0.8	0.0	2.8-2.1	1.9-0.4	1.5-1.5	11.6-10.9	13.2-16.1
February	0.4	0.1	0.0	0.1	0.0	0.9-0.7	1-0.7	1.7-2.7	10.8-10.9	13.6-13
March	1.5	0.0	1.7	0.4	0.0	0.4-0.4	1.2-1.3	2.3-3.4	12-12.5	15.1-13.4
April	8.3	0.1	6.1	0.1	0.0	0.2-1	2.2-2.8	4.3-5	10.8-10.1	12.5-11.1
May	11.6	0.1	5.3	0.4	0.0	2.5-2.4	5.5-4.1	4.2-5.1	7.5-8.5	11.3-10.9
June	25.1	0.0	1.1	0.9	0.0	7.5-8	9.3-8.7	5.2-5.6	3-3.3	5-4.4
July	29.6	0.0	0.4	1.2	0.0	15-14.8	8-8.7	4.1-3.6	0.4-1.5	3.5-2.4
August	28.4	0.0	0.2	2.4	0.0	13.3-13.2	7.2-7.9	5-4.9	1.4-2	4.1-3
September	21.5	0.0	1.3	1.4	0.0	6.7-7.1	6-6	5.4-5.5	3.9-5.7	8-5.7
October	16.2	0.0	2.3	0.6	0.0	4.7-4.8	4-4.9	3-4.2	7.5-8.4	11.8-8.7
November	6.1	0.0	0.9	0.5	0.0	1.8-1.2	4.2-4	2.6-2.7	8.4-9.4	13-12.7
December	1.9	0.0	0.2	0.4	0.0	4-2	2.5-1.8	2.4-2	8.3-8.4	13.8-16.8
Annual Mean	151	0.3	19.6	9.2	0.0	59.8-57.7	53-51.3	41.7-46.2	85.6-91.6	124.9-118.2

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

160. **Medikeri:** High summer temperature over 34°C occurs occasionally in the month of April. Highest temperature has been recorded to be 35.2°C in May 1902. Low temperatures had been recorded during winter months, the lowest being 5.4°C in February 1968. Thunder storms occur

in March-May and also in September-November. Hails have been rarely recorded in February and March but dust storms have not been recorded.

161. On an average, the study area received 0.3 mm or more rainfall in 151 days in a year. Occurrence of fog in winter is occasional. **Table 48** shows the extreme weather data with bar projections denoting incremental frequency.

2. On-site Meteorological Monitoring

162. An automatic weather station was established at Nagamagala 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 49.**

Table 49 Location of Meteorological Station and Monitored Parameters

Parameters	Frequency	Location	Latitude & Longitude
Hourly Wind Speed, Wind Direction, Relative Humidity, Temperature & Rainfall	Hourly data	Nagamangala	12°49'07.70"N 76°45'28.91"E

Source: Field Survey during Dec 2015 to Jan 16

163. 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 50.**

a. Meteorological Monitoring Results

164. A maximum temperature of 33.4°C and minimum temperature of 12.4°C was observed during the monitoring period. Daily fluctuations in maximum and minimum temperature are presented graphically in **Figure 11**.

Table 50 Summary of Meteorological Data of the Study Area

Parameters	Dec 2015 – Jan 2016
Maximum Temperature (°C)	33.4
Minimum Temperature (°C)	12.4
Maximum Relative Humidity (%)	99.0
Minimum Relative Humidity (%)	43.8
Total Rainfall (mm)	2
Average Wind Speed (m/sec)	2.1
Calm condition	1.34
Predominant wind direction (blowing from)	South
Dry hours (%)	99.8%

Source: On-site Monitoring during Dec15 to Jan16

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

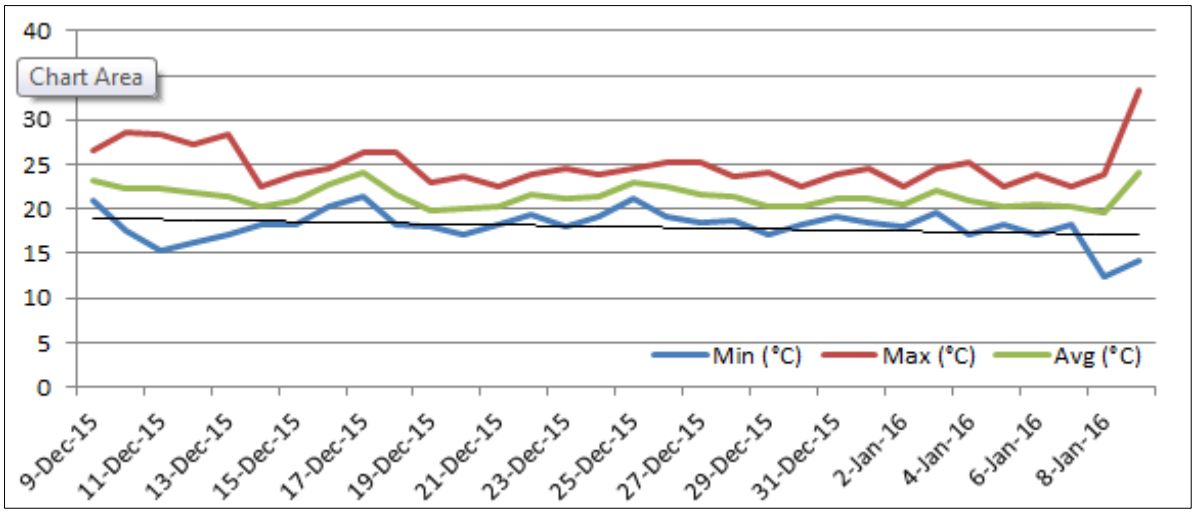


Figure 11 Daily Fluctuations of Temperature in the Study Area

166. Maximum wind speed monitored was found to be 6.0 m/sec while the average wind speed was 2.1 m/sec. The wind speeds show a consistent upward trend till mid- December, then shows little fluctuation before starting to increase in early January. Daily fluctuation of wind speed during the monitoring period is shown in **Figure 12**.

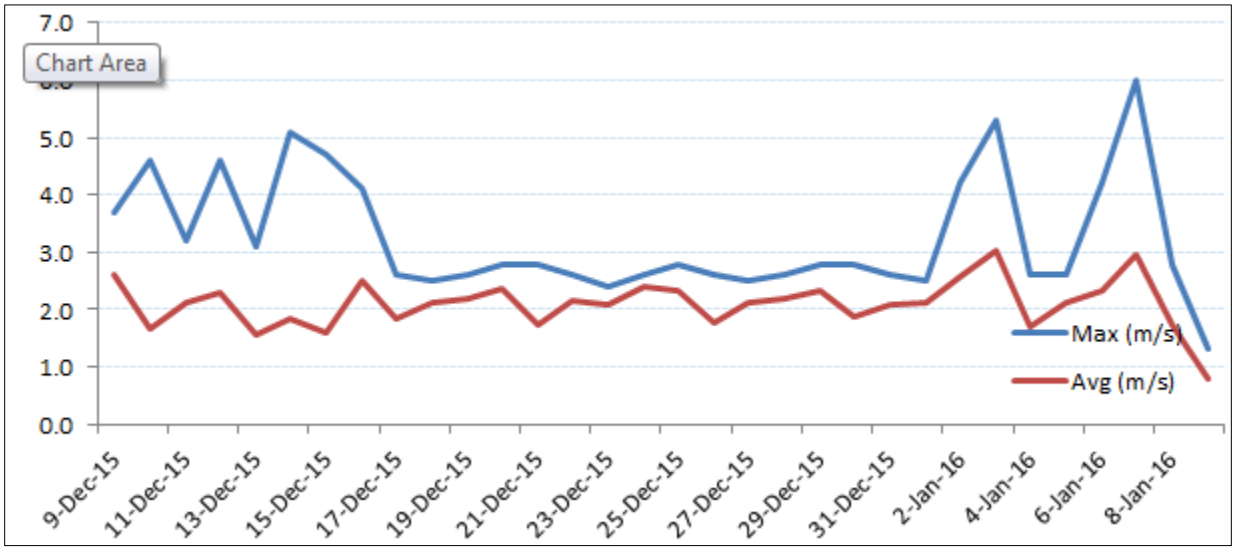


Figure 12 Daily Fluctuation of Wind Speed in the Study Area

167. Maximum Relative humidity during the monitoring period is found to be 99% while the average relative humidity was about 83%. The period was almost dry, except 2 mm occasional rainfall in a single day. The wind rose diagram of the study area is presented in **Figure 13**. Predominant wind direction during the monitoring period is observed to be south and south east (blowing from).

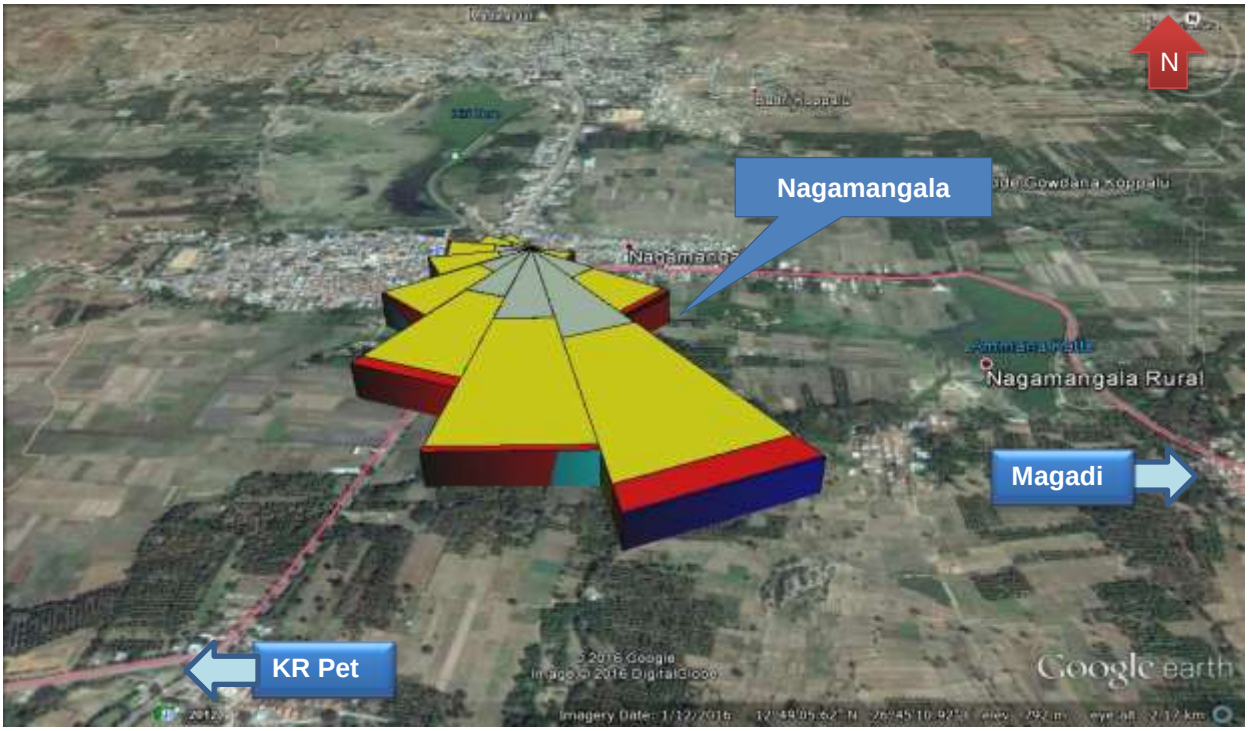


Figure 13 Wind Rose Diagram of the Study Area

J. Ambient Air Quality

1. Ambient Air Quality Monitoring Stations

168. 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 51**.

Table 51 Details of Ambient Air Quality Monitoring Stations

Station Code	Place	Chainage (Km)	Side	Distance# (m)	Area category
AQ1	Kenkere	82+800	LHS	35	Residential
AQ2	Devalapura	100+950	LHS	38	Residential
AQ3	Nagamangala	115+000	RHS	40	Residential
AQ4	Kommenahalli	159+400	RHS	35	Residential
AQ5	Bheriya	174+750	LHS	40	Residential
AQ6	Ramanathapura	207+950	LHS	25	Residential
AQ7	Siddapura	213+000	RHS	20	Residential
AQ8	Konanur	216+750	LHS	50	Residential

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

2. Parameters Monitored & Monitoring Period

169. 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 (SO_2)
- Nitrogen Dioxide (NO_2)
- Carbon monoxide (CO)

170. Ambient air quality monitoring was conducted over one month period (Dec 2015 to Jan 2016) 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 52.**

Table 52 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

171. **Particulate Matter of Size less than 2.5 micron or $PM_{2.5}$** .Arithmetic mean of the 24-hourly average values of $PM_{2.5}$ varied station-wise between 9.5-22 $\mu g/m^3$ with overall mean of the all stations being 14.24 $\mu g/m^3$. The 24-hourly average 98-percentile values of PM2.5 (max 21.72 $\mu g/m^3$ at AQ3) at all locations were observed to be within the limit of 60 $\mu g/m^3$ for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009.

Table 53 Summary of $PM_{2.5}$ levels in Study Area

Station Code	Station Location	Area Category	$PM_{2.5}$ ($\mu g/m^3$)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Kenkere	Residential & Rural	12.0-17.0	15.00	16.94	60
AQ2	Devalapura		11.6-16.4	14.30	16.32	
AQ3	Nagamangala		12-22.0	16.63	21.72	
AQ4	Kommenahalli		12-18.0	14.25	17.72	
AQ5	Bheriya		9.5-14.0	11.38	13.88	
AQ6	Ramanathapura		11.0-16.0	13.00	15.82	
AQ7	Siddapura		10.0-17.0	13.00	16.82	
AQ8	Konanur		11.0-18.0	14.00	17.76	
Overall of 8 locations			**9.5-22.0**	**14.24**	**20.44**	

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

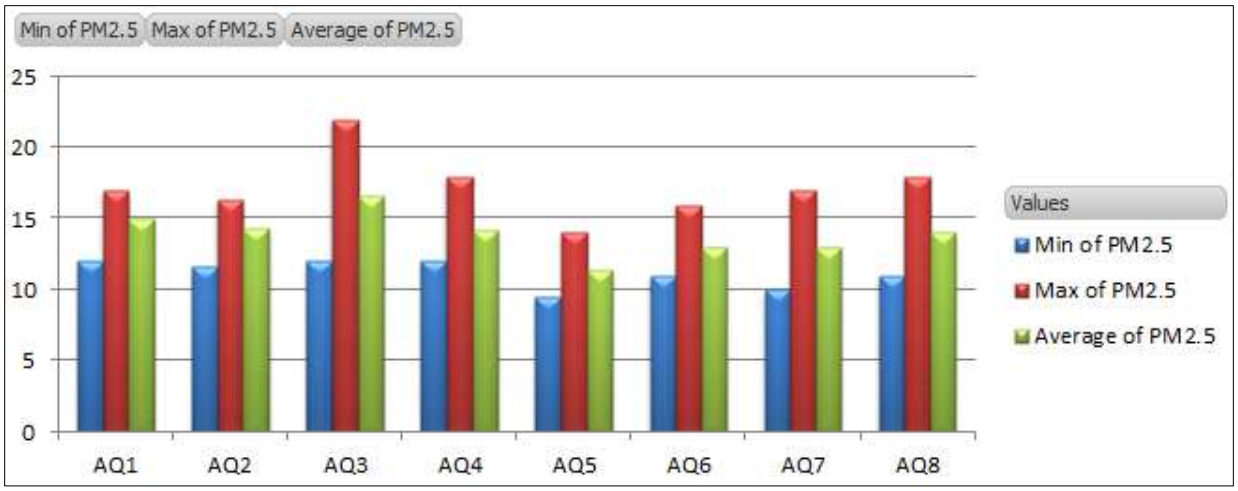


Figure 14: Variation in $PM_{2.5}$ Levels

172. **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 36-80 μg/m^3 (**Table 54**). The overall mean for all stations was 55.50 μg/m^3. The 24-hourly average 98-percentile values of PM_{10} (max 79.72 μg/m^3 at AQ3) 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 54 Summary of PM_{10} levels in Study Area

Station Code	Station Location	Area Category	PM_{10} (μg/m^3)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Kenkere	Residential & Rural	56-66	60.00	65.64	100
AQ2	Devalapura		56-66	60.00	65.64	
AQ3	Nagamangala		66-80	72.13	79.72	
AQ4	Kommenahalli		42-60	51.38	59.44	
AQ5	Bheriya		38-46	42.00	45.88	
AQ6	Ramanathapura		48-56	52.00	55.88	
AQ7	Siddapura		40-60	50.00	59.64	
AQ8	Konanur		36-50	44.00	49.88	
Overall of 8 locations			**36-80**	**55.50**	**78.44**	

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

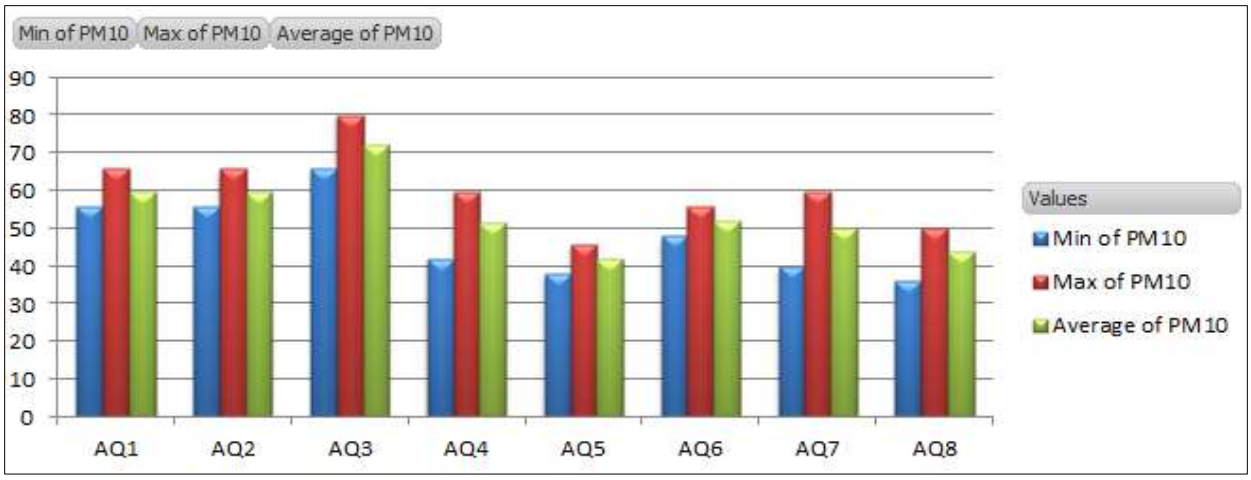


Figure 15: Variation in PM_{10} Levels

173. **Sulphur Dioxide (SO_2).** Arithmetic mean of the 24-hourly average values of SO_2 varied station-wise between 6.0-15.4 μg/m^3 (**Table 55**) with overall mean of the all stations being 9.78 μg/m^3. The 24-hourly average 98-percentile values of SO_2 (max 15.21 μg/m^3 at AQ2) 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.

Table 55: Summary of SO_2 levels in Study Area

Station Code	Station Location	Area Category	SO_2 (μg/m^3)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Kenkere	Residential & Rural	6.5-10.2	8.53	10.18	80
AQ2	Devalapura		10.6-15.4	12.28	15.21	
AQ3	Nagamangala		8.8-13.8	11.33	13.62	
AQ4	Kommenahalli		8.2-12.6	10.09	12.42	
AQ5	Bheriya		6-8.5	7.05	8.42	
AQ6	Ramanathapura		7.4-11.8	9.25	11.64	
AQ7	Siddapura		6.2-9.8	7.88	9.75	
AQ8	Konanur		8.2-11.4	10.00	11.35	
Overall of 8 locations			**6.0-15.4**	**9.78**	**14.15**	

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

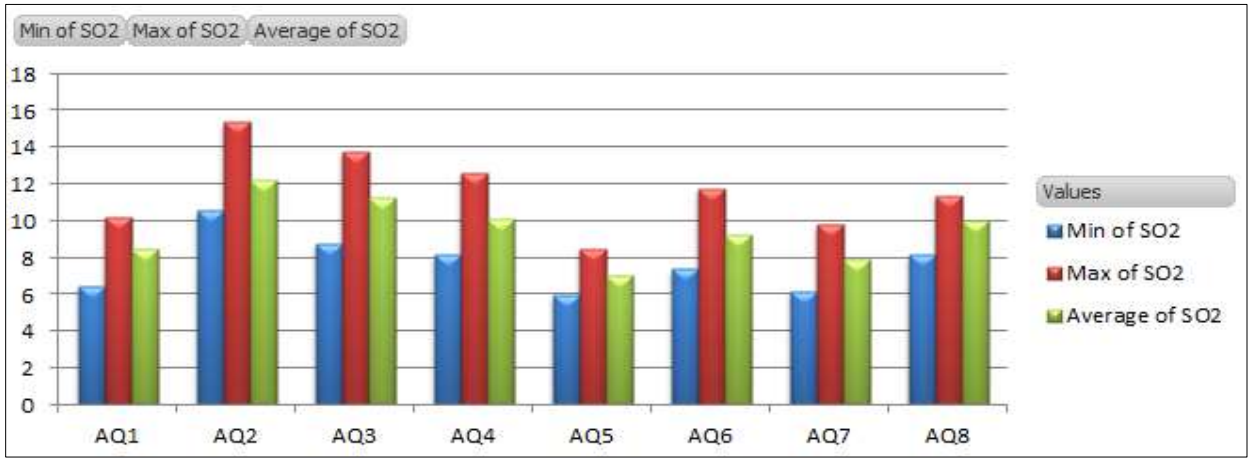


Figure 16: Variation in SO_2 Levels

174. **Nitrogen Dioxide (NO_2).** Arithmetic mean of the 24-hourly average values of NO_2 varied station-wise between 12-32 μg/m^3 (**Table 56**) with overall mean of the all stations being 21.95 μg/m^3. The 24-hourly average 98-percentile values of NO_2 (31.72 μg/m^3 at AQ3 & AQ4) 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.

Table 56: Summary of NO_2 levels in Study Area

Station Code	Station Location	Area Category	NO_2 (μg/m^3)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Kenkere	Residential & Rural	14-20	16.75	19.88	80
AQ2	Devalapura		22-30	26.00	29.88	
AQ3	Nagamangala		22-32	26.50	31.72	
AQ4	Kommenahalli		22-32	26.75	31.72	
AQ5	Bheriya		16-24	19.50	23.76	
AQ6	Ramanathapura		12-22	17.50	21.88	
AQ7	Siddapura		12-22	17.25	21.82	
AQ8	Konanur		12-20	16.00	19.88	
Overall of 8 locations			**12-32**	**21.95**	**32.00**	

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

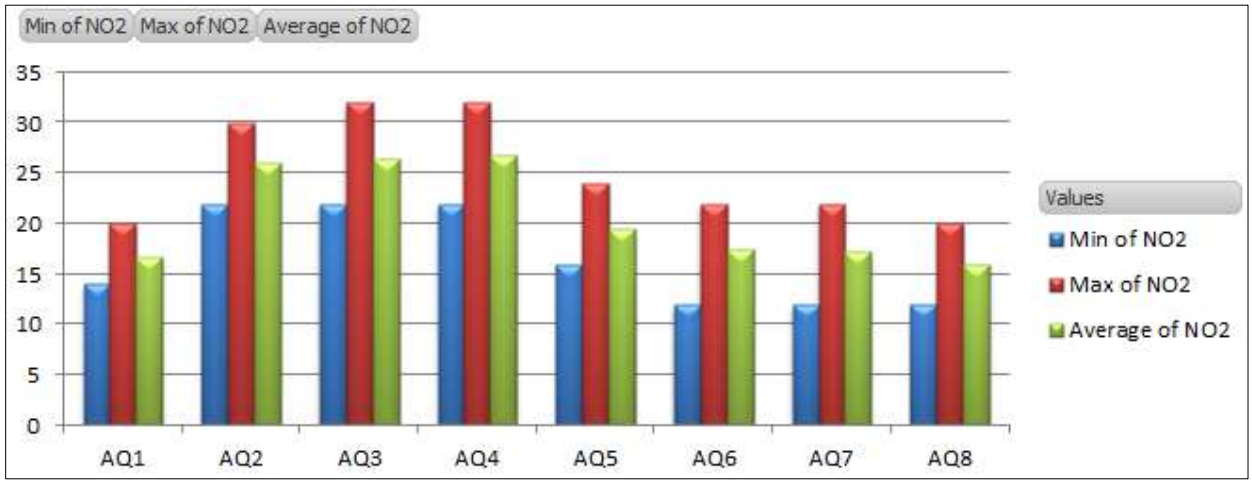


Figure 17: Variation in NO_2 Levels

175. ***Carbon monoxide (CO).*** Arithmetic mean of the 24-hourly average values of CO varied station-wise between 0.31-0.70 mg/m^3 (**Table 57**) with overall mean of the all stations being 0.46 mg/m^3.

176. The 24-hourly average 98-percentile values of CO (max 0.65 mg/m^3 at AQ1) 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.

Table 57 Summary of CO levels in Study Area

Station Code	Station Location	Area Category	CO (mg/m^3)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Kenkere	Residential & Rural	0.6-0.7	0.65	0.70	4
AQ2	Devalapura		0.37-0.45	0.41	0.45	

Station Code	Station Location	Area Category	CO (mg/m^3)			
			Range	Mean	98%tile	NAAQ Standard
AQ3	Nagamangala		0.53-0.68	0.61	0.67	
AQ4	Kommenahalli		0.32-0.45	0.38	0.45	
AQ5	Bheriya		0.39-0.44	0.42	0.44	
AQ6	Ramanathapura		0.32-0.46	0.40	0.46	
AQ7	Siddapura		0.33-0.4	0.37	0.40	
AQ8	Konanur		0.31-0.39	0.36	0.39	
Overall of 8 locations			**0.31-0.7**	**0.46**	**0.68**	

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

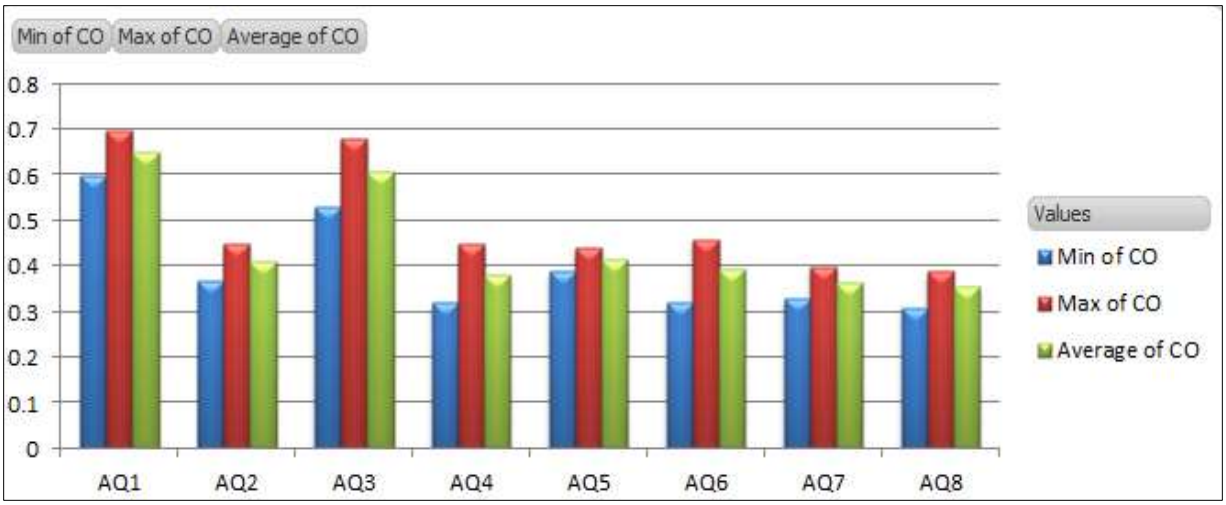


Figure 18 Variation in CO Levels

177. 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 58**. 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 AQ2 are presented in **Annex-4.4.**

Table 58: 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	Kenkere	4	12.00	17.00	1.87	16.94	0	0
	AQ2	Devalapura	4	11.60	16.40	1.75	16.32	0	0
	AQ3	Nagamangala	8	12.00	22.00	3.16	21.72	0	0
	AQ4	Kommenahalli	8	12.00	18.00	1.92	17.72	0	0
	AQ5	Bheriya	4	9.50	14.00	1.78	13.88	0	0
	AQ6	Ramanathapura	4	11.00	16.00	1.87	15.82	0	0
	AQ7	Siddapura	4	10.00	17.00	2.74	16.82	0	0
	AQ8	Konanur	4	11.00	18.00	2.55	17.76	0	0
	Overall 8 Locations		**40**	**9.50**	**22.00**	**2.79**	**20.44**	**0**	**0**
PM_{10} ($\mu g/m^3$)	AQ1	Kenkere	4	56.00	66.00	3.74	65.64	0	0
	AQ2	Devalapura	4	56.00	66.00	3.74	65.64	0	0
	AQ3	Nagamangala	8	66.00	80.00	5.21	79.72	0	0
	AQ4	Kommenahalli	8	42.00	60.00	5.54	59.44	0	0
	AQ5	Bheriya	4	38.00	46.00	3.16	45.88	0	0

Pollutant	AAQMS	Location	Mes	Min	Max	SD	p98	PTV^{IND}	PTV^{WB}
	AQ6	Ramanathapura	4	48.00	56.00	3.16	55.88	0	0
	AQ7	Siddapura	4	40.00	60.00	7.62	59.64	0	0
	AQ8	Konanur	4	36.00	50.00	5.48	49.88	0	0
	Overall 8 Locations		**40**	**36.00**	**80.00**	**11.12**	**78.44**	**0**	**0**
SO_2 ($\mu g/m^3$)	AQ1	Kenkere	4	6.50	10.20	1.53	10.18	0	0
	AQ2	Devalapura	4	10.60	15.40	1.90	15.21	0	0
	AQ3	Nagamangala	8	8.80	13.80	1.54	13.62	0	0
	AQ4	Kommenahalli	8	8.20	12.60	1.47	12.42	0	0
	AQ5	Bheriya	4	6.00	8.50	0.94	8.42	0	0
	AQ6	Ramanathapura	4	7.40	11.80	1.61	11.64	0	0
	AQ7	Siddapura	4	6.20	9.80	1.55	9.75	0	0
	AQ8	Konanur	4	8.20	11.40	1.18	11.35	0	0
	Overall 8 Locations		**40**	**6.00**	**15.40**	**2.16**	**14.15**	**0**	**0**
NO_2 ($\mu g/m^3$)	AQ1	Kenkere	4	14.00	20.00	2.38	19.88	0	0
	AQ2	Devalapura	4	22.00	30.00	3.16	29.88	0	0
	AQ3	Nagamangala	8	22.00	32.00	3.12	31.72	0	0
	AQ4	Kommenahalli	8	22.00	32.00	3.03	31.72	0	0
	AQ5	Bheriya	4	16.00	24.00	2.96	23.76	0	0
	AQ6	Ramanathapura	4	12.00	22.00	3.84	21.88	0	0
	AQ7	Siddapura	4	12.00	22.00	3.70	21.82	0	0
	AQ8	Konanur	4	12.00	20.00	3.16	19.88	0	0
	Overall 8 Locations		**40**	**12.00**	**32.00**	**5.61**	**32.00**	**0**	**0**
CO (mg/m^3)	AQ1	Kenkere	4	0.60	0.70	0.04	0.70	0	0
	AQ2	Devalapura	4	0.37	0.45	0.04	0.45	0	0
	AQ3	Nagamangala	8	0.53	0.68	0.04	0.67	0	0
	AQ4	Kommenahalli	8	0.32	0.45	0.04	0.45	0	0
	AQ5	Bheriya	4	0.39	0.44	0.02	0.44	0	0
	AQ6	Ramanathapura	4	0.32	0.46	0.06	0.46	0	0
	AQ7	Siddapura	4	0.33	0.40	0.03	0.40	0	0
	AQ8	Konanur	4	0.31	0.39	0.03	0.39	0	0
	Overall 8 Locations		**40**	**0.31**	**0.70**	**0.12**	**0.68**	**0**	**0**

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

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

178. As evident from **Table 58** 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

179. To assess the background noise levels in the study area ambient noise monitoring was conducted at three 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

180. 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 59.**

Table 59 Details of Noise Monitoring Stations

Station Code	Place	Chainage (Km)	Side	Distance# (m)	Area category
NQ1	Navagraha Temple, Kenkere	82+380	RHS	20	Silence
NQ2	Nagamangala	115+000	LHS	35	Residential
NQ3	Govt Primary School, Bommenahalli	161+400	RHS	22	Silence
NQ4	Bheriya	174+750	RHS	25	Residential
NQ5	Govt. Degree College, Shaligram	186+250	LHS	40	Silence
NQ6	Ramanathapura, near the ASI Site	207+950	LHS	40	Residential
NQ7	Pattabirama Govt. Girls PU College, Ramanathapura	209+000	LHS	50	Silence
NQ8	MKS Lions Vidhyaniketahan, Konanur	212+950	LHS	18	Silence

Source: On-site Noise Monitoring during December 2015

Distance in meter from existing centerline

2. Methodology of Noise Monitoring

181. 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.

182. 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

183. The ambient noise levels of the study area are presented in **Table 60**. Ambient air quality standards in respect of noise are reproduced in **Annex-3.1**.

Table 60 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	43.0	35.3	40.0	43.4	39.9	31.4	38.9	41.1	39.9	45.2
NQ2	Resi	**68.2**	62.4	63.3	62.2	62.1	62.2	62.2	63.3	62.0	68.7
NQ3	Silence	**68.2**	66.7	67.3	66.3	65.0	66.0	66.2	64.1	63.0	68.3
NQ4	Resi	67.9	66.3	66.5	66.2	59.3	66.9	66.5	**65.1**	59.3	68.1
NQ5	Silence	66.3	43.4	55.4	37.0	28.8	34.9	54.2	63.5	25.4	66.4
NQ6	Resi	43.6	34.7	38.9	34.2	29.2	31.7	37.7	41.7	24.6	46.7
NQ7	Silence	68.7	62.7	67.8	61.3	61.0	61.2	66.6	64.3	61.0	69.0

Station	Zone	L_{d10}	L_{d90}	L_{deq}	L_{n10}	L_{n90}	L_{neq}	L_{dn}	$L_{eq(24)}$	L_{Min}	L_{Max}
NQ8	Silence	**69.0**	66.8	67.1	66.7	59.2	61.0	65.9	**66.8**	37.3	69.1

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)

184. 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 65.1 dB(A) in NQ4 and 66.8 dB(A) in NQ8 respectively.

185. Ld10 values (highest among the monitored values) are found to be 68.2 dB(A) and 69.0 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 Water Quality

186. The project road crosses a number of rivers, canals and causeways en-route, which has been detailed in **Table 61**. 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 62.**

Table 61 List of River, canal and causeway crossings en-route

SN	Description	Village	Existing Ch. km
River Crossing			
1.	Sanabaghatta Halla	Ungra	86+800
2.	Hemavati River Crossing	Akkihebbalu	164+830
Canal / Stream / Causeway Crossing			
3.	Canal crossing	Nagamangala	110+800

SN	Description	Village	Existing Ch. km
4.	Canal crossing	Ganganahalli	120+700
5.	Nala Crossing	Kallenahalli	127+100
6.	Canal crossing	Valagere Manesa	144+100
7.	Canal crossing	Laxmipura	161+700
8.	Canal crossing	Akkihebbalu	163+400
9.	Canal crossing	Akkihebbalu	164+400
10.	Canal crossing	Machaholalu	167+050
11.	Hariavati Left Bank Canal	Kodaliya	176+600
12.	Canal crossing	Saligrama	179+900
13.	Canal crossing	Dorambali	188+580
14.	Canal crossing	Honnenahalli	193+300
15.	Canal crossing	Honnenahalli	194+680
16.	Canal crossing	Juttenahalli	196+500
17.	Harangi Left Bank Canal	Siddapura	217+200
18.	Alur Hole (Rivulet)	Abbur	221+300

Source: Field Survey conducted by ICT Pvt. Ltd.

187. Kaveri River is located beside the project road between Chainage Km 192+00 to 210+500 but never crosses the road. The road crosses Shimsha River at Chainage km 93+200 in its excluded portion with SH-84.

Table 62 List of Water Bodies along the Project Road

Sl. No.	Particulars	Existing Ch. km	Design Ch. Km	Distance# (m)	Side	Village	Use of Water	Length of the Water Bodies along the Road (m)
1	Pond	56+300	55+300	86.0	RHS	Kamesagar	Irrigation	*
2	Road Side Ditch	57+660	56+625	7.7	LHS	Sathanuru	No use	12.0
3	Water Body	59+000	57+970	20.0	RHS	Dhonakuppi	Livestock watering	30.0
4	Road Side Ditch	67+140	65+810	8.1	RHS	Neelasandra	No use	11.5
5	Road Side Ditch	72+050		8.7	LHS	Hangarahalli	Irrigation	15.0
6	Depambudhai Tank	72+400	70+940	18.3	RHS	Devapatna	Irrigation	250.0
7	Pond	75+800	73+700	289.8	RHS	Huliyurdurga	Irrigation	*
8	Pond (Hosa Kere)	78+000	75+700	200.5	RHS	Huliyurdurga	Irrigation	*
9	Road Side Ditch	81+465	79+145	2.3	RHS	Huliyurdurga	No use	20.0
10	Pond	84+200		37.2	RHS	Suggunahalli	Irrigation, Domestic except drinking	*
11	Pond	85+300		129.8	RHS	Suggunahalli	Irrigation, Domestic except drinking	*
12	Pond	89+050	86+450	61.1	RHS	Ungara	Irrigation	*
13	Pond (Dodda Katte)	90+400	87+800	77.2	LHS	Yadavani	Irrigation	*
14	Pond	93+485	90+600	8.5	RHS	Kudagaballu	Irrigation	22.0
15	Pond (Nammora Kere)	100+550	97+600	13.3	RHS	Devalpura	Irrigation	230.0
16	Pond	104+200	101+200	33.3	LHS	Kuntanakoppalu	Livestock watering, Irrigation	70.0

Sl. No.	Particulars	Existing Ch. km	Design Ch. Km	Distance# (m)	Side	Village	Use of Water	Length of the Water Bodies along the Road (m)
17	Pond (Amankatte Kere)	113+300	110+900	10.6	LHS	Nagmangala	Irrigation	700.0
18	Pond (Sule Kere)	117+800	114+800	9.9	RHS	Sankanhalli	Drinking, Irrigation	1200.0
19	Pond	125+935	122+800	11.1	RHS	Kallenahalli	Livestock watering, Irrigation	70.0
20	Road Side Ditch	126+635	123+500	9.7	RHS	Kallenahalli	No use	10.0
21	Pond	128+780	125+600	6.6	LHS	Ayithanahalli	Irrigation	169.0
22	Pond	132+800	129+545	25.6	RHS	Seege Hosuru	Irrigation	*
23	Pond	133+500	130+260	52.4	RHS	Thiraganahalli	Livestock watering, Irrigation	*
24	Pond	138+300	134+800	8.0	RHS	Bommadihalli	Irrigation	15.0
25	Road Side Ditch	141+470	137+940	5.2	LHS	Kotegenahalli	Livestock watering, Irrigation	40.0
26	Road Side Ditch	141+745	138+200	10.7	LHS	Kotegenahalli	No use	15.0
27	Pond	142+100	138+600	151.0	RHS	Kotegenahalli	Irrigation	*
28	Road Side Ditch	142+965	139+435	40.1	LHS	Kotegenahalli	Irrigation	*
29	Road Side Ditch	143+050	139+530	5.2	RHS	Jaginkere	Irrigation	67.0
30	Storm Water Storage Tank	143+120	139+590	13.6	RHS	Jaginkere	Irrigation	15.0
31	Road Side Ditch	143+560	140+035	6.2	LHS	Jaginkere	No use	30.0
32	Pond	148+265	144+750	84.7	LHS	Valagere Menasa	Irrigation	*
33	Pond	149+600	146+050	97.4	RHS	Kodihalli	Irrigation, Domestic except drinking	*
34	Lake (K R Pet Kere)	152+000		6.2	RHS	K. R. Pet	Drinking, Irrigation	Bypass proposed
35	Lake (Hosaholalu kere)	155+550		8.4	LHS	Hosaholalu	Irrigation	Bypass proposed
36	Lake (Hosaholalu kere)	155+800		8.5	RHS	Hosaholalu		
37	Pond	158+700		11.3	RHS	Kommenahalli	Irrigation	Realignment
38	Pond	158+700		447.9	RHS	Kommenahalli	Irrigation	*
39	Pond	158+900	155+300	648.5	RHS	Kommenahalli	Irrigation	*
40	Pond	174+600	170+800	7.1	RHS	Sambaravalli	Irrigation	175.0
41	Pond	177+150	173+350	8.0	RHS	Kodiyala	Livestock watering, Irrigation	105.0
42	Pond	180+175	176+300	10.0	LHS	Yalemudana halli	Livestock watering, Irrigation	210.0
43	Pond	180+700	177+000	247.4	RHS	Kurubahalli	Irrigation	*
44	Road Side Ditch	181+000	177+200	6.0	LHS	Kurubahalli	No use	22.0
45	Road Side Ditch	181+850	178+050	7.3	RHS	Kalli muddanahalli	No use	50.0
46	Saligrama Lake	184+800	181+100	15.3	RHS	Saligrama	No use	830.0
47	Pond	190+777	186+915	9.5	RHS	Haradanahalli	Irrigation	15.0

Sl. No.	Particulars	Existing Ch. km	Design Ch. Km	Distance# (m)	Side	Village	Use of Water	Length of the Water Bodies along the Road (m)
48	Pond	197+000	193+100	264.2	LHS	Honnenahalli	Irrigation	*
49	Pond	197+060	193+150	57.4	RHS	Honnenahalli	No use	*
50	Pond	197+900	193+950	13.9	RHS	Honnenahalli	Irrigation	95.0
51	Pond	198+500	194+550	40.9	RHS	Honnenahalli	Irrigation	*
52	Pond	199+200	195+250	11.4	RHS	Juttenahalli	Irrigation	153.0
53	Shallow Water body	202+500	198+450	6.0	LHS	Kananakopal	Irrigation	196.0
54	Pond	203+200	199+300	6.5	RHS	Basavapatna	Irrigation	331.0
55	Pond	205+445	202+075	7.8	RHS	Shiradanahalli	Irrigation	34.0
56	Pond	213+100	209+100	26.9	RHS	Konanuru	Irrigation, Domestic except drinking	*
57	Pond	216+200	212+150	100.2	LHS	Siddapura	Irrigation	*
58	Pond (Abbur Kere)	220+850	216+850	7.8	RHS	Kurubara Abbur	Livestock Watering	Realignment
59	Road side Ditch	222+040	218+000	12.1	LHS	Hadenoor	Irrigation	110.0
60	Pond	222+500	218+550	7.9	LHS	Hadenoor	Livestock watering, Irrigation	397.0

Source: Field Survey conducted by ICT Pvt. Ltd.

Distance in meter from existing centerline

* Not located adjacent to the project road

1. Surface Water Quality Monitoring Stations

188. 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, seven (7) surface water quality monitoring stations were selected for sampling. Details of the location of Surface Water Quality Stations are provided in **Table 63.**

Table 63 Details of Surface Water Quality Monitoring Stations

Station Code	Place	Chainage (Km)	Side	Distance # (m)	Type
SW1	Depambudhai Lake	72+400	RHS	20	Lake
SW2	Ammana Katte	113+300	LHS	12	Lake
SW3	Sule Kere	117+800	RHS	15	Lake
SW4	Canal Crossing near Jaginakere Village	144+119	LHS	36	Canal
SW5	Hemavati River Crossing	164+830	LHS	35	River
SW6	Shaligrama Lake	184+800	RHS	20	Lake
SW7	Cauvery River (at Ramanathapura)	207+600	LHS	216	River

 # 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

189. 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.

190. 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

191. The salient water quality parameters are statistically analyzed and presented **Table 64** 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. Details of water quality monitoring results are presented in **Table 65**.

192. Temperature varied between 24.8-25.0°C. pH values were generally above the neutral mark (7.42-8.05) which were within the tolerance limit of 6.5-8.5. The slight acidic nature of the river water may be associated with predominantly acidic soil of its catchment. Conductivity varied between 159-1556 μmhos/cm with TDS ranging between 103-1012 mg/l. Low values of conductivity and TDS in pond water samples indicate that the water is marginally mineralized and devoid of any industrial discharges. However, both that river water samples are found to be more mineralized than the pond water, possibly because of the characteristics of its runoff received from a larger area.

193. Dissolved oxygen levels are found to be in the range of 5.6-6.1 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. BOD ranges from 7-21 mg/l while COD ranges are found be 22-64 mg/l. Such high 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. Total hardness values were observed to vary in the range of 61-536 mg/l. It has been observed that the river water (SW5) exceeds the prescribed total hardness limit of 300 mg/l for Class A surface water. Oil & grease and nitrates remain undetected in all samples.

Table 64: Salient Surface Water Quality Features

SN	Parameter	Range	AM	SD	PTV
1.	pH	7.42-8.09	7.6	0.270	0
2.	DO (mg/l)	5.3-6.1	5.7	0.280	71
3.	BOD (3 days at 27°C) (mg/l)	7-21	12.7	4.712	100
4.	TDS (mg/l)	103-1012	462.6	291.129	29
5.	Total hardness (mg/l as $CaCO_3$)	61-536	226.0	153.339	14
6.	Nitrate nitrogen (mg/l as NO_3)	0.75-10.1	3.0	3.028	0
7.	Iron (mg/l as Fe)	0.03-0.23	0.1	0.068	0
8.	Fluoride (mg/l as F)	0.23-0.63	0.4	0.113	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).

Table 65 Surface Water Quality Analysis Results

S	Parameters	Units	SW1	SW2	SW3	SW4	SW5	SW6	SW7	Limits#
1.	pH	-	8.09	7.52	7.75	7.85	7.42	7.57	7.37	6.5-8.5
2.	Temperature	^{O}C	24.5	24.8	25	24.9	25	24.8	25	---

3.	Conductivity	µmhos/cm	575	159	610	764	1556	241	1074	---
4.	Colour	Hazen	<5	<5	<5	<5	<5	<5	<5	10
5.	Turbidity	NTU	2.9	1.8	3.7	4.2	5.4	2.3	4.8	---
6.	Total Hardness as $CaCO_3$	mg/l	130	61	216	272	536	69	298	300
7.	Total Dissolved Solids	mg/l	374	103	397	497	1012	157	698	500
8.	Total Suspended Solids	mg/l	14	7	19	15	21	10	13	---
9.	Sodium as Na	mg/l	47	4	21	23	67	13	79	---
10.	Potasium as K	mg/l	3	1	2	2	6	2	9	---
11.	Calcium as $CaCO_3$	mg/l	56	22	125	95	363	17	194	200
12.	Magnesium as $CaCO_3$	mg/l	74	39	91	177	173	52	104	100
13.	Dissolved Oxygen	mg/l	5.4	5.7	5.5	5.3	6	5.8	6.1	6
14.	COD	mg/l	40	32	56	64	26	38	22	---
15.	BOD 3 days at 27°C	mg/l	12	11	18	21	8	12	7	2
16.	Chloride as Cl	mg/l	39	16	43	55	204	14	188	250
17.	Sulphate as SO_4	mg/l	4.4	4.2	9.8	11	68	4.1	15.9	400
18.	TKN as N	mg/l	1.1	1	1.8	8.4	11.1	1.9	6.2	---
19.	Nitrate as NO_3	mg/l	0.96	0.75	1.5	2.7	10.1	1.6	3.5	20
20.	Iron as Fe	mg/l	0.06	0.03	0.11	0.14	0.23	0.05	0.18	0.3
21.	Manganese as Mn	mg/l	<0.02	<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	<0.001	0.01
23.	Total Arsenic as As	mg/l	<0.01	<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	0.05
25.	Copper as Cu	mg/l	<0.01	<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	0.001
27.	Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
28.	Zinc as Zn	mg/l	0.26	0.05	0.14	0.17	0.35	0.07	0.21	15
29.	Boron as B	mg/l	0.21	0.26	0.25	0.34	0.23	0.23	0.22	---
30.	Fluoride as F	mg/l	0.36	0.23	0.35	0.34	0.63	0.43	0.41	1.5
31.	Chlorine	mg/l	0.2	0.17	0.22	0.18	ND	0.24	ND	---
32.	Phenolic Compound	mg/l	<0.001	<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	<0.05	---
34.	Phosphate as PO_4	mg/l	0.08	0.04	0.06	0.12	0.24	0.17	0.26	---
35.	SAR	mg/l	1.79	0.22	0.62	0.6	1.26	0.68	1.99	---
36.	Total Coliform	MPN/100 ml	3540	3250	3670	9436	5600	3450	4580	50
37.	Faecal Coliform	MPN/100 ml	510	422	446	970	675	425	568	---

Source: On-site Water Quality Monitoring in December 2015

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

194. Chloride and sulphate contents in pond waters varied between 14-43 mg/l and 4.1-11 mg/l respectively, while the same for river water varied between 188-204 mg/l and 16-68 mg/l respectively. While calcium content varied between 17-363 mg/l, magnesium ranged between 39-177 mg/l. Levels of iron was 0.03-0.23 while arsenic, chromium, cadmium, copper, manganese, zinc and mercury are found to be low detectable limit. Both of the samples are found to be high in total and fecal coliforms and therefore not suitable for human use in any manner. The water quality results shows the surface waters in the study area are devoid of any extraneous chemical contamination; there is 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. Agricultural runoff, exfoliated biomass and animal

wastes can be attributed for presence of organic materials in the water, which utilizes dissolved oxygen while decomposing. This has resulted lowering of available DO and high BOD.

M. Ground Water Quality in the Study Area

195. 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

196. 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 66.**

Table 66 Details of Ground Water Quality Monitoring Stations

Station Code	Place	Chainage (Km)	Side	Distance# (m)	Usage
GW1	Malenahalli	115+500	RHS	15	Drinking
GW2	Kommenahalli	159+100	LHS	13	Drinking
GW3	Haradanahalli	191+900	LHS	10	Drinking
GW4	Konanur	212+850	RHS	11	Drinking

Source: On-site Water Quality Monitoring in December 2015

Distance in meter from existing centerline

197. 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

198. Salient features of ground water quality monitoring results are presented in **Table 67**. The ground water quality monitoring results are provided in **Table 68**.

Table 67 Salient Ground Water Quality Features

SN	Parameter	Range	AM	SD	PTV
1.	pH	7.52-8.35	7.90	0.3	0
2.	TDS (mg/l)	381-1268	752.75	354.0	0
3.	Total hardness (mg/l as $CaCO_3$)	212-635	376	165.3	25
4.	Chloride (mg/l as Cl^-)	27-270	113.25	99.1	0
5.	Iron (mg/l as Fe)	0.15-0.34	0.245	0.1	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).

199. 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 7.6-8.35, marginally above the neutral mark but within the permissible limits of 6.5-8.5 stipulated in drinking water quality standards (IS 10500:2012). Total hardness values for all samples are observed to high (212-635 mg/l) and are higher than the desirable limits (200 mg/l) of drinking water quality standards. Out of the three samples, two samples are found to be lower than the acceptable limits (600 mg/l), in absence of alternative sources, while one sample exceeded it.

200. Chloride and sulphate contents were 27-270 mg/l and 10.1-60.5 mg/l respectively. While calcium content varied between 31-168 mg/l, magnesium ranged between 33-53 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. All these parameters were generally within the tolerance limits for drinking water except hardness.

Table 68 Ground Water Quality Monitoring Results

Sl. No.	Parameters	Units	GW1	GW2	GW3	GW4	Indian Standard 10500:2012		WHO Limits
							Desirable	Permissible	
1.	pH	-	7.92	7.52	8.35	7.84	*6.5-8.5*	*No relaxation*	-
2.	Temperature	^{O}C	25	25	25	25	-	-	-
3.	Conductivity	µmhos/cm	586	1951	1370	727	-	-	-
4.	Turbidity	NTU	2.1	4.1	3.9	3.6	*1*	*5*	-
5.	Total Hardness as $CaCO_3$	mg/l	212	635	402	255	*200*	*600*	-
6.	Total Alkalinity as $CaCO_3$	mg/l	177	494	422	285	*200*	*600*	-
7.	Total Dissolved Solids	mg/l	381	1268	890	472	*500*	*2000*	-
8.	Sodium as Na	mg/l	20	94	83	31	-	-	-
9.	Potassium as K	mg/l	3	11	9	3	-	-	-
10.	Calcium as Ca	mg/l	31	168	95	43	*75*	*200*	-
11.	Magnesium as Mg	mg/l	32.6	52.5	40	35.7	*30*	*100*	-
12.	Chloride as Cl	mg/l	27	270	127	29	*250*	*1000*	-
13.	Sulphate as SO_4	mg/l	60.5	86.8	46.2	10.1	*200*	*400*	-
14.	Nitrate as NO_3	mg/l	4.3	7.8	8.6	3.7	*45*	*No relaxation*	*50*
15.	Iron as Fe	mg/l	0.15	0.32	0.34	0.17	*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	0.25	0.4	0.42	0.3	*5*	*15*	-
24.	Boron as B	mg/l	ND	ND	ND	ND	*0.5*	*1*	*2.4*
25.	Fluoride as F	mg/l	0.52	0.89	0.64	0.59	*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

201. From above it can be concluded that the ground water, in general, is hard in nature and the physico-chemical quality, at large (except hardness in GW2) satisfies the permissible limit as stipulated in Drinking Water Standards.

3. Ground Water Availability

202. In **Ramanagara district,** there are 8,854 bore wells providing water supply to 2,117 habitations. Further, ground water is the main source for all types of irrigation in the district. Bore wells (38,059 nos.) irrigate 36,808 ha out of total 41,054 ha. Thus ground water irrigates 86.4% of the total irrigation. This shows the predominant role of bore wells in irrigation in the district. About 1,626 ham of ground water resources is available in the district. In critical and over exploited areas artificial recharge and rainwater harvesting measures have been recommended by CGWB to augment ground water resources. About **45%** of the area of the district is **over exploited**. The **highest percentage of over exploited area is 75% in Magadi taluk** followed by 70% area in Kanakapura taluk. In such a situation there is a need to augment ground water recharge by artificial recharge structures and rainwater harvesting structures to harvest non-committal surface runoff.

203. In **Tumkur** district, there is over exploitation of ground water resource in 55% area of the district. This has resulted in the decline of water level of the order of 0.61m per decade. 919 dug wells and 402 bore wells have gone dry in the district.

204. In **Mandya** district, irrigation (16.29 %) is mainly dependent on ground water through dugwells, dug-cum-borewells and borewells. There are 8501 dug wells and 15905 bore wells in the district. There is over exploitation of ground water resource in 97% area of **K. R. Pet taluk**, and there is critical area of 77% area of Malavalli taluk. This has resulted in the decline of water level.

205. In most parts of the **Mysore** district, ground water is major source for domestic and drinking purposes. Out of the total area of 1180 km^2 under irrigation, about 11% is irrigated using ground water through dug wells and bore wells. There are 4501 dug wells and 16478 bore wells in the district. There is over exploitation of ground water resource in 73% area of Mysore district.

206. 40% of the **Hasan district** is **over-exploited'**, has less than 100% stage of development. 10% of Arkalgud Taluk, 75% of Arsikere taluk, 40% of Belur; 60% of C R Patna, 50% of Hassan and 40% of Holenarsipur are falling under Over Exploited category. Remaining **60%** is safe category areas. (*Source: Ground Water Information Booklet of CGWB*)

N. Ecology and Biodiversity

1. Introduction

207. The Project area is characterized by open countryside predominately plain terrain. The terrain is rugged and broken and is composed of a succession of hills and valleys intersected by rocks. The hills are usually boulder strewn and covered with scrubs.

208. Road side plantation consist of Pongamia pinnata (Karanj), Cassia siamea (Kassod), Leucaena leucocephala (Subabool), Azadirachta indica (Bevu), Ficus benghalensis (Ala), Ficus religiosa (Pipal) Acacia nilotica (Babool), Peltophorum pterocarpum (Copper pod),Tamarindus indica (Hunse), Syzygium cumini (Nerale), Grevillea robusta (Silver Oak) and Eucalyptus tereticornis (Eucalyptus).

View of Project Road

Plantation along Project Road

209. Major plantation in agricultural land comprises of *Cocus nucifera* (Coconut) and *Areca catechu* (Areca nut). Other species planted are *Mangifera indica* (Mango), *Psidium guajava* (Guava), *Musa paradisiaca* (Banana), *Artocarpus heterophyllus* (Jack fruit) *Carica papaya* (Papaya) and *Tamarindus indica* (Hunse). Some farmers also raise plantation of *Eucalyptus* and *Casuarina.*

210. The major crops grown in the region are paddy, sugarcane, jowar, maize, cotton, banana, vegetable, mulberry, gram, ragi, groundnut, horse gram and coconut. Paddy and sugarcane constitute chief crops grown under canal irrigation. Tea, Coffee and Cardamom are cultivated in large scale in the private areas adjacent to forests in Somwarpet.

2. Road Side Trees

211. The number of roadside trees within existing row is estimated to be 7,488. Side and girth size wise distribution of existing trees are provided in **Table 69.** Chainage wise detailed survey data is provided in **Annex 4.5**

Table 69 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	573	1319	1149	428	222	**3691**
LHS	1265	1067	561	295	609	**3797**
Total	**1838**	**2386**	**1710**	**723**	**831**	**7488**

3. Green Tunnels and Giant Trees

212. 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 70** and also marked in map in **Annex 4.6**

Table 70 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.	12°56'35.56"N 77°11'9.55"E	12°56'33.54"N 77°11'5.47"E	55+340	55+480	54+350	54+490	0.140
2.	12°53'16.33"N 77°7'22.21"E	12°53'11.21"N 77°7'12.73"E	65+600	65+925	64+330	64+655	0.325
3.	12°49'24.81"N 77°1'19.20"E	12°49'19.41"N 77°1'10.57"E	81+520	81+830	79+200	79+510	0.310
4.	12°49'8.89"N 77° 0'20.14"E	12°49'11.13"N 77°0'11.21"E	83+440	83+720	81+090	81+370	0.280
5.	12°48'2.62"N 76°48'53.44"E	12°47'58.30"N 76°47'35.72"E	107+800	110+100	104+700	107+000	2.300
6.	12°48'7.86"N 76°47'22.85"E	12°48'16.04"N 76°47'14.05"E	110+620	110+985	107+475	107+840	0.365
7.	12°49'8.00"N 76°45'51.58"E	12°49'8.63"N 76°45'46.18"E	114+310	114+460	111+300	111+450	0.150
8.	12°45'49.35"N 76°37'22.63"E	12°45'48.12"N 76°37'16.30"E	133+100	133+285	129+850	130+035	0.185
9.	12°45'0.43"N 76°34'24.14"E	12°44'58.34"N 76°34'17.05"E	139+340	139+560	135+830	136+050	0.220
10.	12°37'3.74"N 76°26'1.41"E	12°37'2.54"N 76°25'57.83"E	162+310	162+425	158+620	158+735	0.115
11.	12°37'12.23"N 76°4'35.76"E	12°37'14.33"N 76°4'29.72"E	209+700	209+900	205+725	205+925	0.200
							4.59

Source: Field Survey conducted by ICT Pvt. Ltd.

213. **Giant Trees:** Field survey was conducted to identify the location of giant trees. **520 giant trees** are found along the project road, out of which 245 trees are on the left side and 275 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.**

Figure 19 View of Giant Trees along the Project Road

4. Biodiversity Survey

214. Biodiversity survey was conducted in the month of December, 2015 to study the flora and fauna of the project area. 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 15 -20km such that the plots are located on either side of the road. GPS co-ordinates and altitude were recorded for each of the sample plots and presented in **Table-71.**

Table 71 GPS Co-ordinates and Altitude of the Sample Plots

Sample Plots	Latitude	Longitude	Altitude (m)	Vegetation type
1	12˚ 36' 34"	75˚ 58' 23"	871	Fallow agriculture land

Sample Plots	Latitude	Longitude	Altitude (m)	Vegetation type
2	12˚ 36' 49.1"	75˚ 8' 02"	818	Shrubby vegetation
3	12˚ 33' 59.4"	75˚ 16' 54.4"	793	Shrubby vegetation
4	12˚ 37' 4"	75˚ 26' 2.8"	779	Shrubby vegetation
5	12˚ 43' 13.5"	75˚ 32' 21.6"	836	*Acacia* and *Eucalyptus* Plantation
6	12˚ 44' 59.0"	75˚ 34' 19.0"	811	*Acacia* and *Eucalyptus* Plantation
7	12˚ 50' 7"	75˚ 44' 2.0"	760	*Acacia* and *Eucalyptus* Plantation
8	12˚ 48' 18"	75˚ 49' 9.0"	780	Shrubby vegetation
9	12˚ 52' 16"	75˚ 59' 27"	688	Shrubby vegetation

Source: Biodiversity Study conducted by ICT Pvt. Ltd.

215. The data collected on the number of individuals present for each species, for both flora and fauna, were subjected to further analysis. Importance Value Index (IVI), Shannon Diversity Index (H) and Simpson's Index (D) were calculated.

216. **Floral Composition.** Primary data on the floral composition was recorded along the 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. **82 floral species** were identified, out of which, 31 were trees, 29 shrubs and 22 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 72.** All species recorded are common in distribution. No threatened species of flora has been recorded during the survey.

Table 72 List of Flora recorded during Survey

Sl. No.	Species Name	Common Name	IUCN category
Trees			
1.	*Acacia auriculiformis*	Earleaf acacia	Least Concern
2.	*Acacia catechu*	Black cutch	NE
3.	*Acacia nilotica*	Babool	NE
4.	*Albizia amara*	Sujjalu	Least Concern
5.	*Albizia lebbeck*	Siris	NE
6.	*Annona squamosa*	Custared Apple	NE
7.	*Azadirachta indica*	Neem	NE
8.	*Bauhinia parpurea*	Basavana paada	Least concern
9.	*Butea monosperma*	Palash	NE
10.	*Cassia fistula*	Golden Shower	Least Concern
11.	*Cassia siamea*	Kassod tree	NE
12.	*Dalbergia sissoo*	Shisham	Least Concern
13.	*Delonix regia*	Gulmohar	Least Concern
14.	*Diospyros melanoxylon*	East Indian Ebony	NE
15.	*Eucalyptus tereticornis*	Forest Red Gum	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

Sl. No.	Species Name	Common Name	IUCN category
16.	*Ficus amplissima*	Paras pipal	NE
17.	*Ficus benghalensis*	Banyana	NE
18.	*Ficus religiosa*	Pipal	NE
19.	*Grevillea robusta*	Silver Oak	NE
20.	*Leucaena leucocephala*	Subabul	NE
21.	*Morinda tinctoria*	Indian mulberry	NE
22.	*Peltophorum pterocarpum*	Copper pod	NE
23.	*Phoenix sylvestris*	Kajoor	Least Concern
24.	*Pongamia pinnata*	Karanj	NE
25.	*Psidium guajava*	Guava	NE
26.	*Samanea saman*	Rain Tree	NE
27.	*Syzygium cumini*	Jamun	NE
28.	*Tamarindus indica*	Imli	NE
29.	*Terminalia chebula*	Chebulic myrobalan,	NE
30.	*Vitex altisima*	Myrole	NE
31.	*Wrightia tinctoria*	Veppali	Least Concern
	Shrubs		
32.	*Acacia concinna*	Soap pod	NE
33.	*Agave americana*	American aloe	Least Concern
34.	*Argyriea cuniata*	Purple morning glory	NE
35.	*Calotropis procera*	French Cotton	NE
36.	*Canthium parviflorum*	Kadbar	NE
37.	*Cassia auriculata*	Anval	NE
38.	*Cassia tora*	Coffee cassia	NE
39.	*Chromolaena odorata*	Siamweed	NE
40.	*Dodonaea viscosa*	Hop-bush	NE
41.	*Erythroxylum monogynum*	Red cedar	NE
42.	*Jasminum ritchiei*	Jasmine	NE
43.	*Jatropha curcas*	Physic nut	NE
44.	*Lantana camara*	Ghaneri	NE
45.	*Opuntia dillenii*	Nagphani	Least Concern
46.	*Pterolobium hexapetalum*	Baadubakka	NE
47.	*Rhus mysorensis*	Mysore Sumac	NE
48.	*Securinega virosa*	Dalme	NE
49.	*Sida acuta*	Blue okra	NE
50.	*Sida cordifolia*	Blue okra	NE
51.	*Sida rhombifolia*	Bala panchaang	NE
52.	*Solanum indicum*	Ban Tobacco	NE
53.	*Stachytarpheta indica*	Kaadu uttarani	NE
54.	*Stylosanthes fruticosa*	Pencil flower	NE
55.	*Tarenna asiatica*	Paapatige gida	NE
56.	*Tephrosia purpurea*	Orange Tephrosia	Least Concern
57.	*Toddalia asiatica*	Lopez root	Least Concern
58.	*Vicoa indica*	Sonkadi	NE
59.	*Waltheria indica*	Sleepy morning	NE
60.	*Ziziphus oenoploea*	Kakal-ber	NE
	Herbs		
61.	*Achyranthes aspera*	Prickly Chaff-flower	NE
62.	*Asparagus racemosus*	Shathaavari	NE
63.	*Commelina benghalensis*	Tropical Spider wort	Least Concern
64.	*Cynodon dactylon*	Bermuda grass	NE
65.	*Desmodium triflorum*	Matty desmodium	Least Concern

Sl. No.	Species Name	Common Name	IUCN category
66.	*Dolichos falcatus*	Kaduhurali	NE
67.	*Evolvulus alsinoides*	English speedwheel	NE
68.	*Hemidesmus indicus*	Nannari	NE
69.	*Hybanthus enneaspermus*	Ratanpurus	NE
70.	*Ichnocarpus frutescens*	Bakarbel	Least Concern
71.	*Leucas aspera*	Chhota-halkusa	NE
72.	*Mimosa pudica*	Touch me not	Least Concern
73.	*Mitracarpus verticillata*	Girdle pod	NE
74.	*Ocimum americanum*	Jangali-tulsi	NE
75.	*Orthosiphon diffuse*	Cats whisker	NE
76.	*Parthenium hysterophorus*	Carrot grass	NE
77.	*Phyllanthus urinaria*	Hazarmani	NE
78.	*Spilanthes acmella*	Toungue cleaner	NE
79.	*Tinospora cardifolia*	Heart-leaved Moonseed	NE
80.	*Tridax procumbens*	Coatbuttons	NE
81.	*Tylophora asthmatica*	Indian Ipecac	NE
82.	*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.

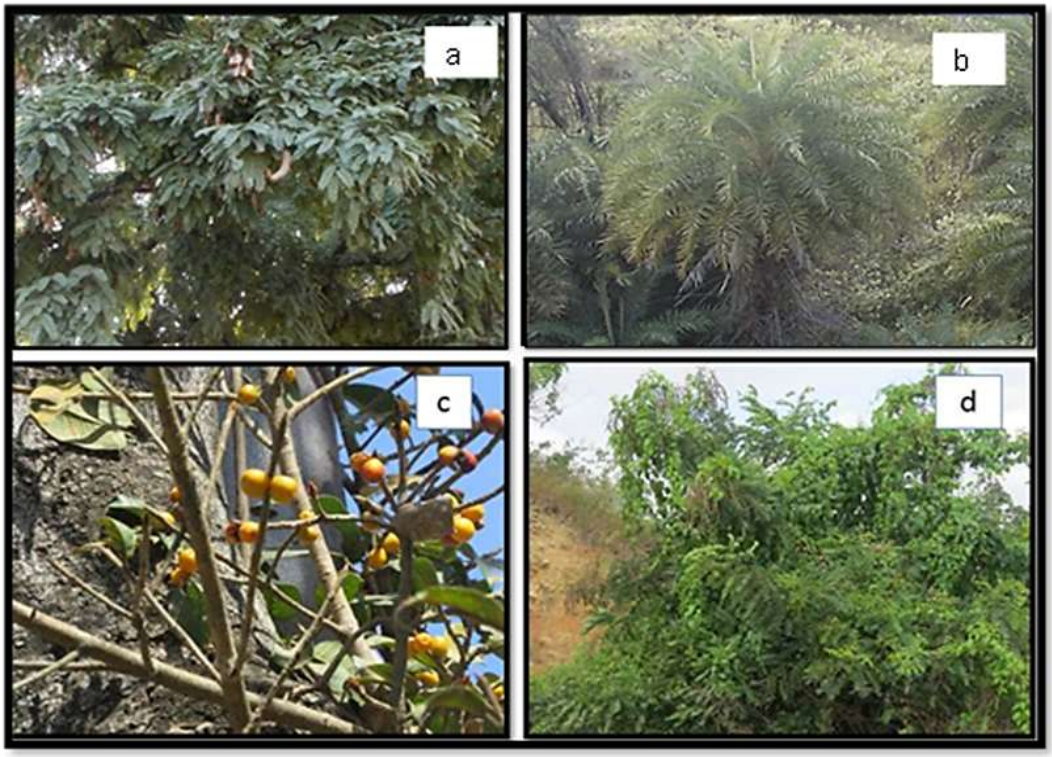


Plate 1: **Tree species**. a *Tamarindus indica* b. *Phoenix sylvestris* c. *Ficus amplissima* d. *Cassia siamea*

Plate 2: Shrub species a) *Chromolaena odorata* b. *Agave americana,* c. *Tephrosia purpurea,* d. *Solanum indicum*

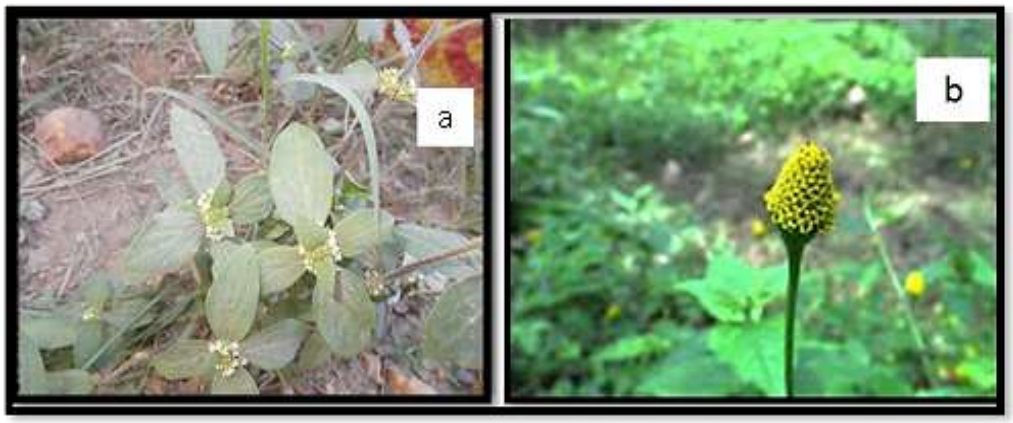


Plate 3: Herb species *a). Mitracarpus verticillata b) Spilanthes acmella*

217. Importance Value Index (IVI) : 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 **Annex-4.7** for trees (Table-A.4.7.1), shrubs (Table-A.4.7.2) and herb (Table-A.4.7.3). *Pongamia pinnata* was the dominant tree species with 14.54 IVI and the least was observed for *Albizia amara* (2.77). Abundance calculated for the tree species inferred that *Albizia amara* was having highest abundance value of 7.00 compared to other species; this is ascribed to the fact that the species though not distributed equally, the number of individual were more.

218. Assessment of shrub species revealed that *Chromolaena odorata* was dominating species with an IVI of 14.43 and the least IVI (2.61) was observed for *Toddalia asiatica.* The species abundance for individual shrub reveals that *Chromolaena odorata* was having highest abundance value of 19.50. IVI for the herb species show that *Mimosa pudica* was found to be dominating with

an IVI of 19.51. The species abundance was calculated for herb species and it is prudent to mention that *Cynodon dactylon* was having highest abundance value of 16.83.

219. **Shannon's Diversity index**: 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:

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

Where,
H = the Shannon diversity index
ni = Number of individuals belonging to the ith species,
N= Number of individuals in the sample,
S = Number of species encountered
∑ = sum from species 1 to species S

220. The estimated values of Shannon's diversity index are presented in **Table 73.** In the present assessment, the Shannon's diversity index for tree species was 3.34, for shrubs 3.21 and for herbs 2.86. Shannon's diversity index values obtained 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]).

Table 73 Shannon's Diversity Index

S.No	Flora	Shannon's Diversity Index (H)
1	Tree	3.34
2	Shrub	3.20
3	Herb	2.86

221. **Simpson's index**: It is also called concentration of dominance; it was calculated by following formula: $D = \sum_{i=1}^{s}(\pi)^2$

222. Where, π is proportion of important value of the ith species ($\pi = n_i/N$, 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 ≤ D ≤ 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 shrub diversity was more compared to trees and herbs (**Table 74**).

Table 74 Simpson's Index

S.No	Flora	Simpson's Index (D)
1	Tree	0.04
2	Shrub	0.05

[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

S.No	Flora	Simpson's Index (D)
3	Herb	0.07

223. **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. The duration of the survey was one day at the site. Based on the identification; scientific name, common name and individual numbers were recorded for further analysis. Total 77 faunal species were identified in the project area during field survey out of which 44 are avian species, 29 insects, 3 (three) reptiles and 1 (one) mammal. The status of fauna is provided as per schedule list of Wildlife Protection Act and International Union for Conservation of Nature (IUCN) red list in the **Table75.**

Table 75 List of Fauna Species identified in the Project Area

Sl. No.	Scientific Name	Common Name	Schedule	IUCN category
Avifauna				
1.	*Accipiter badius*	Shikra	Schedule I	Least Concern
2.	*Acridotheres tristis*	Common myna	Schedule IV	Least Concern
3.	*Actitis hypoleucos*	Common sand piper	Schedule IV	Least Concern
4.	*Anser indicus*	Bar headed goose	Schedule IV	Least Concern
5.	*Anthus rufulus*	Paddy field pippet	Schedule IV	Least Concern
6.	*Ardeola grayii*	Indian pond heron	Schedule IV	Least Concern
7.	*Bubulcus ibis*	Cattle egret	Schedule IV	Least Concern
8.	*Coracias benghalensis*	Indian roller	Schedule IV	Least Concern
9.	*Corvus splendens*	House crow	Schedule V	Least Concern
10.	*Cuculus micropterus*	Indian cuckoo	Schedule IV	Least Concern
11.	*Cypsiurus balasiensis*	Asian palm swift	NA	Least Concern
12.	*Dicaeum agile*	Thick billed flowerpecker	Schedule IV	Least Concern
13.	*Dicrurus leucophaeus*	Ashy drango	Schedule IV	Least Concern
14.	*Dicrurus macrocercus*	Black drango	Schedule IV	Least Concern
15.	*Egretta garzetta*	Little egret	NA	Least Concern
16.	*Fulica atra*	Common coot	Schedule IV	Least Concern
17.	*Gallus sonneratii*	Gray junglefowl	Schedule IV	Least Concern
18.	*Halcyon smyrnensis*	White brested kingfisher	Schedule IV	Least Concern
19.	*Haliaster indus*	Bhramini kite	Schedule I	Least Concern
20.	*Hirundo rustica*	Common swallow	NA	Least Concern
21.	*Ictinaetus malayensis*	Black eagle	Schedule I	Least Concern
22.	*Lanius meridionalis*	Southern grey shrike	NA	NE
23.	*Lonchura punctulata*	Spotted munia	Schedule II	Least Concern
24.	*Megalaima viridis*	White cheeked barbet	Schedule IV	Least Concern
25.	*Merops orientallis*	Small bee eater	NA	NE
26.	*Mirafra contillans*	Singing bush lark	NA	NE
27.	Muscicapa dauurica	Asian brown flycatcher	Schedule IV	Least Concern
28.	*Mycteria leucocephala*	Painted stork	Schedule IV	Near Threatened
29.	*Nectarinia zeylonica*	Purple rumper sunbird	Schedule IV	Least Concern
30.	*Ocyceros birostris*	Indian gray hornbill	Schedule I	Least Concern
31.	*Oriolus oriolus*	Eurasian golden oriole	NA	NE
32.	*Pavo cristatus*	Indian peafowl	Schedule I	Least Concern
33.	*Phalacrocorax carbo*	Great cormorant	Schedule IV	Least Concern
34.	*Pseudibis papillosa*	Black ibis	Schedule IV	Least Concern
35.	*Psittacula krameri*	Rose ringed parakeet	Schedule IV	Least Concern
36.	Pycnonotus jocosus	Red wiskered bulbul	Schedule IV	Least Concern
37.	*Saxicola caprata*	Pied bushchat	Schedule IV	Least Concern
38.	*Saxicoloides fulicata*	Indian robin	Schedule IV	Least Concern

Sl. No.	Scientific Name	Common Name	Schedule	IUCN category
39.	*Streptopelia chinensis*	Spotted dove	Schedule IV	NE
40.	*Streptopelia senegalensis*	Little brown dove	Schedule IV	Least Concern
41.	*Threskiornis melanocephalus*	Oriental white ibis	Schedule IV	Near Threatened
42.	*Turdoides striatus*	Jungle babler	Schedule IV	Least Concern
43.	*Turnix suscitator*	Button quail	Schedule IV	Least Concern
44.	*Vanellus indicus*	Red wattled lapwing	Schedule IV	Least Concern
Insects				
45.	*Apis dorsata*	Rock bee	NA	NE
46.	*Acraea violae*	Tonny Coster	NA	NE
47.	*Apis cerana*	Indian bee	NA	NE
48.	*Ariadne ariadne*	Angled castor	NA	NE
49.	*Ariadne merione*	Common caster	NA	NE
50.	*Atrophaneura aristolochiae*	Common rose	NA	NE
51.	*Atrophaneura hector*	Crimson rose	NA	NE
52.	*Castalius rosimon*	Common pierrot	NA	NE
53.	*Catopsilia pomona*	Common emigrants	NA	NE
54.	Chorthippus brunneus	Grass hopper	NA	Least Concern
55.	*Danaus chrysippus*	Plain tiger	NA	NE
56.	*Delias eucharis*	Common jezebel	NA	NE
57.	*Euploea core*	Common indian crow	NA	Least Concern
58.	*Eurema brigitta*	Small grassyellow	NA	Least Concern
59.	*Eurema hecabe*	Common grassyellow	NA	NE
60.	*Hypolimnas misippus*	Dandaid eggfly	NA	Least Concern
61.	*Ischnura hecterostica*	Damson fly	NA	NE
62.	*Junonia atlites*	Grey pansy	NA	NE
63.	*Junonia iphita*	Chocolate pansy	NA	NE
64.	*Neptis hylas*	Common sailer	NA	NE
65.	*Papillio polytes*	Common mormon	NA	NE
66.	*Phalanta phalanta*	Common leopard	NA	NE
67.	*Psuedocoladenia dan*	Fulvouspied flat	NA	NE
68.	*Sympetrum flavolum*	Dragon fly	NA	NE
69.	*Tirumala septentrionis*	Dark blue tiger	NA	NE
70.	*Vespula vulgaris*	Wasp	NA	NE
71.	*Xylocopa Violacea*	Carpenter bee	NA	NE
72.	*Ypthima huebneri*	Common four ring	NA	NE
73.	*Zizeeria karsandra*	Dark grass blue	NA	NE
Reptile				
74.	*Amphiesma stolatum*	Stripped keelback	NA	NE
75.	Calotes versicolor	Garden lizard	NA	Least Concern
76.	*Lampropholis guichenoti*	Skink	NA	NE
Mammal				
77.	*Lepus nigricollis*	Common Indian Hare	Sch IV	Least Concern

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

224. Avian species *Accipiter badius* (Shikra), *Haliastur indus* (Bhramini Kite), *Ictinaetus malayensis* (Black Eagle), *Pavo cristatus* (Indian Peafowl) and *Ocyceros birostris* (Indian Gray Hornbill) are Schedule-I as per Wildlife Protection Act, are dwelling in the project area. The Act provides protection to listed species of flora and fauna, prohibits hunting of any wild animal specified in Schedule. All the species in schedule-I are under Least Concern as per IUCN red list.

The species have an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion.

225. *Threskiornis melanocephalus* (Oriental white ibis) and *Mycteria leucocephala* (Painted stork) are two avian species which fall in near Threatened category as per IUCN red list.

226. *Threskiornis melanocephalus* is native to Bangladesh, Cambodia, People's Republic of China, Hong Kong, India, Indonesia, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Russian Federation, Sri Lanka, Thailand, Vietnam. It is vulnerable to drainage, disturbance, pollution, agricultural conversion, hunting and collection of eggs and nestlings from colonies. A combination of these factors has probably caused the decline.The species is undergoing a population reduction, which is suspected to be moderately rapid. In India it is widespread and locally common in the west, scarce in the east; possibly increasing locally due to the spread of man-made wetlands. *ycteria leucocephala* although one of the most abundant of the Asian storks, this species is classified as Near Threatened because it is thought to be undergoing a moderately rapid population decline owing primarily to hunting, wetland drainage and pollution. It is Native to Bangladesh, Bhutan, Cambodia; India; Lao People's Democratic Republi, Myanmar; Nepal, Pakistan, Sri Lanka, Thailand and Viet Nam. Habitat loss, disturbance, pollution, wetland drainage and the hunting of adults and collection of eggs and nestlings from colonies are cause for concern. There are no data on population trends of *Mycteria leucocephala* however, the species is suspected to be declining at a moderately rapid rate, owing to hunting, drainage and pollution.

227. **None of the species found in the project area fall under the threatened category as per IUCN red list.**

228. **Analysis of Primary Data:** Relative Frequency (RF), Relative density (Rd), Importance value index (IVI) and Abundance for overall faunal species were calculated and provided in **Annex 4.7** (Table-A.4.7.4). Biodiversity Index has been calculated, Shannon's Diversity Index and Simpson's Index is presented in **Table 76**.

Table 76 Shannon's Diversity Index and Simpson's Index

Shannon's Diversity Index (H)	Simpson's Index (D)
3.60	0.04

Plate 4.- a Great cormorant, b. Painted stork, c. Indian roller, d. Red wattled lapwing, e. Common myna, f. Indian pond heron, g. Oriental white ibis, h. Indian robin, i. Spotted munia, j. Spotted dove, k. Black ibis, l. Paddy field pippet

5. Protected Areas

229. The project road does not traverse through any National Park, Wildlife Sanctuary or Biosphere Reserve.

6. Forest

230. The project road passes through Reserved Forest Area for **16.23 km** stretch. The forests located along the project stretch are presented in **Table 77** and shown in **Figure 20** & **Figure 21**.

Table 77 Location of Forest along Project Alignment

Sl. No.	Ex. Chainage (Km)		Side	Name of the Forest	Length (km)
	From	To			
1	64+830	64+880	LHS	Ippadi Reserved Forest	0.050
2	64+880	66+730	Both	Ippadi Reserved Forest	1.850
3	73+850	76+110	Both	Huliyurdurga Reserved Forest	2.260
4	76+110	76+755	RHS	Huliyurdurga Reserved Forest	0.645
5	81+640	82+670	Both	Kamalapura Reserved Forest	1.030
6	103+660	104+460	RHS	State Forest, Nagamangala	0.800
7	104+460	105+500	Both	State Forest, Nagamangala	1.04
8	105+500	105+830	RHS	State Forest, Nagamangala	0.330
9	105+830	107+280	Both	State Forest, Nagamangala	1.450
10	109+550	109+900	RHS	State Forest, Nagamangala	0.350

Sl. No.	Ex. Chainage (Km)		Side	Name of the Forest	Length (km)
	From	To			
11	109+900	110+170	Both	State Forest, Nagamangala	0.270
12	110+170	110+500	RHS	State Forest, Nagamangala	0.330
13	110+500	110+710	Both	State Forest, Nagamangala	0.210
14	110+710	111+020	RHS	State Forest, Nagamangala	0.310
15	117+575	117+975	RHS	State Forest, Nagamangala	0.400
16	125+270	125+440	RHS	State Forest, Nagamangala	0.170
17	131+965	132+230	LHS	State Forest, Nagamangala	0.265
18	132+230	132+530	Both	State Forest, Nagamangala	0.300
19	132+530	132+660	RHS	State Forest, Nagamangala	0.130
20	134+260	134+600	LHS	State Forest, Nagamangala	0.340
21	134+600	135+500	Both	State Forest, Nagamangala	0.900
22	135+500	135+835	Both	State Forest, K. R. Pet	0.335
23	135+835	137+200	RHS	State Forest, K. R. Pet	1.365
24	139+780	140+310	RHS	State Forest, K. R. Pet	0.530
25	159+450	160+020	RHS	State Forest, K. R. Pet	0.570
Total length of project road abutting the Forests on LHS (km)					*0.655*
Total length of project road abutting the Forests on RHS (km)					*5.930*
Total length of project road abutting the Forests on Both sides (km)					*9.645*
Total Length					**16.23**

231. Forests of the project area falls under Tropical Dry Deciduous and Dry Thorn scrub type These forests do not have any potential for timber production. Most of the activities are in the form of artificial regeneration with focus on urban forestry.

View of Forest Plantation

232. Tropical Dry Deciduous forests are characterized by stunted growth of trees with open canopy. The vegetation comprise of *Acacia sps.*, *Albizia sps*, , *Wrightia tinctoria*, *Zizyphus sps*, *Dendrocalamus strictus etc..*

233. The tropical thorn forests are very open and vegetation is sparse. These forests are characterized by the presence of xerophytic and thorny plants. Trees are extremely branchy and stunted and do not form any clear bole. Main species of Dry Thorn forest are *Tamarindus indica* (Tamarind), *Teminalia bellerica* (Tare), *Canthium parviflorum* (Kare), *Gardenia gummifera* (Bikke), *Dalbergia paniculata* (Pachalli), *Albizia amara* (Chujjalu) and *Acacia nilotica* (Babul). The ground flora consists of *Cassia auriculata*, *Dodonaea viscosa* and *Randia* species*.* The vegetation does not attain any great size owing to scanty rainfall and damages caused by biotic factors such as illicit felling, encroachments, fire and browsing.

234. Forest department have raised plantations, species such as *Eucalyptus sps*. *Acacia auriculiformis, Pongamia pinnata (Honge), Cassia siamea* (Seemethamgadi), *Albizia lebbeck* (Bage) *etc* have been planted. These plantations are raised either on notified Forests or on other Government lands that are under the control of the Forest department. Plantations of *Acacia auriculiformis, Casuarina equisetifolia* and *Eucalyptus* have been raised for Firewood, owing to the increased demand for fuel and the easy mode of rearing this species. Teak (*Tectona grandis*) has been also raised in some forest. Hence, it can be concluded that the forest reserves are

modified habitat. The list of forest species found in forests is presented in **Annex 4.8** (Table – A.4.8.1).

235. The mammalian species dwelling in the in Forest area comprise of *Panthera pardus* (Leopard), *Felis chaus* (Jungle Cat), *Elephas maximus* (Elephant), *Semnopithecus entellus* (Hanuman Langur), *Macaca radiata* (Bonnet Macaque), *Herpestes edwardsii* (Common Mongoose), *Sus scrofa* (Wild boar), *Hystrix Indica* (Indian porcupine), *Canis aureus* (Jackal), *Funambulus palmarum* (Three striped Palm Squirrel) etc. The list of wildlife provided by Forest division is presented in **Annex 4.8** (Table – A.4.8.2).

236. During Public consultation in the project area people have reported that wildlife are visible near the project road except occasional appearance of wild boar, hare and snakes.

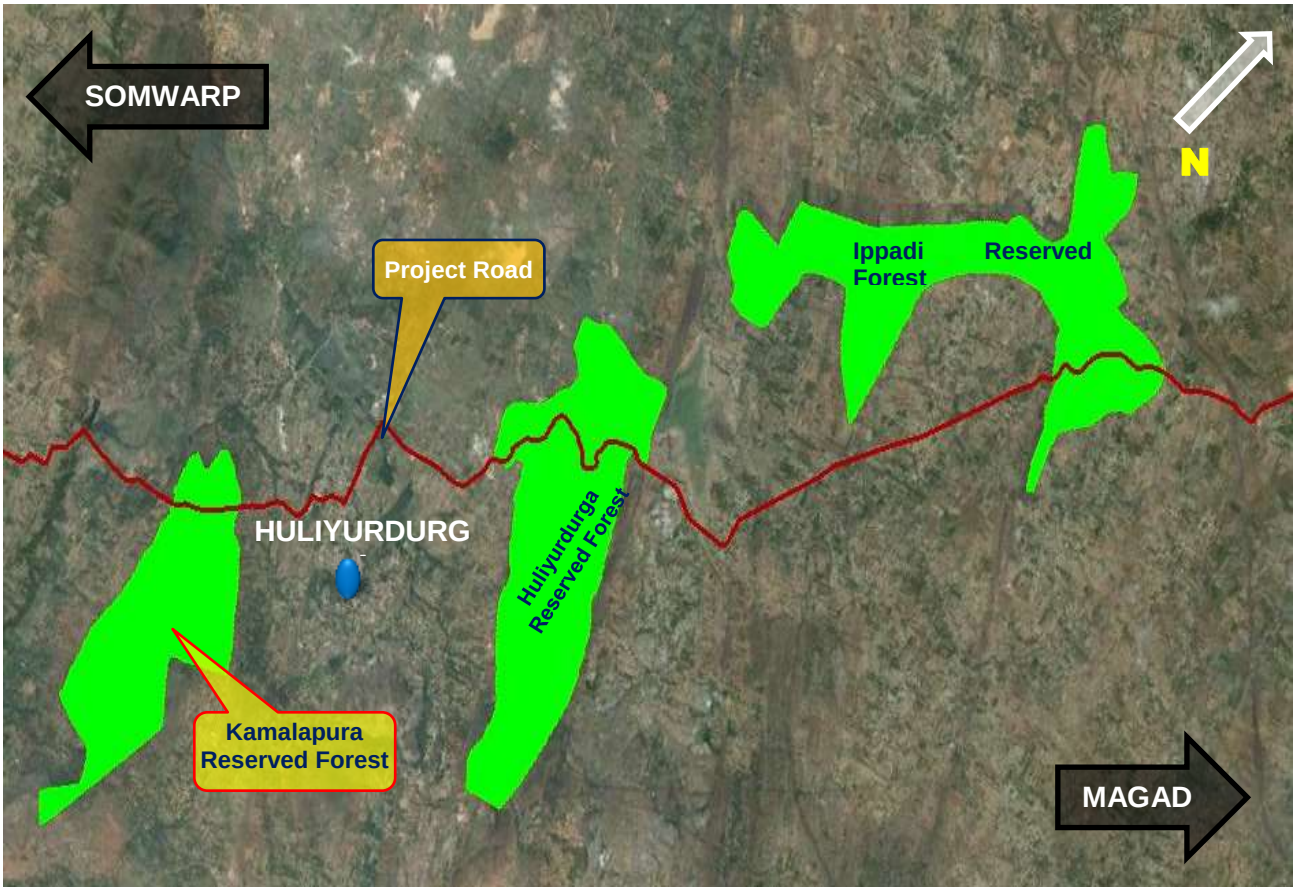


Figure 20 Location of Forest areas along the Project Road in Tumkur District

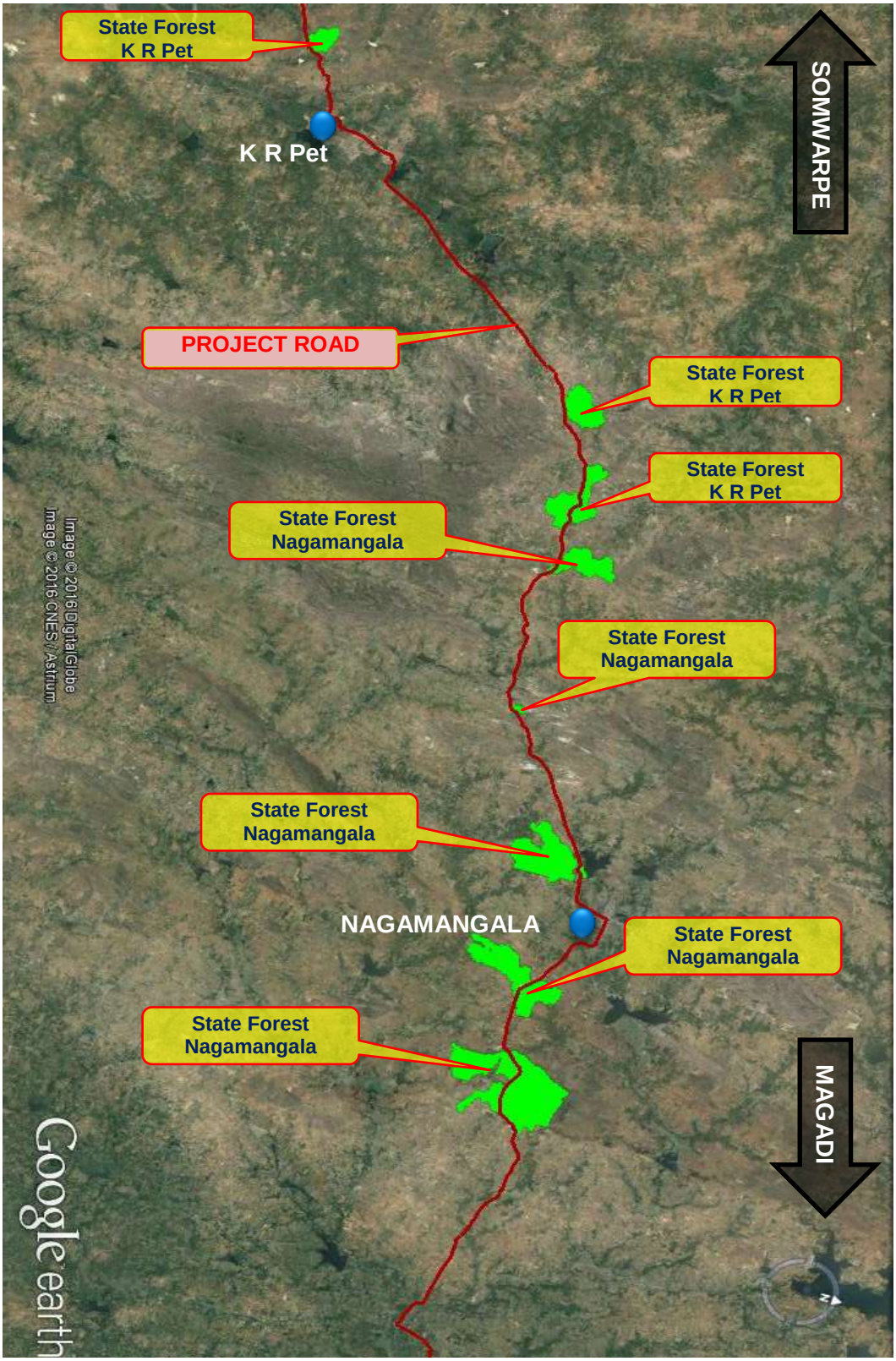


Figure 21 Location of Forest areas along the Project Road in Mandya District

O. Educational, Medical and Religious Properties

237. **Educational Institutions:** 117 educational institutions are located on either side of the project road; out of which, 57 are located on the right side and 60 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 78**.

Table 78 List of Educational Institutions along the Project Road

SN	Particulars	Village	Existing Ch.	Design Ch.	Side	Dist. (m)
1	Govt. Primary School	Vaddarapaly	52+340	51+480	LHS	16.0
2	ICDS (Aanganwadi)	Jamal Sab Palya	52+730	51+860	RHS	22.5
3	Govt. Urdu Primary School	Jamal Sab Palya	52+730	51+860	RHS	33.0
4	Govt. Urdu Primary School	Jamal Sab Palya	52+870	52+000	LHS	11.5
5	Govt. PU College	Dhonakuppi	58+600	57+580	LHS	11.0
6	Sarkari Padavi Purva College	Dhonakuppi	58+900	57+900	RHS	109.9
7	CNS Model English High School	Dhonakuppi	59+150	58+150	RHS	12.3
8	Morarji Desai Residential School	Hullekette	62+450	61+300	RHS	14.5
9	Kitturu Rani Chennamma Residential School	Hullekette	62+600	61+500	RHS	30.5
10	National Public School	Hullekette	62+750	61+650	LHS	7.0
11	Govt. Primary School	Bastarapalya	64+530	63+290	LHS	6.0
12	ICDS (Aanganwadi)	Neelasandra	67+660	66+300	LHS	24.0
13	Govt. Higher Primary School	Neelasandra	67+660	66+300	LHS	46.6
14	ICDS (Aanganwadi)	Chowdanakuppe	70+400	69+025	LHS	13.0
15	Dr. BR Ambedkar High School	Chowdanakuppe	71+040	69+660	RHS	10.0
16	Govt. Higher Primary School	Hangarahalli	71+700	70+300	RHS	8.8
17	Govt. Lower Primary School	Suggunahalli	85+050	*	LHS	32.0
18	ICDS (Aanganwadi)	Suggunahalli	85+300	*	RHS	18.0
19	Govt. Higher Primary School	Ungara	89+430	86+800	RHS	7.5
20	Akshara International Public School	Kowdel	93+330	90+500	LHS	16.0
21	Govt. Higher Primary School (Closed)	Kudagaballu	95+040	92+150	RHS	9.0
22	Govt. High School	Shettahalli	97+260	94+400	LHS	14.0
23	ICDS (Aanganwadi)	Tibbanahalli	99+000	96+065	RHS	63.5
24	ICDS (Aanganwadi)	Devalpura, Nagamangala	100+900	97+920	RHS	17.8
25	Govt. P.U. College	Devalpura, Nagamangala	101+400	98+400	LHS	26.0
26	Govt. Higher Primary School	Devalpura, Nagamangala	101+400	98+400	RHS	8.4
27	Govt. High School	Thattahalli	108+500	105+415	LHS	15.0
28	Govt. Poly Technique College	Nagmangala	110+250	107+150	LHS	19.0
29	Govt. First Grade College	Karadahalli	110+350	107+225	LHS	121.7
30	Govt. Higher Primary School	Balapada Manti Koppalu, Nagmangala	112+875	109+800	LHS	9.0
31	National Nursery, Lower & Higher Primary School (Pvt.)	Nagmangala	114+300	111+300	LHS	13.5
32	Govt. Primary School	Basaveshawara Nagara, Sankanhalli	120+820	117+725	RHS	12.7
33	Govt. Higher Primary School	Kantapura	125+490	122+380	RHS	13.5

SN	Particulars	Village	Existing Ch.	Design Ch.	Side	Dist. (m)
34	Govt. High School	Kantapura	125+500	122+370	LHS	43.5
35	Govt. Primary School	Karikethanahalli	127+680	124+530	RHS	8.7
36	Swamy Vivekanand Public School	Bogadi	128+335	125+175	RHS	52.0
37	Govt. Purva Padvi High School & College	Bogadi	129+650	126+410	RHS	13.2
38	Govt. Lower Primary School	Kotegenahalli	141+800	138+270	LHS	10.0
39	Govt. Lower Primary School	Shetty Nayakana Kopallu	146+850	143+320	RHS	38.0
40	Govt. High School	Valagere Menasa	147+155	143+620	LHS	13.7
41	Govt. Lower Primary School	Valagere Menasa	148+300	144+700	RHS	32.0
42	Govt. Higher Primary School	Valagere Menasa	148+300	144+700	RHS	79.0
43	Govt. Primary School	K. R. Pet	152+750	*	RHS	13.0
44	Adichunchanagiri School	K. R. Pet	153+280	*	LHS	13.9
45	Govt. Higher Primary Morden School	K. R. Pet	153+400	*	LHS	11.0
46	Govt. Girls High School	K. R. Pet	153+400	*	LHS	136.4
47	Govt. Urdu Primary School	K. R. Pet	153+400	*	LHS	11.0
48	Govt. Girls PU College	K. R. Pet	153+400	*	LHS	15.5
49	Govt. Polytechnic College	K. R. Pet	154+100	*	RHS	267.9
50	Govt. Engineering College	K. R. Pet	154+150	*	RHS	147.2
51	First Grade Women College	K. R. Pet	154+760	*	RHS	27.5
52	Govt. Jr.High school and College	K. R. Pet	154+900	*	LHS	16.0
53	Nalanda English Higher Primary School	K. R. Pet	154+970	*	LHS	280.1
54	Govt. High School	Hosaholalu	156+050	*	LHS	9.2
55	Govt. Primary Girls School	Hosaholalu	156+100	*	LHS	18.3
56	Govt. Primary Boys School	Hosaholalu	156+120	*	RHS	45.5
57	Adash Higher Primary School	Hosaholalu	156+650	*	RHS	26.3
58	Vivekanand High School	Bommenahalli	160+900	157+200	LHS	50.5
59	Govt. Primary School	Bommenahalli	161+390	157+700	RHS	9.0
60	Govt. Lower Primary School	Hosadadadahally	167+560	163+830	LHS	19.5
61	Purna Chandra Middle School	Akkihebbal	167+685	163+950	LHS	151.8
62	Govt. Girls PU College	Akkihebbal	167+755	164+000	LHS	11.5
63	ITI	Akkihebbal	167+755	164+025	RHS	14.0
64	Govt. Higher Primary School	Akkihebbal	167+850	164+100	RHS	14.0
65	Govt. Higher Primary School	Voddaragudi	169+280	*	RHS	8.5
66	Govt. Primary School	Machaholalu	170+820	166+915	RHS	8.8
67	ICDS (Aanganwadi)	Machaholalu	170+975	*	RHS	22.0
68	Govt. Higher Primary School	Singanahalli	172+200	*	RHS	6.5
69	Govt. Lower Primary School	Sambaravalli	173+600	169+800	LHS	15.0
70	Govt. Urdu Lower Primary School	Bheriya	174+765	*	RHS	18.5
71	Govt. Higher Primary School	Bheriya	175+280	*	LHS	10.5
72	Govt. Urdu Higher Primary School	Bheriya	175+315	*	RHS	6.5
73	Govt. High School and PU College	Bheriya	175+750	*	LHS	11.7
74	Govt. Higher Primary School	Yalemudanahalli	180+300	176+500	LHS	8.8
75	Supreet Educational Trust Higher Primary School	Kurubahalli	181+600	177+790	LHS	53.5
76	Govt. Lower Primary School	Kalli muddanahalli	182+525	178+725	RHS	9.9
77	ICDS (Aanganwadi)	Saligrama	184+620	180+815	LHS	13.0
78	Girls P U College	Saligrama	185+700	181+875	LHS	78.0
79	Govt. High School	Saligrama	185+800	181+980	LHS	122.6
80	Govt. Purva Padvi College	Saligrama	186+150	182+325	LHS	12.0

SN	Particulars	Village	Existing Ch.	Design Ch.	Side	Dist. (m)
81	Govt. High School	Saligrama	186+200	182+375	LHS	12.0
82	Sara Vidya Mandir Nursery School	Saligrama	186+225	182+400	RHS	10.4
83	Govt. Degree College	Saligrama	186+250	182+425	LHS	12.0
84	Govt. Lower Primary School	Haradanahalli	191+645	187+785	RHS	13.2
85	Govt. Higher Primary School	Haradanahalli	192+200	188+335	RHS	52.4
86	Govt. Higher Primary School	Haradanahalli	192+235	188+360	LHS	11.0
87	ICDS (Aanganwadi)	Haradanahalli	192+585	188+715	RHS	8.8
88	Govt. High School and PU College	Haradanahalli	192+750	188+890	RHS	11.3
89	Nalanda D. Ed (Tech) College	Keralapura	194+400	190+500	RHS	46.6
90	Govt. Primary Girls School and ICDS	Keralapura	195+800	191+925	LHS	26.0
91	Govt. Primary Boys School	Keralapura	195+900	192+000	LHS	27.0
92	Govt. Primary School & ICDS	Honnenahalli	197+800	193+900	RHS	12.0
93	Govt. Primary School	Juttenahalli	199+550	195+585	LHS	10.0
94	Govt. Primary School (Closed) & ICDS	Kanana Kopallu	201+720	197+755	LHS	12.5
95	Govt. Primary School	Basavapatna	204+200	200+230	RHS	9.1
96	Hostel	Basavapatna	204+250	200+250	RHS	169.4
97	Govt. College	Basavapatna	204+300	200+300	RHS	116.4
98	Govt. High School	Basavapatna	204+300	200+300	RHS	146.2
99	Govt. Lower Primary School	Ramanathapura	207+460	203+470	LHS	22.1
100	JSP High School	Ramanathapura	207+520	203+500	LHS	67.5
101	Govt. Urdu Primary School	Ramanathapura	208+660	204+650	LHS	15.0
102	Govt. Higher Primary School	Ramanathapura	208+720	204+710	LHS	12.6
103	Patabhirama Govt. High School	Ramanathapura	208+900	204+940	LHS	15.0
104	Pattabirama Govt. Girls PU College	Ramanathapura	209+000	205+050	LHS	11.6
105	BSS Govt. High School and College	Konanuru	212+200	208+200	RHS	14.0
106	BM Setty Govt. College	Konanuru	212+300	208+300	RHS	81.6
107	Govt. Girls Middle School	Konanuru	212+350	208+350	RHS	8.2
108	Govt. Middle School	Konanuru	212+700	208+700	RHS	103.9
109	MKS Lions Vidhyaniketahan	Konanuru	212+950	209+000	LHS	9.5
110	Nalanda Public School	Ullenahalli	214+030	210+020	LHS	57.0
111	Govt. Lower Primary School	Ullenahalli	214+135	210+150	RHS	17.5
112	Govt. Primary School	Siddapura	216+800	212+750	LHS	60.7
113	Govt. High School	Siddapura	216+850	212+800	LHS	62.0
114	Govt. Primary School	Hadenoor	222+700	218+600	RHS	105.9
115	Govt. High School	Hadenoor	222+800	218+720	RHS	11.0
116	Divya Jyoti Higher Primary School	Mariyanagar, Bettahalale	224+430	220+330	LHS	45.3
117	ICDS (Aanganwadi)	Bettahalale	224+880	220+760	RHS	61.5

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

238. **Religious Places:** 133 religious places are located on either side of the project road, out of which 66 religious places are located on the right side and 67 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 79**.

Table 79 List of Religious Places along the Project Road

S.N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1	Ali Shah Junaydi Dargaha	Vaddarapaly	52+025	51+200	RHS	12.2
2	Road side small Shiv Temple	Vaddarapaly	52+270	51+400	LHS	11.6
3	Dargah	Harohalli	52+870	52+000	RHS	7.6
4	Road side Mini Worship Place (Ganesh)	Jutanahalli	54+200	53+200	RHS	4.5
5	Sani Temple	Kamesagar	55+500	54+500	LHS	8.5
6	Hanuman Temple	Kamesagar	55+500	54+510	RHS	9.1
7	Road side Mini Worship Place (Nag Dev)	Sathanuru	57+610	56+600	LHS	12.3
8	Chamundeshwari Temple	Dhonakuppi	58+800	57+700	LHS	523.5
9	Road Side Mini Worship Place (Hanuman)	Dhonakuppi	59+400	58+375	LHS	7.5
10	Muneshwara Temple	Halasabele	61+310	60+250	RHS	18.7
11	Sani Temple	Halasabele	61+325	60+260	RHS	9.4
12	Road side Small Nag Dev Temple	Halasabele	61+330	60+260	LHS	9.3
13	Road side Small Nag Dev Temple	Halasabele	61+550	60+480	LHS	7.0
14	Maramma Temple	Hullekette	63+190	62+090	LHS	13.4
15	Road side Mini Worship Place (Nag Dev)	Varthihalli	64+500	63+250	LHS	8.1
16	Ganpati, Baseavann and Narshima Temple	Neelasandra	67+615	66+270	LHS	10.2
17	Road side Mini Worship Place (Nag Dev)	Hirohalli	68+500	67+150	LHS	17.4
18	Road side Mini Worship Place (Nag Dev)	Chowdanakuppe	70+500	69+115	LHS	6.9
19	Road side Small Uchchamarama Temple	Chowdanakuppe	70+780	69+400	RHS	8.5
20	Road side Mini Worship Place (Ganesh)	Hangarahalli	71+800	70+425	LHS	15.9
21	Temple	Hangarahalli	71+875	70+500	RHS	24.2
22	Road Side Mini Worship Place (Hanuman)	Huliyurdurga	73+875	*	RHS	9.0
23	Road side Small Vishnu Temple	Huliyurdurga	74+865	*	RHS	6.5
24	Road side Small (Muneshvara) Temple	Huliyurdurga	81+115	78+870	LHS	13.4
25	Road side Mini Worship Place (Nag Dev)	Suggunahalli	82+360	80+000	RHS	9.9
26	Road side Mini Worship Place (Navgrah)	Suggunahalli	82+370	80+000	RHS	22.3
27	Sani Temple	Suggunahalli	82+380	80+020	RHS	10.3
28	Road side Mini Worship Place (Nag Dev)	Suggunahalli	82+825	80+500	LHS	12.1
29	Uchamma Temple	Suggunahalli	83+250	*	RHS	37.5
30	Road side Small Basuanna Temple	Suggunahalli	84+610	*	LHS	16.1
31	Shani Temple	Suggunahalli	85+650	83+100	LHS	66.9
32	Temple	Ungara	89+100	86+440	RHS	57.1
33	Road side Mini Worship Place (Vinayak)	Ungara	89+470	86+815	RHS	8.4
34	Thalslama Temple	Yadavani	90+300	87+690	LHS	73.5
35	Road Side Mini Worship Place (Hanuman)	Yadavani	90+370	87+700	LHS	4.6
36	Road side Small Hanuman Temple	Kudagaballu	93+360	90+500	RHS	10.7
37	Sive Temple	Kudagaballu	94+870	91+950	LHS	77.8

S.N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
38	Iriamma Temple	Shettahalli	97+300	94+440	RHS	5.4
39	Muthinamma Temple	Tibbanahalli	99+040	96+100	RHS	9.5
40	Temple	Devalpura	100+650	*	RHS	156.6
41	Maramma Temple	Thattahalli	109+135	106+040	LHS	19.2
42	Road side Small Basvanna Temple	Thattahalli	109+145	106+050	LHS	20.9
43	Hanuman Temple	Hullukere	111+590	108+485	LHS	14.2
44	Road side Mini Worship Place (Nag Dev)	Hullukere	111+600	108+500	LHS	9.1
45	Shiv Temple	Nagmangala	112+970	109+900	RHS	29.1
46	Road side Mini Worship Place (Nag Dev)	Nagmangala	113+460	*	LHS	22.0
47	Mousqe	Nagmangala	114+650	111+645	LHS	12.4
48	Vishnu Temple	kunnakatte Mallenahalli	116+500	113+500	LHS	32.9
49	Basveshwara Temple	kunnakatte Mallenahalli	116+680	113+655	LHS	10.7
50	Nandi Temple	Sankanhalli	120+840	117+760	LHS	6.1
51	Maramma Temple	Sankanhalli	121+240	118+165	RHS	12.6
52	Periyapattadall Amma Temple	Karikethanahalli	128+065	124+915	RHS	15.9
53	Road side Small Singhamma Temple	Kallenahalli	130+835	127+590	LHS	6.6
54	Road side Small Hanuman Temple	Thiraganahalli	133+480	130+240	LHS	21.2
55	Road side Small Ram Temple	Thiraganahalli	134+440	*	RHS	17.1
56	Road side Mini Worship Place (Vinayak)	Mallenahalli	146+160	142+630	RHS	9.0
57	Small Basuveshwara Temple	K. R. Pet	152+590	*	RHS	4.0
58	Mosque	K. R. Pet	153+275	*	RHS	17.9
59	Guru Bhavan	K. R. Pet	153+335	*	LHS	20.0
60	Basueswara Temple	Hosaholalu	155+735	*	RHS	8.4
61	Sri Lakshminarayana Swamy Temple	Hosaholalu	156+050	*	RHS	260.0
62	Nvagraha & Ganapathi Temple	Hosaholalu	156+070	*	RHS	53.5
63	Hanuman Temple	Hosaholalu	156+075	*	RHS	10.8
64	Maramma Temple	Hosaholalu	156+320	*	LHS	6.7
65	Maramma Temple	Hosaholalu	156+350	*	LHS	23.3
66	Temple Under Construction	Bommenahalli	161+025	157+335	RHS	15.0
67	Road side Mini Worship Place	Bommenahalli	161+100	157+415	LHS	14.1
68	Sani Temple	Bommenahalli	161+200	157+515	RHS	6.0
69	Atilakkamaa Temple	Bommenahalli	162+430	158+750	RHS	17.5
70	Road side Mini Worship Place	Bommenahalli	162+750	159+060	LHS	7.8
71	Nava Grah Temple	Bommenahalli	162+755	159+065	LHS	20.5
72	Hanuman Temple	Bommenahalli	162+760	159+070	LHS	15.3
73	Lakshmi And Venkataramana Temple	Bommenahalli	162+770	159+080	LHS	29.7
74	Ganesh Temple	Bommenahalli	162+775	159+085	LHS	31.4
75	Maramma Temple	Bommenahalli	162+780	159+090	LHS	26.4
76	Road side Mini Worship Place (Nag Dev)	Kurenahalli	162+920	159+220	RHS	5.2
77	Basueswara Temple	Akkihebbal	167+300	163+600	LHS	19.8
78	Ilam Dev Temple (Under Construction)	Akkihebbal	168+240	164+510	LHS	14.8
79	Rama Temple	Akkihebbal	168+250	164+520	LHS	12.3
80	Chamundeshwari Temple	Akkihebbal	168+290	164+560	LHS	14.4
81	Rukmani Pandaranga Temple	Akkihebbal	168+300	164+570	LHS	15.7
82	Road side Small Temple (Gram Devta)	Akkihebbal	168+320	164+590	LHS	15.1

S.N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
83	Basuveshwara Temple	Voddaragudi	168+890	165+185	RHS	25.5
84	Lakshmi Devi Temple	Machaholalu	170+000	166+100	RHS	308.9
85	Road side Mini Worship Place	Singanahalli	172+170	*	RHS	5.3
86	Temple-Rath	Bheriya	174+775	*	RHS	13.4
87	Temple-Rath	Bheriya	174+780	*	RHS	10.1
88	Hanuman Temple	Bheriya	174+800	*	RHS	6.6
89	Navgrha Temple	Kurubahalli	181+520	177+715	LHS	9.9
90	Road side Mini Worship Place (Nag Dev)	Kalli muddanahalli	182+515	178+715	RHS	10.6
91	Small Hanuman Temple	Kalli muddanahalli	183+120	179+320	LHS	39.2
92	Road side Mini Worship Place	Saligrama	184+515	180+710	LHS	7.3
93	Lakshmi Temple	Saligrama	185+660	181+835	LHS	23.7
94	Road side Mini Worship Place (Lakshmi)	Saligrama	186+175	182+350	LHS	16.6
95	Shri Lakshminarshima Swamy Temple	Haradanahalli	192+100	188+250	RHS	27.4
96	Shri Ranganatha Swamy Temple	Haradanahalli	192+190	188+325	RHS	25.6
97	Vaseaeamma Temple	Haradanahalli	192+210	188+345	RHS	19.7
98	Road side Small Chikkamma Temple	Haradanahalli	192+215	188+350	RHS	14.0
99	Lakshminarayan Temple	Haradanahalli	192+400	188+525	LHS	13.6
100	Chikkamma Dodamma Temple	Haradanahalli	192+440	188+565	LHS	13.4
101	Lakshmi Temple	Haradanahalli	192+540	188+675	RHS	18.9
102	Hanuman Temple	Haradanahalli	192+540	188+675	RHS	30.2
103	Basuveshwara Temple	Haradanahalli	192+555	188+675	RHS	30.1
104	Ganesh Temple	Haradanahalli	192+570	188+700	RHS	16.2
105	Maramma Temple	Haradanahalli	192+600	188+735	RHS	28.8
106	Sani Temple	Haradanahalli	192+600	188+740	LHS	12.2
107	Kalbherav Temple	Haradanahalli	192+630	188+760	RHS	34.9
108	Road side Small Temple (Gram Devta)	Keralapura	195+745	191+860	LHS	10.5
109	Shrinivash Temple	Keralapura	195+900	191+950	LHS	79.3
110	Basveswara Temple	Honnenahalli	197+575	193+670	RHS	8.5
111	Shiv Temple	Juttenahalli	199+485	195+520	LHS	32.7
112	Giddamma Temple	Juttenahalli	200+130	196+160	RHS	8.8
113	Hanuman Temple	Basavapatna	203+600	199+628	RHS	8.7
114	Sri Ram Temple	Basavapatna	203+800	199+840	LHS	6.0
115	Karlingeshwramdali Amma Temple	Moole Hoshalli	205+260	201+280	RHS	14.0
116	Shiv Temple	Shiradanahalli	206+340	202+350	RHS	21.8
117	Temple	Ramanathapura		202+990	RHS	8.0
118	Kwaleamma Temple	Ramanathapura	207+150	203+150	LHS	57.9
119	Asi Site Rameshwar Temple	Kotavalu	207+600	203+600	LHS	132.0
120	Asi Lakshmaneshwara Temple	Kotavalu	207+700	203+700	LHS	353.3
121	Asi Site State Sri Agasthyeshwaraswamy Temple	Kotavalu	207+980	203+090	LHS	172.0
122	Asi Site State Pattavirama Temple	Kotavalu	208+000	204+040	LHS	151.4
123	Mini Worship Place (Gram Devta)	Vadavana Hosahalli	210+935	206+930	LHS	27.7
124	Bayalu Basuveshwara Temple	Konanuru	211+620	207+635	RHS	10.4
125	Temple	Konanuru	212+400	208+400	RHS	63.1
126	Road side Mini Worship Place	Konanuru	212+850	208+830	RHS	13.1
127	Kudala Gopala Krishna Temple	Konanuru	212+950	208+950	RHS	15.1
128	Ganesh Temple	Konanuru	213+055	209+040	RHS	41.3
129	Kerakoriamma Temple	Konanuru	213+080	209+065	RHS	81.5

S.N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
130	Gram Devti Temple	Ullenahalli	213+900	209+900	LHS	28.5
131	Malleshwar Temple	Hadenoor	222+870	218+800	RHS	16.5
132	St. Mery Church	Bettahalale	224+375	220+270	LHS	6.0
133	Temple	Bettahalale	224+850	220+740	RHS	77.4

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

239. **Medical Facilities:** There are only 7 primary health centers, 7 Govt. hospital, 7 veterinary hospitals and 1 Ayurveda hospital are located along the project road; out of which, 12 are located on the right side and remaining 10 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 80**.

Table 80 List of Medical Facilities along the Project Road

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1	Veterinary Hospital	Hullekette	63+300	62+180	LHS	12.2
2	Primary Health Center	Chowdanakuppe	70+170	68+850	RHS	11.0
3	Veterinary Hospital	Ungara	70+200	86+900	RHS	16.4
4	Primary Health Center	Devalpura	101+080	98+100	RHS	20.4
5	Govt Hospital	Devalpura	101+115	98+150	RHS	20.6
6	Primary Health Center	Kallenahalli	130+230	127+000	RHS	10.5
7	Veterinary Hospital	Kallenahalli	130+580	127+340	RHS	16.6
8	Govt Hospital	K. R. Pet	154+575	*	RHS	11.3
9	Govt. Hospital, Hosaholalu	Hosaholalu	156+000	*	LHS	42.1
10	Govt Aurveda Hospital	Hosaholalu	156+560	*	RHS	23.5
11	Veterinary Hospital	Bommenahalli	162+170	158+485	RHS	10.7
12	Govt Hospital	Akkihebbal	167+650	163+950	LHS	60.7
13	Primary Health Center	Yalemudanahalli	179+375	175+580	LHS	16.1
14	Govt. Hospital	Saligrama	185+730	181+900	LHS	20.1
15	Saraff Padmarajiah Veterinary Dispensary	Saligrama	185+800	181+980	LHS	11.4
16	Primary Health Center	Haradanahalli	192+835	188+975	LHS	35.4
17	Veterinary Hospital	Keralapura	195+825	191+940	LHS	10.9
18	Primary Health Center	Basavapatna	204+180	200+200	LHS	13.5
19	Primary Health Center	Kotavalu	208+800	204+800	LHS	18.7
20	Hospital	Konanuru	212+600	208+600	RHS	89.1
21	Govt Hospital	Hadenoor	222+830	218+750	RHS	38.0
22	Veterinary Hospital	Hadenoor	222+875	218+800	RHS	34.4

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

240. ***Hand Pump & Wells:*** There are 111 hand pumps located along the project road, out of which, 54 are located on the left and the remaining are in the right side. Out of the total, 76 hand pumps are functional and 35 are not in working condition. 27 wells are also located along the project road; 20 of them are on the left and the balance 7 is on the right side. Out of the total, 21 wells are found to be in useable conditions while the remaining 7 are abandoned or disused.

P. Archaeological Sites

241. Rameshwara & Agasthyeshwara Temples are located within a distance of 300 m from the project road as detailed in **Table 81**. Rameshawara and Agashthyeshwara temples are 132 m and 172 m, respectively from the center line of the road to the boundary wall of main monument,

and therefore, the road falls under the regulated area. The land use of the areas between the two temples and the road is rural.

242. Under the Ancient Monuments and Archaeological Sites and Remains Act of 2010, 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 ASI if the site/remains/ monuments are protected by ASI or the State Directorate of Archaeology.

243. Location of these temples is shown in **Figure 22.** According to popular belief, Lord Ram worshipped God Shiva while his way back to Ayodhya after conquering Lanka.

Table 81 Archaeological (ASI) Sites along the Project Road

Description	Design Ch. Km	Side	Dist. between center line of the project road and boundary wall of the monument	Dist. between center line of the project road and main monument	Protection Status
Rameshwara Temple	203+900	LHS	132 m	162 m	Protected by the State Government
Agasthyeshwara Temple	204+300	LHS	172 m	195 m	

(Source: Field Survey conducted by ICT Pvt. Ltd.)

244. Another Temple, famously known as Lakshmaneshwara is located at 360 m from the project road across the river Cauvery.

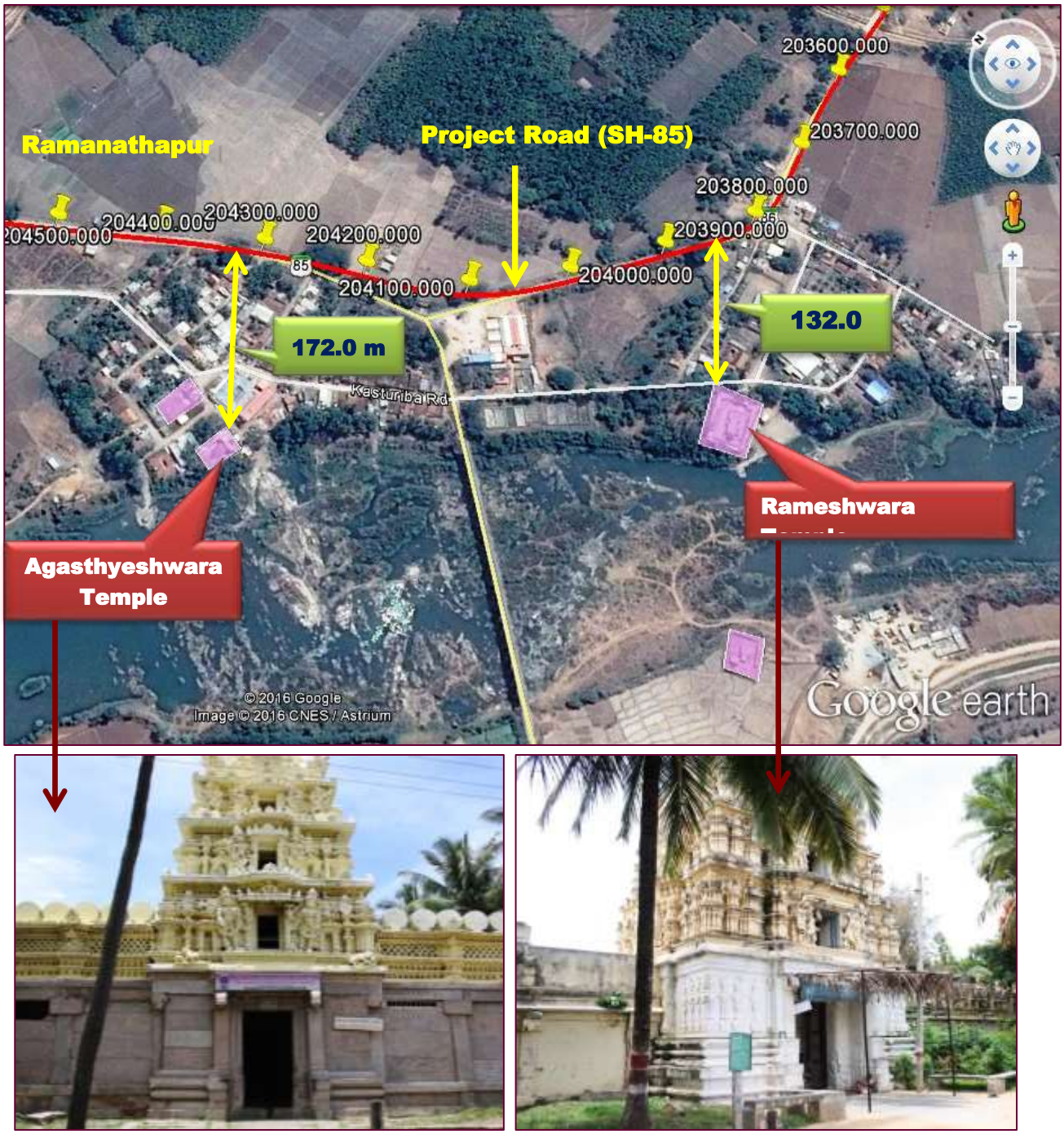


Figure 22 Map showing the Project Road and Location of Protected Monuments

Q. Demographic Details of Affected Population

245. The project road passes through Ramnagara, Tumkur, Mandya, Mysore and, Hassan districts in Karnataka. According to the 2011 census, the total population of Ramnagara, Tumkur, Mandya, Mysore and Hassan are 1.0 million, 2.6 million, 1.8 million, 3.01 million and 1.77 million respectively. 75.27% of the population of Ramnagara lives in rural areas, 77.64% of the

population of Tumkur district lives in rural areas, 82.92% of the population of Mandya district lives in rural areas,58.5% of the population of Mysore district lives in rural areas, and 78.79% of the population of Hassan district lives in rural areas.. The socio-economic information of affected persons (APs) has been collected from the census survey of 100% structures and land. The key findings are presented in this section.

7. Total Affected Households

246. The data reveals that as many as total 2,251 households are likely to be affected due to the up-gradation of the existing road. As per the census survey, 739 structures households, 1,357 land owners households, 153 tenants and 6 employees households will be losing their livelihood due to the proposed widening of the road. The details for the same are shown in **Table 82**.

Table 82 Number of Affected Households

Sl.No.	Type of Households	Number of Households	Number of Families*
1	Structure Owners	739	1267
2	Tenants	153	199
3	Employees	2	3
4	Land Owners	1357	2561
	Total	**2,251**	**4,030**

Source: Census Survey 2015-16

*Family as defined in RFCTLARRA, 2013.

8. Number of Affected Persons (APs)

247. There are a total of 8,913 APs being affected which includes both structures affected and due to loss of land, which includes 4,559 (51.15%) males and 4,354 (48.85%) females. The average household size is 3.9 and the sex ratio among APs is 955. The details of APs being affected in the project are summarized in **Table 83.**

Table 83 Number of Affected Persons

Sl. No.	Categories of APs	Number of Affected Persons	Percentage (%)
1	Male	4,559	51.15
2	Female	4,354	48.85
	Total	**8,913**	**100**

Source: Census Survey 2015-16

9. Religious Category

248. The majority of the PAHs belong to the Hindu religion 79.92%, 1.87% of the PAHs are Muslims and 0.13% belong to the Christian religion. However, nearly 18.08% of households did not respond to the question related to religion. The trend shows that Hindu communities dominate the project road. **Table 84** delineates the religious categories of the affected households.

Table 84 Religious Categories of PAHs along the Project Road

Sl. No.	Religious Group	No. of Households	Percentage (%)
1	Hindu	1799	79.92
2	Muslim	42	1.87
3	Christian	3	0.13
4	NA/NR	407	18.08
	Total	**2,251**	**100**

Source: Census Survey, 2015-16

10. Social Categories

249. The social stratification of the project area shows that 224 households (9.95%) are from general category, 1245 households (55.31%) are from other backward class (OBC), 6.57% are from scheduled caste (SC), and 2.53% are from scheduled tribe (ST) category. The details of social categories in the project area are presented in **Table 85.**

Table 85 Social Categories of the PAHs

Sl. No.	Type of Social Category	No. of Households	Percentage (%)
1	General	224	9.95
2	Other Backward Class	1245	55.31
3	Scheduled Caste	148	6.57
4	Scheduled Tribe	57	2.53
5	NA/NR	577	25.63
Total		**2251**	**100**

Source: Census Survey 2015-16

11. Annual Income

250. The census data revealed that 191 affected households (8.49%) earn income that is up to Rs. 30,000. Most households (39.27%) earn above Rs.1,00,000 annually, while 20.88% households did not respond. The average income level of households is summarized in **Table 86.**

Table 86 Annual Income Level of the Affected Households

Sl. No.	Annual Income	No. of Households	% Age
1	24001-30000	191	8.49
2	30001 to 40000	112	4.98
3	40001 to 50000	97	4.31
4	50001 to 60000	136	6.04
5	60001 to 70000	45	2.00
6	70001 to 80000	130	5.78
7	80001 to 90000	82	3.64
8	90001 to 100000	104	4.62
9	Above 100000	884	39.27
10	NA/NR	470	20.88
Total		**2251**	**100**

Source: Census Survey 2015-16

12. Educational Status

251. A significant percentage of head of affected households (33.32%) are illiterate, 7.60% are up to middle school, 8.09% are below matric, 14.62% APs are Matric (10th standard), 5.55% are up to graduate level. The details are summarized in **Table 87.**

Table 87 Educational Status of Affected Population

Sl. No.	Type of Educational Category	No. of Household	Percentage
1	Illiterate	750	33.32

2	Literate	171	7.60
3	Up to middle (7th standard)	175	7.77
4	Below Matric (Below 10th standard)	182	8.09
5	Matric (10th standard)	329	14.62
6	Up to graduate	125	5.55
7	Above Graduate	89	3.95
8	NA/NR	430	19.10
Total		**2251**	**100**

Source: Census Survey 2015-16

13. Occupational Status

252. The findings of census survey revealed that out of 2,251 affected households, 41.58% households are engaged in agriculture, 1.91% are agriculture labour, 4.31% are daily wage earner, and 15.06% households are doing business as their main occupation. The details of occupational status of affected households are summarized in **Table 88.**

Table 88 Occupational Status of Affected Households

Sl. No.	Occupation	No. of Households	Percentage
1	Agriculture	936	41.58
2	Agriculture labour	43	1.91
3	Daily wage	97	4.31
4	Private employee	146	6.49
5	Rural Artisan	3	0.13
6	Salaried Govt.	114	5.06
7	Unemployed	184	8.17
8	Business	339	15.06
9	NA	389	17.28
Total		**2251**	**100**

Source: Census Survey 2015-16

14. Women Headed Households

253. In this road out of 2,251 affected households only 202 number of women headed households are being affected. From the socio-economic survey it is found that these households are characterized by higher number of dependents and the economic standing is also poor.

Table 89 Number of Women Headed Households

Sl. No.	Properties	No. of Women Headed Household	Percentage (%)
1	Land	177	87.62
2	Structure	25	12.38
Total		**202**	**100**

Source: Socio Economic Survey, 2015-16

V. ANALYSIS OF ALTERNATIVES

A. General

254. In the present chapter, development study of existing road (SH-85) 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 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.

255. The project road throughout length has substandard geometry for both horizontal and vertical. The project road also passes through several congested settlements which include Nagamangala, K.R. Pet, Berya, Basvanpatnna and etc. where it is noted highway traffic is impeded by local traffic and improvement of project road through some of these settlements would lead to R&R impact. There are about 561 Nos. Horizontal curves having radius less than 150 m with a design speed of less than the minimum 80 kmph stipulated in code and 370 vertical curves. Hence to minimize R&R (Rehabilitation and resettlement) impact and to provide safety to road users, one bypass (9.220 km) & fourteen realignments (18.432 km) have been proposed in this section of SH-85 with a total length of **27.652 km**. All the bypasses and realignments proposed are summarized below:

Table 90 Bypass of SH-85

Sl. No.	Name of Town / Village	Existing Chainage		Design Chainage		
		Start	End	Start	End	Length (km)
1	Krishna Raj Pet Bypass	149+690	158+515	146+080	155+300	**9.220**

Table 91 Realignment of SH-85

Sl. No.	Name of Town/Village	Chainage along existing alignment (km)			Chainage along Bypass / Realignment (km)		
		Start	End	Length	Start	End	Length
1.	Huliyurudurga	73+456	76+780	3.324	72+000	74+500	2.500
2.	Kenkeri	83+852	85+500	1.648	81+500	82+900	1.400
3.	Yadavani	90+306	90+928	0.622	87+700	88+100	0.400
4.	Devalapura	100+043	100+764	0.721	97+100	97+780	0.680
5.	Nagamangal rural	112+858	114+111	1.253	109+800	111+200	1.400
6.	Kunnakatte Mallenahalli	117+219	118+278	1.059	114+200	115+200	1.000
7.	Ayithanahalli	128+550	129+540	0.99	125+400	126+300	0.900
8.	Tiraganahalli	134+145	136+006	1.861	130+900	132+550	1.650
9.	Bommadihalli	137+971	138+900	0.929	134+508	135+400	0.892
10.	Komenahalli	158+700	159+788	1.088	155+100	156+100	1.000
11.	Lakshmipura	165+100	166+078	0.978	161+400	162+350	0.950
12.	Singanahalli-ROB approach	170+910	172+000	1.09	167+000	169+100	2.100
13.	Bherya Realignment	173+875	176+330	2.455	170+075	172+575	2.500
14.	Kurubara Abburu	221+600	222+688	1.088	217+550	218+610	1.060
Total Length (Km)				**19.106**			**18.432**

256. The study and analysis has been based upon ground verification of the possible alignments. A 2-lane divided highway with 7 m wide carriageway and 1.5 m wide shoulder on both sides with proposed ROW of minimum 26 m has been proposed.

B. "With" and "Without" Project Scenario

257. The Project road between Magadi to Somwarpeth forms an important connectivity for five major districts Ramanagara, Tumkur, Mandya, Mysore & Hassan, which is an existing intermediate lane for majority section and passes through plain / rolling terrain. The proposed improvement proposal would help to uplift the project road section of SH 85 of State Highway category 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 kmph in open country locations and minimum speed of 50 to 60 kmph in settlement locations. 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 92**. 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.

258. 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, an important benefit which is not represented in this assessment will be major reduction in the SPM levels from vehicles using a surfaced road (with project scenario) in the built condition, compared to a continued use of dusty un surfaced/tracks (without project scenarios).

259. It will provide mitigation not only for air, noise, vegetative cover; wildlife and soil erosion but will also provide other appropriate mitigative measures such as roadside plantation, arboriculture & landscaping, compensatory afforestation and negative impact on environment.

C. Analysis of Alternatives

260. As mentioned above one bypass and fourteen realignments have been recommended in the improvement proposal for the project road to improve existing bad geometry for safer movement of traffic.

Table 92 "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	▪ Minor changes in land use pattern ▪ Loss of some properties and livelihood ▪ Diversion of minimum reserved forest land for	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.

With Project		Without Project	
Impacts		Impacts	
Positive	Negatives	Positive	Negative
vehicles will be reduced reducing air pollution ▪ Enhancement/protection of Archaeological Monuments ▪ Enhancement/Protection of Community property e.g. Places of worship & meeting ▪ 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 ▪ 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.	geometric improvement ▪ Removal of vegetative cover along the road ▪ 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 due to construction, construction phase		▪ 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.

D. Proposed Bypass and Realignments

261. 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. Krishna Raj Pet Bypass


View of blind curve in congested


View of Congested Market

262. The project road passes through Krishna Raj Pet (K. R. Pet) town in Mandya District. At the start of the town area, the SH 85 crosses the K. R. Pet Kare (lake) with a bridge of 5.5 m carriageway and length of about 52 m. There are 3 right angle horizontal curves before it crosses SH-7 en-route. The available distance between building line is about 10m to 20m. Within the market area, a length of about 2.4 km of existing SH 85 is having 4 lane divided carriageway with raised median. There are 3 schools, one collage, police station, hospital and 132 kv electrical substation along the existing road. After crossing the main market area near Hosahalalo, there are 4 substandard horizontal curves with available land of about 10m (Building line). Keeping in view the congestion and traffic safety within the town and to segregate the local traffic, both side service roads are required in this section. To accommodate 4 lane divided carriageway with both side service road, a minimum of 40 m ROW is required. Considering the above factors and land acquisition, there will be about 119 nos. of structures on left side and 68 nos. on right side affected from Km 151 to Km 157+000. Demolition of numerous residential / commercial structures would entail higher resettlement cost and opposition from local population and other stake holders.

263. Therefore, due to the above constraints the improvement of existing road is not feasible and bypass from Km 146+080 to Km 154+905 (design chainage as along the existing road) for K. R. Pet has been explored. Three options have been explored for K.R. Pet bypass as shown in **Figure 23**.

- Option I : Bypass on North side
- Option II : Bypass on South side
- Option III : Up gradation of Existing road.

Table 93 Alternative Analysis for KR Pet Bypass

SN.	Factor	Option I	Option II	Option III
1.	Length (Km)	9.220	7.60	8.825
2.	Lane Configuration	2 Lane	2 Lane	4 Lane- 4.14 Km 2 lane urban-1.77 Km 2 lane-2.91 Km
3.	Geometrics	Good. Design speed 80/100 Kmph	Fair Design Speed 80 Kmph	Poor – S curves Design speed 40-50 kmph
4.	PROW (m)	32	32	20
5.	Land Acquisition (Hectare)	29.504	24.32	28.24

SN.	Factor	Option I	Option II	Option III
6.	Bridges/ structures	Minor Bridge3 (56 m) Culvert-26	Minor Bridge-2 (101.5m) Culvert-26	Minor Bridge-2 (101.5m) Culvert-26
7.	Junctions	Major -1 Minor-3	Major -1 Minor-3	Major -1 Minor-32
8.	Structures Impacted	Nil	Pond in front of existing Temple and few structures near Babujagjivan Nagar	187
9.	Utility Relocation	Negligible	Negligible	Water supply Sewer Line –Both Side Electrical
10.	Change of Land Use	High	High	Low
11.	Trees	Low	Low	High
12.	Water Bodies	Nil	Low (Doddakhere lake)	High
13.	Environmentally Sensitive Receptors	Nil	Nil	High
14.	Social Impact	Only Cultivation land acquisition	Only Cultivation land acquisition	Land acquisition Demolition of structure
15.	Tentative Civil Construction Cost (Rs. in Crores)	41.52	40.88	58.70

Figure 23 Proposed K.R. Pet Bypass

264. The Resettlement and Rehabilitation (R&R) cost along the existing alignment will be very high. Demolition of the affected structures is likely to cause social unrest. Option II is though lesser

in length as compared to Option I, it runs very close to settlements and is sandwiched between a temple and a lake at Km 152. Bypass Option-I has encumbrance free alignment with negligible R&R impact. Hence **Option I is recommended.**

2. Bherya Realignment

265. The project road (SH 85) passes through Bherya village in Mysore District. At the entrance to the village, the existing road is having an S curve of horizontal radius of 40m and 60m. The available land between building line is about 10m. Then project road crosses SH 57 at Km 175+200. The congested length within this village area is about 1.2 Km with junction of several crossroads. Improvement along existing road will involve acquisition of one temple, 2 schools and about 37 nos. of structures on left side and 47 nos. on right side from Km 174+70 to Km 175+90. Demolition of numerous residential/commercial structures would entail higher resettlement cost and opposition from local population and other stake holders. Considering the above constraints the improvement of existing road is not feasible and bypass from Km 170+075 to Km 172+575 (existing- Km 173+875 to Km173+330) for Bherya village has been explored. Three options have been explored for Bherya settlement as shown in **Figure 24.**

- Option I : Bypass on North side
- Option II : Bypass on South side
- Option III : Up gradation of Existing road.

Figure 24 Proposed Bherya Bypass

Table 94 Alternative Analysis for Bherya Realignment

S. No.	Factor	Option I	Option II	Option III
1	Length (Km)	2.500	3.165	2.455
2	Lane Configuration	2 Lane	2 Lane	2 lane with Footpath
3	Geometrics	Good. Design speed 100 Kmph	Good. Design Speed 100 Kmph	Poor – S curves Design speed 40-50 kmph
4	PROW (m)	30	30	20

S. No.	Factor	Option I	Option II	Option III
5	Land Acquisition (Hectare)	8.0	10.12	7.85 (With Urban 20m width)
6	Bridges/ structures	Minor Bridge-2 Culverts-8	Minor Bridge-2 Culverts-8	Minor Bridge-2 Culverts-8
7	Junctions	Major -1	Major -1	Major -1 Minor 13
8	Environmental Constraints	Nil	Nil	Nil
9	Structures Impacted	1	Nil	84
10	Utility Relocation	Negligible	Negligible	Water supply Sewer Line –Both Side Electrical
11	Social Impact	Only Cultivation land acquisition	Only Cultivation land acquisition	Land acquisition Demolition of structure
12	Tentative Civil Cost (Rs.Crores)	14.12	17.88	18.24

266. The Resettlement and Rehabilitation (R&R) cost along the existing alignment will be very high. Demolition of the affected structures is likely to cause social unrest. In comparison Option I involve less land acquisition and less civil cost than Option II. Bypass Option-I is encumbrance free and less length in comparison to other alignment with marginal R&R impact. Hence **Option I is recommended.**

3. Huliyurudurga Forest Realignment

267. A bypass for Huliyurudurga is being built in a separate contract. However, just after the bypass the project road has very poor geometry passing through forest area after village Devapatna. The total length within the forest area is about 3.2 Km. There are about 12 substandard horizontal curves (minimum of 60m) along the existing alignment within this stretch. Due to presence of such type of S curve and broken back curve, this stretch of the project road is an accident prone area and is a black spot where number of accident have happened in the past. .Hence considering the safety and to reduce the series of curves, a realignment has been proposed from Km 72+000 to Km 74+500. The proposed realignment on google Imagery is shown in **Figure 25.**

Figure 25: Proposed Realignment (Huliyurudurga)

4. Singanahalli-ROB Approach Realignment

268. After crossing Machaholalu village junction, the project road moves towards right side with 2 horizontal curve of radius about 50m. The SH 85 crosses the broad gauge single track South Western Railways line at km 172 with a level crossing. Then the project road takes left turn very close to the level crossing. A major canal is also running parallel to SH 85 at a distance of about 100m. Considering the maximum allowable skew, provision of Railway over Bridge (ROB) close to the crossing location is not feasible.

269. Provision of ROB at existing crossing will involve acquisition of Canal and dismantling of residential structure in village Singanahalli at km 173. Hence considering the above facts, realignment has been proposed with provision of ROB. Since the alignment takes right turn after Machaholalu village (before crossing), realignment on right side will be shortest. The realignment proposal marked on google imagery is given below as **Figure 26**.

Figure 26: Proposed Realignment (ROB)

270. The proposed improvement would help in capacity augmentation and further safer movement of goods and people. The improvement proposal is important as it forms connectivity to several tourist destinations including Coorg area.

271. 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 and other short term reversible negative impact on environment.

VI. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Introduction

272. 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

273. **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.

274. **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

275. ***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.

276. ***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 95.**

Table 95 Raw Materials Requirement during Construction

Sl. No.	Item & Unit	Quantity	Mode of Transport	Source
1.	Blue metal (m^3)	10,20,000	Truck	Pre-identified quarry areas
2.	Sand (m^3)	6,80,000	Truck	Pre-identified quarry areas
3.	Cement (MT)	57,500	Truck	Local traders
4.	Bitumen (MT)	30,000	Truck	Refinery
5.	Diesel (KL)	21,000	Tanker	Local petrol pumps
6.	Steel (MT)	8,918	Truck	Local traders
7.	Earth (m^3)*	32,08,245	Truck	Identified Borrow areas

277. ***Construction of Borrow Areas:*** about 32,08,245 cubic meter of borrow 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 22,33,283 Cum. Therefore, 9,74,962 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 96**.

Table 96 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)	Present Land Use
1.	47.700	LHS	Magadi	0.1	Barren Land
2.	54.900	LHS	Vishwanathpura	0.1	Barren Land
3.	57.350	RHS	Kempasagara	0.3	Barren Land
4.	63.300	RHS	Alesabela	0.2	Barren Land
5.	69.800	LHS	Byadarahalli	2	Barren Land
6.	75.000	LHS	K. G. Devapana	0.1	Barren Land
7.	79.600	LHS	Hulidurga	0.3	Barren Land
8.	83.300	LHS	Sugganahalli	0.5	Barren Land
9.	85.200	RHS	Pallarayahalli	0.8	Barren Land
10.	93.700	LHS	Kudugubalu	0.4	Barren Land
11.	98.200	LHS	Devalapura	0.5	Barren Land
12.	105.200	RHS	Tattahalli	0.3	Barren Land
13.	118.700	RHS	Sankanahalli	0.2	Barren Land
14.	121.900	RHS	Gangasamudra	0.5	Barren Land
15.	128.000	LHS	Sriramnahalli	2.3	Barren Land
16.	133.600	RHS	Giduvinahasahalli	0.5	Barren Land
17.	139.700	RHS	Chakkaharanahlli	1	Barren Land
18.	143.400	RHS	Kaigonahalli	0.5	Barren Land
19.	149.800	LHS	Guddenahalli	2.5	Barren Land
20.	156.200	RHS	Hosaholalu	0.2	Barren Land
21.	163.200	RHS	Dadahalli	0.5	Barren Land
22.	169.600	LHS	Jainahalli	1.6	Barren Land
23.	176.600	RHS	Somanahalli	0.2	Barren Land
24.	177.600	RHS	Somanahalli	1.4	Barren Land
25.	188.700	RHS	Haradanahalli	0.2	Barren Land
26.	192.250	RHS	Seegehol	1.1	Barren Land
27.	196.100	RHS	Bodanur	2	Barren Land
28.	202.100	RHS	Garudanahalli	1.5	Barren Land
29.	206.900	RHS	Shiradanahalli	0.6	Barren Land
30.	212.800	RHS	Hirehalli	2.2	Barren Land
31.	219.000	RHS	Siddapura	0.1	Barren Land

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Location / Village Name	Lead From Nearest Point on Project Road (km)	Present Land Use
32.	223.200	RHS	Vadenura	0.3	Barren Land
33.	225.200	RHS	Betkale	0.1	Barren Land

278. 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.

279. ***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.

280. ***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)

281. 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.

282. **Operation Phase:**

- During operation phase of the project road, no impact is anticipated on the topography and geology of the area.

2. Soil

Impacts:

283. **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 98.811 km, out of which height of embankment is more than 3.0 m for a length of 27.350 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.

284. **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

285. **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

286. **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**.

- **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**.

- **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.

287. 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. **36,765 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**.

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

288. **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 existing land adjacent to

the road at present is mainly of agricultural use with some roadside residential & commercial plots which will need to be acquired for widening of the road.

289. 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.

290. **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

291. **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.

292. **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.

293. 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.

294. **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

295. **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

296. The project road runs through mainly plain terrain and crosses river at two locations. The project road also crosses natural drainage channel / stream at several 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 97 Location of River Crossings

Sl. No	Design Chainage Km	Name of the River
1.	84+200	Sanabaghatta Halla River
2.	161+130	Hemavati River

297. **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.

298. **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 67.36 km on either side and the length of unlined drain is 207.456 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

299. **Impacts:** 75 hand Pumps are located within the proposed right of the way of the project road. Apart from hand pumps; there are bore-wells and water pipeline within the proposed RoW. Removal of all drinking water sources along the ROW is essential for the widening. This will lead to major community problems if not resolved.

300. **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

301. **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 98**.

Table 98 Breakup of Fresh Water Requirement during Construction

SN	Purpose	Quantity (KL)
1.	For road construction: a) Construction related to earthwork b) Construction of GSB c) Construction of WMM d) Bridges, culverts, retaining walls & other structures	41,03,000
2.	Dust suppression	8,000
3.	For drinking & other household purpose	14,000
	Total	**41,25,000**

302. **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

303. **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

304. **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.

305. **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.

306. **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 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**.

307. **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**.

308. **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 **23 locations** near water bodies, river crossing, canal crossing, forest area and agricultural area (**Table 100**) 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. The project road is passing through 5 districts and it has been observed from the past meteorological data of IMD & CGWB, total number of rainy days annual average rainfall varies district wise as tabulated below:

Table 99 Distrctiwise Variationin Annual Average Rainfall

Sl. No.	District	Annual Average Rainfall (mm)	Number of Rainy Days
1	Ramnagar	868	57.5
2	Tumkur	650	45.0
3	Mandya	623	42.9
4	Mysore	776	53.0
5	Hassan	1074	65.0
6	Average	798.2	52.7

309. 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 100 Proposed Location of Ground Water Recharge Pit

Sl. No.	Design Ch.	Village	Particulars
1	57+900	Dhonakuppi	Near Pond
2	65+350	Neelasandra	In Forest Area
3	71+100	Devapatna	Near Depambudhai Tank
4	73+700	Huliyurdurga	In Forest Area

5	80+100	Suggunahalli	In Forest Area
6	84+300	Suggunahalli	Near Sanabaghatta Halla River
7	90+500	Kudagaballu	Near River
8	97+650	Devalpura	Near Nammora Kere
9	101+200	Kuntanakoppalu	In Forest Area
10	103+400	Nagmangala	In Forest Area
11	114+900	Sankanhalli	Near Sule Kere
12	122+700	Kallenahalli	Near Pond
13	123+800	Ayithanahalli	Near Pond
14	129+100	Thuruganahalli	In Forest Area
15	140+700	Jaginkere	Near Canal Crossing
16	161+000	Akkihebbal	Near Alemavati River Crossing
17	176+100	Yalemudanahalli	Near Pond
18	195+000	Juttenahalli	Near Pond
19	198+400	Kananakopal	Near low lying area
20	203+000	Ramanathapura	Near Cauveri River
21	210+500	Ullenahalli	Near Cauveri River
22	218+700	Hadenoor	Near Pond
23	221+400	Bettahalale	Near End Point in Agricultural area

310. **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.

311. **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

312. **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 32 m** in rural / open country areas. There are 31 water bodies, which are located within the COI (**Table 101**).
- All water bodies (pond & lakes) have been saved by providing toe wall / change in engineering design or through realignment except 6 road side ditches. These are small depression (natural or manmade) along the road where water stored during rainy seasons. Water of these ditches is of no use.

Table 101 List of Water Bodies Located within the COI

SL	Particular	Existing Ch. km	Design Ch. Km	Distance# (m)	Side	Village	Affected Status	Remarks
1.	Road Side Ditch	57+660	56+625	7.7	LHS	Sathanuru	Partially Affected	Water accumulated during rainy season
2.	Road Side Ditch	67+140	65+810	8.1	RHS	Neelasandra	Affected	
3.	Road Side Ditch	72+050	-	8.7	LHS	Hangarahalli	Not Affected	Realignment
4.	Road Side Ditch	81+465	79+145	2.3	RHS	Huliyurdurga	Affected	Water accumulated during rainy season
5.	Pond	93+485	90+600	8.5	RHS	Kudagaballu	Not Affected	
6.	Nammora Kere	100+550	97+600	13.3	RHS	Devalpura	Not Affected	
7.	Amankatte Kere	113+300	110+900	10.6	LHS	Nagmangala	Not Affected	
8.	Sule Kere	117+800	114+800	9.9	RHS	Sankanhalli	Not Affected	Toe wall provided
9.	Pond	125+935	122+800	11.1	RHS	Kallenahalli	Not Affected	
10.	Road Side Ditch	126+635	123+500	9.7	RHS	Kallenahalli	Not Affected	
11.	Pond	128+780	125+600	6.6	LHS	Ayithanahalli	Not Affected	Curve improvement
12.	Pond	138+300	134+800	8.0	RHS	Bommadihalli	Not Affected	
13.	Road Side Ditch	141+470	137+940	5.2	LHS	Kotegenahalli	Not Affected	
14.	Road Side Ditch	141+745	138+200	10.7	LHS	Kotegenahalli	Not Affected	
15.	Road Side Ditch	143+050	139+530	5.2	RHS	Jaginkere	Not Affected	
16.	Storm Water Storage Tank	143+120	139+590	13.6	RHS	Jaginkere	Not Affected	
17.	Road Side Ditch	143+560	140+035	6.2	LHS	Jaginkere	Partially Affected	Water accumulated during rainy season
18.	Pond	174+600	170+800	7.1	RHS	Sambaravalli	Not Affected	
19.	Pond	177+150	173+350	8.0	RHS	Kodiyala	Not Affected	
20.	Pond	180+175	176+300	10.0	LHS	Yalemudanahalli	Not Affected	
21.	Road Side Ditch	181+000	177+200	6.0	LHS	Kurubahalli	Partially Affected	Water accumulated during rainy season
22.	Road Side Ditch	181+850	178+050	7.3	RHS	Kalli muddanahalli	Partially Affected	
23.	Saligrama Lake	184+800	181+100	15.3	RHS	Saligrama	Not Affected	Retaining Wall provided
24.	Pond	190+777	186+915	9.5	RHS	Haradanahalli	Not Affected	
25.	Pond	197+900	193+950	13.9	RHS	Honnenahalli	Not Affected	
26.	Pond	199+200	195+250	11.4	RHS	Juttenahalli	Not Affected	
27.	Shallow Water body	202+500	198+450	6.0	LHS	Kananakopal	Not Affected	
28.	Pond	203+200	199+300	6.5	RHS	Basavapatna	Not Affected	
29.	Pond	205+445	202+075	7.8	RHS	Shiradanahalli	Not Affected	
30.	Road side Ditch	222+040	218+000	12.1	LHS	Hadenoor	Not Affected	
31.	Pond	222+500	218+550	7.9	LHS	Hadenoor	Not Affected	

Distance in meter from existing centerline

313. **Enhancement of Water Body**. 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 102**.

Table 102 Water Bodies Proposed for Enhancement

SL	Particular	Existing Ch. km	Design Ch. Km	Distance# (m)	Side	Village
1.	Saligrama Lake	184+800	181+100	15.3	RHS	Saligrama

Distance in meter from existing centerline

Figure 27 View of the Saligrama Lake (Ch. Km 184+800) proposed for Enhancement

314. 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

315. **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.

316. 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.

317. 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.

318. 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

319. 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.

320. Undesirable gaseous pollutants will be generated mostly by the automobile traffic and construction machineries. Pollutants of primary concern include PM2.5 and PM10. 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.

321. **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

322. **Mitigation Measures:**

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.

323. **Emission Control: 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.

324. 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:

325. **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.
- Cost Benefits: Reduced cost of construction considerably because of providing lesser thickness of pavement crust compared to the pavement incorporating conventional materials.

326. **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.

327. **Air Quality Monitoring.** 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

328. ***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.

329. **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.

330. **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.

331. **Homogeneous Traffic Sections.** As per the iDeCK Traffic Report 2014, the project road CEW 28 (SH-85) from Magadi to Somwarpet has been divided into four sections.

Table 103 Homogeneous Traffic Sections considered for Air Prediction Models

Section No.	Sections	Existing Chainage (km)		Design Chainage (km)	
		Start	End	Start	End
III	Magadi to Nagamangala	51+815	114+500	51+000	113+370
IV	Nagamangala to K.R.Pet	114+500	151+800	113+370	150+250
V	K.R Pet to Ramanathpura	151+800	206+400	150+250	204+780
VI	Ramanathpura to Somwarpet	206+400	226+800	204+780	221+833

332. **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 III and V (major variation is not observed between traffic section IV & VI). 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 28 to 45.**

Figure 28 Predicted CO Levels in Traffic Section III for the Base Year 2015

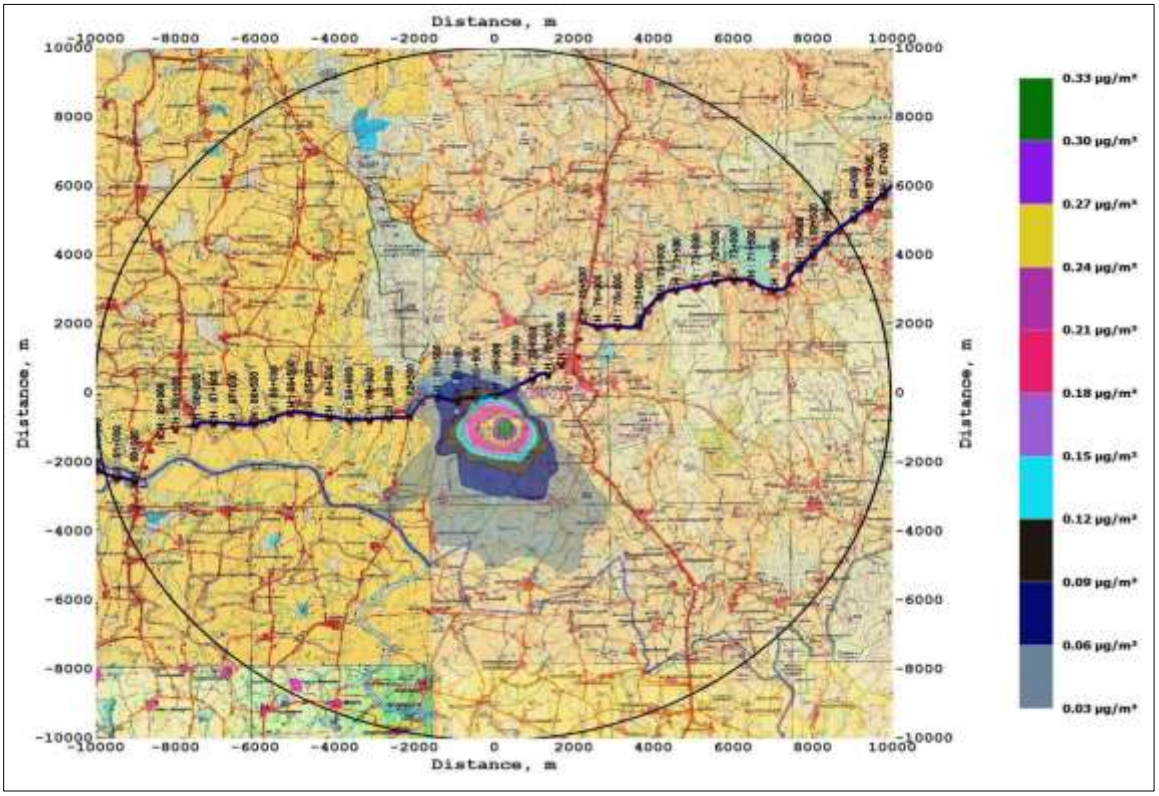


Figure 29 Predicted CO Levels in Traffic Section III for the Year of Operation 2020

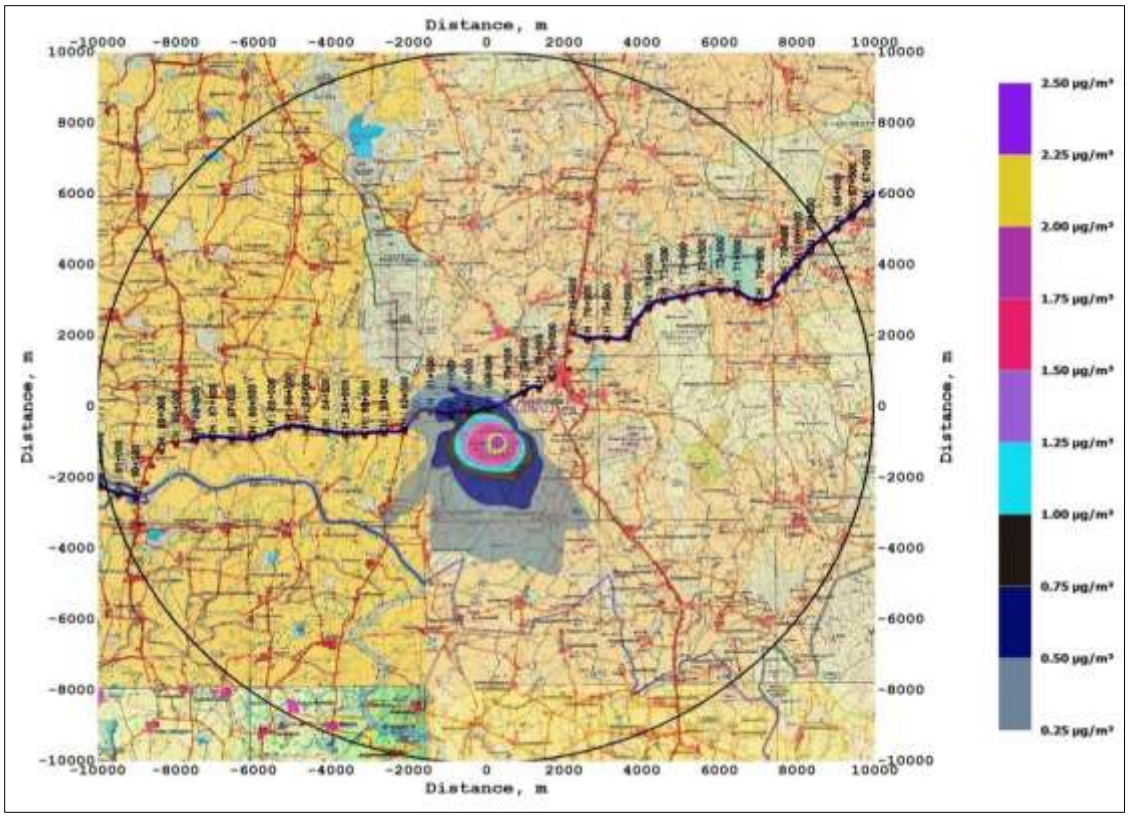


Figure 30 Predicted CO Levels in Traffic Section III for the Year 2040

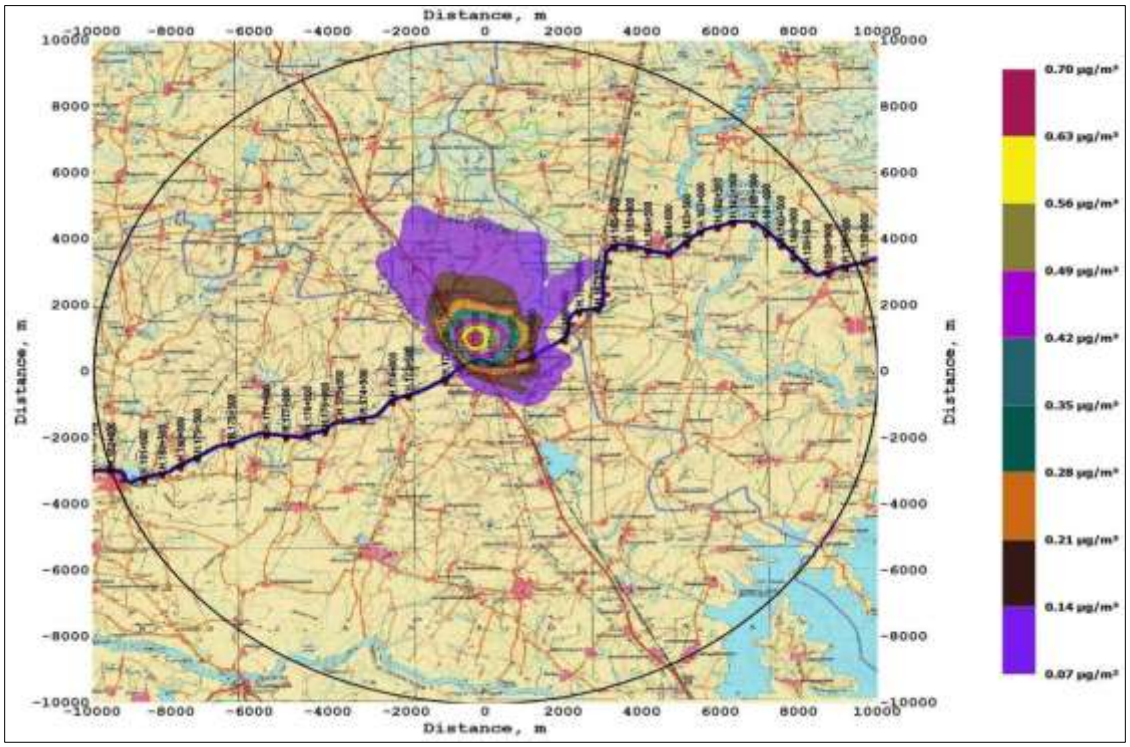


Figure 31 Predicted CO Levels in Traffic Section V for Base Year 2015

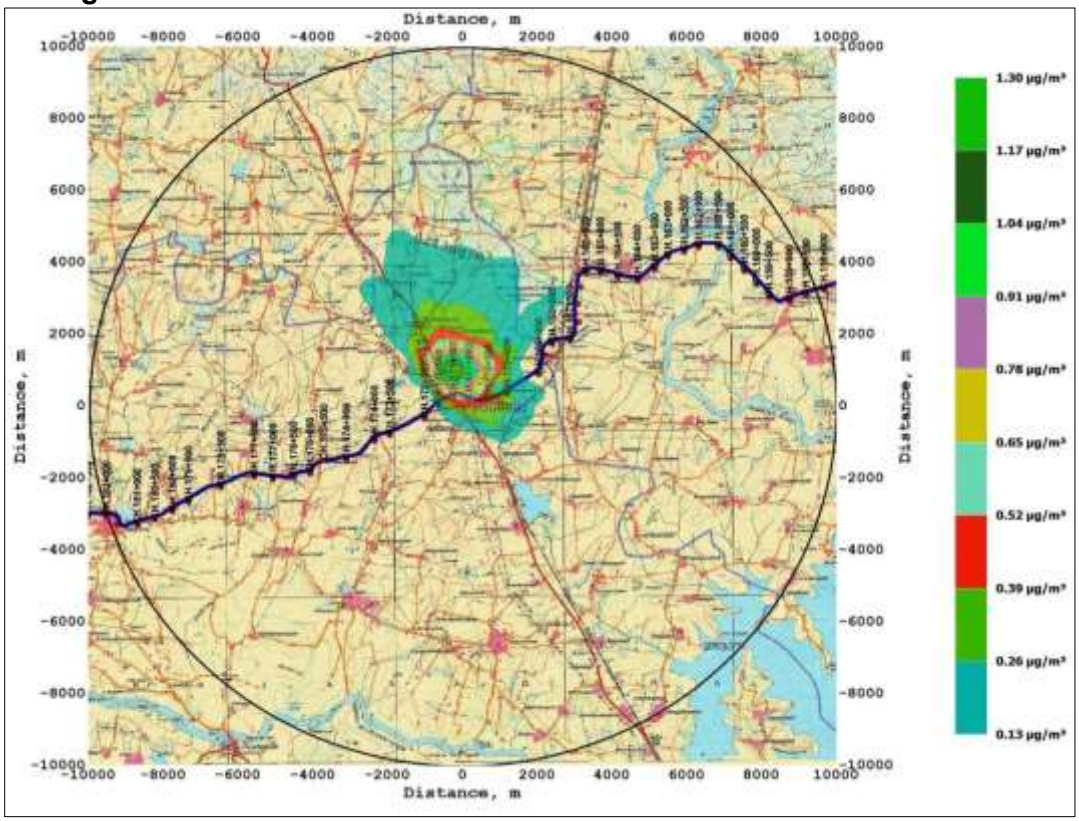


Figure 32 Predicted CO Levels in Traffic Section V for the Year of Operation 2020

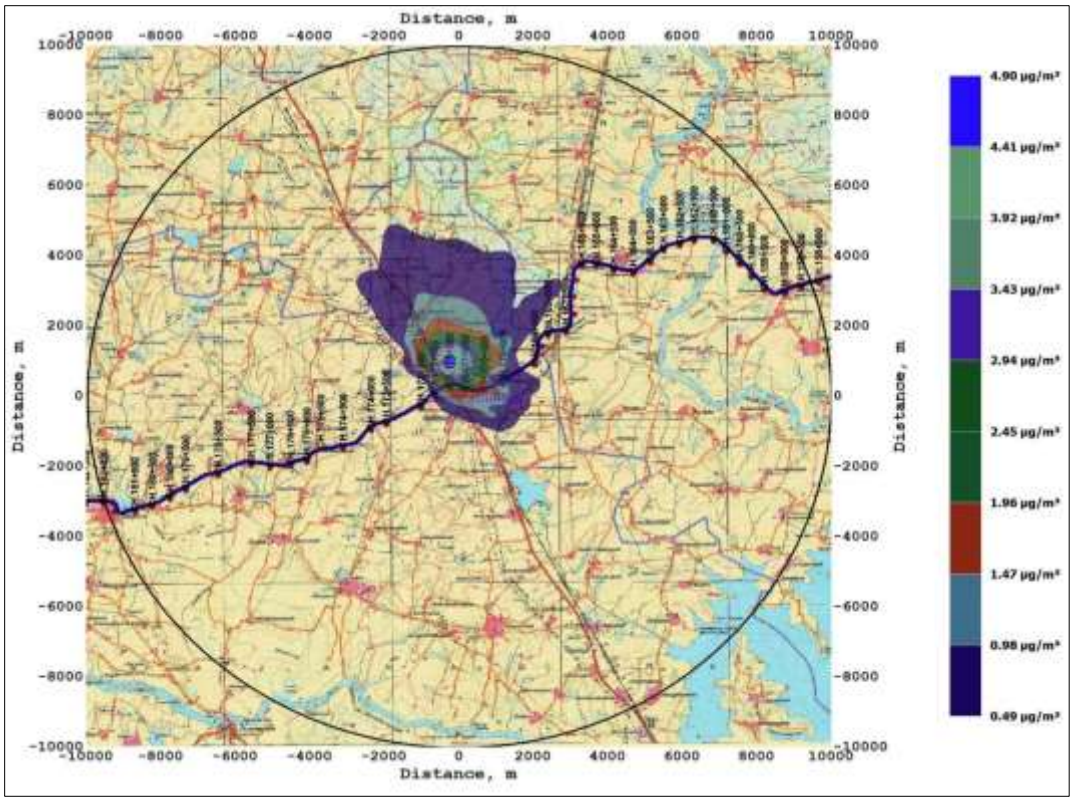


Figure 33 Predicted CO Levels in Traffic Section V for the Year 2040

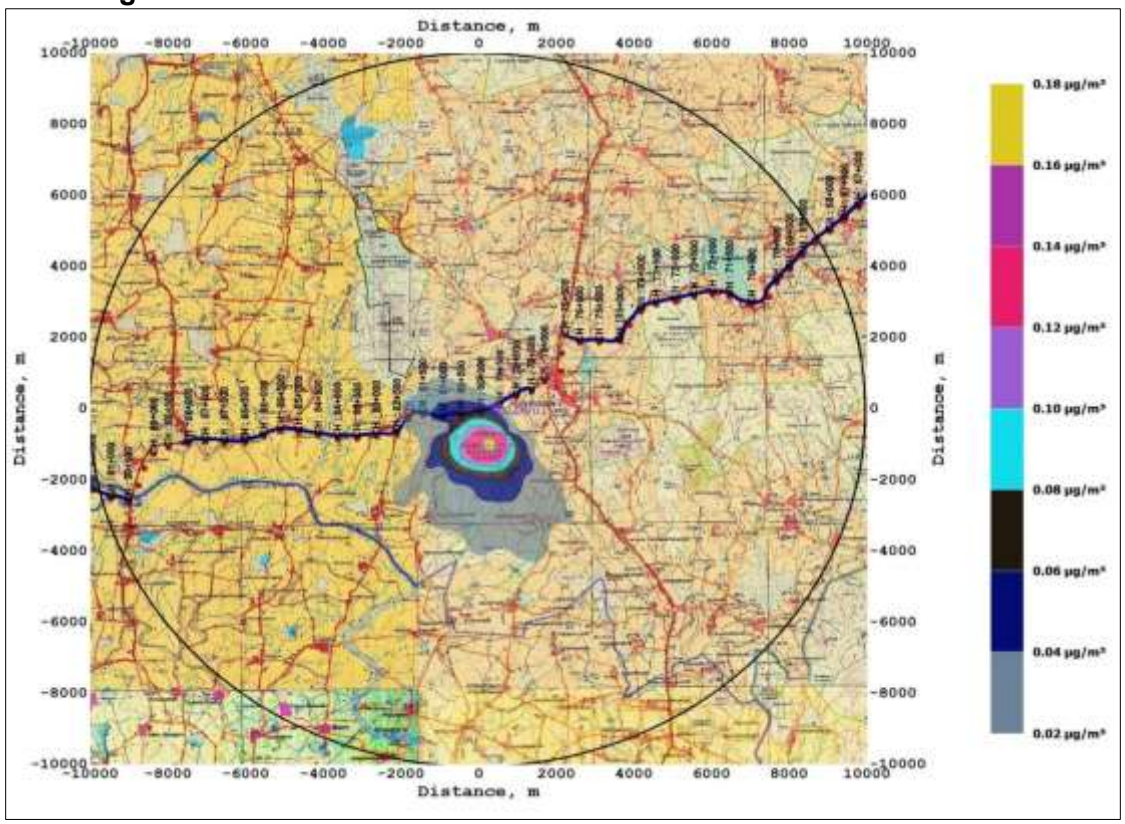


Figure 34 Predicted NO_x Levels in Traffic Section III for Base Year 2015

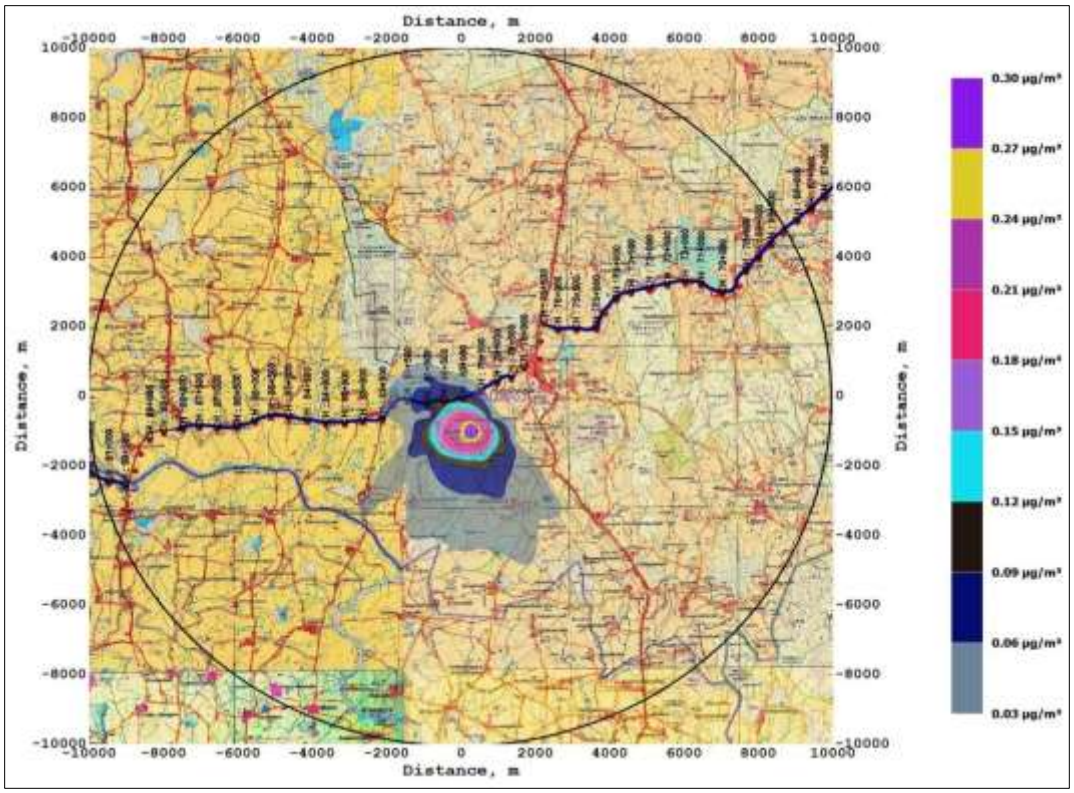


Figure 35 Predicted NO_x Levels in Traffic Section III for the Year of Operation 2020

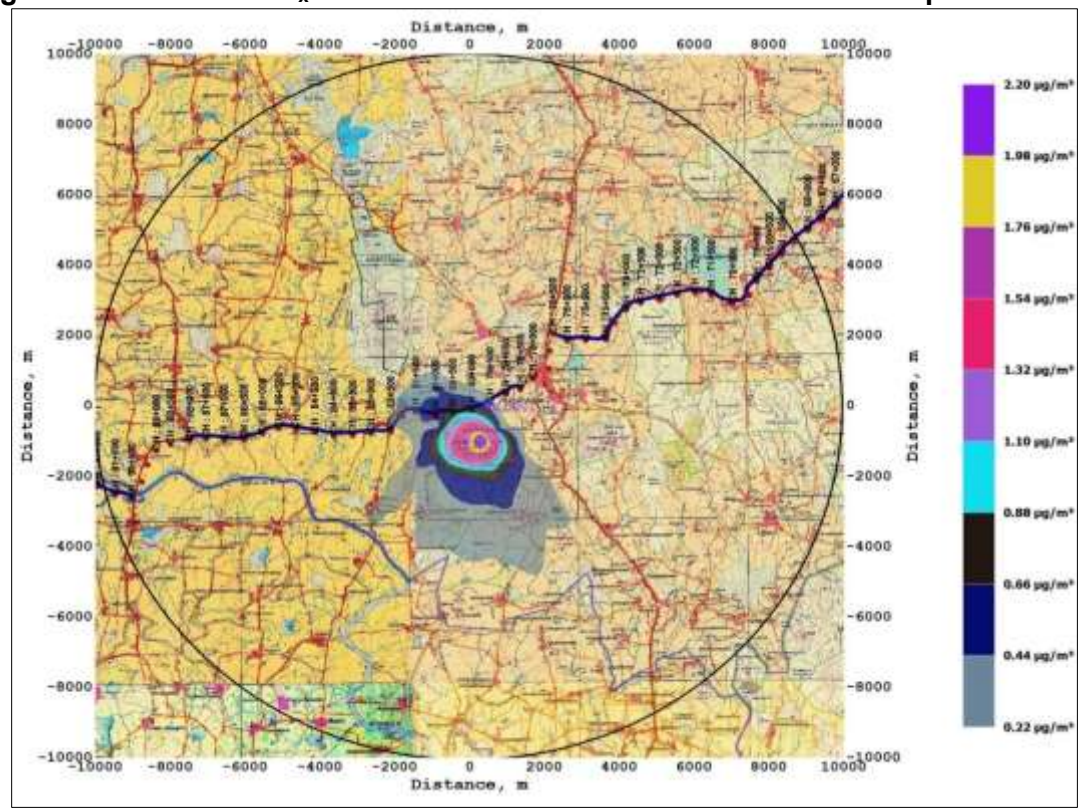


Figure 36 Predicted NO_x Levels in Traffic Section III for the Year 2040

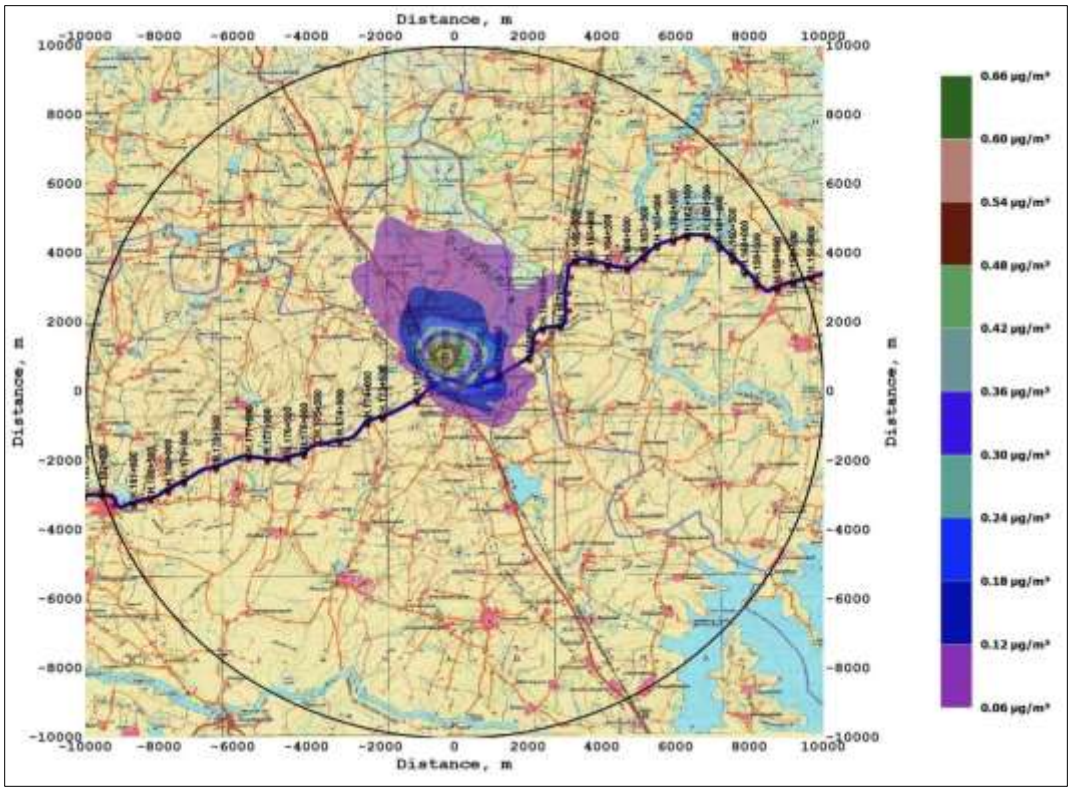


Figure 37 Predicted NO_x Levels in Traffic Section V for Base Year 2015

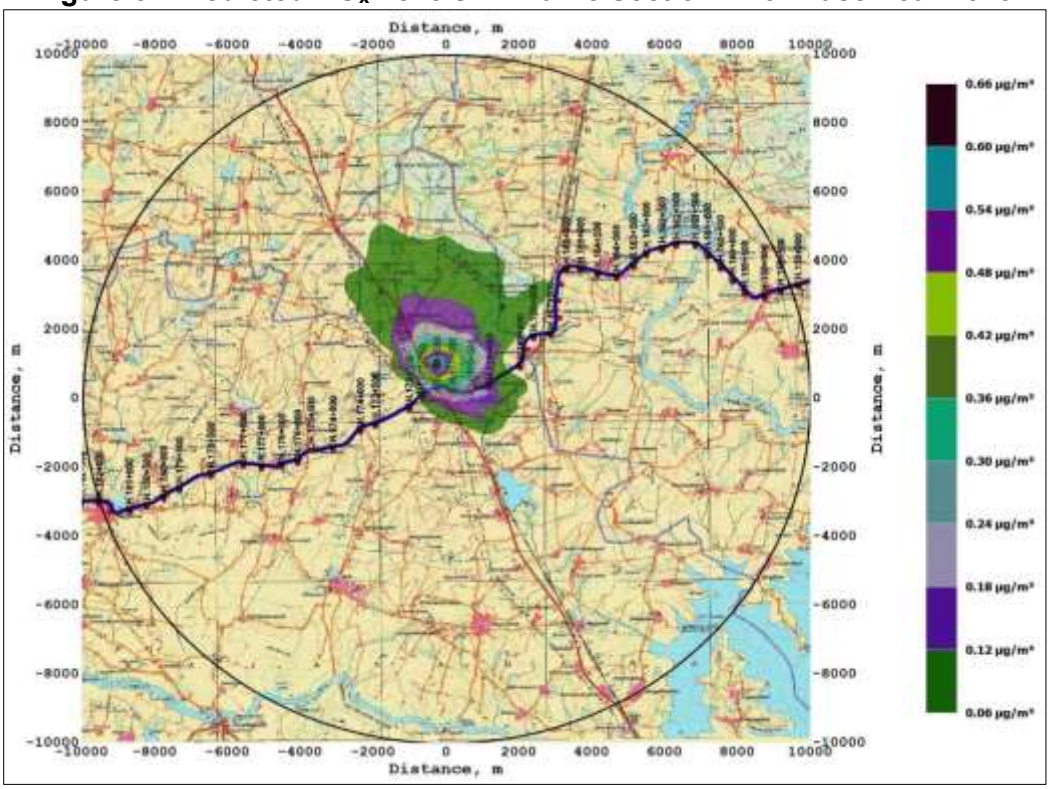


Figure 38 Predicted NO_x Levels in Traffic Section V for the Year of Operation 2020

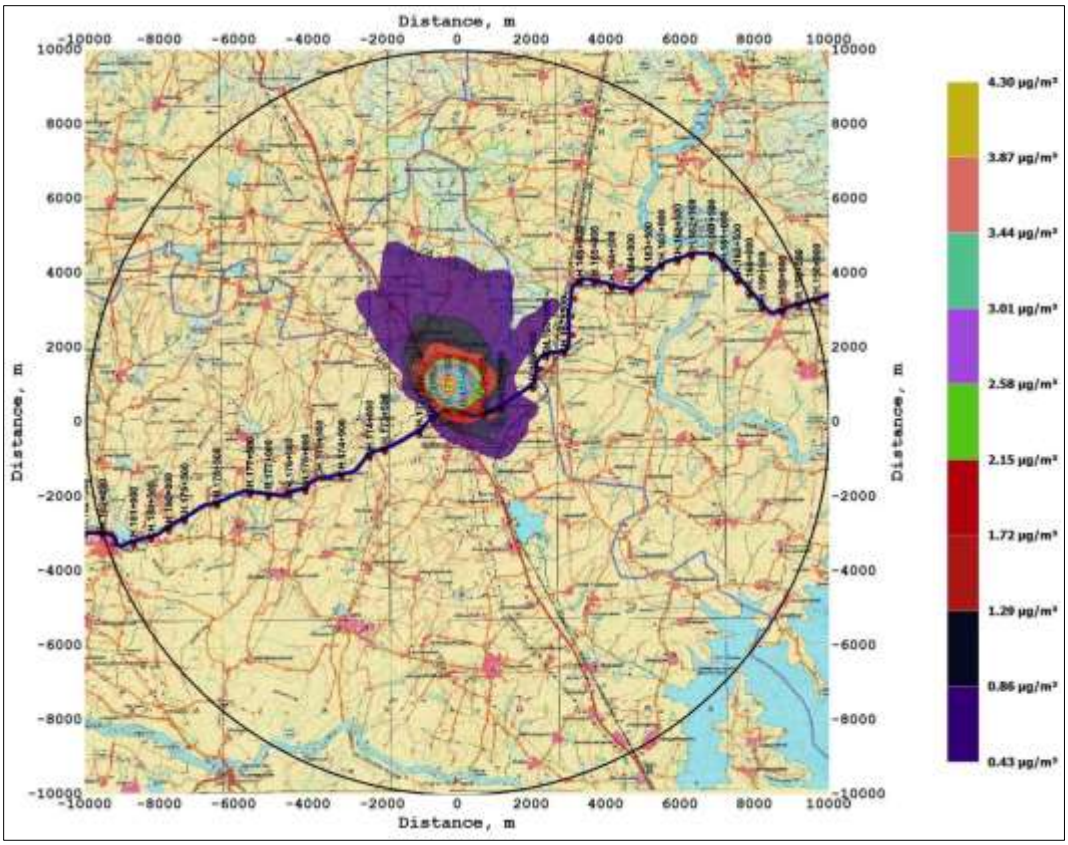


Figure 39 Predicted NO_x Levels in Traffic Section V for the Year 2040

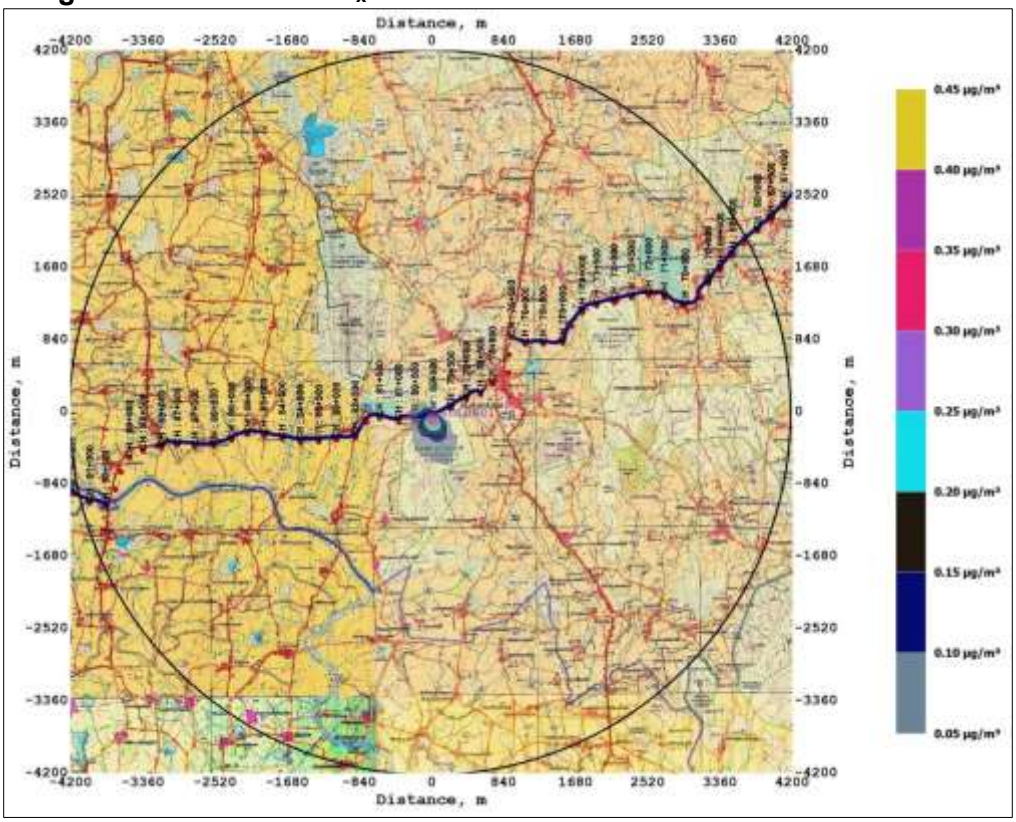


Figure 40 Predicted PM Levels in Traffic Section III for Base Year 2015

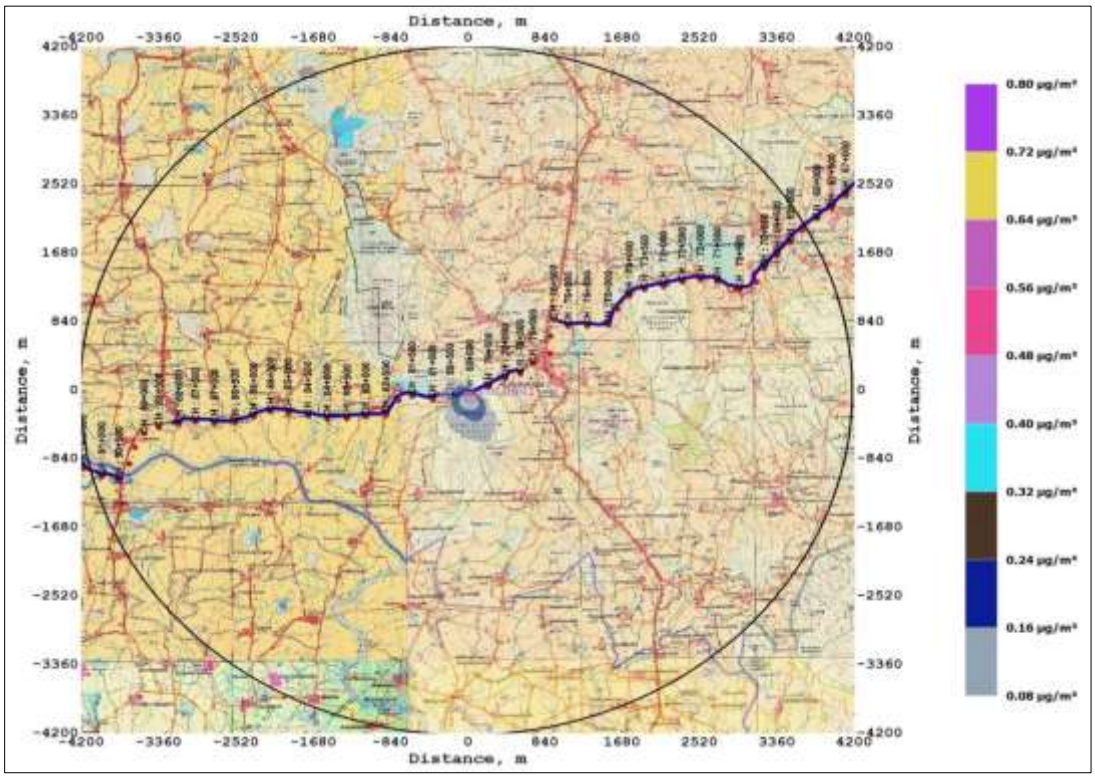


Figure 41 Predicted PM Levels in Traffic Section III for the Year of Operation 2020

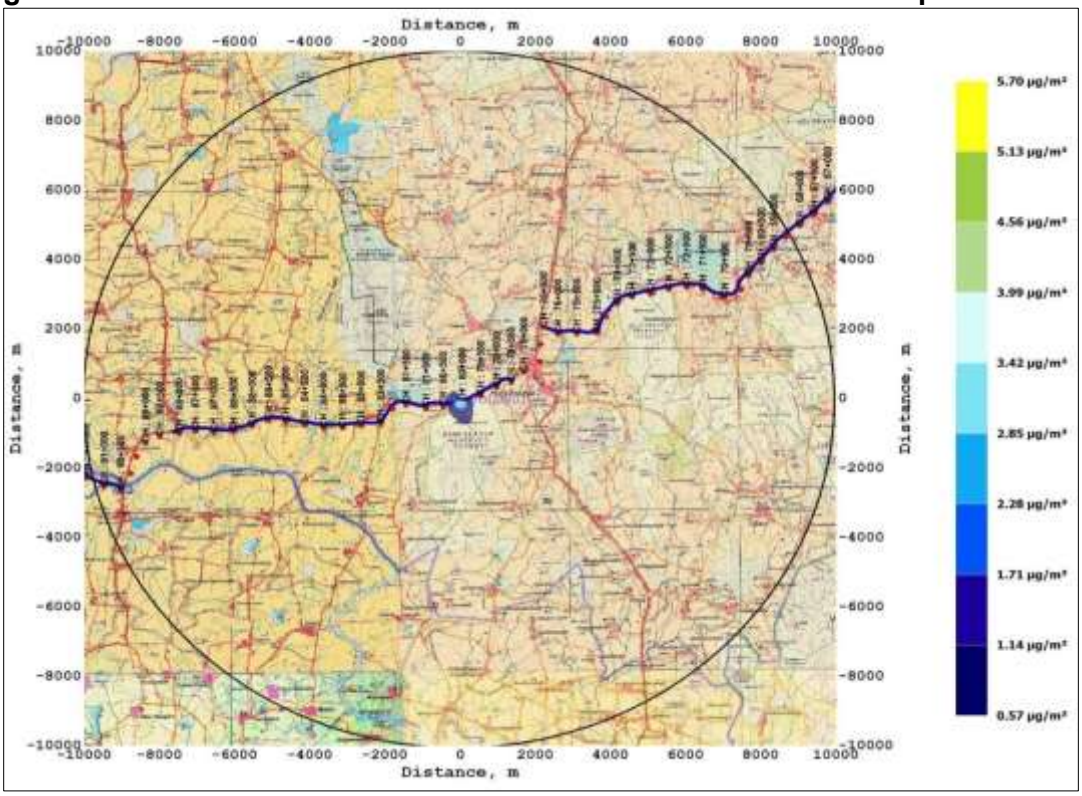


Figure 42 Predicted PM Levels in Traffic Section III for the Year 2040

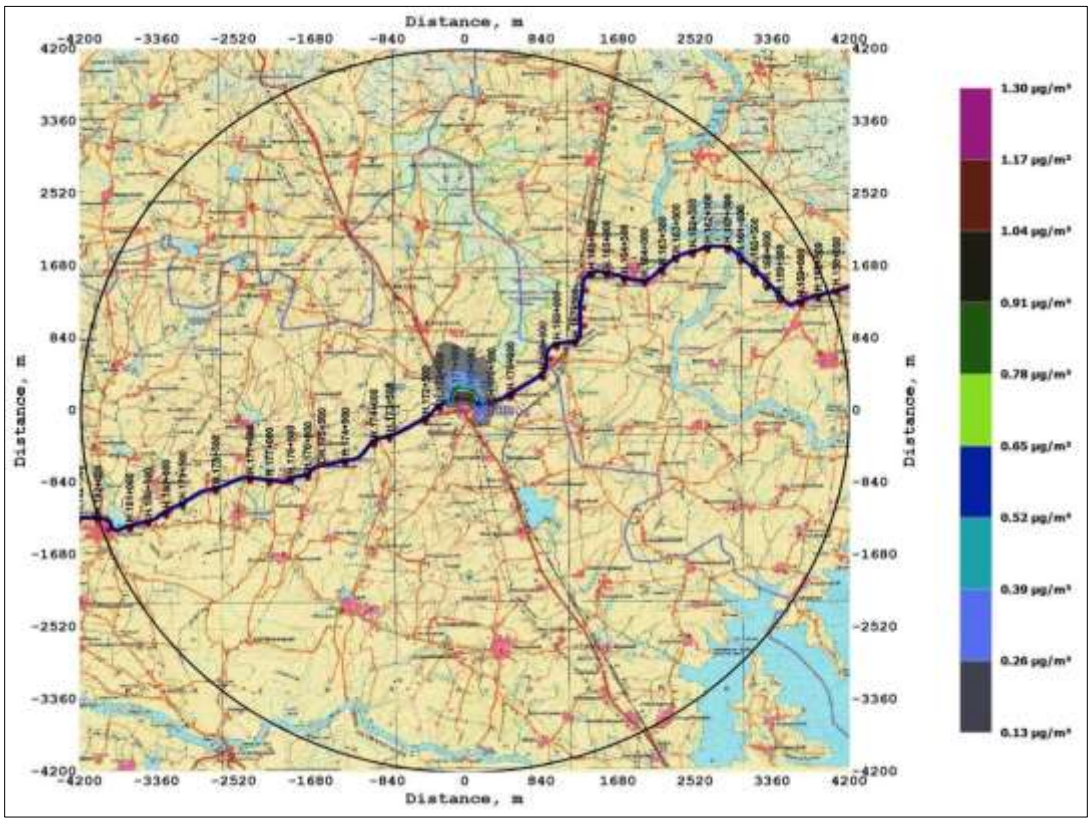


Figure 43 Predicted PM Levels in Traffic Section V for Base Year 2015

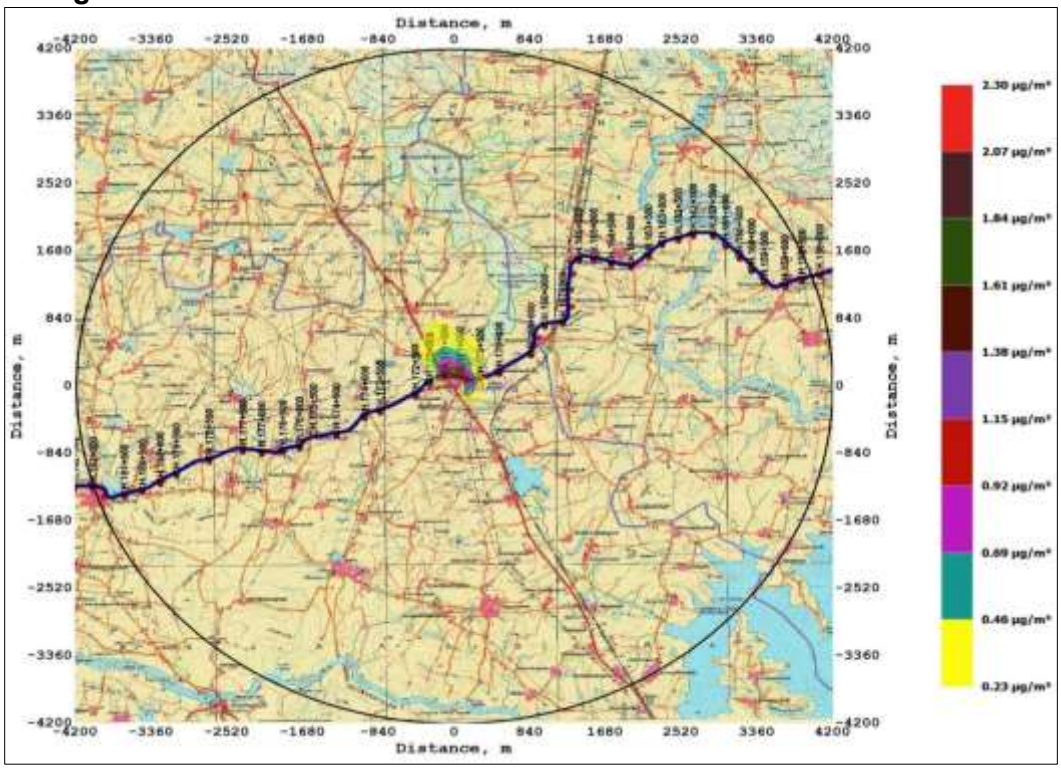


Figure 44 Predicted PM Levels in Traffic Section V for the Year of Operation 2020

Figure 45 Predicted PM Levels in Traffic Section V for the Year 2040

333. **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 can be observed from the isopleths that dispersion of gaseous pollutants have wide geographical spread in comparison to the particulate matters, as the it tends to settle down owing to gravitional forces. Further, 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. Thereafter, the concentration will gradually increase with the increase in the traffic flow.

334. **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,

335. 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.

336. 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]

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

338. **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.

339. **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 NOx, SO2 and PM10, it was conducted for 24 hourly concentrations. Predicted concentrations on four homogenous section of the Project for CO, NOx, and PM10 and their spread around the road sections have been presented in **Figure 46** to **Figure 51.**

340. **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.

341. 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.

342. **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

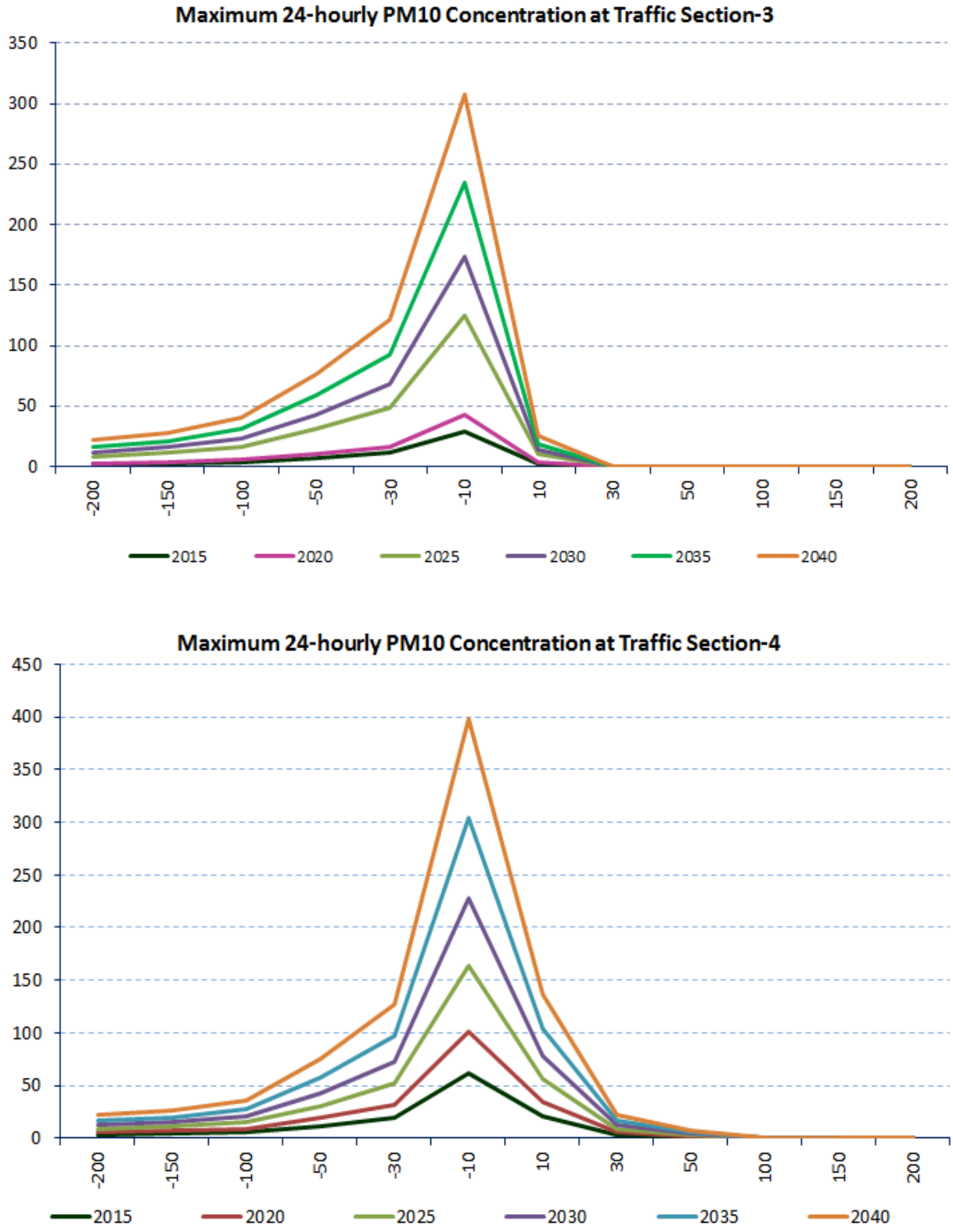


Figure 46 Maximum 24 Hourly PM_{10} Concentration at Traffic Section-III and IV

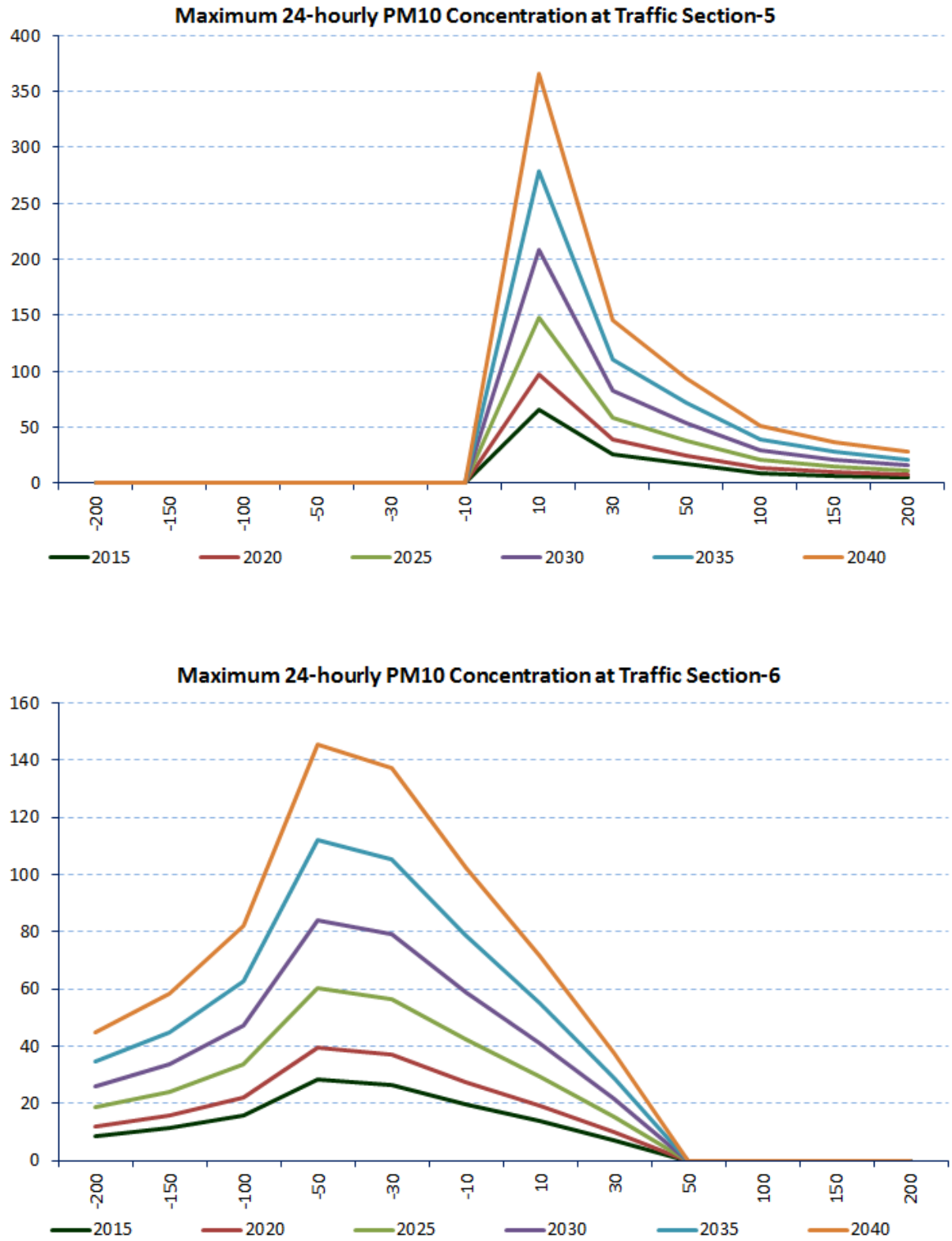


Figure 47 Maximum 24 Hourly PM_{10} Concentration at Traffic Section-V and VI

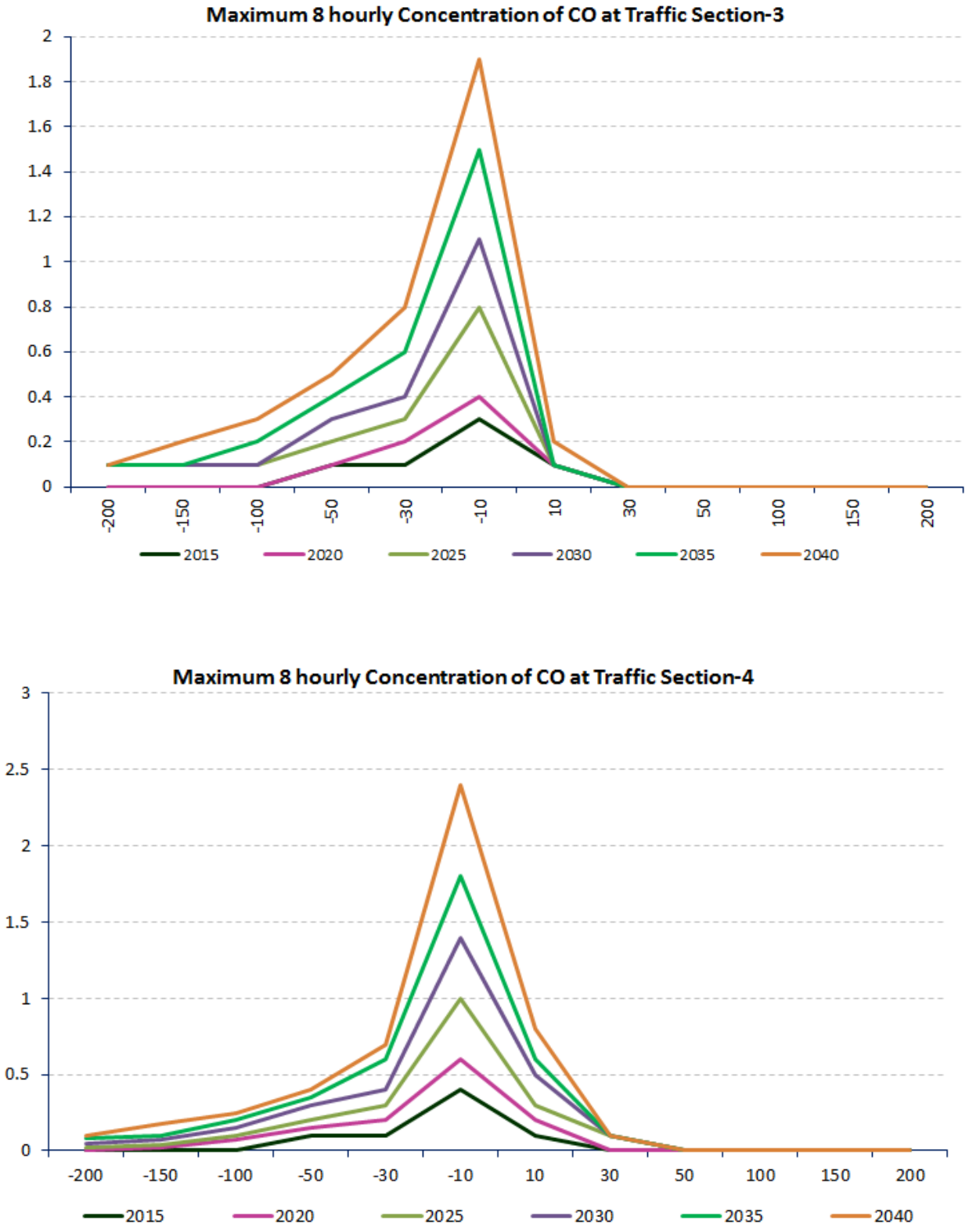


Figure 48 Maximum 24 Hourly CO Concentration at Traffic Section-III and IV

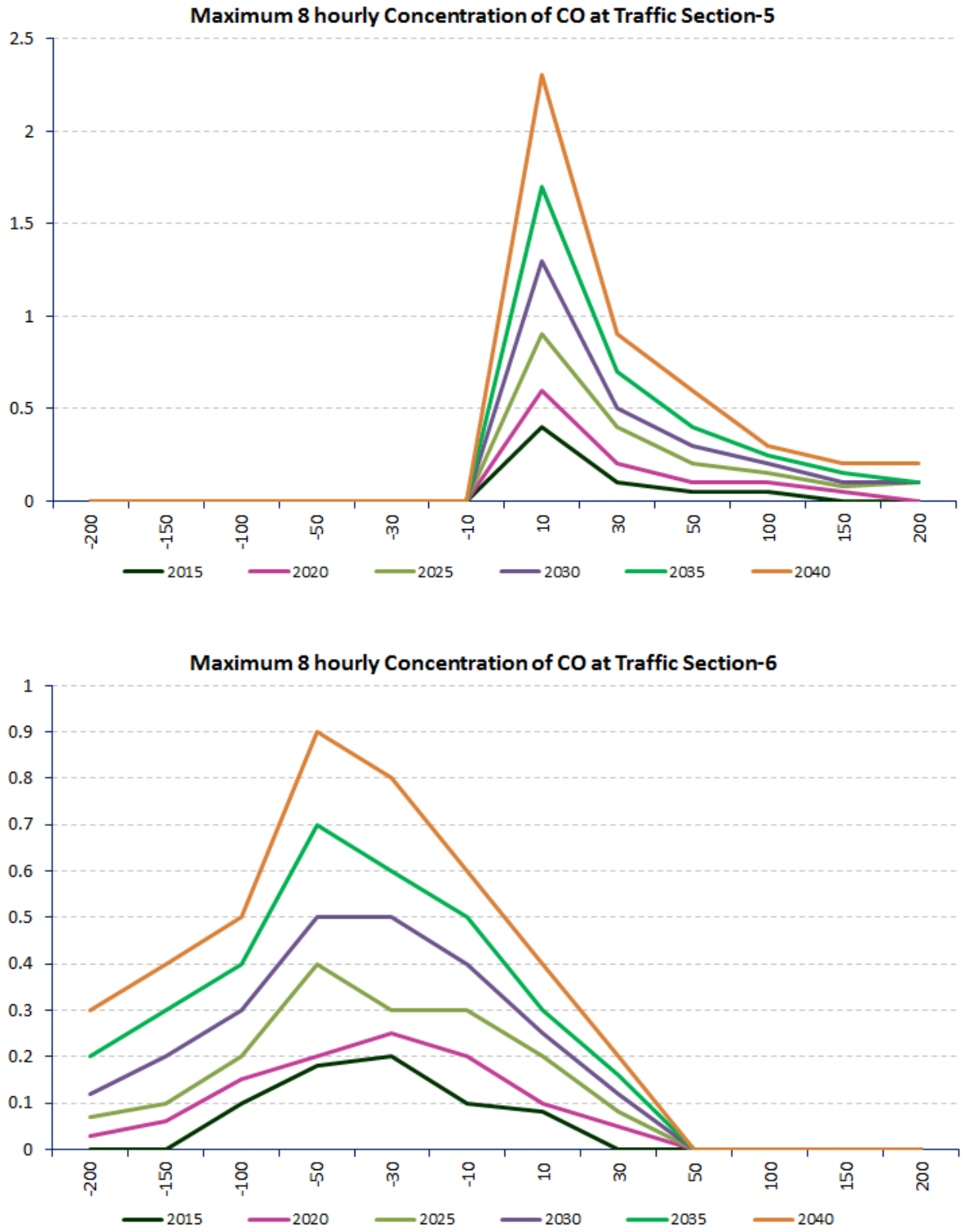


Figure 49 Maximum 24 Hourly CO Concentration at Traffic Section-V and VI

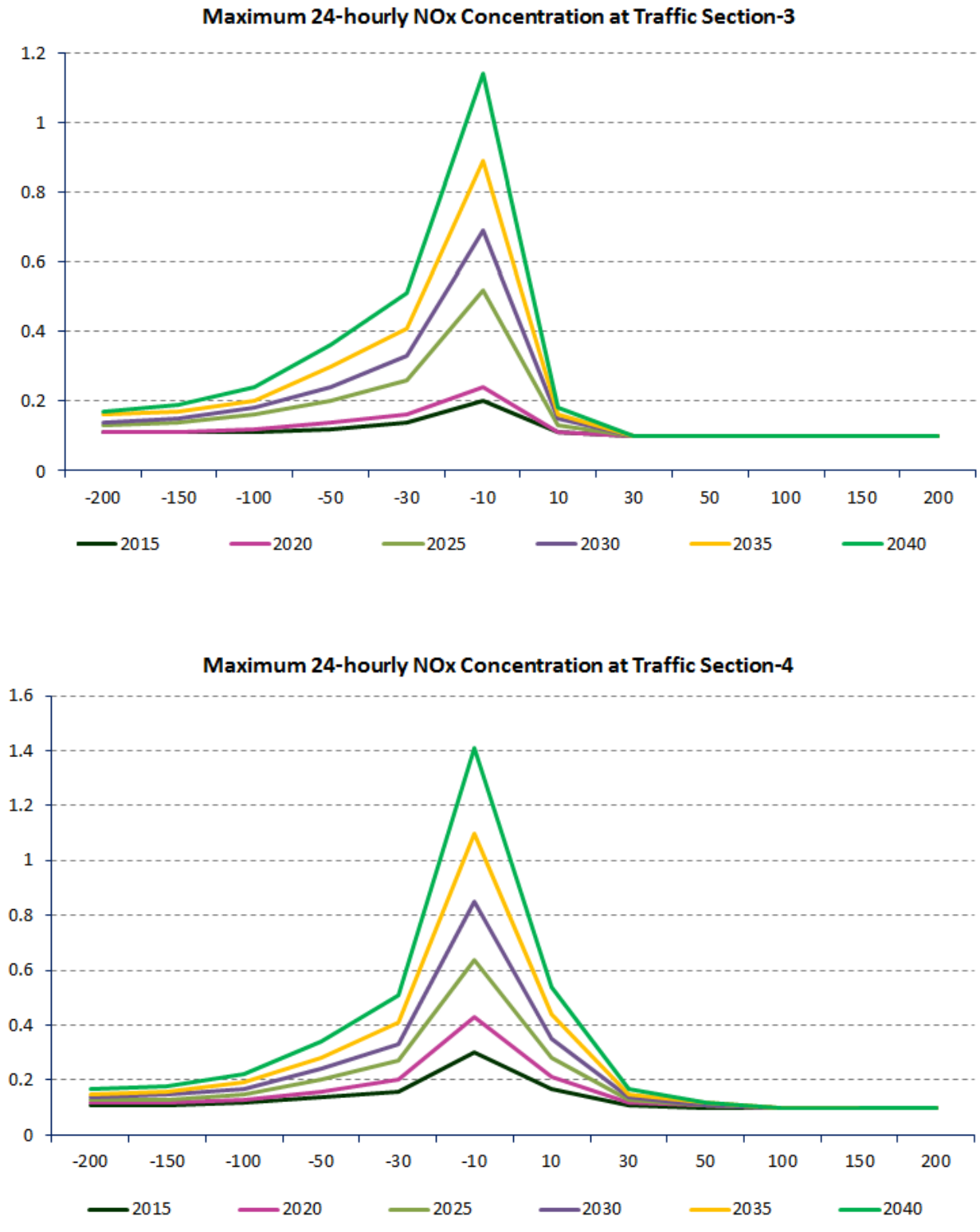


Figure 50 Maximum 24 Hourly NO_X Concentrations at Traffic Section-III and IV

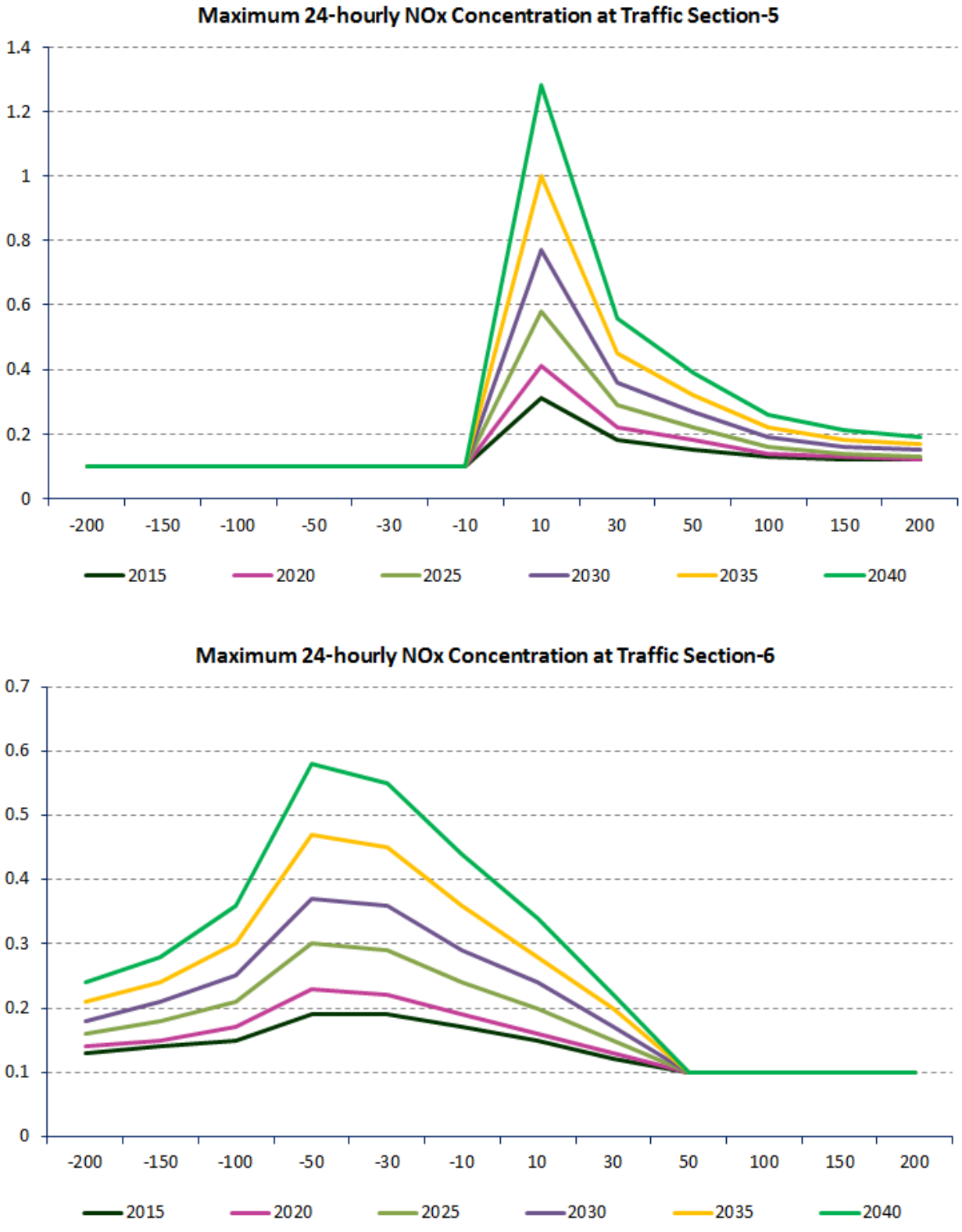


Figure 51 Maximum 24 Hourly NO_X Concentrations at Traffic Section-V and VI

343. 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

344. 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.

345. 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.

346. **Impacts:** Increase in noise level due to construction activities like operation of construction equipment & vehicular traffic.

347. 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 104 Typical Noise Level of Road Construction Activities

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

348. 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 105 Typical Noise Level of 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

349. 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.

350. 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 106**.

Table 106 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

351. 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.

352. **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

353. 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 (60.7%) followed by residential cum commercial area (19.6%), mixed land use (15.6%) and forest (4.1%). The sensitive structures comprising schools, temples, mosques and health 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.

354. **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.

355. **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 52**).

356. 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.

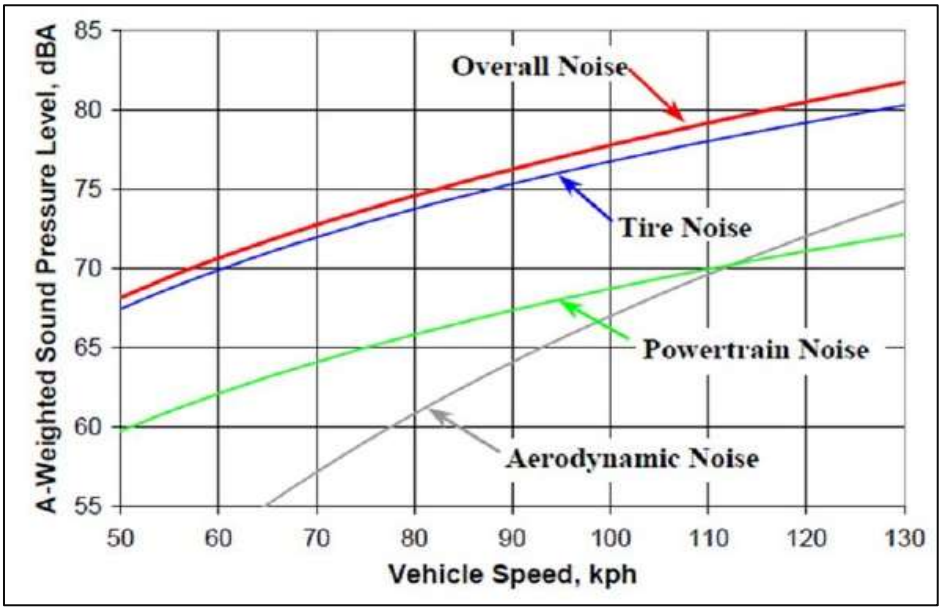


Figure 52 Comparison of Noise Level Separated by Component [Donovan, 2007]

357. **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 barrier has been proposed in 56 educational institutions, 1 government hospital and 1 primary health centre. List of sensitive receptors where noise barrier has been proposed is tabulated below:

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[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).*

Table 107 Proposed Noise Barriers

Sl. No.	Particulars	Village	Design Ch.	Dist. (m)	Height of Noise Barrier (m)	Length of Noise Barrier (m)
1	Govt. Primary School	Vaddarapaly	51+480	16.0	3	46.6
2	ICDS (Aanganwadi)	Jamal Sab Palya	51+860	22.5	3	30.0
3	Govt. Urdu Primary School	Jamal Sab Palya	51+860	33.0		
4	Govt. PU College	Dhonakuppi	57+580	11.0	3	84.0
5	CNS Model English High School	Dhonakuppi	58+150	12.3	3	44.0
6	National Public School	Hullekette	61+650	7.0	3	152.0
7	Govt. Primary School	Bastarapalya	63+290	6.0	3	14.0
8	ICDS (Aanganwadi)	Neelasandra	66+300	24.0	3	34.2
9	Govt. Higher Primary School	Neelasandra	66+300	46.6		
10	Dr. BR Ambedkar High School	Chowdanakuppe	69+660	10.0	3	24.0
11	Govt. Higher Primary School	Hangarahalli	70+300	8.8	3	39.0
12	Govt. Higher Primary School	Ungara	86+800	7.5	3	101.5
13	Akshara International Public School	Kowdel	90+500	16.0	3	154.0
14	Govt. High School	Shettahalli	94+400	14.0	3	146.0
15	Govt. P.U. College	Devalpura, Nagamangala	98+400	26.0	3	115.0
16	Govt. Higher Primary School	Devalpura, Nagamangala	98+400	8.4	3	120.0
17	Govt. High School	Thattahalli	105+415	15.0	3	116.5
18	Govt. Higer Primary School	Balapada Manti Koppalu, Nagmangala	109+800	9.0	3	55.0
19	National Nursery, Lower & Higher Primary School	Nagmangala	111+300	13.5	3	5.0
20	Govt. Primary School	Basaveshawara Nagara, Sankanhalli	117+725	12.7	3	113.0
21	Govt. Primary School	Karikethanahalli	124+530	8.7	3	75.0
22	Govt. Purva Padvi High School & College	Bogadi	126+410	13.2	3	75.0
23	Govt. Lower Primary School	Kotegenahalli	138+270	10.0	3	87.0
24	Govt. Lower Primary School	Shetty Nayakana Kopallu	143+320	38.0	3	100.0
25	Govt. High School	Valagere Menasa	143+620	13.7	3	85.0
26	Govt. Lower Primary School	Valagere Menasa	144+700	32.0	3	114.0
27	Govt. Higher Primary School	Valagere Menasa	144+700	79.0		
28	Vivekanand High School	Bommenahalli	157+200	50.5	3	160.0
29	Govt. Primary School	Bommenahalli	157+700	9.0	3	50.0
30	Govt. Lower Primary School	Hosadadadahally	163+830	19.5	3	37.0
31	Govt. Girls PU College	Akkihebbal	164+000	11.5	3	84.0
32	ITI	Akkihebbal	164+025	14.0	3	45.0
33	Govt. Higher Primary School	Akkihebbal	164+100	14.0	3	75.0
34	Govt. Higher Primary School	Yalemudanahalli	176+500	8.8	3	115.0
35	Govt. Lower Primary School	Kalli muddanahalli	178+725	9.9	3	72.5
36	Govt. Hospital	Saligrama	181+900	20.1	3	120.0
37	Govt. Purva Padvi College	Saligrama	182+325	12.0	3	278.0
38	Govt. High School	Saligrama	182+375	12.0		
39	Govt. Degree College	Saligrama	182+425	12.0		
40	Sara Vidya Mandir Nursery School	Saligrama	182+400	10.4	3	11.0
41	Govt. Lower Primary School	Haradanahalli	187+785	13.2	3	50.0
42	Govt. Higher Primary School	Haradanahalli	188+360	11.0	3	48.0
43	Govt. High School and PU College	Haradanahalli	188+890	11.3	3	84.0
44	Nalanda D. Ed (Tech) College	Keralapura	190+500	46.6	3	163.0

Sl. No.	Particulars	Village	Design Ch.	Dist. (m)	Height of Noise Barrier (m)	Length of Noise Barrier (m)
45	Govt. Primary Girls School and ICDS	Keralapura	191+925	26.0	3	38.5
46	Govt. Primary School & ICDS	Honnenahalli	193+900	12.0	3	61.0
47	Govt. Primary School	Juttenahalli	195+585	10.0	3	23.0
48	Primary Health Center	Basavapatna	200+200	13.5	3	100.0
49	Govt. Primary School	Basavapatna	200+230	9.1	3	80.0
50	Govt. Urdu Primary School	Ramanathapura	204+650	15.0	3	70.0
51	Govt. Higher Primary School	Ramanathapura	204+710	12.6	3	35.0
52	Pattabirama Govt. Girls PU College	Ramanathapura	205+050	11.6	3	26.0
53	BSS Govt. High School and College	Konanuru	208+200	14.0	3	103.0
54	Govt. Girls Middle School	Konanuru	208+350	8.2	3	55.0
55	MKS Lions Vidhyaniketahan	Konanuru	209+000	9.5	3	39.0
56	Govt. Lower Primary School	Ullenahalli	210+150	17.5	3	39.0
57	Govt. High School	Hadenoor	218+720	11.0	3	75.0
58	Divya Jyoti Higher Primary School	Mariyanagar, Bettahalale	220+330	45.3	3	108.0
Total length of Noise Barrier (m)						**4174.8 ≅ 4175**

358. **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.

359. **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 108** and results of CRTN model is graphically presented (**Figure 53 to 56**) and Noise Contours near the sensitive receptors is shown (**Figure 57 to 60**) for 4 sensitive receptors for the year 2015, 2020 and 2040.

Table 108 Sensitive Receptor Wise Predicted Noise Levels[8]

Year →	2015	2020	2025	2030	2035	2040
Govt. Primary School, Vaddarapalya						
Traffic Noise in dB(A)	58.5	63	69	70.2	71.5	72.6
Noise at Receptor w/o Noise Barrier dB(A)	54.2	58.8	64.9	66.1	67.4	68.5
Noise at Receptor with Noise Barrier dB(A)	42	46.6	52.7	53.9	55.2	56.3
Reduction (dBA)	-12.2	-12.2	-12.2	-12.2	-12.2	-12.2
ICDS (Aanganwadi), Jamal Sab Palya						
Traffic Noise in dB(A)	58.5	63	69	70.2	71.5	72.6
Noise at Receptor w/o Noise Barrier dB(A)	53	57.5	63.5	64.7	66	67.1
Noise at Receptor with Noise Barrier dB(A)	41.7	46.2	52.2	53.4	54.7	55.8
Reduction (dBA)	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3
Govt. Urdu Primary School, Jamal Sab Palya						
Traffic Noise in dB(A)	58.5	63	69	70.2	71.5	72.6

[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 Govt. Primary School, Vaddarapalya in 2040, the $LA_{eq,\ 1h}$ is only equivalent to 69.0 dB (A).

Year →	2015	2020	2025	2030	2035	2040
Noise at Receptor w/o Noise Barrier dB(A)	50.9	55.4	61.4	62.6	63.9	65
Noise at Receptor with Noise Barrier dB(A)	40.9	45.4	51.4	52.6	53.9	55
Reduction (dBA)	-10	-10	-10	-10	-10	-10
Govt. PU College, Donakuppe						
Traffic Noise in dB(A)	58.5	63	69	70.2	71.5	72.6
Noise at Receptor w/o Noise Barrier dB(A)	55	59.8	66.1	67.3	68.6	69.7
Noise at Receptor with Noise Barrier dB(A)	42	46.8	53.1	54.3	55.6	56.7
Reduction (dBA)	-13	-13	-13	-13	-13	-13
CNS Model English High School, Donakuppe						
Traffic Noise in dB(A)	59	63.5	69.5	70.7	72	731
Noise at Receptor w/o Noise Barrier dB(A)	59.1	65	72.3	73.5	74.8	75.9
Noise at Receptor with Noise Barrier dB(A)	38.8	44.7	52	53.2	54.5	55.6
Reduction (dBA)	-20.3	-20.3	-20.3	-20.3	-20.3	-20.3
National Public School, Hullekettel						
Traffic Noise in dB(A)	58.5	63	69	70.2	71.5	72.6
Noise at Receptor w/o Noise Barrier dB(A)	55.5	60.5	67	68.2	69.5	70.6
Noise at Receptor with Noise Barrier dB(A)	41.9	46.9	53.4	54.6	55.9	57
Reduction (dBA)	-13.6	-13.6	-13.6	-13.6	-13.6	-13.6
Govt. Primary School, Bastarapalya						
Traffic Noise in dB(A)	58.5	63	69	70.2	71.5	72.6
Noise at Receptor w/o Noise Barrier dB(A)	56.8	62.2	69	70.2	71.5	72.6
Noise at Receptor with Noise Barrier dB(A)	41.5	46.9	53.7	54.9	56.2	57.3
Reduction (dBA)	-15.3	-15.3	-15.3	-15.3	-15.3	-15.3
ICDS (Aanganwadi), Neelashandra						
Traffic Noise in dB(A)	58.5	63	69	70.2	71.5	72.6
Noise at Receptor w/o Noise Barrier dB(A)	54.8	59.6	65.9	67.1	68.4	69.5
Noise at Receptor with Noise Barrier dB(A)	38	42.8	49.1	50.3	51.6	52.7
Reduction (dBA)	-16.8	-16.8	-16.8	-16.8	-16.8	-16.8
Govt. Higher Primary School, Neelashandra						
Traffic Noise in dB(A)	58.5	63	69	70.2	71.5	72.6
Noise at Receptor w/o Noise Barrier dB(A)	51.4	55.9	61.9	63.1	64.4	65.5
Noise at Receptor with Noise Barrier dB(A)	41.1	45.6	51.6	52.8	54.1	55.2
Reduction (dBA)	-10.3	-10.3	-10.3	-10.3	-10.3	-10.3
Dr. BR Ambedkar High School, Chowdankuppe						
Traffic Noise in dB(A)	58.5	63	69	70.2	71.5	72.6
Noise at Receptor w/o Noise Barrier dB(A)	51.9	56.4	62.4	63.6	64.9	66
Noise at Receptor with Noise Barrier dB(A)	40.3	44.8	50.8	52	53.3	54.4
Reduction (dBA)	-11.6	-11.6	-11.6	-11.6	-11.6	-11.6
Govt. Higher Primary School, Hangarahalli						
Traffic Noise in dB(A)	59.1	63.6	69.6	70.8	72.1	73.1
Noise at Receptor w/o Noise Barrier dB(A)	56.8	62	68.6	69.8	71.1	72.2
Noise at Receptor with Noise Barrier dB(A)	42.3	47.5	54.1	55.3	56.6	57.7
Reduction (dBA)	-14.5	-14.5	-14.5	-14.5	-14.5	-14.5
Govt. Higher Primary School, Ungra						
Traffic Noise in dB(A)	58.7	63.2	69.2	70.4	71.7	72.8
Noise at Receptor w/o Noise Barrier dB(A)	58.6	64.5	71.7	72.9	74.2	75.3
Noise at Receptor with Noise Barrier dB(A)	40.6	46.5	53.7	54.9	56.2	57.3
Reduction (dBA)	-18	-18	-18	-18	-18	-18
Akshara International Public School, Kowdle						
Traffic Noise in dB(A)	58.5	63	69	70.2	71.5	72.6
Noise at Receptor w/o Noise Barrier dB(A)	51.1	55.6	61.6	62.8	64.1	65.2
Noise at Receptor with Noise Barrier dB(A)	41	45.5	51.5	52.73	54	55.1

Year →	2015	2020	2025	2030	2035	2040
Reduction (dBA)	-10.1	-10.1	-10.1	-10.07	-10.1	-10.1
Govt. High School, Shettahalli						
Traffic Noise in dB(A)	58.5	63	69	70.2	71.5	72.6
Noise at Receptor w/o Noise Barrier dB(A)	50.2	54.7	60.7	61.9	63.2	64.3
Noise at Receptor with Noise Barrier dB(A)	40.3	44.8	50.8	52	53.3	54.4
Reduction (dBA)	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9
Govt. P U College, Devalapura, Nagamangala						
Traffic Noise in dB(A)	58.5	63	69	70.2	71.5	72.6
Noise at Receptor w/o Noise Barrier dB(A)	54	58.5	64.6	65.8	67.1	68.2
Noise at Receptor with Noise Barrier dB(A)	42.1	46.6	52.7	53.9	55.2	56.3
Reduction (dBA)	-11.9	-11.9	-11.9	-11.9	-11.9	-11.9
Govt. Higher Primary School, Devalapura, Nagamangala						
Traffic Noise in dB(A)	58.5	63	69	70.2	71.5	72.6
Noise at Receptor w/o Noise Barrier dB(A)	54.2	58.8	64.9	66.1	67.4	68.5
Noise at Receptor with Noise Barrier dB(A)	41.9	46.5	52.6	53.8	55.1	56.2
Reduction (dBA)	-12.3	-12.3	-12.3	-12.3	-12.3	-12.3
Govt. High School, Thattahalli						
Traffic Noise in dB(A)	58.6	63.1	69.1	70.3	71.6	72.7
Noise at Receptor w/o Noise Barrier dB(A)	54.5	59.2	65.4	66.6	67.9	69
Noise at Receptor with Noise Barrier dB(A)	42	46.7	52.9	54.1	55.4	56.5
Reduction (dBA)	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5
Govt. Higher Primary School, Balapada Manti Koppalu						
Traffic Noise in dB(A)	58.5	63	69	70.2	71.5	72.6
Noise at Receptor w/o Noise Barrier dB(A)	55.8	60.9	67.4	68.6	69.9	71
Noise at Receptor with Noise Barrier dB(A)	41.9	47	53.5	54.7	56	57.1
Reduction (dBA)	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9
National Nursery Lower & Higher Primary School (Private), Nagamangala						
Traffic Noise in dB(A)	58.6	63.1	69.1	70.3	71.6	72.7
Noise at Receptor w/o Noise Barrier dB(A)	53.7	58.2	64.2	65.4	66.7	67.8
Noise at Receptor with Noise Barrier dB(A)	41.8	46.3	52.3	53.5	54.8	55.9
Reduction (dBA)	-11.9	-11.9	-11.9	-11.9	-11.9	-11.9
Govt. Primary School, Basaveshawara Nagara						
Traffic Noise in dB(A)	62.9	68.6	70.6	72	73.1	74.3
Noise at Receptor w/o Noise Barrier dB(A)	60.2	65.9	67.9	69.3	70.4	71.6
Noise at Receptor with Noise Barrier dB(A)	47	52.7	54.7	56.1	57.2	58.4
Reduction (dBA)	-13.2	-13.2	-13.2	-13.2	-13.2	-13.2
Govt. Primary School, Karikyathanahalli Village						
Traffic Noise in dB(A)	62.4	68.1	70.1	71.5	72.6	73.8
Noise at Receptor w/o Noise Barrier dB(A)	61.3	67.1	69.1	70.5	71.6	72.8
Noise at Receptor with Noise Barrier dB(A)	47.6	53.4	55.4	56.8	57.9	59.1
Reduction (dBA)	-13.7	-13.7	-13.7	-13.7	-13.7	-13.7
Govt. Purva Padvi High School and College, Bogadi						
Traffic Noise in dB(A)	62.1	67.8	69.8	71.2	72.3	73.5
Noise at Receptor w/o Noise Barrier dB(A)	60.6	66.4	68.4	69.8	70.9	72.1
Noise at Receptor with Noise Barrier dB(A)	46.4	52.2	54.2	55.6	56.7	57.9
Reduction (dBA)	-14.2	-14.2	-14.2	-14.2	-14.2	-14.2
Govt. Lower Primary School, Kotagahalli						
Traffic Noise in dB(A)	61.9	67.6	69.6	71	72.1	73.3
Noise at Receptor w/o Noise Barrier dB(A)	58.7	64.4	66.4	67.8	68.9	70.1
Noise at Receptor with Noise Barrier dB(A)	45.8	51.5	53.5	54.9	56	57.2
Reduction (dBA)	-12.9	-12.9	-12.9	-12.9	-12.9	-12.9
Govt. Lower Primary School, Shetty Nayakana Kopallu						

Year →	2015	2020	2025	2030	2035	2040
Traffic Noise in dB(A)	62.7	68.4	70.4	71.8	72.9	74.1
Noise at Receptor w/o Noise Barrier dB(A)	56.9	62.6	64.6	66	67.1	68.3
Noise at Receptor with Noise Barrier dB(A)	45.4	51.1	53.1	54.5	55.6	56.8
Reduction (dBA)	-11.5	-11.5	-11.5	-11.5	-11.5	-11.5
Govt. High School,Valagere Menasa						
Traffic Noise in dB(A)	62.9	68.8	70.6	72	73.1	74.3
Noise at Receptor w/o Noise Barrier dB(A)	62.7	68.5	70.5	71.9	73	74.2
Noise at Receptor with Noise Barrier dB(A)	45	50.8	52.8	54.2	55.3	56.5
Reduction (dBA)	-17.7	-17.7	-17.7	-17.7	-17.7	-17.7
Govt. Lower Primary School, Valagere Menasa						
Traffic Noise in dB(A)	61.9	67.6	69.6	71	72.1	73.3
Noise at Receptor w/o Noise Barrier dB(A)	57.1	62.8	64.8	66.2	67.3	68.5
Noise at Receptor with Noise Barrier dB(A)	42.1	47.8	49.8	51.2	52.3	53.5
Reduction (dBA)	-15	-15	-15	-15	-15	-15
Govt. Higher Primary School, Valagere Menasa						
Traffic Noise in dB(A)	61.9	67.6	69.6	71	72.1	73.3
Noise at Receptor w/o Noise Barrier dB(A)	52	57.7	59.7	61.1	62.2	63.4
Noise at Receptor with Noise Barrier dB(A)	43.1	48.8	50.8	52.2	53.3	54.5
Reduction (dBA)	-8.9	-8.9	-8.9	-8.9	-8.9	-8.9
Vivekanand High School, Bommenahalli						
Traffic Noise in dB(A)	64.6	68.9	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	56.5	60.8	62.6	63.9	65.2	66.4
Noise at Receptor with Noise Barrier dB(A)	45.9	50.2	52	53.3	54.6	55.8
Reduction (dBA)	-10.6	-10.6	-10.6	-10.6	-10.6	-10.6
Govt. Primary School, Bommenahalli						
Traffic Noise in dB(A)	64.6	68.9	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	65.6	69.9	71.7	73	74.3	75.5
Noise at Receptor with Noise Barrier dB(A)	49.8	54.1	55.9	57.2	58.5	59.7
Reduction (dBA)	-15.8	-15.8	-15.8	-15.8	-15.8	-15.8
Govt. Lower Primary School, Hosadadadahally						
Traffic Noise in dB(A)	64.7	69	70.8	72.1	73.4	74.6
Noise at Receptor w/o Noise Barrier dB(A)	61.9	66.2	68	69.3	70.6	71.8
Noise at Receptor with Noise Barrier dB(A)	46.3	50.6	52.4	53.7	55	56.2
Reduction (dBA)	-15.6	-15.6	-15.6	-15.6	-15.6	-15.6
Govt. Girls PU College, Akkihebbal						
Traffic Noise in dB(A)	64.6	68.9	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	57.7	62	63.8	65.1	66.4	67.6
Noise at Receptor with Noise Barrier dB(A)	46.3	50.6	52.4	53.7	55	56.2
Reduction (dBA)	-11.4	-11.4	-11.4	-11.4	-11.4	-11.4
ITI, Akkihebbal						
Traffic Noise in dB(A)	64.6	68.9	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	65.3	69.6	71.4	72.7	74	75.2
Noise at Receptor with Noise Barrier dB(A)	49.1	53.4	55.2	56.5	57.8	59
Reduction (dBA)	-16.2	-16.2	-16.2	-16.2	-16.2	-16.2
Govt. Higher Primary School, Akkihebbal						
Traffic Noise in dB(A)	65.1	69.4	71.2	72.5	73.8	75
Noise at Receptor w/o Noise Barrier dB(A)	60.4	64.7	66.5	67.8	69.1	70.3
Noise at Receptor with Noise Barrier dB(A)	48.6	52.9	54.7	56	57.3	58.5
Reduction (dBA)	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8
Govt. Higher Primary School, Yalemuddanahalli						
Traffic Noise in dB(A)	65	69.3	71.1	72.4	73.7	74.9
Noise at Receptor w/o Noise Barrier dB(A)	62.7	67	68.8	70.1	71.4	72.6

Year →	2015	2020	2025	2030	2035	2040
Noise at Receptor with Noise Barrier dB(A)	49.1	53.4	55.2	56.5	57.8	59
Reduction (dBA)	-13.6	-13.6	-13.6	-13.6	-13.6	-13.6
Govt. Lower Primary School, Kalli muddanahalli						
Traffic Noise in dB(A)	64.6	68.9	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	62.8	67.1	68.9	70.2	71.5	72.7
Noise at Receptor with Noise Barrier dB(A)	48.8	53.1	54.9	56.2	57.5	58.7
Reduction (dBA)	-14	-14	-14	-14	-14	-14
Govt. Hospital, Saligrama						
Traffic Noise in dB(A)	65	69.3	71.1	72.4	73.7	74.9
Noise at Receptor w/o Noise Barrier dB(A)	65	69.3	71.1	72.4	73.7	74.9
Noise at Receptor with Noise Barrier dB(A)	50.4	54.7	56.5	57.8	59.1	60.3
Reduction (dBA)	-14.6	-14.6	-14.6	-14.6	-14.6	-14.6
Govt. High School, Saligrama						
Traffic Noise in dB(A)	65.7	70	71.8	73.1	74.4	75.6
Noise at Receptor w/o Noise Barrier dB(A)	62.5	66.8	68.6	69.9	71.2	72.4
Noise at Receptor with Noise Barrier dB(A)	50	54.3	56.1	57.4	58.7	59.9
Reduction (dBA)	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5
Govt. Purba Padabi College, Saligrama						
Traffic Noise in dB(A)	65.7	70	71.8	73.1	74.4	75.6
Noise at Receptor w/o Noise Barrier dB(A)	54.9	59.2	61	62.3	63.6	64.8
Noise at Receptor with Noise Barrier dB(A)	44.8	49.1	50.9	52.2	53.5	54.7
Reduction (dBA)	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1
Govt. Degree College, Saligrama						
Traffic Noise in dB(A)	65.7	70	71.8	73.1	74.4	75.6
Noise at Receptor w/o Noise Barrier dB(A)	55.7	60	61.8	63.1	64.4	65.6
Noise at Receptor with Noise Barrier dB(A)	45.3	49.6	51.4	52.7	54	55.2
Reduction (dBA)	-10.4	-10.4	-10.4	-10.4	-10.4	-10.4
Sara Vidya Mandir Nursery School, Saligrama						
Traffic Noise in dB(A)	65.7	70	71.8	73.1	74.4	75.6
Noise at Receptor w/o Noise Barrier dB(A)	60.2	64.5	66.3	67.6	68.9	70.1
Noise at Receptor with Noise Barrier dB(A)	48.1	52.4	54.2	55.5	56.8	58
Reduction (dBA)	-12.1	-12.1	-12.1	-12.1	-12.1	-12.1
Govt. Lower Primary School, Haradanahalli						
Traffic Noise in dB(A)	64.6	68.9	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	59.2	63.5	65.3	66.6	67.9	69.1
Noise at Receptor with Noise Barrier dB(A)	47.7	52	53.8	55.1	56.4	57.6
Reduction (dBA)	-11.5	-11.5	-11.5	-11.5	-11.5	-11.5
Govt. Higher Primary School, Haradanahalli						
Traffic Noise in dB(A)	64.6	68.9	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	63.4	67.7	69.5	70.8	72.1	73.3
Noise at Receptor with Noise Barrier dB(A)	49.6	53.9	55.7	57	58.3	59.5
Reduction (dBA)	-13.8	-13.8	-13.8	-13.8	-13.8	-13.8
Govt. High School and PU College, Haradanahalli						
Traffic Noise in dB(A)	64.6	68.9	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	57.3	61.6	63.4	64.7	66	67.2
Noise at Receptor with Noise Barrier dB(A)	46.1	50.4	52.2	53.5	54.8	56
Reduction (dBA)	-11.2	-11.2	-11.2	-11.2	-11.2	-11.2
Nalanda D. Ed. (Tech) College, Keralapura						
Traffic Noise in dB(A)	64.6	68.9	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	57.6	61.9	63.7	65	66.3	67.5
Noise at Receptor with Noise Barrier dB(A)	46.5	50.8	52.6	53.9	55.2	56.4
Reduction (dBA)	-11.1	-11.1	-11.1	-11.1	-11.1	-11.1

Year →	2015	2020	2025	2030	2035	2040
Govt. Primary Girls School and ICDS, Keralapura						
Traffic Noise in dB(A)	65	69.3	71.1	72.4	73.7	74.9
Noise at Receptor w/o Noise Barrier dB(A)	60.2	64.5	66.3	67.6	68.9	70.1
Noise at Receptor with Noise Barrier dB(A)	47.5	51.8	53.6	54.9	56.2	57.4
Reduction (dBA)	-12.7	-12.7	-12.7	-12.7	-12.7	-12.7
Govt. Primary Boys School, Keralapura						
Traffic Noise in dB(A)	65	69.3	71.1	72.4	73.7	74.9
Noise at Receptor w/o Noise Barrier dB(A)	61.2	65.5	67.3	68.6	69.9	71.1
Noise at Receptor with Noise Barrier dB(A)	47.9	52.2	54	55.3	56.6	57.8
Reduction (dBA)	-13.3	-13.3	-13.3	-13.3	-13.3	-13.3
Govt. Primary School and ICDS, Honenahalli						
Traffic Noise in dB(A)	64.9	69.2	71	72.3	73.6	74.8
Noise at Receptor w/o Noise Barrier dB(A)	64.5	68.8	70.6	71.9	73.2	74.4
Noise at Receptor with Noise Barrier dB(A)	49.5	53.8	55.6	56.9	58.2	59.4
Reduction (dBA)	-15	-15	-15	-15	-15	-15
Govt. Primary School, Juttenahalli						
Traffic Noise in dB(A)	65.5	69.8	71.6	72.9	74.2	75.4
Noise at Receptor w/o Noise Barrier dB(A)	66	70.3	72.1	73.4	74.7	75.9
Noise at Receptor with Noise Barrier dB(A)	49.3	53.6	55.4	56.7	58	59.2
Reduction (dBA)	-16.7	-16.7	-16.7	-16.7	-16.7	-16.7
Primary Health Centre, Basavapatna						
Traffic Noise in dB(A)	64.8	69.1	70.9	72.2	73.5	74.7
Noise at Receptor w/o Noise Barrier dB(A)	65.3	69.6	71.4	72.7	74	75.2
Noise at Receptor with Noise Barrier dB(A)	49.5	53.8	55.6	56.9	58.2	59.4
Reduction (dBA)	-15.8	-15.8	-15.8	-15.8	-15.8	-15.8
Govt. Primary School, Basavapatna						
Traffic Noise in dB(A)	64.8	69.1	70.9	72.2	73.5	74.7
Noise at Receptor w/o Noise Barrier dB(A)	65.3	69.6	71.4	72.7	74	75.2
Noise at Receptor with Noise Barrier dB(A)	49.9	54.2	56	57.3	58.6	59.8
Reduction (dBA)	-15.4	-15.4	-15.4	-15.4	-15.4	-15.4
Govt. Urdu Primary School, Ramanathapura						
Traffic Noise in dB(A)	65.4	69.7	71.5	72.8	74.1	75.3
Noise at Receptor w/o Noise Barrier dB(A)	57.3	61.6	63.4	64.7	66	67.2
Noise at Receptor with Noise Barrier dB(A)	46.5	50.8	52.6	53.9	55.2	56.4
Reduction (dBA)	-10.8	-10.8	-10.8	-10.8	-10.8	-10.8
Govt. Higher Primary School, Ramanathapura						
Traffic Noise in dB(A)	65.4	69.7	71.5	72.8	74.1	75.3
Noise at Receptor w/o Noise Barrier dB(A)	67.5	71.8	73.6	74.9	76.2	77.4
Noise at Receptor with Noise Barrier dB(A)	50.5	54.8	56.6	57.9	59.2	60.4
Reduction (dBA)	-17	-17	-17	-17	-17	-17
Patabhirama Govt. Girls P U College, Ramanathapura						
Traffic Noise in dB(A)	64.6	68.9	70.7	72	73.3	74.5
Noise at Receptor w/o Noise Barrier dB(A)	57.1	61.4	63.2	64.5	65.8	67
Noise at Receptor with Noise Barrier dB(A)	46.3	50.6	52.4	53.7	55	56.2
Reduction (dBA)	-10.8	-10.8	-10.8	-10.8	-10.8	-10.8
BSS Govt. High School and College, Konanur						
Traffic Noise in dB(A)	59.9	64.1	65.9	67.4	68.6	69.8
Noise at Receptor w/o Noise Barrier dB(A)	53.2	57.4	59.2	60.7	61.9	63.1
Noise at Receptor with Noise Barrier dB(A)	42	46.2	48	49.5	50.7	51.9
Reduction (dBA)	-11.2	-11.2	-11.2	-11.2	-11.2	-11.2
Govt. Girls Middle School, Konanur						
Traffic Noise in dB(A)	59.1	63.3	65.1	66.6	67.8	69

Year →	2015	2020	2025	2030	2035	2040
Noise at Receptor w/o Noise Barrier dB(A)	60.3	65.4	67.8	69.4	70.6	71.8
Noise at Receptor with Noise Barrier dB(A)	43.5	48.6	51	52.6	53.8	55
Reduction (dBA)	-16.8	-16.8	-16.8	-16.8	-16.8	-16.8
MKS Lions Vidhyaniketahan, Konanur						
Traffic Noise in dB(A)	59.1	63.3	65.1	66.6	67.8	69
Noise at Receptor w/o Noise Barrier dB(A)	58.2	63	65.3	66.8	68	69.2
Noise at Receptor with Noise Barrier dB(A)	43.5	48.3	50.6	52.1	53.3	54.5
Reduction (dBA)	-14.7	-14.7	-14.7	-14.7	-14.7	-14.7
Govt. Lower Primary School, Ullenahalli						
Traffic Noise in dB(A)	60.1	64.3	66.1	67.6	68.8	70
Noise at Receptor w/o Noise Barrier dB(A)	58.3	63	65.1	66.6	67.8	69
Noise at Receptor with Noise Barrier dB(A)	43.5	48.2	50.3	51.8	53	54.2
Reduction (dBA)	-14.8	-14.8	-14.8	-14.8	-14.8	-14.8
Govt. High School, Hadenoor						
Traffic Noise in dB(A)	60.1	64.3	66.1	67.6	68.8	70
Noise at Receptor w/o Noise Barrier dB(A)	59.5	64.3	66.6	68.1	69.3	70.5
Noise at Receptor with Noise Barrier dB(A)	43.9	48.7	51	52.5	53.7	54.9
Reduction (dBA)	-15.6	-15.6	-15.6	-15.6	-15.6	-15.6
Divya Jyoti Higer Primary School, Mariyanagar, Bettahalale						
Traffic Noise in dB(A)	59.4	63.6	65.4	66.9	68.1	69.3
Noise at Receptor w/o Noise Barrier dB(A)	52.6	56.8	58.6	60.1	61.3	62.5
Noise at Receptor with Noise Barrier dB(A)	41.3	45.5	47.3	48.8	50	51.2
Reduction (dBA)	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3

360. Height of noise barrier has been proposed 3 m. It has been observed that, in the year 2030, 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 2030 (height 3.5 m) and further 0.5 m in 2040 (height 4.0 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.

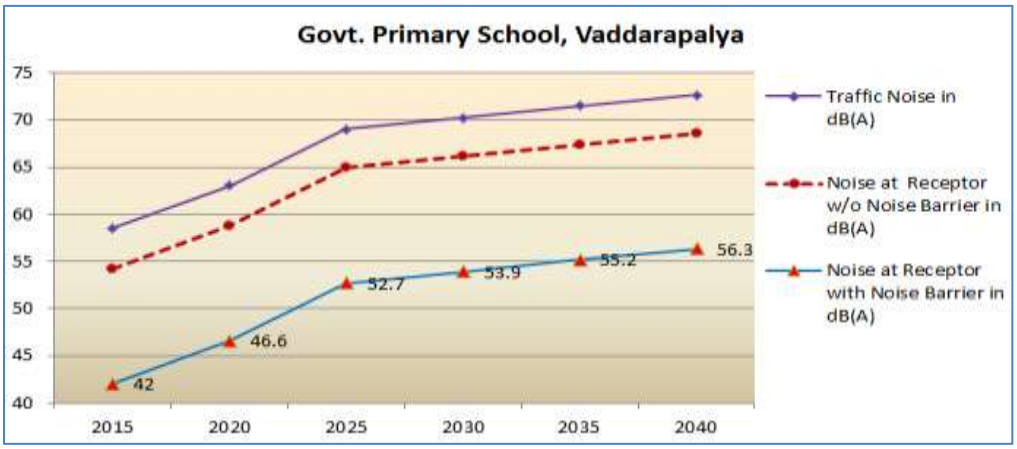


Figure 53 Noise Level at Govt. primary School, Vaddarapalya - with & without Noise Barrier

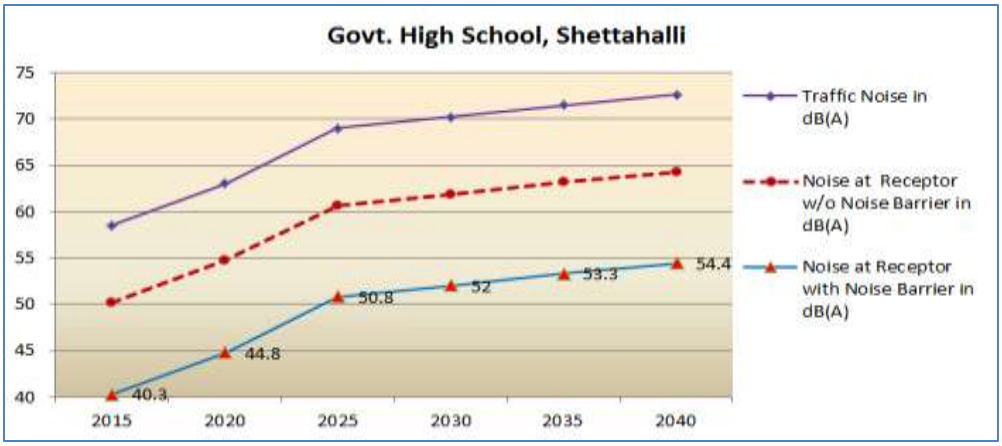


Figure 54 Noise Level at Govt. High School, Shettahalli- with & without Noise Barrier

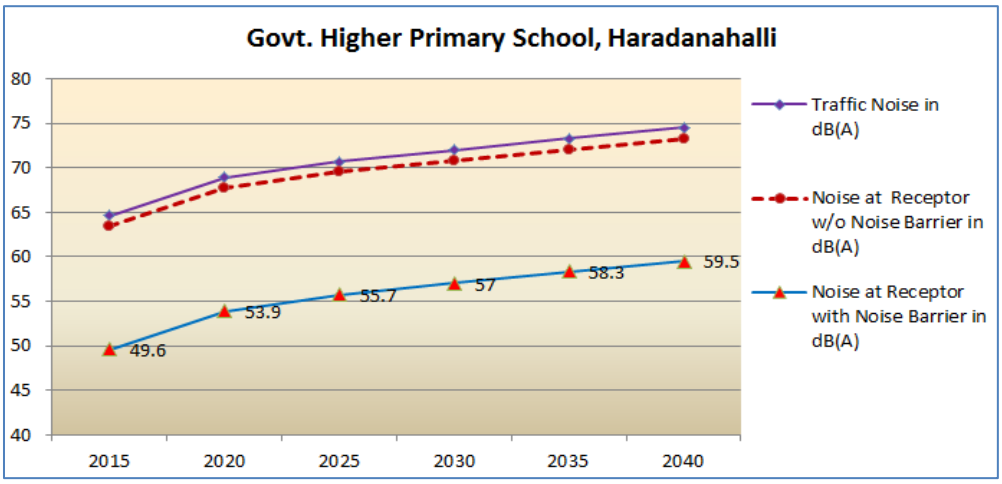


Figure 55 Noise Level Govt. Higher Primary School, Haradanahalli - with & without Noise Barrier

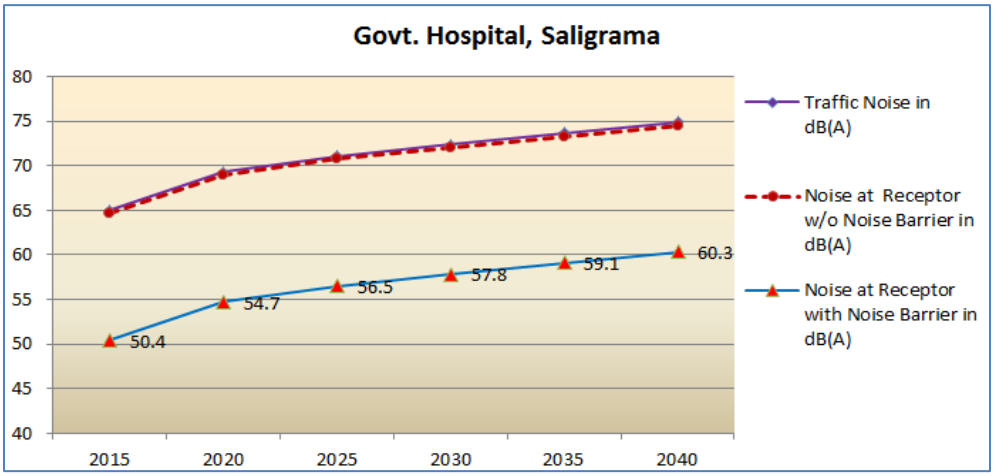
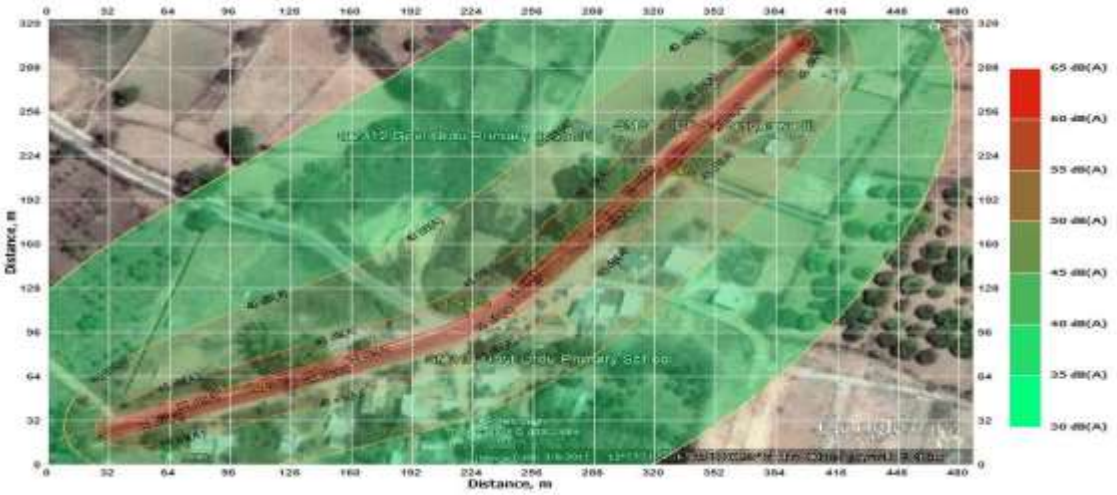
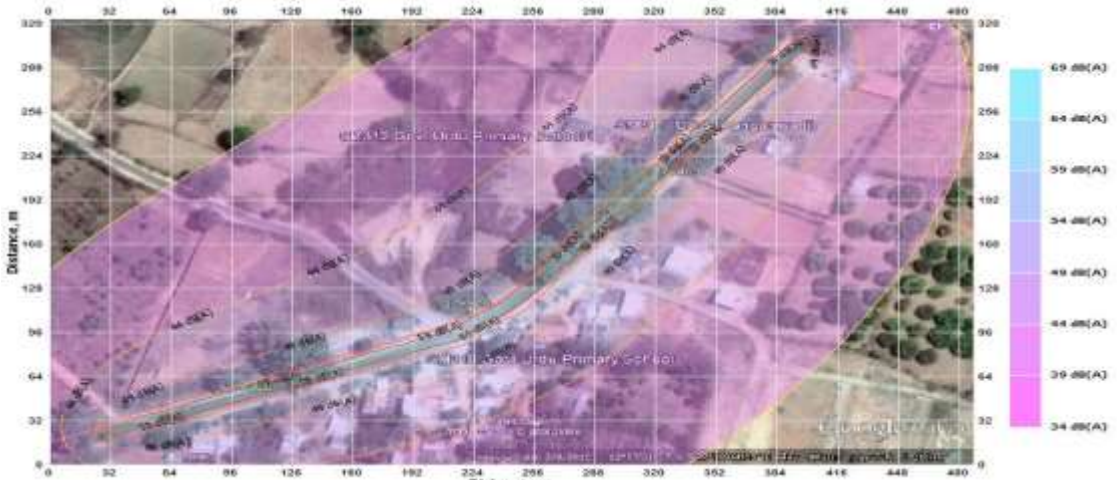


Figure 56 Noise Level at Govt. Hospital, Saligrama - with & without Noise Barrier

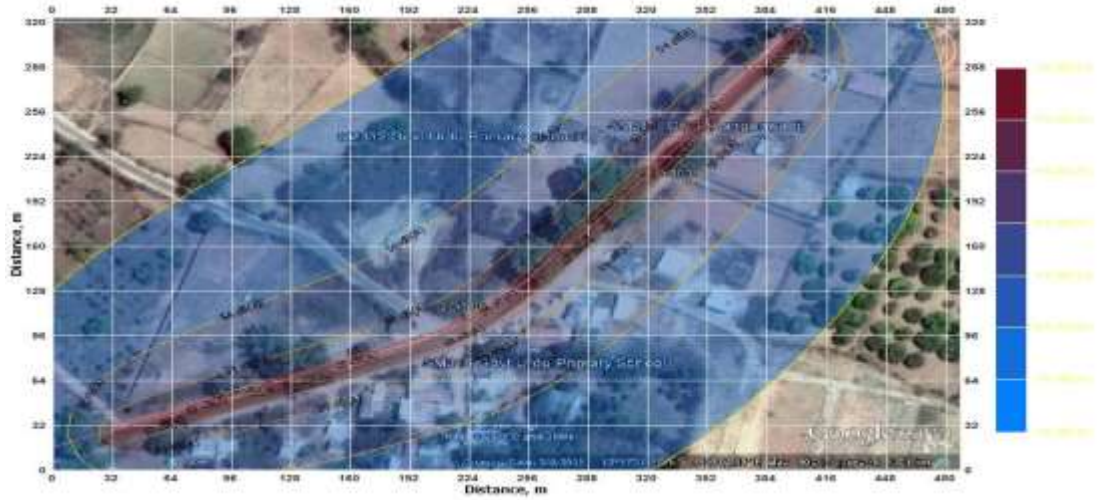
2015

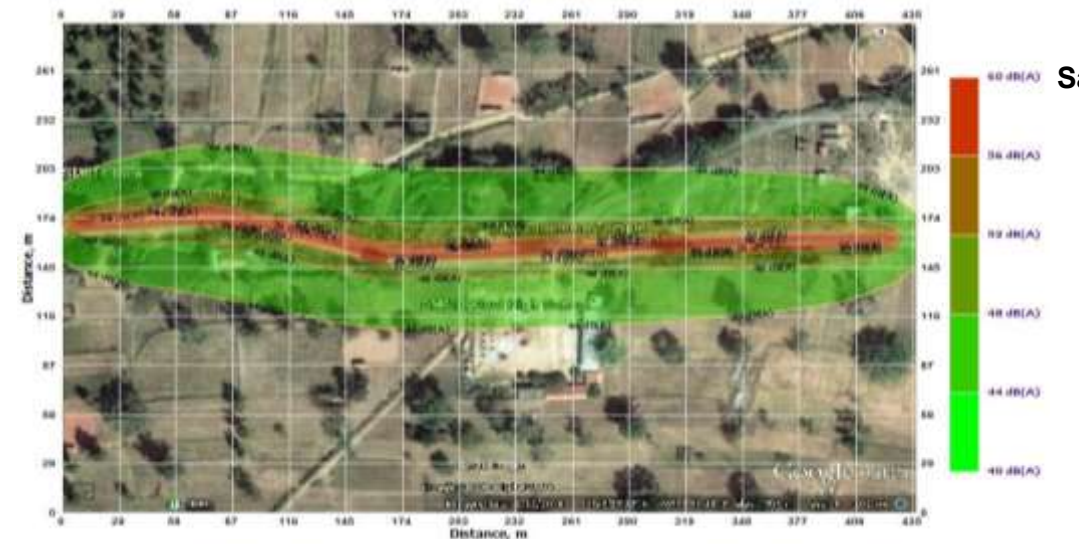


2020



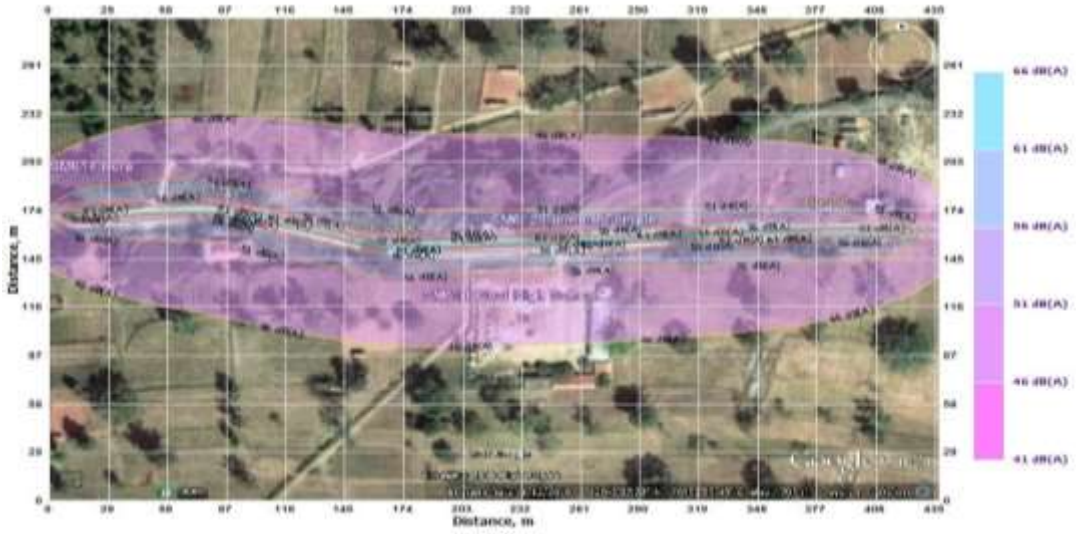
2040



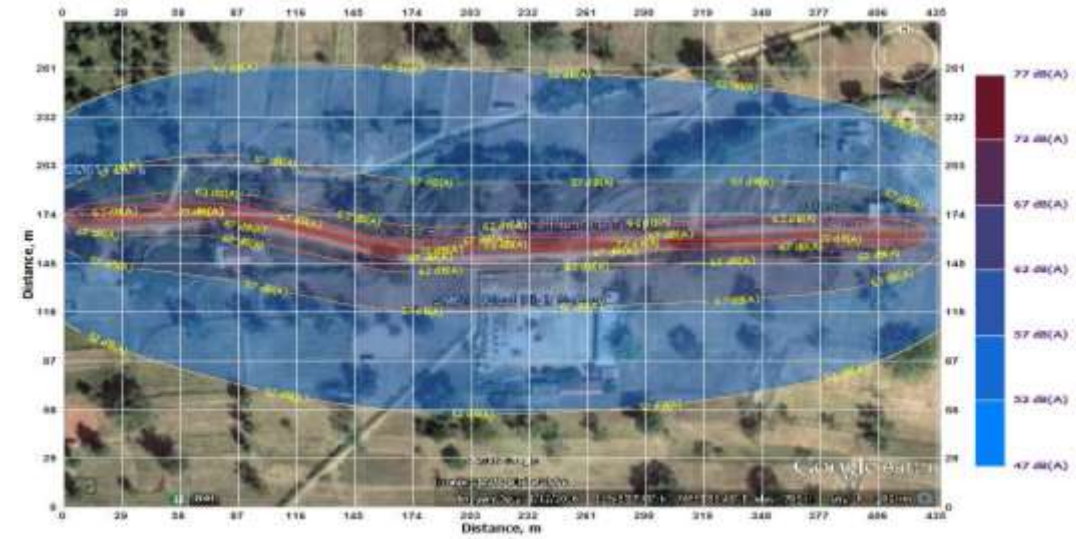


2015

Sab Palya

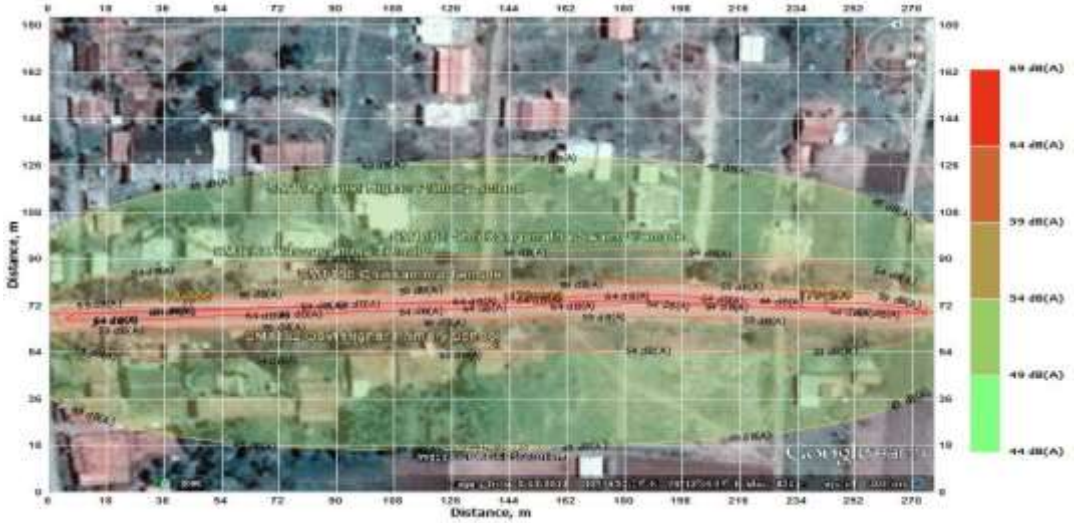


2020

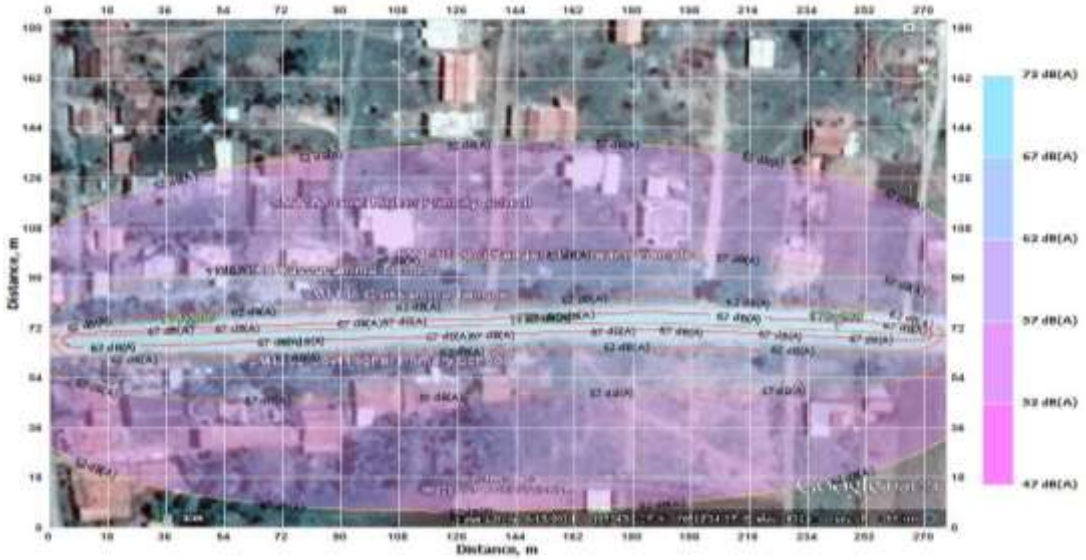


2040

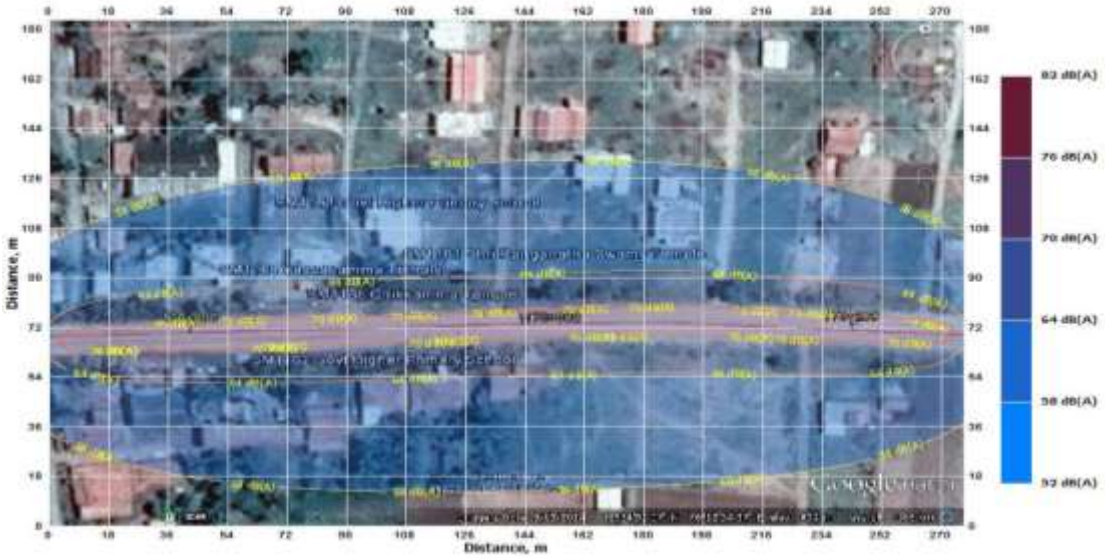
2015



2020



2040



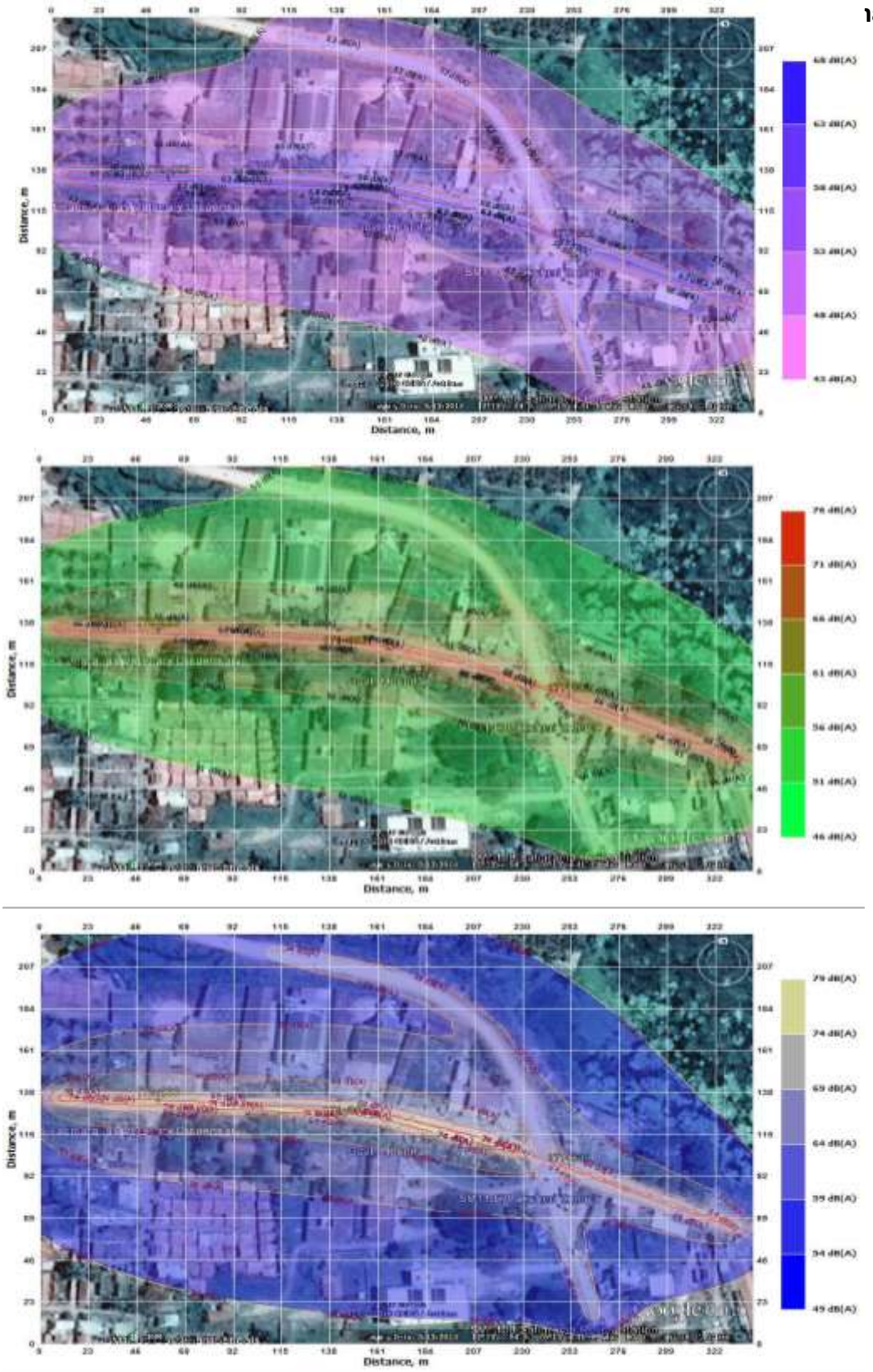


Figure 60 Noise Contour at Govt. Hospital, Saligrama

3. Noise Barrier

361. 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 61**). 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 61 View of Solid Boundary Wall with Trees and Creepers

362. ***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.

363. 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.

364. 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.

365. **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

366. 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.

367. 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.

368. 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.

369. 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.

370. 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 109**.

Table 109 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
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.

371. 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 62**.

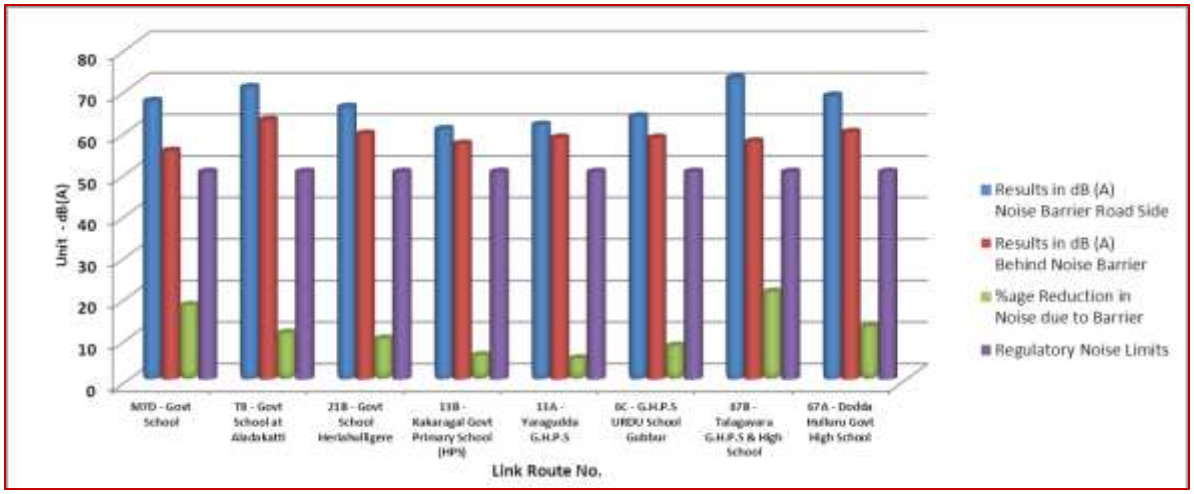


Figure 62 Noise Level Monitoring Results at Selected Noise Barrier Locations

F. Flora

1. Construction Phase

372. **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.

373. **Felling of Roadside Trees:**

- Efforts were made to minimize the number of trees to be felled in other locations also. Approximately 5,406 trees are required to be felled for the improvement of the road out of total 7,488 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 110.

Table 110 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	437	932	855	342	203	**2,769**
LHS	799	669	447	229	493	**2,637**
	1236	**1601**	**1302**	**571**	**696**	**5,406**

374. ***Green Tunnel:*** Efforts were made to save green tunnel along the project road and this issue was also discussed during public consultation. Green tunnel has been saved at following 4

locations by modifying engineering design. In these sections, approximately 323 trees have been saved.

Table 111 Location where Green Tunnel Saved

Existing Chainage Km		Design Chainage Km		Length (m)	No. of trees saved	Remarks
From	To	From	To			
55+340	55+480	54+350	54+490	0.140	16	Tress saved on RHS
83+440	83+720	81+090	81+370	0.280	26	Tress saved on LHS
107+800	110+100	104+700	107+000	2.300	256	50% trees saved
110+620	110+985	107+475	107+840	0.365	25	Covering LHS & RHS
				3.085	**323**	

375. To minimise the impacts on residential, commercial, religious and educational structures as well as to minimise the acquisition of fertile agricultural land, green tunnel could not be saved. However, most of the giant trees will be saved.

376. **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 165.47 km length of project road 85.474 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.
- 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.
- Total length of the project road is 165.47 km out of which in 70.337 km stretch, there is no space available for plantation. Therefore, effective length available for plantation is 95.093 km (≅95 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 95 km stretch, 19,000 trees shall be planted on both sides of the project road. Detail of plantation provided in Tree Plantation Strategy (Annex-8.12).
- 1,044 trees will be planted along the boundary of noise barrier at 4 m interval (total length of noise barrier is 4.175 km)
- 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
- 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.

- Therefore, Total Compensatory Plantation will be more than 1:5 for Magadi to Somwarpet
- Species suggested for plantation are provided in the Table 112.

Table 112 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

377. **Impacts:** Illegal felling of road side plantation

378. **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

379. **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.

- Stretch of Magadi to Somwarpet road traverses Tropical Dry Deciduous and Dry Thorn scrub type forests. A total of 16.23 km stretch of the project road is passing through the reserved forest / state forest. 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

380. **Mitigation Measures**

- Reserve Forest / State Forest is located on either side of the project road at 25 locations. Avian species Accipiter badius (Shikra), Haliastur indus (Bhramini Kite), Ictinaetus malayensis (Black Eagle), Pavo cristatus (Indian Peafowl) and Ocyceros birostris (Indian Gray Hornbill) 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

381. **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

382. **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

383. The project road does not pass through any Wildlife Sanctuary/ National Park / Biosphere Reserve. No protected area is located within 10km radius of the project area. Hence, there is **no impact** on protected area.

I. Reserved Forest

384. The project road is passing through Reserved Forests /and State Forest at various locations. Total **16.23 km** stretch of the project road is passing through the reserved forest / state forest.

385. **21.3872 ha** reserved forest land is to be diverted for the proposed development. The acquisition of forest land will be taken up in accordance to the requirements of Government of India.

386. **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

387. 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.

388. 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.

389. 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.

390. 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.

391. 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 Impact abd Risks

1. Climate Change Mitigation

392. 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. Information that was fed into the model for projecting the CO_2 emissions were:

i) The project will rehabilitate and widen 169.495 km of the SH-85 from Magadi to Somwarpet, which will have four different Homogeneous sections: HS-III, HS-IV, HS-V and HS-VI.
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.

393. 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 113 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

394. It was assumed that in Section-III, Section-IV, Section-V, and Section-VI, 2-wheelers and 3-wheelers have average trip distance of 1/3rd of the total road length and all other vehicles do

[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.

use the entire length as average trip distance. Furthermore, 2-wheelers and 3-wheelers constitute 100% and 90%, respectively of the total local traffic. 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 114 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%

395. 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

396. 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.

397. 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 169.49 km, total CO_2 emissions will be of the order of **18,576 tons** (**Table 115**).

Table 115 Estimated Total CO2 Emissions during Road Construction

Road Section	Length (km)	Emission Factor (ton CO2/km)	CO2 Emission (tons)
HS-III	62.37	109.6	6,835.8
HS-IV	36.88		4,042.0
HS-V	53.19		5,829.6
HS-VI	17.05		1,868.7
Total	**169.49**		**18,576.1**

398. The design life of roads is 20 years. Total CO_2 emission at Business-As-Usual scenario was estimated at **5,487.01** tons/year, without and with-induced traffic are **8,919.91** tons / year and **9,424.03** tons / year respectively (**Table 117**). 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:

Table 116 Section-wise Project CO2 Emissions Intensity Indicators

Road Sections	Particular	CO2 emission		
		Business-As-Usual	Project (without Induced Traffic)	Project (with Induced Traffic)

[11] Page 38, Appendix I, footnote 10 of SPS 2009

HS-III	tons/km	501.63	744.13	788.00
	tons/year	**2,489.35**	**3,692.75**	**3,910.47**
	tons/km/year	25.08	37.21	39.40
	g/t km	47.69	51.59	51.34
	g/tkm	167.85	194.53	193.68
HS-IV	tons/km	229.61	419.97	443.92
	tons/year	**1,139.42**	**2,084.08**	**2,202.93**
	tons/km/year	11.48	21.00	22.20
	g/pkm	56.73	69.76	69.32
	g/tkm	131.13	179.43	178.43
HS-V	tons/km	477.57	892.76	936.93
	tons/year	**1,677.22**	**3,135.38**	**3,290.50**
	tons/km/year	23.88	44.64	46.85
	g/t km	67.67	69.79	69.42
	g/tkm	86.25	95.88	95.37
HS-VI	tons/km	51.54	113.52	117.06
	tons/year	**181.02**	**398.69**	**411.13**
	tons/km/year	2.58	5.68	5.85
	g/t km	77.35	170.36	165.30
	g/tkm	96.19	211.85	205.58

399. Overall Project's CO2 emission intensity indicators are provided below:

Table 117 Project CO2 Emissions Intensity Indicators

Particular	**CO2**		
	Business-As-Usual	**Project (without Induced Traffic)**	**Project (with Induced Traffic)**
tons/km	1,260.35	2,075.32	2,190.85
tons/year	**5,487.01**	**8,919.91**	**9,424.03**
tons/km/year	63.02	103.77	109.54
g/t km	118.71	125.64	125.10
g/tkm	241.41	278.94	277.94

400. 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

401. 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.

402. 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.

403. **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.

404. The project road is located in Ramnagar, Tumkur, Mandya, Mysore and Hassan districts. As per the KSAPCC, projected minimum temperature increases are slightly above those of the maximum temperatures (**Table 118**).

Table 118 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
Ramnagar	1.97	2.05	1.92
Tumkur	1.99	2.06	1.96
Mandya	1.99	2.03	2.00
Mysore	1.95	1.99	1.98
Hassan	1.92	1.96	1.95

Source: Karnataka State Action Plan on Climate Change, March 2012

405. **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 southwest 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.

406. Increased temperature and precipitation will have following impacts:

407. **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.

408. **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.

409. **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.

410. **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.

411. **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.

412. **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.

413. **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.

414. 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 119, costs for taking these measures add up to a total of Rs. 36.2 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 6-19 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 119 Details of Climate Adaptation Measures with Cost Implications

Roads/Details	Magadi Somwarpet
Cross Drainage Structures	
Increase in Length in proposed culverts (in meter)	1152.8
Cost Impact (Rs. Crore)	***9.82***
Increase in Length of Bridges (in meter)	134.4
Cost Implication (Rs. Crore)	***8.68***
Embankment	
Total length of Embankment (in meter)	94811
Increase in Height (in meter)	0.6-1 m
Cost Implication for increasi (Rs. Crore)	***9.30***
Roadside drains	
Lined built-up (m)	6736
Unlined open (m)	207456
Cost Implication increasing depth (Rs. Crore)	**8.40**
Total Cost (Rs. Crore)	**36.20**

L. Social Impacts

1. Educational, Medical and Religious Properties

415. ***Impacts:*** Roadside amenities, religious and cultural properties generally include:

- Educational institutions (schools & colleges)
- Medical amenities (hospitals & health centers)
- Religious properties (temples, mosques, Church etc.)

416. 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 120**.

Table 120 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	10	107	117
Medical Amenities	1	1	20	22
Religious Places	25	1	107	133

- Out of 117 educational institutions along the project road, 10 will be partially affected, i.e., boundary wall will be affected. There will be no impact on school building.
- 1 Veterinary Hospital at Keralapura will be fully affected and boundary wall of 1 Veterinary Dispensary at Saligrama will be affected. There will be no impact on remaining 20 medical amenities
- Out of 133 religious structures along the project road, 25 will be fully affected, 1 partially affected. There will be no impact on remaining 107 religious places. Details of affected properties are presented in Table 121.

Table 121 List of affected Educational, Medical and Religious Properties

S. N.	Description	Village	Existing Ch. km	Proposed Ch. Km	Side	Distance# (m)	Affected Status
Educational Institutions							
1.	Akshara International Public School	Kowdel	93+330	90+500	LHS	16.0	Partially Affected
2.	Govt. Higher Primary School (Closed)	Kudagaballu	95+040	92+150	RHS	9.0	Partially Affected
3.	Govt. Primary School	Bommenahalli	161+390	157+700	RHS	9.0	Partially Affected
4.	Govt. Lower Primary School	Sambaravalli	173+600	169+800	LHS	15.0	Partially Affected
5.	Govt. High School	Saligrama	186+200	182+375	LHS	12.0	Partially Affected
6.	Govt. Primary Girls School and ICDS	Keralapura	195+800	191+925	LHS	26.0	Partially Affected
7.	Govt. Primary School	Basavapatna	204+200	200+230	RHS	9.1	Partially Affected
8.	Govt. Girls Middle School	Konanuru	212+350	208+350	RHS	8.2	Partially Affected
9.	MKS Lions Vidhyaniketahan	Konanuru	212+950	209+000	LHS	9.5	Partially Affected
10.	Govt. Lower Primary School	Ullenahalli	214+135	210+150	RHS	17.5	Partially Affected
Medical Amenities							
1.	Saraff Padmarajiah Veterinary Dispensary	Saligrama	185+800	181+980	LHS	11.4	Partially Affected
2.	Veterinary Hospital	Keralapura	195+825	191+940	LHS	10.9	Affected
Religious Properties							
1.	Dargah	Harohalli	52+870	52+000	RHS	7.6	Affected
2.	Road side Mini Worship Place (Ganesh)	Jutanahalli	54+200	53+200	RHS	4.5	Affected
3.	Sani Temple	Kamesagar	55+500	54+500	LHS	8.5	Affected
4.	Road side Mini Worship Place (Nag Dev)	Sathanuru	57+610	56+600	LHS	12.3	Affected
5.	Road Side Mini Worship Place (Hanuman)	Dhonakuppi	59+400	58+375	LHS	7.5	Affected
6.	Sani Temple	Halasabele	61+325	60+260	RHS	9.4	Affected
7.	Road side Small Nag Dev Temple	Halasabele	61+330	60+260	LHS	9.3	Affected
8.	Road side Small Nag Dev Temple	Halasabele	61+550	60+480	LHS	7.0	Affected
9.	Road side Mini Worship Place (Nag Dev)	Chowdanakuppe	70+500	69+115	LHS	6.9	Affected
10.	Road side Small Uchchamarama Temple	Chowdanakuppe	70+780	69+400	RHS	8.5	Affected
11.	Road side Mini Worship Place (Ganesh)	Hangarahalli	71+800	70+425	LHS	15.9	Affected
12.	Road side Mini Worship Place (Nag Dev)	Suggunahalli	82+360	80+000	RHS	9.9	Affected
13.	Sani Temple	Suggunahalli	82+380	80+020	RHS	10.3	Affected
14.	Road side Mini Worship Place (Vinayak)	Ungara	89+470	86+815	RHS	8.4	Affected
15.	Road Side Mini Worship Place (Hanuman)	Yadavani	90+370	87+700	LHS	4.6	Affected
16.	Road side Small Hanuman Temple	Kudagaballu	93+360	90+500	RHS	10.7	Affected

S. N.	Description	Village	Existing Ch. km	Proposed Ch. Km	Side	Distance# (m)	Affected Status
17.	Iriamma Temple	Shettahalli	97+300	94+440	RHS	5.4	Affected
18.	Muthinamma Temple	Tibbanahalli	99+040	96+100	RHS	9.5	Partially Affected
19.	Road side Mini Worship Place (Nag Dev)	Hullukere	111+600	108+500	LHS	9.1	Affected
20.	Road side Small Singhamma Temple	Kallenahalli	130+835	127+590	LHS	6.6	Affected
21.	Road side Mini Worship Place	Bommenahalli	162+750	159+060	LHS	7.8	Affected
22.	Road side Mini Worship Place (Nag Dev)	Kurenahalli	162+920	159+220	RHS	5.2	Affected
23.	Road side Mini Worship Place	Saligrama	184+515	180+710	LHS	7.3	Affected
24.	Road side Small Temple (Gram Devta)	Keralapura	195+745	191+860	LHS	10.5	Affected
25.	Sri Ram Temple	Basavapatna	203+800	199+840	LHS	6.0	Affected
26.	Temple	Ramanathapura		202+990	RHS	8.0	Affected

Distance in meter from existing centerline

417. **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

418. According to the Land Acquisition Plan (LAP) **178.7472 Ha** of land will be acquired for the project, out of which 134.59 Ha. is private land. These lands are a source of livelihood. The details of land acquisition requirement are summarized in the **Table 122**

Table 122 Type of Land Affected

Sl. No.	Land Details	Acquisition of Land Area (Ha.)	Percentage
1	Private Land	134.58	75.3
2	Forest Land	21.3872	12.0
3	Govt. Land / Waste Land	22.78	12.7
Total		**178.7472**	**100**

Source: Land acquisition Plan, ICT Pvt. Ltd 2015

3. Impacts on Structure in the Project Area

419. After considering the mitigation measures, 1029 assets including government and common property resources (CPRs) are likely to be affected. Out of total 1029 affected properties, 739 (71.82%) are private structures while 224 structures are government properties, which includes 76 mini water tanks, 35 bus shelters, 25 bore wells, 20 boundary walls, 36 hand pump, 2 milk dairy, 5 water tap, 10 pump house, 5 Gram panchayat building etc. The details of affected properties are presented in **Table 123**.

Table 123 Details of Affected Structures

Sl. No.	Structure/ properties in the Affected Area	Number of Affected Properties	Fully affected	Percentage
1	Private Structures	739	231	71.82

2	Government Structures	224	200	21.76
3	Community Structures	40	38	3.89
4	Religious structures	26	21	2.53
	Total	**1029**	**490**	**100**

Source: Census Survey 2015-16

4. Impacts on Private Structures

420. As per the census survey, 739 private properties are likely to be affected due to the road improvement project. 231 private structures will be significantly affected while 508 private structures will be marginally affected and will remain viable for use. Both partially and fully affected structures are owned by 509 title-holders and 230 non-titled holders. Details on the loss of private assets are given in **Table 124**.

Table 124 Impact on Private Structures

Sl. No.	Type of Private Property	Total No. of Structures	Partially affected Structures	Fully affected Structures	No. of displaced HHs (including Tenants& Employees)	No. of affected HHs (including Tenants& Employees)	No. of affected Families (including Tenants & Employees	No. of affected Persons (including Tenants &Employees
1	Residential	367	227	140	154	410	682	1440
2	Commercial	150	80	70	89	204	275	580
3	Res-Cum-Commercial	95	74	21	24	135	260	557
4	Boundary wall	127	127	0	0	145	252	535
	Total	**739**	**508**	**231**	**267**	**894**	**1469**	**3112**

Source: Census Survey 2015-16

5. Legal Ownership of the Properties/ Structures

421. 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, and in 4 lane urban section the COI is customized to 20 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 125**.

Table 125 Details of Ownership of Properties

Sl. No.	Type of Properties	No. of Households		Total	Percentage
		Titleholder	Non-Titleholder		
1	Residential	263	104	367	49.66
2	Commercial	67	83	150	20.30
3	Res-cum-commercial	87	8	95	12.86
4	Boundary Wall	92	35	127	17.19
	Total	**509**	**230**	**739**	**100**

Source: Census Survey 2015-16

6. Severity of Impact on Households Losing Structures

422. The analysis of impact on the scale of severity reveals that out of 739 private structures, 508 structures are moderately affected (up to 25%), while 231 structures are significantly affected, leading to physical displacement. The intensity of impact is further classified in the **Table 126**.

Table 126 Intensity of Impact on Structures

Sl. No.	Scale of Impact	To the scale of 25 %	No. of Household	Percentage
1	Fully Impacted	(More than 25%)	231	31.26
2	Partially Impacted	(Less than 25%)	508	68.74
		Total	**739**	**100**

Source: Census Survey 2015-16

7. Loss of Livelihoods

423. Out of 339 total households losing their livelihood, 113 are fully affected and 226 are partially affected commercial households. Majority of them are owners and carrying out commercial activities in these structures but some of them are tenants who have taken the premises on rent for commercial purpose. The details of economic impact as per the category of affected households are presented in **Table 127.**

Table 127 Loss of Livelihoods

Sl. No.	Loss	Partially affected Households	Partially affected Families	Fully affected Households	Fully affected Families	Total affected Households	Total affected Families
1	Owners of Shop	154	256	91	154	245	410
2	Tenants	71	104	22	31	93	135
3	Employees	1	1	0	0	1	1
	Total	**226**	**361**	**113**	**185**	**339**	**546**

Source: Census Survey 2015-16

8. Impacts on Common Property Resources

424. The summary list of CPRs affected along the project is presented in **Table 128.**

Table 128 Types of CPRs and Government Properties likely to be affected

Sl. No.	Types of Properties	Items	Total	% Age
1	A. The Other Community Properties (CPRs)	Aralikatte	19	6.55
2		Community Hall	1	0.34
3		Flag hosting Stage	5	1.72
4		Samadhi	2	0.69
5		Well	12	4.14
6		Community hall Compound Wall	1	0.34
7	B. Religious Properties	Temple	25	8.62
8		Temple Compound wall	1	0.34
9	C. Government Properties	Bore-well	25	8.62
10		Bus Shelter	35	12.07
11		Check Post	1	0.34
12		Govt. offices	1	0.34
13		Gram Panchyath Building	5	1.72

14		Hand pump	36	12.41
15		Hospital	1	0.34
16		Milk dairy	2	0.69
17		Mini water tank	76	26.21
18		Pump house	10	3.45
19		School	6	2.07
20		Water Tap	5	1.72
21		Well	1	0.34
22		High school Compound wall	4	1.38
23		School Compound wall	6	2.07
24		Grama panchyath building Compound wall	3	1.03
25		Overhead tank Compound Wall	1	0.34
26		Govt. offices Compound wall	5	1.72
27		Hospital Compound Wall	1	0.34
	Total		**290.00**	**100.00**

Source: Census Survey 2015-16

9. Key Effects on Assets and Displaced Persons

425. A summary of the impacts based on the Census survey of likely to be impacted structures and Land owners is provided in **Table 129**.

Table 129 Summary of Impact on Structures and Displaced Persons

Type of Impact	Number
Total number Project Affected Persons (PAPs)	8913
Total Households Affected including (Structures, Land, Tenants and Employees)	2251
Total Vulnerable Households Affected	1615
Significantly Affected Households (Title-Holders & Non-titleholders)	231
Moderately Affected Households (Title-Holder & Non-Title Holders)	508
Marginally Affected Households (Non-Title Holders)	155
Significantly Affected Households (Title-Holders)	146
Significantly Affected Households (Non-Title Holders)	85
Significantly Affected Families (Title-Holders)	293
Significantly Affected Familes (Non-Title Holders)	90
Moderately Affected Households (Title-Holders)	363
Moderately Affected Households (Non-Title Holders)	145
Moderately Affected Families (Title-Holders)	732
Moderately Affected Families (Non-Title Holders)	152
Marginally Affected Families (Non-Title Holders)	202
Households Affected by loss of income (Shop owner, -Tenants & Employees)	339
Households Affected by Land Acquisition	1361
Households Affected by Impact on Private Structures (Structures, Tenants & Employees)	894
Number of trees likely to be affected	2705
CPR affected	40
Religious structures affected	26
Government structures affected	224

M. Steps for Minimizing Adverse Impacts

426. Social impacts were minimized to the extent possible. The following steps were followed to minimize social impacts and in particular impacts on very congested areas and sensitive structures (i.e. clusters, community and religious structures)*:* The Social team working in the field, weighed up the alternative alignment options proposed by the Survey and Engineering team and this field information were shared and discussed with engineering design team, to avoid or minimize adverse impact on large number of households. Moreover, local level consultations regarding the impact of widening of the road and in particular its impacts on sensitive sites were conducted and alternative suggestions offered by road residents were considered. In response, the engineering team considered various options.

427. These minimization efforts resulted in:

- Potential displacement avoided by modifying the alignment;
- 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
- Evolving Community consensus on shifting the existing community properties and religious structures.

428. At some instance, the alignment has been modified to avoid certain sensitive structures. Few key examples are at J S Paliya (km.51.800) and Ungra village (Km. 86.950) in Ramanagara district, Mosque, and Houses were saved. At Kudugabalu village two Temples and one House was saved by shifting the alignment to the left hand side (LHS)

Table 130 Sensitive Structures Saved Safeguard Measures

Sl. No.	Chainage		Name of the Settlement	Type of Impact	Mitigation measure
	Census Survey & Structure Nos.	Proposed/ Design Design			
1	47+000 (CR47/7)	51. 800	JS Paliya	Mosque	Saved due to curve improvement to the LHS
2	84+500 (L84/13, L84/14)	86.950	Ungra	2 Houses	Shifting of alignment to RHS
3	92+000 (CR92/2)	94.450	Kudugabalu	Temple	Saved due to realignment to the right side
4	93+300 (CR 93/6)	96.150	Kudugabalu	Temple	Shifting of alignment to LHS
5	107+800 (R107/3)	109.880	Machoholalu	House	Shifting of alignment to LHS

N. Rehabilitation and Resettlement

429. 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 476.29 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

430. 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.

431. 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.

432. **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

433. 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

434. **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

435. **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

436. **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.

R. Occupational Health and Safety

437. **Impacts:** Health & safety related problems to construction workers due to inadequate health & safety measures

438. **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)

S. Road Safety

1. Construction Phase

439. **Impacts:**
- Increase on incidence of road accidents due to disruptions caused in existing traffic movements

440. **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

441. **Impacts:**

- Impacts on human health due to accidents
- Damage of road due to wear & tear

442. **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

T. 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 and Meeting

443. 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. 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

444. **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.

445. **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.

446. **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

447. **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

448. The public consultation meeting schedule for the project road in provided in **Table 131**.

Table 131 Public Consultation Meeting Schedule

Sl	Date	Time	Venue	Location Coordinates
PCM-1	10 Dec 2015	12.00 p.m.	Govt. Higher Primary School Ramanathpura Village	12°37'1.88"N 76°05'5.59"E
PCM-2	10 Dec 2015	01:30 p.m.	Govt. High School, Haradanahalli Village	12°34'51.61"N 76°12'31.06"E
PCM-3	14 Dec 2015	10:30 a.m.	Govt. Girls High School K R Pet	12°39'48.03"N 76°29'27.32"E
PCM-4	12 Jan 2016	10:30 a.m.	Govt. Higher Primary School, Kanthapura Village	12°45'55.35"N 76°41'13.71"E
PCM-5	12 Jan 2016	3:00 p.m.	Govt. Higher Primary School, Bommenahalli Village	12°37'12.11"N 76°26'30.52"E
PCM-6	13 Jan 2016	10:30 a.m.	Govt. Higher Primary School, Yele Muddanahalli Village	12°34'21.01"N 76°18'28.54"E
PCM-7	13 Jan 2016	1:00 p.a.	Govt. Higher Primary School, Keralapura Village	12°34'57.38"N 76°10'31.58"E
PCM-8	13 Jan 2016	3:00 p.m.	Govt. Higher Primary School, Basavapatna Village	12°36'52.81"N 76° 7'10.80"E
PCM-9	14 Jan 2016	12:00 p.m.	Govt. Lower Primary School, Kotagahalli Village	12°42'1.61"N 76°31'34.16"E

Photographs of Public Consultation

Photographs of Public Consultation

D. Analysis of Collected Feedback

1. Stakeholders and women participants

449. A total of 228 stakeholders participated in 9 public consultation meetings. Meeting at Govt. Lower Primary School at Kotagahalli village had the highest number of participants including women participants. The percentage of women participation varied between 15%-44% in these public meetings, with over participation percentage being 26%. However, no women participants were found in meeting held in Basavapatna village. Gender-wise distribution of participants is provided in **Table 132.**

Table 132: Gender wise Distribution of Participants in PCMs

SL	Location	Female	Male	Total
PCM-1	Govt. Higher Primary School, Ramanathpura Village	3	14	17
PCM-2	Govt. High School, Haradanahalli Village	7	39	46
PCM-3	Govt. Girls High School, K R Pet	6	28	34
PCM-4	Govt. Higher Primary School, Kanthapura Village	9	21	30
PCM-5	Govt. Higher Primary School, Bommenahalli Village	7	19	26
PCM-6	Govt. Higher Primary School, Yele Muddanahalli Village	8	22	30
PCM-7	Govt. Higher Primary School, Keralapura Village	16	20	36
PCM-8	Govt. Higher Primary School, Basavapatna Village	0	32	32
PCM-9	Govt. Lower Primary School, Kotagahalli Village	25	33	58
	Total	**81**	**228**	**309**

450. 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 133**. Overall, 89% of women and 80% of men responded with written response.

Table 133 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, Ramanathpura Village	0	11	11	0.0%	78.6%	64.7%
PCM-2	Govt. High School, Haradanahalli Village	5	27	32	71.4%	69.2%	69.6%
PCM-3	Govt. Girls High School, K R Pet	6	26	32	100%	92.9%	94.1%
PCM-4	Govt. Higher Primary School, Kanthapura Village	9	19	28	100%	90.5%	93.3%
PCM-5	Govt. Higher Primary School, Bommenahalli Village	7	17	24	100%	89.5%	92.3%
PCM-6	Govt. Higher Primary School, Yele Muddanahalli Village	8	20	28	100%	90.9%	93.3%
PCM-7	Govt. Higher Primary School, Keralapura Village	14	15	29	87.5%	75.0%	80.6%
PCM-8	Govt. Higher Primary School, Basavapatna Village	0	16	16	0.0%	50.0%	50.0%
PCM-9	Govt. Lower Primary School, Kotagahalli Village	23	31	54	92.0%	93.9%	93.1%
Total		**72**	**182**	**254**	88.9%	79.8%	82.2%

2. Perception on Noise Pollution Issues

451. About 88% respondents felt that traffic induced noise pollution could be disturbing. Over 60% respondents scaled present traffic noise as highly disturbing while another 17% viewed it as moderately disturbing. About 40% of the respondents expected the traffic volume to increase after project implementation.

452. About 59% of the respondents anticipated increased noise level either to be high or moderate after project implementation, while 41% respondents expect reduction in traffic noise after the project implementation. It may be interesting to note that the a considerable majority of respondents anticipated that noise menace due to honking will be reduced after the project implementation due to improved road features. The perception of the respondents with respect to noise pollution is detailed in **Table-123.**

Table 134 Perception of Respondents on Noise Pollution due to Traffic

1 Do you feel disturbed due to traffic noise	**Yes**	**88.2%**			No	**11.8%**
If yes, then Degree of Impact	*High*	*Moderate*	*Low*	*Insignificant*	*Can't Say*	*Not Applicable*
Disturbance from Noise of present traffic	60.6%	16.5%	5.9%	1.2%	3.9%	*11.8%*
Disturbance from Honking of present traffic	57.1%	17.3%	6.7%	3.1%	3.9%	*11.8%*
2 Increase in traffic volume after project implementation	40.2%	15.7%	14.2%	4.7%	25.2%	-
3 Do you anticipate change in noise level due to the project?	**Increase**	58.7%	Decrease	33.5%	No Change	7.9%
If anticipated increase, then Degree of Impact	*High*	*Moderate*	*Low*	*Insignificant*	*Can't Say*	*Not Applicable*

Increase in noise after project implementation	31.1%	14.2%	5.5%	3.1%	4.7%	*41.3%*
Disturbance due to honking after project implementation	26.8%	18.9%	9.4%	2.4%	1.2%	*41.3%*
Disturbance due to construction machinery & vehicles	24.8%	16.1%	7.5%	3.1%	7.1%	*41.3%*

453. PCM wise variation of response on noise pollution is presented in **Table 135.** It may be observed that about high disturbance due to traffic noise and honking has been reported by respondents of Kotagahalli Village (PCM-9). The respondents at large, has also expressed concern on the honking noise of the vehicles.

Table 135 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	3.1%	1.6%	1.2%	0.8%	0.4%
PCM-2	11.8%	11.4%	8.7%	3.9%	3.1%
PCM-3	8.7%	5.1%	7.1%	3.5%	2.4%
PCM-4	9.8%	6.7%	5.9%	3.1%	2.8%
PCM-5	8.3%	4.7%	5.1%	2.8%	4.3%
PCM-6	10.6%	5.5%	4.7%	2.4%	7.1%
PCM-7	10.2%	4.3%	6.7%	7.9%	2.8%
PCM-8	4.7%	2.4%	2.4%	2.8%	1.2%
PCM-9	20.9%	18.9%	15.4%	13.0%	7.1%
Overall	**88.2%**	**60.6%**	**57.1%**	**40.2%**	**31.1%**

3. Perception on Air Pollution Issues

454. About 88% of the respondents felt that traffic induced air pollution could be disturbing. Further, about 62% respondents scaled present air pollution and dust levels due to traffic as highly disturbing while other 18% and 5% respondents viewed the same as moderately and low disturbing respectively. 82% of them could not identify any other sources of air pollution in vicinity. About 8% respondents opined that open drain and burning of crop residues also contribute to air pollution.

455. It is noteworthy that about 23% 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 (69%) of the respondents anticipated air quality to deteriorate due to increased traffic flow in post project scenario. The perception about dust pollution due to traffic movement remains more or less same among the respondents in present and future traffic scenarios. The perception of the respondents with respect to air pollution is detailed in **Table 136.**

Table 136 Perception of Respondents on Air Pollution due to Traffic

4 Do you feel disturbed due to air pollution	**Yes**	**87.8%**			**No**	**11.8%**
If yes, then Degree of Impact	*High*	*Moderate*	*Low*	*Insignificant*	*Can't Say*	*Not Applicable*

Disturbance due to air emissions from present traffic	62.6%	18.1%	4.7%	0.8%	1.6%	*12.2%*
Disturbance due to dust due to present traffic	53.9%	19.7%	9.4%	1.2%	3.5%	*12.2%*
5 Any other sources of Air Pollution other than traffic	8.3%	2.4%	2.0%	5.1%	82.3%	-
6 Change in air quality due to the project?	Deteriorate	68.9%	Improve	23.6%	No Change	7.5%
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	50.4%	13.4%	2.0%	2.8%	0.8%	*31.1%*
Increase in dust due to increased traffic	42.1%	23.2%	2.4%	0.8%	0.4%	*31.1%*
Increase in dust due to construction activity	40.2%	13.0%	6.7%	2.8%	6.3%	*31.1%*

456. PCM wise variation of response on air pollution is presented in **Table 137**. Highest disturbance (by %) due to present traffic emission has been reported by 16% of the respondents in PCM 9 at Kotagahalli village. As evident from the table below, the anticipated air emission and dust pollution in the construction and operation phase has little variations among respondents across all PCMs.

Table 137 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	1.6%	1.6%	2.0%	2.4%	1.6%
PCM-2	11.4%	8.3%	5.5%	5.1%	3.1%
PCM-3	8.3%	6.7%	7.1%	5.9%	6.3%
PCM-4	4.7%	3.9%	2.8%	1.6%	1.6%
PCM-5	4.7%	2.8%	4.7%	3.5%	3.9%%
PCM-6	7.5%	6.3%	8.3%	5.9%	4.7%
PCM-7	5.9%	7.9%	2.8%	2.8%	4.3%
PCM-8	2.8%	2.0%	1.6%	1.6%	2.0%
PCM-9	15.7%	14.6%	15.7%	13.4%	12.6%
Overall	**62.6**%	**53.9**%	**50.4**%	**42.1**%	**40.2**%

4. Perception on Road Safety Issues

457. About 57% of the respondents opined that the road at the present condition is accident prone and requested to take immediate steps for its improvement. 32% of the respondents feared that construction period may lead to further increase of accidents and adequate safety measures must be enforced.

458. 76% of the respondents wanted pedestrian crossings at important junctions and popular movement locations like schools, hospitals and temples etc. while 69% 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 (80%). 35% respondents viewed regular police patrol can also curb the accident rate while another 56% 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 56% 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 138.** Overall, the respondents were unanimous over the requirement of road safety features and demanded for its implementation at the earliest.

Table 138 Perception of Respondents on Road Safety Issues

Perception on Road Accidents	%
Is the road accident prone?	58.7
Anticipation of increased road accidents in construction phase?	32.3
Choice of People on Road Safety Measures	
Speed Breaker	69.3
Pedestrian crossing	76.0
Road signage	79.9
Improved emergency services	63.8
Police Patrol	35.4
Speed Cameras	38.6
Road safety education camps	50.4
Driver Awareness Programs	56.3

5. Perception on Ecology and Biodiversity Issues

459. Only about 9% respondents reported sighting of wild animals in the project area. None of them agreed that sighting of animals are of high prevalence, while 0.4% respondents ranked the sighting prevalence as moderate. 10% of the respondents reported that they experienced crop damage by some time or other by wild animals. Accidents involving wildlife is reported by only 1% 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.

460. Respondents reported that major wildlife observed in the project area involves fox, deer, rabbit and wild boars. Respondents opined that flowering and fruit being trees like mango should be selected for median plantations. The perception of the respondents regarding ecology and biodiversity issues is detailed in **Table 139.**

Table 139 Perception of Respondents on Ecology & Biodiversity Issues

Indicators	**%**
Are wild animals sighted in your area?	8.7%
Frequency of Sighting wild animals	*High – 0.0%* *Moderate – 0.4%* *Low - 2.4%* *Insignificant – 3.9%*
Crop damage by wild animals	3.9%
Accident involving wildlife	Not reported
Incident on man wildlife conflict	Not reported
Poaching / wildlife trafficking incident in nearby locality	No
Frequently sighted wild animals	Fox, Wild boar & Peacock
Frequent Wildlife accident spots, if any	Nil
Preferred tree species in agricultural land boundaries	Coconut, Palm, Beetle Nut
Preferred species for roadside plantation	Neem, Banyan & Coconut

E. Outcome of the Public Consultation Meeting

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

a) Stakeholders are concerned about the existing traffic noise and anticipate that increase of traffic flow may lead to increased noise level after project implementation.
b) 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.
c) Stakeholders viewed the road as moderately accident prone and requested to take possible measures to further minimize the accidents.
d) Pedestrian crossing, proper road signage and speed control measures are the most sought after road safety measures by the stakeholders.
e) Accident involving wildlife and man-animal conflicts are reported to be nil and incidents of crop damage by wild boars and deer are limitedly reported.
f) School authorities and citizens at large are in favour of introducing speed restriction near the schools.
g) 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.
h) Participants requested for trees with large crown areas such as Banyan (Ficus Sp.) and Neem should be planted as Avenue plantation.
i) 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. Consulttaion in Religious Places

462. 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. **Six temples**, as detailed in **Table 140** were selected for such consultation based on its local importance and relative proximity with the proposed alignment.

Table 140 List of Temples Identified for Consultation

S.N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1.	Nava Grah Temple	Bommenahalli	162+755	159+065	LHS	20.5
2.	Hanuman Temple		162+760	159+070	LHS	15.3
3.	Lakshmi & Venkataramana Temple		162+770	159+080	LHS	29.7
4.	Rukmani Pandaranga Temple	Akkihebbal	168+300	164+570	LHS	15.7
5.	Vaseaeamma Temple	Haradanahalli	192+210	188+345	RHS	19.7
6.	Kwaleamma Temple	Ramanathapura	207+150	203+150	LHS	57.9

Distance in meter from existing centerline

Location of Consultations at Religious Places along Magadi TO Somwarpet Road
Location of Consultations at Religious Places along Magadi to Somwarpet Road

1. Outcome of Consultation at Religious Places

463. The response of the participants varied widely regarding installation of noise barrier, as detailed in **Table 141** below. While participants at Akkihebbal village unanimously (100%) ruled out any requirement of boundary wall for mitigating traffic noise, but 33.33% stakeholders at Bommenahalli village welcomed the move. This divided opinion was again observed at two other venues as evident from the Table. Overall **77.78%** participants showed reservation against construction of boundary wall due to temple aesthetics and accessibility; while those supported the concept (**22.22%**) were delighted to get a wall constructed around the property at government's expenses as a part of big ticket public expenditure.

Table 141 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.	Nava Grah Temple	15	Devotees, Priest, Trustee	5	33.33	10	66.67
2.	Hanuman Temple						

S. N.	Description	No. of participants	Type of Participants	Response of Participants regarding Noise Barrier			
				Yes	%	No	%
3.	Lakshmi & Venkataramana Temple						
4.	Rukmani Pandaranga Temple	6	Devotees	0	0	6	100
5.	Vaseaeamma Temple	10	Devotees	1	9.09	10	90.91
6.	Kwaleamma Temple	13	Devotees and Trustee	4	30.77	9	69.23
			Overall Response	**10**	**22.22**	**35**	**77.78**

Photographs of Consultation at Religious Places

VIII. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

464. 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

465. 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 142 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 3 locations where the soaked CBR is less than 8%. On the total borrow area soils sample, about 85% borrow area soil soaked CBR (97% compaction) is in the range from 10% to 24%. 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 and also inconvenience caused to	Design requirement IRC:37-2012 IRC: 58-2015	Throughout the stretch, Embankment raised for a length of **94.811 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
	▪ 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 67.36 Km and the length of unlined drain is 207.456 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 **741** 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-2.16 to Table-2.19** 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 561 nos. Horizontal 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 (where the height of embankment is more than 3.0 m) ▪ Provision of retro-	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 = **27.350 km** <u>Horizontal Curve:</u> Please refer Annexure-1.2 of Volume-II Design Report <u>Vertical Alignment:</u> Please refer Annexure-1.3 of	<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
	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. All the built up locations as well Underpasses has been proposed lighting arrangements. ▪ 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		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 Resettlement Plan to be undertaken as per National Policy	The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act,	Throughout the corridor	MI: Payment of compensation and assistance to PAFs as per RAP Number of	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
	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	2013. and ADB's Involuntary Resettlement Policy. Contract Clause for preference to local people during employment.		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. ▪ Stacking, transport and storage of the wood will be done as per the	▪ Forest Conservation Act, 1980 ▪ The Karnataka Preservation of Trees Act, 1976 ▪ Environmental Policy of KSHIP	Throughout the corridor Total number of affected trees=**5406** LHS: **2,637** RHS: **2,769**	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
	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.6-12** of Chapter-6 of IEE As per the revenue record **11.58 ha** forest land is to be diverted. However, as per joint verification with the Forest Department Officials, **19.1316 Ha** of Forest land is to be diverted for widening / improvement of the project road. It is observed that in the revenue record, some of the land parcels are listed as private land. It may be possible that the revenue records have not been updated. However, any change in the	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

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
			information will be updated in due course. The acquisition of forest land will be taken up in accordance to the requirements of Government of India.				
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 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	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. Minimal time for utility shifting	Interaction with concerned utility authorities and local public	Contractor/ KSHIP / Utility company	KSHIP / IE
B. CONSTRUCTION STAGE							
1. Air Quality							
1.1 Dust Generation due to construction activities and transport, storage and handling of	▪ 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.	▪ MORT&H Specifications for Road and Bridge works ▪ The Air (Prevention and	Throughout project corridor	MI: PM10 level measurements Complaints from locals due to dust PT: PM10 level<	Standards CPCB methods; Observations; Public consultation;	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
construction materials	▪ Water spraying on the unpaved haulage roads and other dust prone areas. ▪ Provision of PPEs to workers.	Control of Pollution) Act, 1981 and ▪ Central Motor and Vehicle Act 1988 ▪ Environmental Policy of KSHIP		100 µg/m^3; Number of complaints should be 0.	Review of monitoring data maintained by contractor		
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 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	▪ 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
	▪ 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 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	▪ Legal requirement ▪ Noise Pollution (Regulation and Control) Rules, 2000 and amendments thereof; ▪ Environmental Policy of KSHIP	Throughout project section especially at construction sites, residential and identified sensitive locations. **Refer Table No. 4-41, 4-42, 4-43 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 site	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
	Environmental Monitoring Program						
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 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**	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
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** regarding **Guideline on Soil Stabilization**	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
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	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
	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, 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	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	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;	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
	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 in the **Format** given in **Annex-8.18**	Environmental Policy of KSHIP		No case of non-compliance to consent /permit conditions and \ Air quality meets the prescribed limit			
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	▪ 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	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	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
demolition and road construction	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 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			conforming to no – contamination; No sighting of spilled oil or bitumen in construction site or camp site			
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	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

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	condition in the area						
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. PT: Existence of proper drainage system. No water logging in project area	Standards methods; Site observation and review of documents	Contractor	KSHIP / IE
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	Design requirement; Worldwide Best Practices; Annex-8.6 Guideline for Sediment Control	Near all water bodies/ waterway Refer **Table No. 4-25 of Chapter-4 of IEE** for information on	MI: Presence/absence of siltation in rivers, streams, nala, ponds and other water bodies in	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
	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. ▪ 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**		Water Bodies / low lying areas along the project road	project area; water quality monitoring PT: No records of siltation due to project activities. 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	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

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	only. ▪ Water quality shall be monitored						
5. Flora and Fauna							
5.1 Vegetation loss due to site preparation and construction activities	▪ Restrict tree cutting up to toe line considering safety to road users. ▪ Roadside trees to be removed with prior approval of competent authority. ▪ Contractor will be responsible for plantation of trees along the side of the road as per the Tree Plantation Strategy given in **Annex-8.12** ▪ Mandatory compensatory plantation is to be done by Forestry Department ▪ Local villagers to be employed for afforestation activities. Employment preference to be given to women ▪ 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. ▪ Controlled use of pesticides / fertilizers	Forest Conservation Act 1980; IRCSP:21and IRCSP:66 Environmental Policy of KSHIP	Throughout project corridor Estimated No. of affected tree=**5,406** Additional Plantation at Sensitive receptors (school), borrow areas, quarry area etc.	MI: ROW width; 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%.	Review of relevant documents; Tree cutting permit; Compensatory plantation plan; Meeting with villagers; Field Observations	Contractor	KSHIP / IE
6. Construction Camp							
6.1 Impact associated with	All camps should be established with prior permission	Design Requirement	All construction camps	MI: Location of camp sites and	On site observation	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
location	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 possible # 500 m from through traffic route	The Water (Prevention and Control of Pollution) Act,1974and its amendments thereof **Annex-8.2** Guidelines for Siting and Layout of Construction Camp		distance from habitation, forest areas, water bodies and through traffic PT: Distance of camp site is less than 500m from listed locations	Interaction with workers and local community		
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	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
	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,						
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	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 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
	suitably disposed-off at pre-designated disposal locations, with approval of the concerned authority. The bituminous wastes 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**			contractor or IE			
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	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	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
	to only one side of the existing road. ▪ 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**	workers Act 1996 and Factories Act 1948 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	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"			accidents.			
8.4 Accident risk to local community	▪ Restrict access to construction sites only to authorized personnel. ▪ Physical separation must be	Same as above	Construction sites	MI: Safety signs and their location; Incidents of accidents;	Site inspection Consultation with local	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
	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.			Complaints from local people PT: Zero incident of accidents. Zero complaints.	people		
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 surface condition ▪ Air quality monitoring. If monitored parameters exceeds prescribed limit, suitable control measures must be taken.	Environmental Protection Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981 Environmental Policy of KSHIP	Throughout the Corridor	MI: Air quality monitoring as per post project Environmental Monitoring Program PT: Levels are	As per CPCB requirements Site inspection	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
	▪ 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			equal to or below baseline levels given in the IEE report			
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 measures while constructing a building near road	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: Not exceeding standards and no more than >3dB increase over baseline	Noise monitoring as per noise rules , 2000 Discussion with people at sensitive receptor sites	PIU / Pollution Monitoring Agency	KSHIP
3. Land & Soil							
3.1 Soil erosion at embankment during heavy	▪ Periodic checking to be carried to assess the effectiveness of the stabilization measures viz. turfing,	Project requirement	At bridge locations and embankment slopes and other	MI: Existence of soil erosion sites; Number of soil	On site observation	PIU	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
rainfall.	stone pitching etc. ▪ Necessary measures to be followed wherever there are failures		probable soil erosion areas.	erosion sites PT: Zero or minimal occurrences of soil erosion			
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. ▪ The tree survival audit to be conducted at least once in a year to assess the effectiveness	Forest Conservation Act 1980 Environmental Policy of KSHIP	Project tree plantation sites	MI: Tree/plants survival rate PT: Minimum rate of 70% tree survival	Records and field observations. Information from Forestry Department	Forest Department / PIU	KSHIP
6. Maintenance of Right of Way and Safety							
6.1 Accident Risk	▪ Efforts shall be made to make	Project requirement	Throughout the	MI: Presence and	Visual	PIU	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
due to uncontrolled growth of vegetation	shoulder completely clear of vegetation. ▪ Regular maintenance of plantation along the roadside ▪ No invasive plantation near the road.		Project route	extent of vegetation growth on either side of road. Number of accidents. PT: No accidents due to vegetation growth	inspection Check accident records		
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
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

466. **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.

467. 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

468. This policy is established in line with the Vision and Environmental Policy of the KPWD, Government of Karnataka.

D. Emergency Response Plan

469. 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

470. 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.

471. 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.

472. **Grievance Redress Process:** KSHIP PIU has a well-established and functioning grievance redress system. The same system will be followed for this project.

473. **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)

474. 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.

475. 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.

476. 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.

477. 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

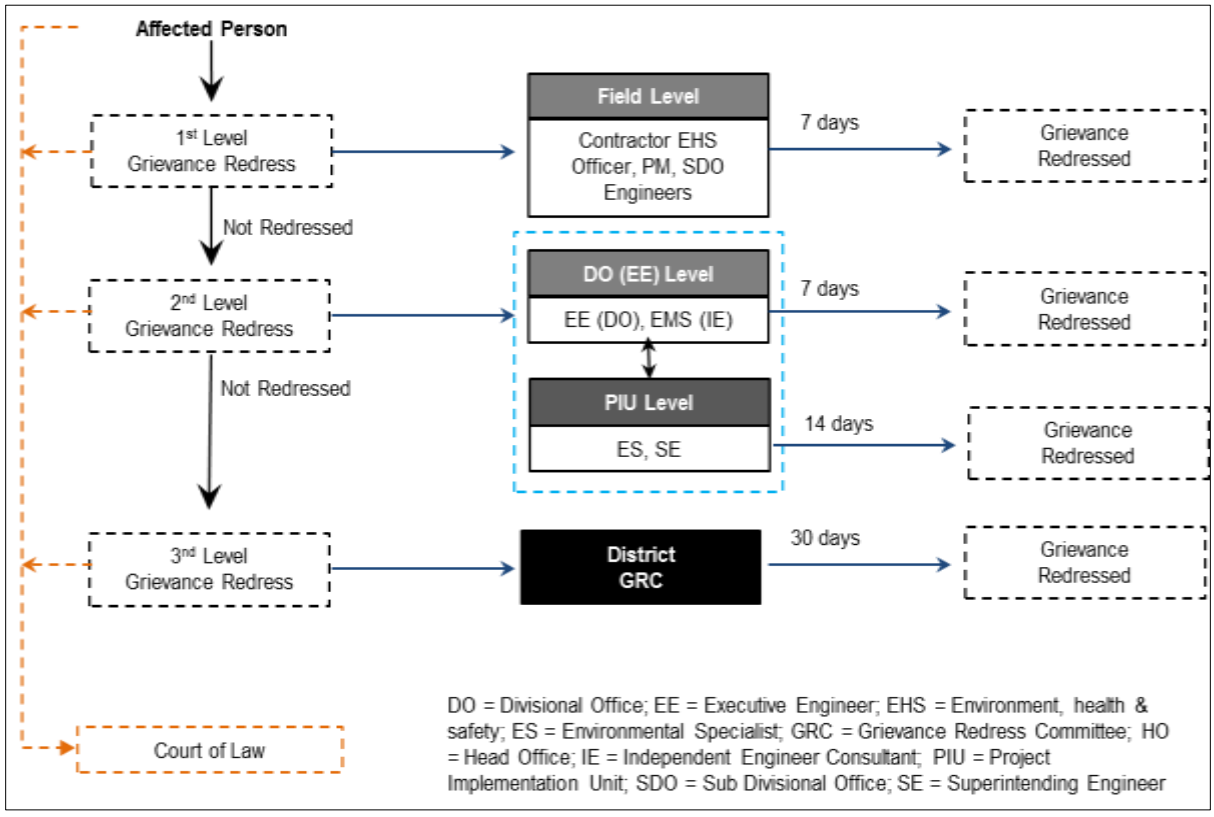


Figure 63: Grievance Redress Process

478. 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.

479. **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.

480. **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.

481. **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

482. 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

483. The environmental monitoring plan contains:

- Performance Indicators
- Environmental Monitoring Program
- Reporting Formats
- Necessary Budgetary Provisions

1. Performance Indicators

484. 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

485. The Performance Indicators and monitoring plans prepared are presented in **Table 143**.

Table 143 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-8.3**)	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 suggested for slope	Slope Stabilization	Construction	Contractor

S.N.	Details	Indicators	Stage	Responsibility
	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

486. The detail monitoring schedule during construction and operation stages are presented in **Table-133.** 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 144 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)	Contractor through NABL approved monitoring agency	IE / PIU

[12] Construction period is 30 months

Environment Component	Project Stage	Environmental Monitoring Program			Institutional Responsibility	
		Parameters	Location	Frequency	Implementation	Supervision
				Construction work should be in full swing during monitoring Duration: 24 hours		
		PM_{10}, $PM_{2.5}$, SO_2, NOx, CO,	At 8 locations: - Kenkere - Devalapura - Nagamangala - Kommenahalli - Ramanathapura - Bheriya - Siddapura - Konanur	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: - Devalapura - Nagamangala - Kommenahalli - Ramanathapura - Bheriya - Konanur	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 7 locations: - Kenkere - Nagamangala - Bommenahalli - Bheriya - Shaligram - Ramanathapura - Konanur	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 7 locations: - Kenkere - Nagamangala - Bommenahalli - Bheriya - Shaligram - Ramanathapura - Konanur	Once in every three years Duration: 24 hours	PIU through NABL approved monitoring agency	PIU/KSHIP
Ground Water Quality	Construction	Physical, Chemical & Biological parameters	At 7 locations: - Nagamangala - Malenahalli - Kommenahalli	4 times a year (in each season)	Contractor through NABL approved monitoring	IE / PIU

[13] Monitoring in Operation Phase will be conducted in every 3 years for 10 years

<table>
<tr><th rowspan="2">Environment Component</th><th>Project</th><th colspan="3">Environmental Monitoring Program</th><th colspan="2">Institutional Responsibility</th></tr>
<tr><th>Stage</th><th>Parameters</th><th>Location</th><th>Frequency</th><th>Implementation</th><th>Supervision</th></tr>
<tr><td></td><td></td><td>as per IS 10500:2012

However, IE may include additional parameters</td><td>- Haradanahalli
- Shaligram
- Ramanathapura
- Konanur</td><td></td><td>agency</td><td></td></tr>
<tr><td></td><td>Operation</td><td>Physical, Chemical & Biological parameters as per IS 10500:2012</td><td>At 5 locations:
- Nagamangala
- Haradanahalli
- Shaligram
- Ramanathapura
- Konanur</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>Ch. Km</th><th>Description</th></tr><tr><td>72+400</td><td>Depambudhai Lake</td></tr><tr><td>113+300</td><td>Ammana Katte</td></tr><tr><td>117+800</td><td>Sule Kere</td></tr><tr><td>144+119</td><td>Canal Crossing (Ne Jaginakere Village)</td></tr><tr><td>164+830</td><td>Hemavati River</td></tr><tr><td>184+800</td><td>Shaligrama Lake</td></tr><tr><td>207+600</td><td>Cauvery River Ramanathapura)</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 6 locations:<table><tr><th>Ch. Km</th><th>Description</th></tr><tr><td>72+400</td><td>Depambudhai Lake</td></tr><tr><td>113+300</td><td>Ammana Katte</td></tr><tr><td>117+800</td><td>Sule Kere</td></tr><tr><td>164+830</td><td>Hemavati River</td></tr><tr><td>184+800</td><td>Shaligrama Lake</td></tr><tr><td>207+600</td><td>Cauvery River Ramanathapura)</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 as agricultural area, residential area, forest land and river bed</td><td>Once in a year</td><td>Contractor through NABL approved monitoring agency</td><td>IE / PIU</td></tr>
<tr><td>Soil</td><td>Operation</td><td>pH, Conductivity, Organic matter, N, P, Na, K, Pb</td><td>4 will be from different land use area
along the project road such as agricultural area, residential area, forest land and low lying areas</td><td>Once in every three years</td><td>PIU through NABL approved monitoring agency</td><td>PIU / KSHIP</td></tr>
<tr><td>Soil Erosion</td><td>Construction</td><td>Visual observation & turbidity test</td><td>Visual observation at high embankments sites such as bridge location, culvert locations, embankment area etc.</td><td>Pre-monsoon and post-monsoon season</td><td>Environmental Specialist, Hydrologist, and Material Specialist of</td><td>IE / PIU</td></tr>
</table>

Environment Component	Project Stage	Environmental Monitoring Program			Institutional Responsibility	
		Parameters	Location	Frequency	Implementation	Supervision
					Construction Supervision Consultants & Contractor	
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

487. 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

488. 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.

489. 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 145.**

- 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.

490. 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 145 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

491. 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.

492. 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.

493. 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.

494. 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 64.**

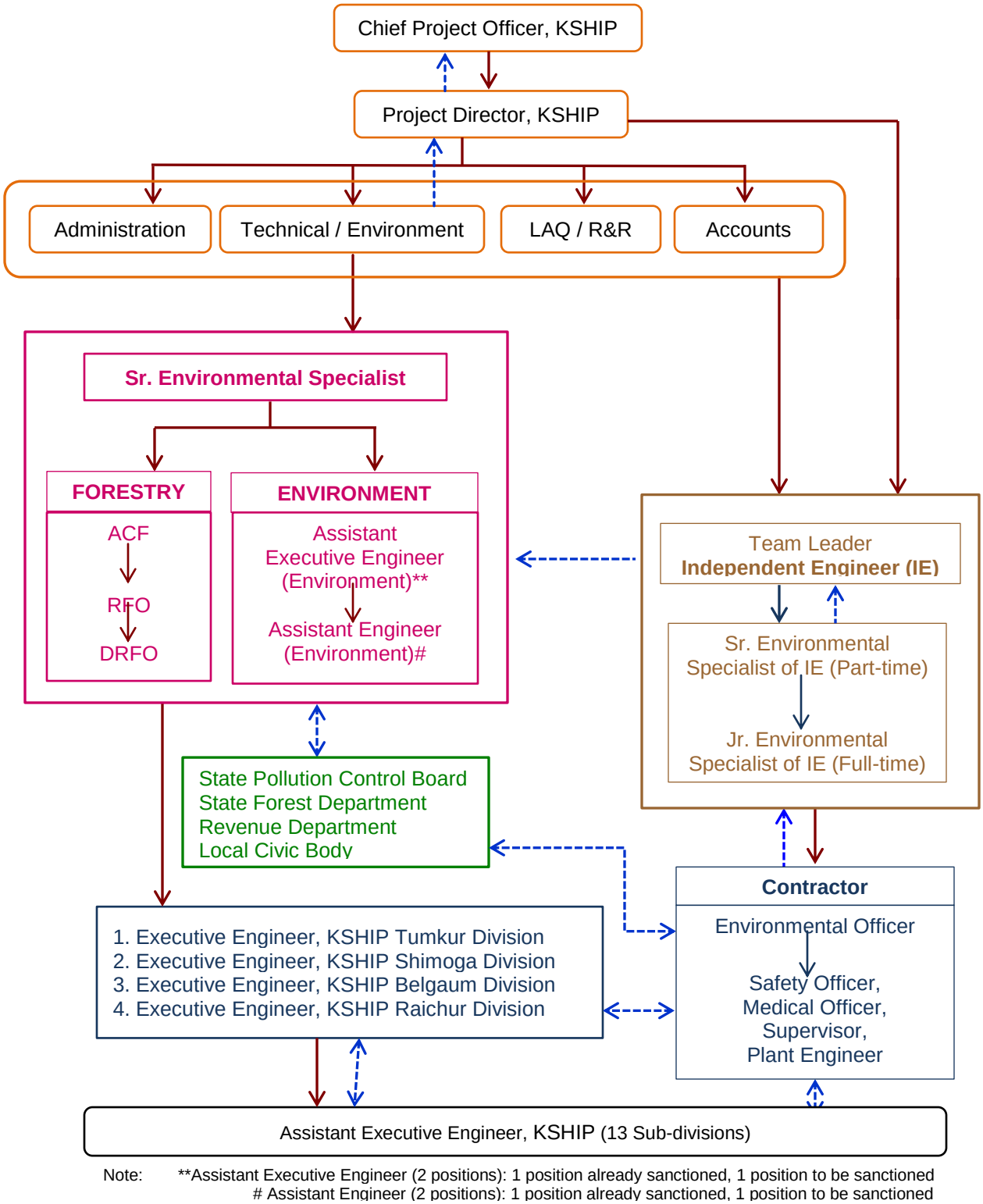


Figure 64 Implementation Arrangement

2. Implementation Arrangements

495. 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.

496. **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.

497. 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.

498. Qualification and Responsibilities of Senior Environmental Specialist of IE:

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

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

499. 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

500. Qualification and Responsibilities of Junior Environmental Specialist of IE (Sub Professional):

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

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

501. **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:

502. Qualification and Responsibilities of Environmental Officer (EO) of Contractor:

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

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

503. **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.

504. 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.

505. **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.

506. **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.

507. **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.

508. **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

509. 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.

510. 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

511. 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

512. 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.

513. Given below is a list of Training Institutes (**Table 146**) which can be contacted for providing training in various issues related to environmental management as identified in Training Component.

Table 146 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 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.	**B. 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: 0**11 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

514. 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

515. A capital cost provision of about **Rs. 11.4 Crore** has been kept towards implementation of environmental management plan. Summary of environmental budget is presented in **Table 147**.

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: 200 Total area required = (200 x 100) = 20,000 sq.ft	300	6,000,000
Soil	Construction	Slope stabilization	Covered under Engineering Cost			
Air	Construction	Dust suppression with sprinkling of water;	Trip	4 trips per day x 300 days in a year for 2.5 years = 3,000 trips	500	1,500,000
Water	Construction	Provision of water supply facilities for the construction camps	Month	30	30,000	900,000
Water	Construction	Provision of sewage and sanitation facilities for the construction camps, including maintenance for 2.5 years	Month	30	30,000	900,000
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

Component	Stage	Item	Unit	Quantity	Cost# (Rs.)	Total Cost (Rs.)
Water	Construction	Silt fencing near water bodies, low lying areas and areas identified by the IE	Meter	2,680	850	2,278,000
Water	Construction	Ground Water Recharge Pit / Rainwater Harvesting Structures	No.	23	3,50,000	8,050,000
Water	Construction	Enhancement of water body at 1 locations 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	72,97,000	7,297,000
Water	Construction	Phyco-Remediation of water body using NUALGI as per details provided in Annex-8.26	Liter	100	9,000	900,000
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	4,175	7,500	31,312,500
Vegetation loss	Construction	Provision of fuel in the construction camp	No.	12 commercial LPG Cylinder per month x 30 months = 360 cylinders	1,500	540,000
Solid Waste Management	Construction	Clearing garbage from construction camp and construction site	Month	30	10,000	300,000
Safety of Workers	Construction	Providing PPE to the labours during the construction	Cost/ person	200	1,200	240,000
Health Checkup	Construction	Provision for biannual health checkups	No.	200 persons x 4 checkups = 800	2,000	1,600,000
Resettlement & Rehabilitation	Construction	Compensation for structure including affected religious structures, livelihood loss, resettlement assistances & RP implementation	Covered under Engineering Cost			
					Total	**62,057,500**

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	No. of	Unit Cost/	Total

			Locations	Samples	Sample# (Rs.)	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)	9	90	2,000	180,000
	Operation	Once in every three years	7	21	2,000	42,000
Ground 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	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	6	36	7,000	252,000
Soil Quality	Construction	Once in a year	6	15	5,000	75,000
	Operation	once in every three years	4	12	5,000	60,000
Transportation of samples to the laboratory	Construction	Immediately after sampling	-	-	Lump sum	400,000
	Operation	Immediately after sampling	-	-	Lump sum	500,000
					Grand Total	**3,515,000**

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.)
Forest Land Diversion						
Net Present Value (NPV)	Pre-construction	Diversion of Reserved Forest Land	Ha	11.58	626,000	7,249,080
Compensatory Afforestation	Pre-construction	Mandatory Compensatory Afforestation for diversion of forest land	Ha	11.58	234,000	2,709,720
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.	19,000	1,911	36,309,000
Plantation along the Noise Barrier	Construction	Plantation of trees (one row) along the boundary wall, which will act as noise barrier at 4 m interval & its maintenance for 5 years. (250 trees / 1,000m)	No	1,044	1,911	1,995,084

Component	Stage	Item	Unit	Quantity	Cost# (Rs.)	Total Cost (Rs.)
		Length of noise barrier – 2,174 m				
					Total	**48,262,884**

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 147 Summary of Environmental Budget

Component	Description	To be implemented by	Amount (Rs.)
A.	Mitigation / Enhancement	Contractor	62,057,500
B.	Environmental Monitoring		3,515,000
		Subtotal	***65,572,500***
C.	Forestry	KSHIP	48,262,884
D.	Training & Mobilization		1,040,000
		Subtotal	***49,302,884***
		Grand Total	**114,875,384**

IX. CONCLUSION & RECOMMENDATIONS

A. Conclusion

516. The proposed project (**Magadi to Somwarpet**) includes strengthening and widening of existing State Highway (SH-85). One new bypass is proposed at K. R. Pet (9.220 km) and realignments are proposed at fourteen locations (total 18.432 km) for improving the road geometrics and meet the project objectives. The length of the project road is **165.47 km.** Project road traverses through plain and rolling terrain.

517. The existing road is to be widened to standard 2-lane with paved shoulder configuration based on the traffic projection. To address the safety issue in the built up sections en-route and as per applicable standards, 4-lane carriageway with paved shoulder has been proposed for a length of 11.7 km. The proposed improvements as far as possible are kept within the existing right of way to avoid / minimize land acquisition.

518. 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.

519. 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.

520. 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 and clearance from Archaeological Survey of India (ASI) will be required before start of construction.

B. Recommendations

521. 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.

522. 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.

523. **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.

524. **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.

525. 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 CO_2 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