

Initial Environmental Examination

January 2017

IND: Karnataka State Highways Improvement Project III

Bengaluru – Magadi – Kunigal

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

ABBREVIATIONS

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

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

MSL	:	Mean Sea Level
NAAQS	:	National Ambient Air Quality Standards
NABL	:	National Accreditation Board for Testing and Calibration Laboratories
NBWL	:	National Board for Wildlife
NE	:	Not Evaluated
NGO	:	Non-Government Organization
NO ₂	:	Nitrogen Dioxide
NOC	:	No Objection Certificate
NPV	:	Net Present Value
NQ	:	Noise Quality
NTU	:	Nephelometric Turbidity Unit
OBC	:	Other Backward Caste
ODR	:	Other District Road
PAF	:	Project Affected Families
PAH	:	Project Affected Households
PAP	:	Project Affected Persons
Pb	:	Lead
PBDPS	:	Performance Based Deferred Payment System
PCC	:	Plain Cement Concrete
PCM	:	Public Consultation Meeting
PCU	:	Passenger Car Unit
PD	:	Project Director
PHH	:	Physically Handicapped Persons
PIA	:	Project Influence Area
PIU	:	Project Implementation Unit
PM	:	Particulate Matter
PP	:	Project Proponent
PPE	:	Personal Protective Equipment
PPM	:	Parts Per Million
PPTA	:	Project Preparatory Technical Assistance
PRC	:	Public Response Centre
PT	:	Performance Target
PTV	:	Percent Time Violation
PUC	:	Pollution under Control
RAP	:	Reclaimed Asphalt Pavement
RCC	:	Roller Compacted Concrete
REA	:	Rapid Environmental Assessment
RHS	:	Right Hand Side
ROB	:	Road Over Bridge
RoW	:	Right of Way
RUB	:	Road Under Bridge
SAR	:	Sodium Absorption Ratio
SC	:	Schedule Caste
SD	:	Standard Deviation
SDO	:	Social Development Officer
SEAC	:	State Level Expert Appraisal Committee
SH	:	State Highway
SIA	:	Social Impact Assessment
SO	:	Safety Officer
SO ₂	:	Sulphur Dioxide

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

WEIGHTS AND MEASURES

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

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EXECUTIVE SUMMARY

A. Introduction

1. The Government of Karnataka through the Government of India has received in principle 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 part of SH 85 (Bengaluru to Jalsoor) and part of MDR (from Magadi to Kunigal). The proposed improvement starts in Bengaluru district from the junction of Loop of NICE Road near Bengaluru (Km 15+325) up to Km 51+680 (Existing), then along MDR from Km 0+000 and ends at junction with NH 75 near Kunigal via Chikkamudigere & Iyandahalli in Ramanagara district. The latitude & longitude of start and end points are 120 59’ 20.76”N & 770 28’.17.89”E and 130 02’ 6.918” N & 770 05’ 33.58” E respectively (**Figure E.1**). Length of the project road is **51.660 km**.

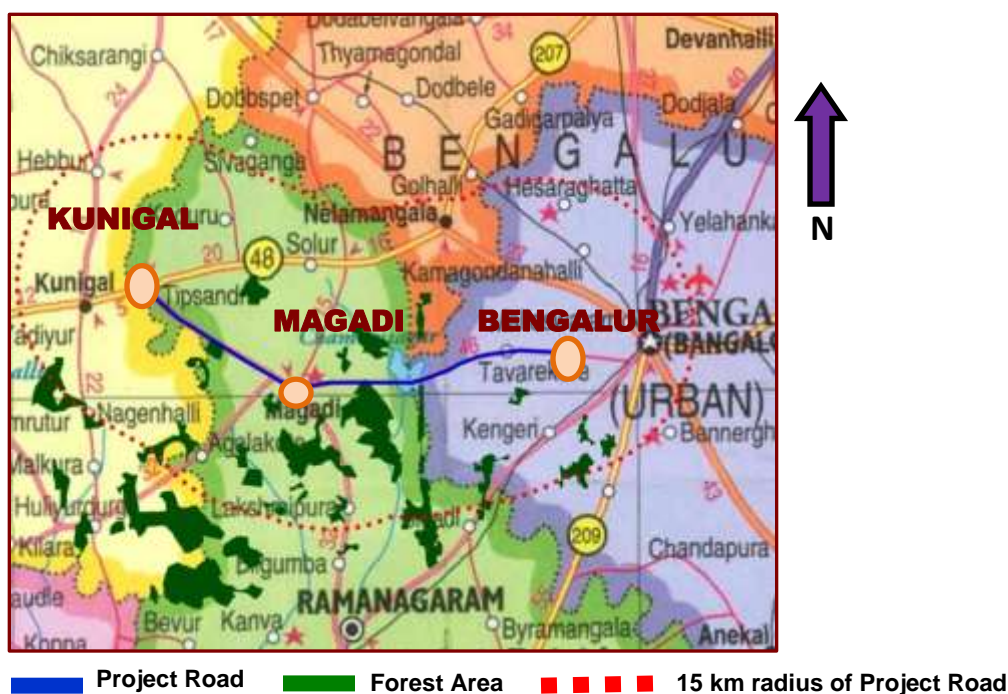


Figure E.1 Map Showing location of the Project Road

D. Project Highlights

Table E.1 Salient Existing Features of the Project Road

Road stretch	Bengaluru to Magadi (SH-85) and Magadi to Kunigal (MDR)
Road length	51.660 km
Start point	Junction of NICE Road near Bengaluru at Ch. Km 15+325 of SH-85
End point	Ends at junction with NH 75 near Kunigal via Chikkamudigere & Iyandahalli in Ramanagara district
Districts en-route	Bengaluru Urban & Ramanagara
Important settlements / villages	Seegahalli Town, Thavarekere Town, Deomacharly Village, Chollanayakanahalli Village, Shan Boganahali Village, Bhachenahatti Village, Chikkathurpalya, Magadi Town, Kunigal
Existing carriageway	The majority of the carriageway of the Project Highway has two-lane carriageway with width of 7.0 m except 2.22 km length of 4-lane divided and undivided carriageway. The existing bridges have carriageway width varying from 7.70 m to 11.25 m.
Terrain	Plain and rolling terrain
Land Use	Mainly agricultural followed by built-up area
Major Bridge	1
Minor Bridges	7
Culverts	78 culverts (63 Hume pipe culverts, 14 slab culverts and 1 box culvert)
RUB	Nil
Flyover	Nil
Road Intersections:	14 major junctions and 91 minor road/village roads connecting the project road

E. Identification of Homogeneous Sections

5. Based on the traffic surveys conducted by iDeCK during the pre-feasibility study the entire project road (SH-85 Bengaluru to Somwarpet) was divided into 5 homogenous sections. However, this package of SH-85 from Bengaluru to Magadi involves 2 homogeneous sections and Magadi to Kunigal involve 1 homogeneous section. Homogeneous section wise Annual Average Daily Traffic is presented in Table E.2.

Table E.2 Homogeneous Sections of Traffic on Project Highway

Section No.	Sections	Start Chainage (Km)	End Chainage (Km)	Distance (Km)	Traffic Volume AADT(PCU)
HS-I	Bengaluru to Tavarekere	15+200	24+000	8.8	20,078
HS-IIA	Tavarekere to Magadi	24+000	51+000	27	9,182
HS-IIB	Magadi to Kunigal	0+000	15+150	15.150	6,096

Source: Survey conducted by iDeCK & ICT

F. Traffic Forecast

6. The projected traffic for each of the homogeneous sections is presented in **Table-E.3**.

Table E.3 Projected Annual Average Daily Traffic on Various Homogenous Sections (Bengaluru - Magadi - Kunigal)

Homogenous Section I - Bengaluru to Tavarekere km 15+325 to km 24+000								
	2015	2020	2021	2025	2030	2035	2040	2050
Total PCUs	20,078	30,809	35,663	47,520	65,214	86,613	112,193	181,658
Total Vehicles	16,988	26,838	31,269	43,012	60,058	80,257	104,407	168,987
Homogenous Section II - Tavarekere to Magadi km 24+000 to km 51+000								
	2015	2020	2021	2025	2030	2035	2040	2050
Total PCUs	9,182	15,038	18,256	24,518	33,858	44,970	58,144	93,141
Total Vehicles	8,353	13,878	16,787	23,149	32,454	43,375	56,325	90,409
Homogenous Section III - Magadi-Kunigal Road (MDR) km 50+820 to km 66+014								
	2016	2020	2021	2025	2030	2035	2040	2050
Total PCUs	6,096	9,088	10,812	14,584	20,191	26,936	34,947	56,422
Total Vehicles	5,818	8,854	10,581	14,657	20,585	27,592	35,925	58,036

7. HS-I and HS-IIA would be required to be widened to four lanes with paved shoulder configuration at LoS 'B' from the year 2015 and 2020 onwards respectively. HS-I, which is on the outskirts of Bengaluru, would require to be widened to six lane configuration considering LoS 'C' as per IRC:SP:84-2014, from the year 2028.

8. Kunigal-Magadi section of the project road (Homogenous Section IIB) would require to be improved to two-lane with granular shoulder configuration from the year 2016. It would require to be improved to four-lane configuration from the year 2028.

G. Improvement Proposal

Table E.4 Summary of Improvement Proposal

Proposed RoW	<ul style="list-style-type: none"> ▪ In urban / built up area: 25 m ▪ In rural / open country area: varies from 38 m to 40 m depending on the height of embankment 																													
Widening Scheme	<p>4-lane divided carriageway with paved shoulder</p> <ul style="list-style-type: none"> ▪ Concentric Widening : 40.093 km ▪ Eccentric Widening : 1.213 km ▪ Curve Improvement : 2.457 km ▪ Realignment : 6.926 km 																													
Bypass	No bypass proposed																													
Realignment	<p>At two locations:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">Name of Village</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> </thead> <tbody> <tr> <td>Bychaguppe Junction</td> <td>24+700</td> <td>25+756</td> <td>24+700</td> <td>25+600</td> <td>0.900</td> </tr> <tr> <td>Tippagondanehalli</td> <td>33+837</td> <td>35+135</td> <td>33+383</td> <td>34+500</td> <td>1.117</td> </tr> <tr> <td>Basavapatna at Junction of MDR with SH-94</td> <td>-</td> <td>-</td> <td>55+450</td> <td>56+070</td> <td>0.620</td> </tr> </tbody> </table>	Name of Village	Existing Ch. Km		Design Chainage			Start	End	Start	End	Length	Bychaguppe Junction	24+700	25+756	24+700	25+600	0.900	Tippagondanehalli	33+837	35+135	33+383	34+500	1.117	Basavapatna at Junction of MDR with SH-94	-	-	55+450	56+070	0.620
Name of Village	Existing Ch. Km		Design Chainage																											
	Start	End	Start	End	Length																									
Bychaguppe Junction	24+700	25+756	24+700	25+600	0.900																									
Tippagondanehalli	33+837	35+135	33+383	34+500	1.117																									
Basavapatna at Junction of MDR with SH-94	-	-	55+450	56+070	0.620																									
Bridge	<ul style="list-style-type: none"> ▪ 1 major bridge proposed to be replaced due to realignment ▪ 1 minor bridge proposed to be rehabilitated and widened ▪ 5 minor bridges proposed to be replaced due to realignment and six laning (new bridge) ▪ 1 minor bridge proposed to be reconstructed (new bridge) ▪ 1 minor bridge proposed for additional 3 lane structure (new bridge) ▪ A flyover with 4-lane configuration with both side slip roads has been proposed for a length of 270.05 m at the main junction in Tavarekere 																													
RUB	Nil																													
Culverts	<ul style="list-style-type: none"> ▪ 12 new culverts proposed to be constructed ▪ 29 culverts proposed to be widened ▪ 46 culverts proposed for reconstruction ▪ In addition to the above, 115 hume pipe culverts has been proposed in junction area 																													
Road Side Drains	<ul style="list-style-type: none"> ▪ Roadside drains have been proposed with suitable outfalls. ▪ Length of lined drain along the project road is 44,778 m ▪ Length of unlined drain is 55,760 m 																													
Bus Bays	54 bus bays at 27 locations																													
Truck Lay Bys	Since the proposed improvement is within the urban area, truck lay bye has not been proposed																													
Toll Plaza	Considering traffic flow and Homogeneous section, one toll plaza has been proposed at Km 38+300. However as decided during consultation with the client, construction of toll plaza will not be taken up immediately & only provision of land for the toll plaza has been made.																													
Design Speed	Considering the projected traffic on the project road, the project road is proposed to be improved to 4-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. However, considering urban condition with heavy settlements along existing road, at 2 locations (250m) the design speed																													

	has been limited to 65 Kmph
Road Safety Devices	<ul style="list-style-type: none"> ▪ Road Markings ▪ Road Signs ▪ Roadside Safety Barriers ▪ Pavement Marking and Lighting
Project Cost	Civil Cost : Rs. 419.16 Crore EMP Cost : Rs. 4.44 Crore R&R Cost : Rs. 346.43 Crore
Project Completion period	24 months

H. Policy, Legal and Administrative Framework

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

10. Environment Clearance: The proposed project is the strengthening & widening of existing State Highway. Project road is passing through plain & rolling 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 Bengaluru to Magadi (SH-85) and Magadi to Kunigal (MDR) [Total Length : 50.689 Km] in the State of Karnataka.

11. A summary of various statutory clearances required for the project road is presented in Table E.5.

Table E.5 Statutory Clearances required for the Project Road

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

12. Apart from the clearances for the overall project work, the contractor, before starting the construction work, has to obtain required Clearances / NOCs listed in Table E.6 for operating his equipment and carrying out construction work.

Table E.6 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, Wet Mix Macadam (WMM) Plant, Stone Crushers and Batching Plant	<ul style="list-style-type: none"> ▪ Karnataka State Pollution Control Board 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Central Ground Water Authority ▪ State Ground Water Board 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Department of Mines & Geology, Government of Karnataka 	<ul style="list-style-type: none"> ▪ Environment (Protection) Act, 1986
5.	Permission for extraction of sand from river bed	<ul style="list-style-type: none"> ▪ District Level Environment Impact Assessment Authority (DEIAA) 	<ul style="list-style-type: none"> ▪ Environment (Protection) Act, 1986
6.	New Quarry and its operation	<ul style="list-style-type: none"> ▪ Department of Mines & Geology, Government of Karnataka ▪ Karnataka State Pollution Control Board 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ MoEF&CC / SEIAA / DEIAA ▪ Karnataka State Pollution Control Board ▪ District Collector 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Karnataka State Pollution Control Board 	<ul style="list-style-type: none"> ▪ Environment (Protection) Act, 1986; ▪ Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989
9.	Discharges from labour camp	<ul style="list-style-type: none"> ▪ Karnataka State Pollution Control Board 	<ul style="list-style-type: none"> ▪ Water (Prevention and Control of Pollution) Act, 1974
10.	Storage, handling and transport of hazardous materials	<ul style="list-style-type: none"> ▪ Karnataka State Pollution Control Board 	<ul style="list-style-type: none"> ▪ Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016 ▪ Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989
11.	Disposal of Bituminous Wastes	<ul style="list-style-type: none"> ▪ Intimate local civic body to use local solid waste disposal site 	<ul style="list-style-type: none"> ▪ Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016
12.	PUC Certificate for all construction vehicles and all machineries	<ul style="list-style-type: none"> ▪ Transport Department of Govt. of Karnataka 	<ul style="list-style-type: none"> ▪ 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)	<ul style="list-style-type: none"> ▪ Karnataka State Pollution Control Board 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Labour Commissioner (Ministry of Labour and Employment) 	<ul style="list-style-type: none"> ▪ The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 ▪ Contract Labour (Regulation and

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
			Abolition) Act 1970 along with Rules, 1971
16.	Engagement of Labour - Social Security - Labour Welfare - Wages	<ul style="list-style-type: none"> ▪ Labour Commissioner (Ministry of Labour and Employment) 	<ul style="list-style-type: none"> ▪ 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

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

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

I. Description of the Environment

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

1. Seismicity

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

2. Land Use

16. The land use pattern in most of the stretch along the project road is agricultural (67.9%) followed by residential cum commercial area (24.9%), and only residential (7.3%). Within ROW the land use is mainly open land with trees by the side of the earthen shoulder.

3. Soil Quality

17. One (1) sampling location within the study area was selected for studying soil characteristics. It has been observed that the texture of soil is sandy loam with 67% sand content and 11% clay content. The pH of the soils is found to be 7.51 indicating neutral soil which can hold moderate calcium and molybdenum salts but generally low in iron and boron nutrients. The organic matter was observed to be sufficient (1.8%). The sodium absorption ratio is moderate (1.3%), while the nitrogen content of the soil is sufficient. Therefore, it can be inferred that the overall fertility status of the soils within the study area is moderate.

4. Climate & Meteorology

18. The study area has a tropical climate with moderate summer, high rainfall and mild winter. The months between November to January are generally dry and cool. The month of April is the hottest with mean daily maximum temperature being above 33°C. Temperature drops with the onset of monsoon. Humidity is high (89%) during monsoon season. Visibility in winter months remains clear and mist rarely leads to foggy conditions.

19. Past meteorological data of nearest IMD Observatory at Bangalore, located at 13 km areal distance from the start point of the project road, is presented below for the period of 1951-1980 to establish the baseline climatic conditions of the area. The key parameters of collected meteorological data have been summarized in Table E.7

Table E.7 Summary of Climatological Data (Based on IMD Records of 1951-80)

Parameter	IST	Monthly Range	Annual Mean/Total
Mean Daily Maximum Temperature (°C)		25.9 (Dec) – 33.6 (April)	29.0
Mean Daily Minimum Temperature (°C)		15.1 (Jan) – 21.5 (May)	18.6
Relative Humidity (%)	0830	63 (Mar) - 89 (Aug)	79
	1730	26 (Mar) – 67 (Aug)	52
Total Rainfall (mm)		2.7 (Jan) – 194.6 (Sep)	970.0
Wind Speed (km/h)		7.1 (Oct) – 13.8 (Jul)	9.8
Cloud Cover (all cloud oktas)	0830	1.7 (Mar) – 7.4 (Jul)	4.9
	1730	2.7 (Mar) – 7.1 (Jul)	5.1

Source: Climatological Data of Bangalore (Station 43295), Indian Meteorological Department

5. Ambient Air Quality

20. For drawing up the baseline status of ambient air quality in the study corridor, ambient air quality monitoring has been conducted at 3 representative locations along the project road (Table E.8) at a frequency of twice a week at each station for one month. 24-hourly monitoring results of PM_{2.5}, PM₁₀, SO₂, NO₂ and 1-hourly CO corresponding to air quality stations AQ1 to AQ3 are presented in Table E.9.

21. 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.8 Details of Ambient Air Quality Monitoring Stations

SN	Station	Place	Existing Chainage	Side	Distance # (m)	Land use
1	AQ1	Seegahali	16+300	LHS	60	Residential
2	AQ2	Tavarekere	23+950	LHS	32	Residential
3	AQ3	Magadi	49+300	RHS	60	Residential

Source: On-site Field Monitoring during Dec 15 – Jan 16

Distance in meter from existing centerline

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

Pollutant	AAQMS	Location	Mes	Min	Max	SD	p98	PTV ^{IND}	PTV ^{WB}	Indian Standard
PM _{2.5} ($\mu\text{g}/\text{m}^3$)	AQ1	Seegahali	4	11.60	15.00	1.24	14.94	0	0	60
	AQ2	Tavarekere	4	11.60	13.60	0.82	13.58	0	0	
	AQ3	Magadi	8	15.00	22.00	2.42	21.86	0	0	
	Overall of 3 locations		16	11.60	22.00	3.16	21.70	0	0	
PM ₁₀ ($\mu\text{g}/\text{m}^3$)	AQ1	Seegahali	4	66.00	74.00	2.96	73.76	0	0	100
	AQ2	Tavarekere	4	58.00	68.00	4.12	67.88	0	0	
	AQ3	Magadi	8	64.00	73.00	2.80	72.86	0	0	
	Overall of 3 locations		16	58.00	74.00	4.17	73.70	0	0	
SO ₂ ($\mu\text{g}/\text{m}^3$)	AQ1	Seegahali	4	9.20	12.00	1.20	11.96	0	0	80
	AQ2	Tavarekere	4	10.90	15.40	1.60	15.27	0	0	
	AQ3	Magadi	8	5.30	8.60	1.09	8.59	0	0	
	Overall of 3 locations		16	5.30	15.40	2.90	14.74	0	0	
NO ₂ ($\mu\text{g}/\text{m}^3$)	AQ1	Seegahali	4	24.00	30.00	2.29	29.82	0	0	80
	AQ2	Tavarekere	4	20.00	26.00	2.24	25.88	0	0	
	AQ3	Magadi	8	14.00	26.00	3.74	25.72	0	0	
	Overall of 3 locations		16	14.00	30.00	4.09	29.10	0	0	
CO (mg/m^3)	AQ1	Seegahali	4	0.54	0.74	0.08	0.74	0	0	4
	AQ2	Tavarekere	4	0.27	0.50	0.08	0.50	0	0	
	AQ3	Magadi	8	0.63	0.75	0.04	0.74	0	0	
	Overall of 3 locations		16	0.27	0.75	0.14	0.75	0	0	

Source: On-site Field Monitoring during Dec 15 – Jan 15, 2016

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

22. To assess the background noise levels, ambient noise monitoring was conducted at 2 representative locations, 1 in residential areas and other at silence zone (Table E.10).

Table E.10 Details of Noise Monitoring Stations

SN	Station Code	Place	Chainage (Km)	Side	Distance# (m)	Area category
1	NQ1	Embassy Public School, Seegahali	16+250	LHS	30	Silence
2	NQ2	Magadi	49+400	RHS	25	Residential

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)

23. The daytime (L_{deq}) and night time (L_{neq}) noise equivalent levels in the monitored silence location, NQ1 Embassy Public School shows that the ambient noise levels exceed the stipulated Noise standards during both day and night time. The daytime (L_{deq}) noise equivalent level in the monitored residential location NQ2-Magadi shows that the ambient noise levels are within the stipulated Noise standards, while night time equivalent levels exceed slightly than the stipulated limits.

24. L_{90} values in day and night time are found to be 56.6 db(A) for NQ1 while the stipulated limit is 50 db(A). This signifies that noise levels exceed 56 db(A) in 90% of the measured time during the day. The reason for such high noise may be attributed to high vehicular traffic in front of the school. L_{10} values in day time at NQ2 are found to be below the standard while the same for night time slightly exceeds the stipulated limits.

7. Surface and Ground Water Quality

25. In Total, 2 surface water (Reservoir / pond) and 2 ground water quality monitoring stations (hand-pumps) in the study corridor were selected for 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	Thippagonganahalli Reservoir	32+500	RHS	170	Drinking water supply, Crop Irrigation
2	SW2	Honnapura Kere (Pond)	46+270	RHS	6.4	Crop Irrigation
Ground Water						
1	GW1	Seegahali	17+800	RHS	50	Drinking & Domestic
2	GW2	Magadi	49+700	RHS	45	Drinking & Domestic

Distance in meter from existing centerline

Source: On-site Water Quality Monitoring in December 2015

26. The water quality results show the surface waters in the study area are devoid of any extraneous chemical contamination. Toxic or organic constituents are not detected in samples. However, surface waters have high coliform count, high BOD levels and low dissolved oxygen, which indicate discharge of fecal matters and agricultural runoff in the water.

27. Ground water, in general, is hard in nature and the physico-chemical quality satisfies the permissible limit as stipulated in Drinking Water Standards (IS 10500:2012).

8. Ecology and Biodiversity

28. Road Side Trees: The number of roadside trees within existing row is estimated to be 1,967 out of which 879 trees are on the right side and 1,088 trees are on the left side of the project road.

29. Giant Trees: Field survey was conducted to identify the location of giant trees. 275 giant trees are found along the project road, out of which 158 trees are on the left side and 117 trees are on the right side.

30. Biodiversity Study: Biodiversity survey was conducted in the month of December, 2015 to study the flora and fauna of the project area. Before conducting the assessment work, reconnaissance survey of the entire road stretch was made and sampling was done in each vegetation type. In all, three sample plots of 100 m x 10 m were laid for biodiversity assessment. The sample plots were laid around an interval of 10 to 15 km such that the plots are located on either side of the road. GPS coordinates and altitude were recorded for each of the sample plots and presented in Table E.12.

Table E.12 GPS Coordinates and Altitude for the Sample Plots

Sample Plots	Latitude	Longitude	Altitude (m)	Vegetation Type
1	12° 50' 53"	77° 03' 20"	812	Fallow agriculture land
2	12° 57' 35"	77° 19' 14"	840	Fallow agriculture land
3	12° 58' 43"	77° 25' 57"	859	Fallow agriculture land

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

31. 69 floral species were identified, out of which, 23 were tree species, 24 shrubs and 22 herb species. In the present assessment, the Shannon's diversity index for tree species was 3.03, for shrubs 2.93 and for herbs 2.88 for the overall project road irrespective of sample plots.

32. 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 is higher 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	3.03	0.04
Shrub	2.93	0.06
Herb	2.88	0.06

Source: Biodiversity Study conducted by ICT

34. A total 48 faunal species were identified in the project area during field survey out of which 17 are avian species, 28 insects, 2 mammals and 1 reptile. Two Avian species *Haliastur indus* (Bramini Kite) and *Ictinaetus malayensis* (Black Eagle) belong to Schedule I category as per Wildlife Protection Act, 1972, are dwelling in the project area. However, both the schedule I species 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. **None of the species** found in the project area **fall under the threatened category as per IUCN red list**. All the evaluated species are in Least Concern Category.

Table-E-14 Shannon and Simpson Index

Shannon's Diversity Index (H)	Simpson's Index (D)
3.03	0.08

Source: Bio-diversity Study conducted by ICT

35. Protected Areas: The project road does not traverse through any National Park, Wildlife Sanctuary or Biosphere Reserve.

36. Forest: The project road does not pass through any Forest area.

9. Educational, Medical and Religious Properties

37. The number of roadside educational, medical and religious / cultural properties is summarized in Table E.14.

Table E.14 Roadside Educational, Medical and Religious Properties

Items	Total Number
Educational Institutions	38
Medical Amenities	6
Religious Places	72

Source: Field Study conducted by ICT in December 2015

10. Archaeological Sites

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

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, 1,083 households are likely to be affected due to the upgradation of the existing road.
- There are 4,723 APs being affected which includes both structures affected and due to loss of land, which includes 2,424 (51.32%) males and 2,299 (49.68%) females. The average household size is 4.2 and the sex ratio among APs is 948 females vs. 1,000 males.
- Majority of the project affected households (PAHs) belong to the Hindu religion (85.78%), 9.88% Muslims and 0.09% Christian.
- Out of 1,083 affected households, the social stratification of the project area shows that 143 households (13.20%) are from general category, 691 households (63.80%) are from other backward class (OBC), 60 households (5.54%) are from scheduled caste (SC), and 26 household (2.40%) are from scheduled tribe (ST) category
- 67 affected households (6.19%) earn income that is up to Rs. 30,000. Most households (525 equivalent to 48.48%) earn above Rs.1,00,000 annually, while 18.37% households did not respond
- 24.01% are illiterate, 9.42% are up to middle school, 11.17% are below matric, 20.87% affected persons are Matric (10th standard), 10.06% are up to graduate level
- 29.55% households are engaged in agriculture, 0.92% are agriculture labour, 4.89% are daily wage earner, and 32.69% households are doing business as their main occupation

J. Analysis of Alternatives

39. The project road passes through congested area of Tavarekere, the available land (building line) is about 20 to 24m and the horizontal geometry is good. However, the project

road after Tavarekere is having substandard horizontal and vertical geometry. Hence, to minimize rehabilitation and resettlement (R&R) impact and to provide safety, realignments have been proposed at two locations. However, no bypass has been proposed. The analysis of alternatives was carried out 'with the project' and 'without the project' scenarios in terms of potential environmental impacts.

K. Anticipated Impacts and Mitigation Measures

1. Environmental Impacts

40. A summary of the potential environmental impacts during construction and operation phase along with recommended mitigation measures is summarized in Table E.15.

Table E.15 Summary of Anticipated Impacts and Recommended Mitigation Measures

Area	Impacts	Mitigation Measures
Construction Phase		
Topography and geology	<ul style="list-style-type: none"> ▪ 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. 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Disruption & loss of productive top soil from agricultural fields due to borrow pits ▪ Loosening of top soil & loss of vegetative cover along the road due to excavation & back filling which will lead to enhanced soil erosion. 	<ul style="list-style-type: none"> ▪ Adequate measures like drainage, embankment consolidation & slope stabilization will be taken along the road to avoid soil erosion. ▪ Top soils (15 cm) of borrow pit sites will be conserved and restored after excavation is over. ▪ Accidental spills of lubricants/oil and molten asphalt will be avoided by adherence to good practices.
Land use	<ul style="list-style-type: none"> ▪ 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 23 m to 25 m and in rural area it varies from 38 m to 40 m depending on the height of embankment 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ 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 	<ul style="list-style-type: none"> ▪ 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

Area	Impacts	Mitigation Measures
	drainage courses during earth filling.	strictly avoided. <ul style="list-style-type: none"> ▪ Suitable drainage at construction site & camp will be provided to avoid water stagnation, soil erosion & mosquito breeding.
Water use	<ul style="list-style-type: none"> ▪ Impact on the local water sources due to use of construction water. 	<ul style="list-style-type: none"> ▪ Maximum rainwater harvesting and minimum use of existing water sources for construction will be ensured to minimize likely impacts on other users.
Water quality	<ul style="list-style-type: none"> ▪ 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. 	<ul style="list-style-type: none"> ▪ 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 10 locations near natural drainage channel / causeways and near stream crossing ▪ 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	<ul style="list-style-type: none"> ▪ 11 ponds are located within the Col 	<ul style="list-style-type: none"> ▪ All water bodies have been saved and there will be no impact on surface water bodies. ▪ Enhancement measures have been proposed for roadside water body [Honnapura Kere (Pond)] located at Thirumali village at Design Ch. km 45+500 on the right side of the project road
Air quality	<ul style="list-style-type: none"> ▪ 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. 	<ul style="list-style-type: none"> ▪ 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. ▪ Use of Recycled Asphalt Cold Mix Technology to reduce air pollution ▪ Air quality shall be monitored during construction and operation phases as per environmental monitoring program to understand the effectiveness of mitigation measures suggested
Noise level	<ul style="list-style-type: none"> ▪ Increase in noise level due to construction activities like 	<ul style="list-style-type: none"> ▪ Construction camp and temporary labour sheds will be located away from the

Area	Impacts	Mitigation Measures
	operation of construction equipment & vehicular traffic.	<p>immediate vicinity of the construction sites and major road traffic.</p> <ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Total 1,658 trees are required to be felled ▪ No threatened species of flora is falling in the ROW of the project road 	<ul style="list-style-type: none"> ▪ Approx. 6,626 trees shall be planted along the road ▪ 3,587 trees shall be planted in the community area, school etc. ▪ Plantation in oxbow land (100 trees) will be carried out as per standard tree plantation program approved by the Forest Department, GoK. ▪ Plantation shall be maintained for 5 years ▪ Total compensatory plantation will be 1:6 ▪ Cooking fuel (LPG/ Kerosene) will be provided to construction workers to avoid cutting / felling of trees for fuel wood. ▪ Soil erosion shall be checked by adopting bio-engineering measures ▪ The Concessionaire shall ensure that no open fire is done in construction camp as it may lead to fire to surrounding forest causing injury to wildlife ▪ Noise will be kept under control by regular maintenance of equipment and vehicles. No honking board shall be placed near Forest. Noisy activity shall be prohibited during night time
Forest	<ul style="list-style-type: none"> ▪ Project does not involve diversion of forest land 	<ul style="list-style-type: none"> ▪ No impact on Reserved Forest
Amenities, Religious and Cultural Properties	<ul style="list-style-type: none"> ▪ 1 educational institution will be fully affected and 9 will be partially affected i.e. only boundary wall will be affected ▪ 13 religious structures will be fully affected and 3 will be partially affected 	<ul style="list-style-type: none"> ▪ 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

Area	Impacts	Mitigation Measures
	<ul style="list-style-type: none"> ▪ 1 hospital will be fully affected and 1 primary health centre will be partially affected 	
Construction camp	<ul style="list-style-type: none"> ▪ 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. 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Health & safety related problems to construction workers due to inadequate health & safety measures. 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Increase on incidence of road accidents due to disruptions caused in existing traffic movements. 	<ul style="list-style-type: none"> ▪ Proper traffic diversion and management will be ensured during construction at the interactions and construction areas. ▪ Reduction of speed through construction zones.
Operation Phase		
Land use and Encroachment	<ul style="list-style-type: none"> • Change of land use by squatter/ encroachment within ROW and induced development outside the ROW. 	<ul style="list-style-type: none"> • Planning agencies and Collector/ Revenue Officer will be made involved for controlled development and prohibiting squatter/ encroachment within ROW.
Drainage	<ul style="list-style-type: none"> • Filthy environment due to improper maintenance of drainage. 	<ul style="list-style-type: none"> • Drainage system will be properly maintained.
Water quality	<ul style="list-style-type: none"> • Chances of contamination of water bodies from road surface run off containing oil spills due to traffic movement & accidents. 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Air pollution due to vehicular emission from road traffic. 	<ul style="list-style-type: none"> ▪ Truck parking lay-byes and bus bays will be provided at required locations to facilitate smooth traffic flow. ▪ Monitoring of air quality at specified

Area	Impacts	Mitigation Measures
		locations will be conducted at fixed interval
Noise level	<ul style="list-style-type: none"> ▪ Noise pollution due to Traffic noise. 	<ul style="list-style-type: none"> ▪ 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. Creepers may be planted in consultation with the local forest officials to give an aesthetic look ▪ 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	<ul style="list-style-type: none"> ▪ Illegal felling of road side plantation. ▪ Effect on aquatic fauna in case of accidental spill of oil, fuel & toxic chemicals into water bodies 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> • Impacts on human health due to accidents. • Damage of road due to wear & tear. 	<ul style="list-style-type: none"> ▪ 54 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

41. According to the Land Acquisition Plan (LAP), 71.86 Ha of land, which is going to be affected, 60.65 ha (84.39%) land is privately owned, while remaining 11.22 ha (15.61%) land belongs to Government / Waste land. A summary of the impacts based on the Census survey of likely to be impacted structures carried out from 3rd December to 23rd December 2015 and Census survey of Land owners, and Realignments conducted during 30th January to 16th February 2016 is provided in Table E.16.

Table E.16 Summary of Key Impacts

SN	Categories of Impact	Sub-Categories	Area (Ha.)	Total
A	Impact on Land			
	Private land to be acquired (in Ha.)	Irrigated	4.8	60.64
		Non- Irrigated	44.76	

SN	Categories of Impact	Sub-Categories	Area (Ha.)		Total
		NA	11.08		
	Government /Forest Land (in Ha.)	Government	11.22		11.22
		Forest	0		
	Total (ha.)				71.86
B	Impacts on Households / Families / Persons		No. of HH	No. of Families	No. of PAPs
	Title-Holders losing Land and Structure	Land	201	555	939
		Structure	560	1,175	2745
	Non-Title Holders	Squatters	135	247	418
		Encroachers	0	0	0
		Renters	181	310	605
		Employees	6	8	16
	Total Affected		1,083	2,295	4,723
C	Extent of Impact				
	Physically Displaced / Significantly Affected	Titled	51	143	236
		Non-Titled	83	152	259
	Moderately Affected	Titled Including Land	710	1,587	3,448
		Non-Titled	239	413	780
	Vulnerable Affected	Titled	603	1493	3175
		Non-Titled	258	476	849
	Total		1,944	4,264	8,747
D	Community Structure		19		19
	CPRs Affected		195		195
	Religious Structure Affected		16		16
	Total		230		230

42. 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 346.43 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.

L. Public Consultation

43. The following are the major points of concern of the participants of public consultation meeting (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 stakeholders are concerned with the existing air emission by the present traffic but their opinion in post project scenario is fragmented to a considerable extent.
- Majority of the stakeholders agreed that the road is accident prone and needs immediate improvement.
- Pedestrian crossing, proper road signage and speed control measures are the most sought after road safety measures by the stakeholders.
- Stakeholders considered dumping of waste and debris on the edge of the

carriageway as a safety threat and requested the project authorities to take measures against such offenders.

- Stakeholders considered burning of waste at the edge of the road is contributing to pollution from vehicular emission that worsens air quality.
- Accident involving wildlife and man-animal conflicts are reported to be absent, and incidents of crop damage by wild animals are reported by very few respondents.
- 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 participants. The stakeholders felt construction of boundary wall 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 other fruit bearing trees, especially Neem and Tamarind should be selected for avenue plantation.
- Participants at large requested for upgradation 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 upkeep.

44. 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 4 religious places. There were no variations in the response of the participants regarding installation of noise barrier. All the participants unanimously ruled out any requirement of boundary wall for mitigating traffic noise. They showed reservation against construction of boundary wall due to temple aesthetics and accessibility.

M. Environmental Management Plan

45. 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; and
- Set specific environmental objectives and targets relating to the key environmental aspects of KSHIP activities and measure and report progress in achieving these targets.

2. Environmental Budget

46. 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 KHSIP

47. A capital cost provision of about Rs. 4.44 Crore has been kept towards implementation of environmental management plan. Summary of environmental budget is presented in Table E.17.

Table E.17 Summary of Environmental Budget

Component	Description	To be implemented by	Amount (Rs.)
A.	Mitigation / Enhancement	Contractor	21,170,100
B.	Environmental Monitoring		2,476,000
Subtotal			23,646,100
C.	Forestry	KSHIP	19,691,163
D.	Training & Mobilization		1,040,000
Subtotal			20,731,163
Grand Total			44,377,263

N. Conclusion and Recommendations

48. **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.

49. **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 principle 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 pursuit 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-1C “Bengaluru to Magadi and Magadi to Kunigal” has been discussed.



Figure 1. Index Map showing Package wise Project Roads

B. Objectives of the Study

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

C. Approach and Methodology

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

- **Reconnaissance Survey:** A reconnaissance study has been made for identification of Valued Environment Components (VECs) on proposed project road. Location of environmentally protected areas (National Parks, Wildlife Sanctuaries, Biosphere Reserves, Reserved / Protected Forest, Important Bird Areas, World heritage Sites, Archeological Monuments etc.); surface water bodies; environmentally sensitive receptors (educational institutions, religious structures, medical facilities etc.) along the alignment has been identified during the survey. The Consultant conducted preliminary analysis of the nature, scale and magnitude of the impacts that the project is likely to cause on the environment, especially on the identified VECs.
- **Data Collection & Review:** Secondary data such as Survey of India Topo Sheets, District Planning Maps, Forest Working Plans, booklet of Central Ground Water Board, details of Archeological Monuments etc. have been collected from various secondary sources. Further, secondary data, which are relevant to understand the baseline as pertaining to physical and biological environments has been collected and reviewed. Applicable environmental legislation, regulations & guidelines of ADB and MOEF&CC has also been reviewed.
- **Environmental Screening & Scoping:** Screening has been conducted with specific consideration such as location of the sub-projects with respect to environmentally sensitive areas and critical issues to be studied in detail as well as provide important feedback to the design / technical team. It helped to modify the designs at locations where impacts had to be avoided and incorporate mitigation measures wherever the impacts were unavoidable due to other constraints. Based on the screening, scope of the study of the assignment i.e.

scoping has been done.

- **Baseline Environmental Monitoring:** To establish the baseline environmental status, monitoring was carried out for various environmental parameters such as meteorology, ambient air quality, ambient noise level, ground & surface water quality and soil quality along the proposed alignment
- **Stakeholder Consultation:** Consultations on environmental issues have been carried out with relevant stakeholders identified through stakeholder analysis.
- **Analysis of Alternatives:** The environmental analysis of alternatives mainly focuses on bypasses, if any, cross-sections, sources of materials from an environmental management perspective.
- **Prediction of Impacts & Mitigation Measures:** Based on the above study potential positive and negative impacts on land environment, air environment, noise environment, water environment and biological environment has been assessed for both construction and operation phase. For each impact predicted, feasible and cost effective mitigation measures has been suggested to reduce potentially significant adverse environmental impacts to acceptable levels.
- **Environment Management Plan:** EMP has been prepared as per the requirements of ADB safeguard policy statement. EMP includes management and redevelopment of borrow areas, quarries, construction camp; rain water harvesting, storm water management practices; enhancement plan for water bodies; requirement of noise barrier, capacity building & training; environmental supervision, monitoring & auditing requirements; bill of quantities etc.

D. Structure of the Report

7. This Initial Environmental Examination Report and Environment Management Plan (Volume-VIII) is a part of the Detailed Project Report of the Bengaluru to Magadi and Magadi to Kunigal Section of the 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: VIII (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: VIII (B)	Annex

II. DESCRIPTION OF THE PROJECT

A. Project Location

9. The Project road is a part of SH 85 (Bengaluru to Jalsoor) and part of MDR (from Magadi to Kunigal). The proposed improvement starts in Bengaluru district from the junction of Loop of NICE Road near Bengaluru (Km 15+325) up to Km 51+680 (Existing), then along MDR from Km 0+000 and ends at junction with NH 75 near Kunigal via Chikkamudigere & Iyandahalli in Ramanagara district. The Latitude & Longitude of start and end points are $12^{\circ} 59' 20.76''\text{N}$ & $77^{\circ} 28' 17.89''\text{E}$ and $13^{\circ} 02' 6.918''\text{N}$ & $77^{\circ} 05' 33.58''\text{E}$ respectively (Figure-2). Length of the project road is 51.660 km.

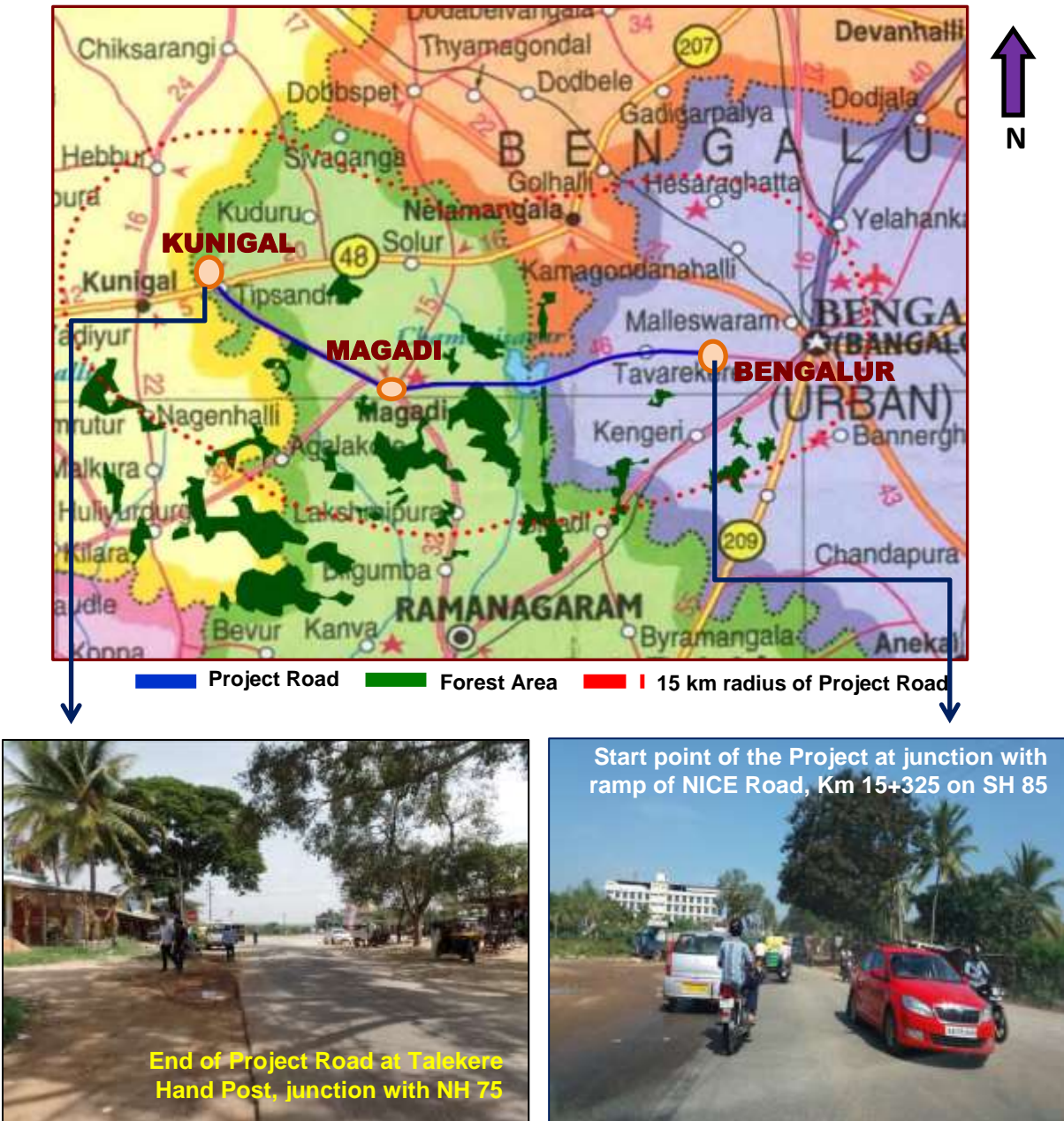


Figure 2 Map Showing location of the Project Road

B. Description of the Project Road

10. The project road is passing through Bengaluru Urban and Ramanagara districts. Project road has connectivity to a National Highway and State Highway. At the start point, the SH-85 over passes the NICE road, which connects Bengaluru & Mysore. At the end, the project road connects NH 75. The Project road also has junction with SH-3 and SH-94 leading towards Ramanagara.

11. The project road connects Seegehalli to the outskirts of Bengaluru to Ramanagara district, Southern part of Tumkur district and also Bengaluru Rural. Hence improvement of this section of SH 85 will improve the regional connectivity between Bengaluru, Mysore, Tumkur and Ramanagara districts. The existing road is a 2 Lane carriageway with earthen shoulder on either side except at three locations where it is 4-lane carriageway. The summary of lane configuration of the existing road is given Table-2.

Table 2 Summary of Lane Configuration of the Existing Road

Sl. No.	Ch. Km (From)	Ch. Km (To)	Length (km)	Lane	Name of Existing Road
1	15+325	23+500	8.175	2 lanes	SH-85
2	23+500	23+815	0.315	4-lane divided	
3	23+815	44+950	21.135	2 lanes	
4	44+950	45+075	0.125	4-lane undivided	
5	45+075	49+410	4.335	2 lanes	
6	49+410	51+190	1.78	4-lane undivided	
7	51+190	51+835*	0.645	2 lanes	
8	0+000*	15+150	15.150	2 lanes	MDR
Total Length (Km)			51.660		

* MDR takes off SH 85 from Ch. 51+680 towards Right hand side. The improvement of existing road of SH 85 from Km 51+680 to 51+835 is part of junction improvement.

12. Due to influence of built up section, the traffic flow pattern also varies after Tavarekere junction. Based on the field observations and traffic study, project road divided into two sections as described below:

13. Bengaluru (Km 15+325) - Tavarekere Junction (Km 23+875): The improvement proposal for SH-85 starts from the junction of the ramp of the interchange on NICE road. Then the existing alignment traverse westward passing through Seegahalli, which is a suburb of Bengaluru city and due to urbanization, series of cross roads connect the project road in this section. The existing road in this section is of 2-lane bituminous type except in Tavarekere. Within Tavarekere section, the existing road is having 4-lane divided carriageway with raised median for length of 315 m. The Janpura township road takes up from SH-85 near Kadabagere Cross at about Km 17+850. The Gas Authority of India Ltd. (GAIL) pipe line is crossing the project road at 18+630. After crossing Honniganihatti, en-route, the Nilamangala-Kengari Road connects the project road at Tavarekere Junction (Km 23+875). Although the section is having 4-lane divided carriageway, due to settlements on both sides and market area, the section is very congested. The horizontal alignment in this section is good. There is no nalla crossing in this road section.

14. Tavarekere Junction (Km 23+875) to Magadi (Km 51+815): The project road further moves westward and enters in Ramnagar District. The existing road in this section is of 2 lane bituminous type except in Magadi area. In this section the road is 4-lane undivided carriageway

for a length of 1.78 km. However, due to built-up and series of minor junctions, congestion has been observed in this section. After crossing Kunigal junction, the traffic volume also reduces. The Kunigal road (SH-94) connects near Magadi. In this section the project road traverses through both plain and rolling terrain. There are many substandard horizontal as well as vertical curves. About 44 horizontal curves are found substandard having radius less than 150 m. There are only six major roads and 43 minor road crossings. The project road crosses gas pipe line at 2 locations and water pipe line at 3 locations. The alignment crosses six minor nalla and one River (Akkravathi River near Km 34) where a major bridge exists.

15. Magadi Junction (Km 51+680) to Junction with NH 75 (Near Kunigal): This section of the project road is a part of existing MDR. The project road takes off from SH 85 at Km 51+680 towards North-West direction and meets SH 94 near Basavapatana and ends near Kunigal intersecting with NH 75. The existing road in this section is of 2 lane bituminous type basically in plain terrain. About 8 horizontal curves are found substandard. There are two major road and 31 minor road crossings. In this section there are 16 Hume pipe culverts, one Slab culvert, one RCC box culvert and one Minor Bridge

16. Carriageway: The majority of the Carriageway of the Project Highway has two-lane carriageway with width 7.0 m except 2.22 km length of 4-lane divided and undivided carriageway. The existing bridges have carriageway width varying from 7.70 m to 11.25 m. The type of the existing pavement is flexible.

17. Terrain: Project road predominately traverses through plain terrain however small section from Thavarekere towards Magadi passes through rolling terrain.

18. Road Intersections: There are 14 major roads including the one at start point (Loop of NICE road) and 91 minor road/village roads connecting the project road. All the junctions have been proposed for improvement.

19. Pavement Condition: The existing pavement is flexible and the composition of layer predominantly consists of bituminous layers laid over granular base/WMM and granular sub base/river material with boulders/moorum present at some locations. The bituminous surfacing varies in the range of 30 mm to 260 mm and the Granular Base/sub base layer varies from 50 to 410mm.

20. Existing Bridges & Culverts: There is one major bridge, 7 minor bridges and 78 culverts (63 Hume pipe culverts, 14 slab culverts and 1 box culvert) along the project road.

Table 3 Location of Major Bridges along the Project Road

Sl. No.	Existing Chainage (km)	Type of Structures			No. of Spans & Length (m)	Width (m)
		Foundation	Sub-structure	Super structure		
1	34+300	Open	RCC Wall Type Abutment and RCC Wall Type Piers	RCC Slab, Integral Structure	4 x 17.75	12

Table 4 Location of Minor Bridges and Vented Causeways along the Project Road

Sl. No.	Existing Chainage (km)	Type of Structures			No. of Spans & Length (m)	Width (m)
		Foundation	Sub-structure	Super structure		
1	29+200	Open	RCC Wall Type Abutment	RCC Solid Slab	1 x 8.25	12.00
2	31+100	Open	RCC Wall Type Abutment	RCC Solid Slab	1 x 10.35	12.05
3	41+000	Open	RCC Wall Type Abutment and RCC Wall Type Pier	RCC Solid Slab	2 x 8.65	11.85
4	42+100	Open	RCC Wall Type Abutment and RCC Wall Type Pier	RCC Girder and Solid Slab	2 x 16	8.30
5	43+900	Open	RCC Wall Type Abutment	RCC Solid Slab	1 x 6.7	12.00
6	44+700	Open	RCC Wall Type Abutment	RCC Solid Slab	1 x 6.85	11.90
7	6+372	Open	PCC Wall Type	RCC Solid Slab	1 x 7.7	11.0

C. Traffic Study

21. 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

22. 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.

23. 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. On NH-75, peak hour proportion is 6.5%.

2. Identification of Homogeneous Sections

24. Based on the traffic surveys conducted by iDeCK during the pre-feasibility study the entire project road (SH-85 Bengaluru to Somwarpet) was divided into 5 homogenous sections. However, this package of SH-85 from Bengaluru to Magadi involves 2 homogeneous sections and Magadi to Kunigal involve 1 homogeneous section (Table-5).

Table 5 Homogeneous Sections of Traffic on Project Highway

Section No.	Sections	Start Chainage (Km)	End Chainage (Km)	Distance (Km)	Traffic Volume AADT(PCU)
HS-I	Bengaluru to Tavarekere	15+200	24+000	8.8	20,078
HS-IIA	Tavarekere to Magadi	24+000	51+000	27	9,182
HS-IIB	Magadi to Kunigal	0+000	15+150	15.150	6,096

3. Annual Average Daily Traffic (AADT)

25. 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.

26. 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. As there is no petrol pump on Magadi Kunigal road the seasonality factor was taken same as that adopted for MCC locations near Magadi on SH85 considering that the variation of traffic movement on Magadi-Kunigal MDR throughout the year would also be similar. 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-6, which gives the mode-wise AADT for all the survey locations.

Table 6 Annual Average Daily Traffic at Various Surveyed Location

Location	Description	Survey conducted by	Total Traffic	
			Vehicles	PCUs
MCC-01	Km 20+500	ICT 2015	16,989	20,079
MCC-02	Km 31+500	ICT 2015	8,353	9,183
	Km 31+000	iDeCK 2015	6,483	7,643
MCC-08	Km. 7+200 (Magadi - Kunigal Road)	ICT 2016	5,818	6,096

4. Turning Movement Survey

27. The total Turning Movement surveys were carried out at 4 locations both by iDeCK and ICT. It is observed that, the total approach volumes during peak hour, is varies from 644 PCUs to 855 PCUs which is about 7 to 8% of the traffic.

5. Axle Load Survey

28. 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 0.50-6.88 while the VDF for 3-axle truck lies in the range 1.08 -7.80. The VDF for multi- axle vehicle has been calculated to be in the range 3.65-1.15.

Vehicle Type	Year							
	2015	2020	2021	2025	2030	2035	2040	2050
Animal Drawn	0	0	0	0	0	0	0	0
Non Tollable	11	11	11	11	11	11	11	11
Non Tollable PCUs	11	11	11	11	11	11	11	11
Total PCUs	9,182	15,038	18,256	24,518	33,858	44,970	58,144	93,141
Total Vehicles	8,353	13,878	16,787	23,149	32,454	43,375	56,325	90,409
Homogenous Section IIB - Magadi-Kunigal Road (MDR) km 50+820 to km 66+014								
Vehicle Type	2016	2020	2021	2025	2030	2035	2040	2050
Car	1671	2745	3432	4807	6923	9380	12185	19218
Total Jeep/ Van	77	183	281	367	493	627	778	1143
Mini Bus	27	42	53	65	81	101	125	192
Bus	135	209	268	343	445	561	698	1060
Tempo LGV - Freight (3,4 Axle)	392	584	691	898	1218	1644	2169	3621
Tempo LGV - Freight (6 Axle)	-	-	-	-	-	-	-	-
2 Axle Truck	259	350	389	492	655	869	1130	1881
3 Axle Truck	213	276	299	380	505	668	863	1436
MAV	34	42	46	58	75	98	128	214
Three Wheeler	273	382	436	583	819	1121	1500	2685
Two Wheeler	2681	3975	4618	6591	9288	12430	16246	26463
Tractor	21	24	25	28	33	38	43	53
Tractor With Trailer	21	25	26	29	34	39	44	54
Cycle	15	16	16	16	16	16	16	16
Cycle Ricks	0	0	0	0	0	0	0	0
Hand Cart	0	0	0	0	0	0	0	0
Animal Drawn	0	0	0	0	0	0	0	0
Non Tollable	0	0	0	0	0	0	0	0
Non Tollable PCUs	0	0	0	0	0	0	0	0
Total PCUs	6,096	9,088	10,812	14,584	20,191	26,936	34,947	56,422
Total Vehicles	5818	8854	10581	14657	20585	27592	35925	58036

30. 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

31. The summary of the above guideline for roadway improvements is shown in Table-8.

Table 8 Design Service Volumes at Different Level of Services

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

32. 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-9.

33. HS-I and HS-IIA would be required to be widened to four lane with paved shoulder configuration at LoS'B' from the year 2015 and 2020 onwards respectively. HS-I, which is on the outskirts of Bengaluru, would require to be widened to six lane configuration considering LoS 'C' as per IRC:SP:84-2014, from the year 2028. Kunigal-Magadi section of the project road (Homogenous Section IIB) would require to be improved to two-lane with granular shoulder configuration from the year 2016. It would require to be improved to four-lane configuration from the year 2028.

Table 9 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-I	15+200	24+000	Plain	-	-	2015	2028
2	HS-IIA	24+000	50+900	Plain		2015	2021	2041
3	HS-IIB	0+000	15+150	Plain	2016	2021	2028	-

34. Since Homogenous Section IIA would require four laning from the year 2021 at LOS'B' which is only two years after the year of opening, this section is also recommended to be widened to 4-lanes with paved shoulder configuration from the year of opening only.

D. Improvement Proposal

1. Corridor of Impact

35. 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. Therefore, the Corridor of Impact (COI) is the proposed construction width, which varies from 23 to 25 m in built-up areas and 38 to 40 m in rural / open country area.

2. Widening Scheme

36. The lane configurations recommended for the project road is as given in Table-10. 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-11.

Table 10 Recommended Lane Configuration

Sl. No.	Design Chainage (Km)		Design Length (km)	Lane configuration
	From	To		
1	15+325	51+700	36.375	4-lane divided carriageway with paved shoulder
2	51+700	65+700	14.000	2 lane carriageway with paved shoulder
3	65+700	66+014	0.314	4-lane divided carriageway with paved shoulder

Table 11 Summary of Widening

Widening length in Km		Curve Improvement (Km)	Realignment (Km)
Concentric	Eccentric		
40.093	1.213	2.457	6.926

37. Length of the existing road is 51.660 km. After the proposed improvement (realignment, curve improvement), length of the project road will be 50.689 km.

3. Typical Cross Sections

38. 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. As explained above, the entire stretch has been recommended to be improved to 4-lane standard. Considering the turning movement traffic and congestion affect due to presence of settlements along existing road on Tavarekere junction, one 4-lane flyover for a length of 279 m has been proposed. Except, the flyover, other stretches have been proposed to 4-lane standard depending on the terrain, widening scheme and land use. 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 25m to 40m, without compromising on safety and capacity augmentation requirement of the project road. These typical sections have been prepared separately for various alternatives like reconstruction, rehabilitation, Built-up areas, etc. as follows:

Table 12 Details of Typical Cross Sections

TCS-1	4-lane with Paved Shoulder Concentric Widening (Open Country)
TCS-2	4-lane with Paved Shoulder Realignment/New Construction (Open Country)
TCS-3	4-lane with Paved Shoulder Eccentric Widening in Hill Section (Open Country)
TCS-4	4-lane with Paved Shoulder Realignment/New Construction in Hill Section (Open Country)
TCS-5	4-lane with Paved Shoulder + Foot Path Concentric Widening (Urban Section)
TCS-6	4-lane with Paved Shoulder + Foot Path in Realignment/New Construction (Urban Section)
TCS-7	4-lane divided Flyover with Slip Road
TCS-8	4-lane Flyover approaches with Slip Road
TCS-9	Typical Cross Section for 2-Lane with Paved Shoulder (Open Country) – Concentric Widening (Embankment Height<3m)
TCS-9A	Typical Cross Section for 2-Lane with Paved Shoulder (Open Country) – Concentric Widening (Embankment Height>=3m)
TCS-10	Typical Cross Section for 2-Lane with Paved Shoulder (Open Country) – Realignment/New Construction (Embankment Height<3m)
TCS-11	Typical Cross Section for 2-Lane Paved Shoulder (Urban Section) – Concentric Widening Built-Up section

4. Bypasses and Realignments

39. The project road passes through congested area of Tavarekere, the available land (building line) is about 20 to 24 m and the horizontal geometry is good. At junction of project road with Nilnangala-Kangari road a flyover has been proposed. However, the project road after Tavarekere is having substandard horizontal and vertical geometry. Hence to minimize R&R (Rehabilitation and resettlement) impact and to provide safety realignments have been proposed. There are about 44 nos Horizontal curves having radius less than 150m with a design speed of less than the minimum 80 kmph stipulated in code, which have been proposed for curve improvement as per standards. The details of the proposed major realignment are as given in Table-13.

Table 13 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	Bychaguppe Junction	24+700	25+756	1.056	24+700	25+600	0.900
2	Tippagondanehalli	33+837	35+135	1.298	33+383	34+500	1.117
3	Basavapatna at Junction of MDR with SH-94	4+610	5+200	0.590	55+450	56+070	0.620

5. Improvement of the Existing Road Geometrics

40. 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 14 Location of Geometric Improvement

Sl. No.	Design Chainage		Type of Deficiency	Remarks
	From (Km)	To (Km)		
1	27+200	27+769	Deficient Geometry	Geometric Improvement
2	28+500	29+383	Deficient Geometry	Geometric Improvement
3	29+700	30+031	Deficient Geometry	Geometric Improvement
4	30+400	31+200	Deficient Geometry	Geometric Improvement
5	32+200	32+560	Deficient Geometry	Geometric Improvement
6	37+629	38+100	Deficient Geometry	Geometric Improvement
7	40+050	40+600	Deficient Geometry	Geometric Improvement
8	40+700	41+000	Deficient Geometry	Geometric Improvement
9	41+400	41+900	Deficient Geometry	Geometric Improvement
10	44+000	44+400	Deficient Geometry	Geometric Improvement
11	46+438	46+800	Deficient Geometry	Geometric Improvement
12	55+450	56+070	Deficient Geometry	Geometric Improvement
13	57+700	58+160	Deficient Geometry	Geometric Improvement

41. Horizontal Alignment: The alignment has been largely designed to a minimum design speed of 80 kmph except in some built-up and rolling terrain section. The project road has 136 numbers of horizontal curves in a length of 50.689 km.

42. Vertical Alignment: The vertical alignment of the project road has been designed conforming to the design standards for the design speed limit as per IRC-SP:84-2014. The project Road has 141 numbers of Vertical curves in a length of 50.689 km.

6. Pavement Design

43. 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

44. A comparative study of both the options is also made. For RAP Layer, maximum 30% recycled asphalt materials considered to be recovered from existing pavement. As per IRC: 37-2012, VG 40 bitumen is to be used for homogenous sections having traffic greater than 30 MSA and VG 30 bitumen is to be used for homogenous sections having traffic less than 30 MSA

45. **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

46. 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. 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 with CBR value not lesser than CBR of suitable nearest borrow area. The Summary of Rehabilitation (partial / full depth reconstruction and overlay) of the project road sections are presented in Table-15 and Table-16 below.

Table 15 Pavement Design for Rehabilitation (15 Years Design Life)

Homogeneous Sections	Pavement Condition	Existing Pavement Composition Avg. Thickness (mm)		Existing Subgrade CBR at 97 % MDD	Borrow Soil CBR of Subgrade (%)	Design Traffic (MSA)	Rehabilitation (Reconstruction/Overlay) (mm)								Recommended Rehabilitation Option
		Bituminous Layer	Granular Layer				Option 1				Option 2				
							BC	DBM	WMM	GSB	BC	DBM	RAP	CTSB	
HS-I	Fair	145	210	10.5-24.6	15	65	40	70	250	200	50	50	90	250	Option 1
HS-IIA	Fair	110	290	9.0-26.0	15	20	40	60	250	200	40	-	80	200	Option 2
HS-IIB	Fair	70	200	5.5 – 11.0	15	20	40	60	250	200	40	-	80	200	Option 2

47. For Option 1 Reconstruction starts from exiting subgrade top and for option 2 exiting bituminous layer is scarified and reconstruction start from CTSB, treating existing granular layer as Subgrade.

Table 16 Pavement Design for Rehabilitation (20 Years Design Life)

Homogeneous Sections	Pavement Condition	Existing Pavement Composition Avg. Thickness (mm)		Existing Subgrade CBR at 97 % MDD	Borrow Soil CBR of Subgrade (%)	Design Traffic (MSA)	Rehabilitation (Reconstruction/Overlay) (mm)								Recommended Rehabilitation on Option
		Bituminous Layer	Granular Layer				Option 1				Option 2				
							BC	DBM	WMM	GSB	BC	DBM	RAP	CTSB	
HS-I	Fair	145	210	10.5-24.6	15	100	50	80	250	200	50	50	110	250	Option 1
HS-IIA	Fair	110	290	9.0-26.0	15	30	40	65	250	200	40	-	100	200	Option 1
HS-IIB	Fair	70	200	5.5 – 11.0	15	25	40	65	250	200	40	-	90	200	Option 1

48. Final Pavement Schedule: Based on the study of pavement for the project road, following pavement composition for 15 years and 20 years for new construction as well as rehabilitation and overlay is presented in Table-17 and Table-18 below.

Table 17 Recommended Pavement Composition for 15 Years Design Life (New / Rehabilitation)

Homogeneous Section	From Km	To Km	Subgrade CBR (%)	Design Traffic (Msa)	Design Period	Pavement Composition (mm) (New/Rehabilitation)											
						New						Rehabilitation					
						BC	DBM	RAP	WMM	GSB	CTSB	BC	DBM	RAP	WMM	GSB	CTSB
HS-I	15.0	24.0	15	65	2019-33	40	70	-	250	200	-	40	70	-	250	200	-
HS-IIA	24.0	51.8	15	20	2019-33	40	-	80	-	-	200	40	-	80	-	-	200
HS-IIB	50.82	66.014	15	20	2020-34	40	-	80	-	-	200	40	-	80	-	-	200

Table 18 Recommended Pavement Composition for 20 Years Design Life (New / Rehabilitation)

Homogenous Section	From Km	To Km	Subgrade CBR (%)	Design Traffic (Msa)	Design Period	Pavement Composition (mm) (New/Rehabilitation)											
						New						Rehabilitation					
						BC	DBM	RAP	WMM	GSB	CTSB	BC	DBM	RAP	WMM	GSB	CTSB
HS-I	15.0	24.0	15	100	2019-38	50	80	-	250	200	-	50	80	-	250	200	-
HS-IIA	24.0	51.8	15	30	2019-38	40	65	-	250	200	-	40	65	-	250	200	-
HS-IIB	50.82	66.014	15	25	2020-39	40	65	-	250	200	-	40	65	-	250	200	-

7. Bridges

- 1 major bridge proposed to be replaced due to realignment
- 1 minor bridge proposed to be rehabilitated and widened
- 5 minor bridges proposed to be replaces due to realignment and six laning (new bridge)
- 1 minor bridge proposed to be reconstructed (new bridge)
- 1 minor bridge proposed for additional 3 lane structure (new bridge)
- A flyover with 4-lane configuration with both side slip roads has been proposed for a length of 270.05 m at the main junction in Tavarekere.

49. The details of proposed bridges / structures are presented in Table-19.

Table 19 Details of Proposed Bridges / Structures

Sl. No.	Design Chainage (Km)	Span Arrangement (m)	Total Length (m)	Deck width (m)	Remarks
Major Bridge					
1	33+775	5 x 19	95.40	2 x 16.00	Replaced due to realignment
Minor Bridge					
2	29+127	2 x 6.527	15.273	2 x 16.00	Replaced due to realignment and six laning
3	30+925	1 x 10.8	10.82	2 x 16.00	Replaced due to realignment and six laning
4	40+432	2 x 10.8	21.62	2 x 16.00	Replaced due to realignment and six laning
5	. 41+574	2 x 17.20	34.44	2 x 16.00	Replaced due to realignment and six laning
6	43+339	1 x 6.70	6.72	1 x 16.00	Additional 3 lane Widening of existing
7	43+352	1 x 6.70	6.72	1 x 16.00	4.0 m right side of right c/w
8	44+072	1 x 6.0 x 6.346	-	1 x 23.500	Replaced due to realignment and six laning
9	57+245	2 x 4.0 x 5.7	-	1 x 16.00	Reconstruction
Flyover					
8	23+875	9 x 30.00	270.05	1 x 19.00	New 4-lane flyover

8. Railway over Bridge / Railway under Bridge

50. There is no Railway crossing within the proposed improvement section (Bengaluru to Kunigal) of SH 85.

9. Culverts

51. Considering the adequacy and hydrological requirements, some additional culverts and replacement of some existing culverts have been proposed.

- 12 new culverts proposed to be constructed
- 29 culverts proposed to be widened
- 46 culverts proposed for reconstruction
- In addition to the above, 115 hume pipe culverts has been proposed in junction area.

Table 20 Summary of Proposed Culverts

Type	New Proposal	Reconstruction	Repair & Widened	Total
Hume Pipe	0	1	24	25
Slab	0	0	4	4
RCC Box	12	45	1	58
Total	12	46	29	87

10. At-Grade Intersection / Grade Separated Intersection

52. Apart from the junction with ramp of NICE road at start point, 10 major and 60 nos. minor junctions have been identified and improvement has been proposed. For smooth merging & diverging of cross road traffic, at-grade intersections have been proposed. As explained above, a flyover with 4-lane configuration with both side slip roads has been proposed for a length of 279m at the main junction in Tavarekere.

11. Service Road / Slip Road

53. Considering the turning movement on Tavarekere Junction, one grade separated Fly over has been proposed. For entry, exit of local traffic and to segregate from the through traffic, 7.0m width Slip road for a length of 1.3Km on both sides approaches of the proposed elevated section.

12. Road Side Drain

54. 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. 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 Inner-2.0(H):1(V), Outer-1.5(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 depth of flow up to the outfall point.

55. Length of lined drain along the project road is 44,778 m (22,389 m on either side) and the length of unlined drain is 55,760 m (27,880 m on either side).

13. Footpath

56. 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 21 Location of Drain cum Footpath along the Project Road

Sl. No.	Stretch (Km)		Side
	From	To	
1	15+325	24+900	Both sides
2	26+100	26+600	Both sides
3	29+900	30+250	Both sides
4	31+000	31+200	Both sides
5	35+850	36+200	Both sides
6	38+600	39+200	Both sides
7	41+200	41+400	Both sides
8	46+700	52+700	Both sides
9	54+100	55+100	Both sides
10	56+700	57+150	Both sides
11	58+900	59+600	Both sides
12	60+200	61+000	Both sides
13	61+550	62+200	Both sides
14	63+000	64+100	Both sides
15	64+900	65+200	Both sides
16	65+700	66+014	Both sides

57. Utilities: To facilitate utilities along the project road which may include electric lines and poles, fibre optics, waterlines etc. sufficient space on both sides of the project road will be provided for sections passing through open country. For project road passing through settlement locations provision of RCC pipes of suitable size along the length of the road below footpath have been proposed. The size of pipes to carry utilities will be based on settlement size and utilities likely to be carried. In addition to above utilities, Gas Authority of India (GAIL) gas pipe line is crossing at 3 locations and water pipe line is crossing at 3 locations.

14. Bus Bays

58. 54 Bus bays (27 Locations) on each project road along with stops are identified as probable locations to address the need of people living along the stretch. However, most of the bus bays have been proposed on existing bus stop.

15. Truck Lay Bys

59. Since the proposed improvement is within the urban area, truck lay bye has not been proposed.

16. Toll Plaza

60. Considering traffic flow and Homogeneous section, one toll plaza has been proposed at Km 38+300. 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

61. Considering the projected traffic on the project road, the project road is proposed to be improved to 4-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. However considering urban condition with heavy settlements along existing road, at 2 locations (250m) the design speed has been limited to 65 Kmph.

18. Additional Land Acquisition

62. According to the Land Acquisition Plan (LAP) 71.86 Ha of land will be acquired for the project. Out of total 71.87 Ha of land, which is going to be acquired, 60.65 Ha land is privately owned, while remaining 11.22 Ha land is Government / Waste land. The details of land acquisition requirement are summarized in the Table-22.

Table 22 Details of Land being acquired for the Project

Sl. No.	Land Details	Acquisition of Land Area (Ha.)	Percentage
1	Private Land	60.64	84.39
3	Govt. Land / Waste Land	11.22	15.61
Total		71.86	100

Source: Land acquisition Plan, ICT Pvt. Ltd 2015

E. Road Safety Devices

63. 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

64. 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

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

3. Roadside Safety Barriers

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

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

4. Boundary Stone, Km Stone and Hectometer Stone

67. 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

68. 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.

69. Street lighting shall be provided in urban stretches / built-up areas, Bus bays, Major Junctions and Rest Areas as per manual of Specifications and Standards. Solar lighting system shall be provided at each location as per manual of Specifications and Standards in terms of lux and length of lighting except at major junction areas where high mast lighting along with normal lighting shall be provided

F. Sources of Construction Materials

70. 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.

71. 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-23.

Table 23 Location of Proposed Borrow Areas

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Location / Village Name	Lead From Nearest Point on Project Road (km)	Type of Land	Present Land Use
1.	25+500	LHS	Kanakanagar	4	Govt.	Barren
2.	29+500	RHS	Tippagondanahalli	0.6	Govt.	Barren
3.	33+300	LHS	Tuppagondanahalli	0.1	Govt.	Barren
4.	39+500	LHS	Adakamaranahalli	0.2	Govt.	Barren

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Location / Village Name	Lead From Nearest Point on Project Road (km)	Type of Land	Present Land Use
5.	45+500	RHS	Tandya	1	Private	Barren
6.	47+700	LHS	Magadi	0.1	Govt.	Barren
7.	54+900	LHS	Vishwanathpura	0.1	Private	Barren
8.	57+350	RHS	Kempasagara	0.3	Govt.	Barren
9.	63+300	RHS	Alesabela	0.2	Govt.	Barren

72. **Stone/Coarse Aggregate Material.** Three 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 one quarry is far away from project road and has long leads. 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-24.

Table 24 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	32+400	LHS	Ganapati Stone Crusher, Mahadevapatna	3.0	Huge
2	44+200	RHS	TJM-AIKYA-JV, Panakanakallu	1.2	Huge
3	80+200	RHS	Balaji Stone Crusher, Tharikare	17.0	Huge

73. **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 two sources of manufactured sand were identified and representative samples were collected and tested from these sources. Details of these locations are presented in Table-25.

Table 25 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

74. 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.

75. 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.

76. 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.

77. Steel: High strength deformed bars manufactured by various steel manufacturing companies conforming to IS 1786 are available with local stockists in and around Bengaluru and Magadi. Before incorporation into the work, steel needs approval by the Engineer.

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

79. Waste plastic is available from K. K. Plastic Waste Management Pvt. Ltd,

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

G. Project Cost

80. The Project Cost for the project road from Bengaluru to Magadi and Magadi to Kunigal is given as follows:

Table 26 Project Cost

Road Section	Length (In Km)	Civil Cost (In INR Cr.)	Per Km Civil Cost (In INR Cr.)
Bengaluru to Magadi (4-lane section)	35.525	353.33	9.95
Magadi to Kunigal (2 lane section)	15.164	65.83	4.34
		419.16	

III. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Introduction

81. 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

82. 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

83. 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

84. 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.

85. 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

86. 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

87. **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;

88. **Conclusions:** The proposed project is the strengthening & widening of existing State Highway. Project road is passing through plain & rolling 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 Bengaluru to Magadi (SH-85) and Magadi to Kunigal (MDR) [Total Length : 50.689 Km] in the State of Karnataka.

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

89. 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.

90. 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 (Bengaluru to Magadi) and MDR (Magadi to Kunigal). It has also been verified from the Karnataka State Pollution Control Board

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

91. 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.

92. 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.

93. 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 (Bengaluru to Magadi) and MDR (Magadi to Kunigal). It has also been verified from the Karnataka State Pollution Control Board.

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

94. 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.

95. 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.

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

96. 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.

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

97. 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-

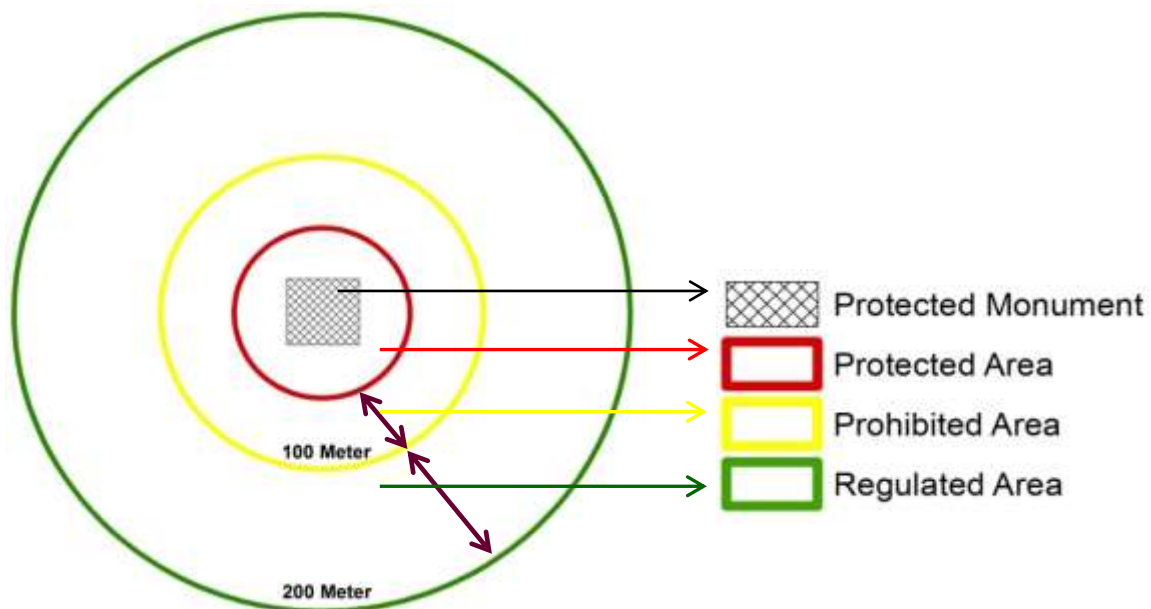
FC dated 4-12-1998 issued by the Asst. Inspector General of Forests states that the Ministry of Environment and Forest has taken a decision not to permit development activities inside National Park/Sanctuaries and Tiger reserves areas that are not in consonance of Section 29 of the Wildlife (Protection) Act, 1972.

7. The Karnataka Preservation of Trees Act, 1976

98. 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.

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

99. 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.



100. 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.

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

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

102. 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.

103. 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).

104. 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.

105. Bellary 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.

10. ADB Safeguard Policy Statement, 2009

106. 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

107. 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 Bengaluru to Magadi and Magadi to Kunigal Project corridor having length of 50.689 km has been classified as Category 'B' project requiring Initial Environmental Examination (IEE).

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

108. 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 27 Timeframe for Planning & Implementation

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

D. Applicable Indian Road Congress (IRC) Codes

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

Table 28 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

110. A summary of various statutory clearances required for the project road is presented in Table-29.

Table 29 Statutory Clearances required for the Project Road

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

111. 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-30 for operating his equipment and carrying out construction work.

Table 30 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	<ul style="list-style-type: none"> ▪ Karnataka State Pollution Control Board 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Central Ground Water Authority ▪ State Ground Water Board 	<ul style="list-style-type: none"> ▪ Environment (Protection) Act, 1986 ▪ Ground Water Rules, 2002
4.	Permission for extraction of sand from river bed	<ul style="list-style-type: none"> ▪ Department of Mines & Geology, Government of Karnataka 	<ul style="list-style-type: none"> ▪ Environment (Protection) Act, 1986
5.	Permission for extraction of sand from river bed	<ul style="list-style-type: none"> ▪ District Level Environment Impact Assessment Authority (DEIAA) 	<ul style="list-style-type: none"> ▪ Environment (Protection) Act, 1986
6.	New Quarry and its operation	<ul style="list-style-type: none"> ▪ Department of Mines & Geology, Government of Karnataka ▪ Karnataka State Pollution Control Board 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ MoEF&CC / SEIAA / DEIAA ▪ Karnataka State 	<ul style="list-style-type: none"> ▪ Environment (Protection) Act, 1986 ▪ Air (Prevention and Control of

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
		<ul style="list-style-type: none"> ▪ Pollution Control Board ▪ District Collector 	<ul style="list-style-type: none"> ▪ Pollution) Act, 1981 ▪ Minor Mineral and Concession Rules, 2015
8.	Location and layout of workers camp, & equipment and storage yards	<ul style="list-style-type: none"> ▪ Karnataka State Pollution Control Board 	<ul style="list-style-type: none"> ▪ Environment (Protection) Act, 1986; Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989
9.	Discharges from labour camp	<ul style="list-style-type: none"> ▪ Karnataka State Pollution Control Board 	<ul style="list-style-type: none"> ▪ Water (Prevention and Control of Pollution) Act, 1974
10.	Storage, handling and transport of hazardous materials	<ul style="list-style-type: none"> ▪ Karnataka State Pollution Control Board 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Intimate local civic body to use local solid waste disposal site 	<ul style="list-style-type: none"> ▪ Hazardous and Other Waste (Management and Trans-boundary Movement) Rules, 2016
12.	PUC Certificate for all construction vehicles and all machineries	<ul style="list-style-type: none"> ▪ Transport Department of Govt. of Karnataka 	<ul style="list-style-type: none"> ▪ 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)	<ul style="list-style-type: none"> ▪ Karnataka State Pollution Control Board 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Labour Commissioner (Ministry of Labour and Employment) 	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Labour Commissioner (Ministry of Labour and Employment) 	<ul style="list-style-type: none"> ▪ 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

112. 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

113. 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

114. 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

115. 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

116. 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

117. 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

118. 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

119. The existing environmental conditions of the study area covers 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.

B. Location – Districts En-Route

120. The project road, having a length of about 36.490 km, passes through the Bangalore Urban and Ramanagara districts of Karnataka. The length of the road in Bangalore Urban district is 20.175 km while in Ramanagara district, the length of the project road is 16.315 km. The location of the project road is shown on Index Map at Figure-3

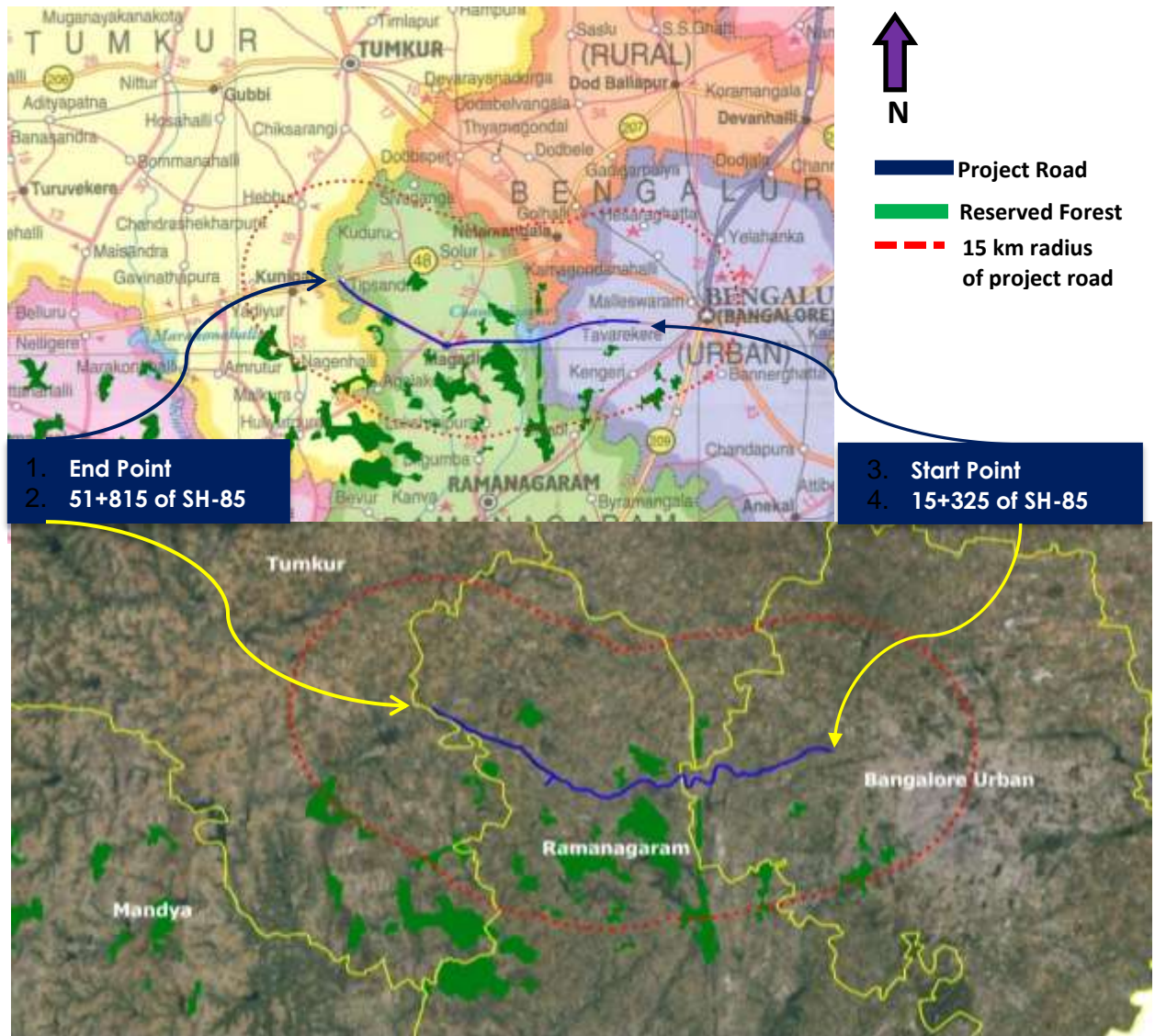


Figure 3 Map showing location of the Project Road

C. Geology, Topography and Soil

121. Physiographically, Bangalore Urban & Rural districts can be divided into rocky upland, plateau & flat topped hills at a general elevation of about 950 amsl. The major part is sloping towards south and south east forming pediplains interspersed with hills all along the western part. The pediplains form the majority of the districts underlain by granites and gneisses with the highest elevation of 850 to 950 m amsl. Rocky upland pediplain and plateau constitute erosional topography.

122. The topography of the study area is mostly plain but rolling in select stretches. Physiographically study area can be divided into rocky upland, plateau & flat topped hills at a general elevation of about 900amsl with its major part sloping towards south and south east forming pediplains interspersed with hills all along the western part. The pediplains form the major part of the area underlain by granites and gneisses. Major part of the pediplain constitute low relief area having matured dissected rolling topography with erosional land slope covered by a layer of red loamy soil of varied thickness. Major part of the pediplains is dissected by streamlets flowing in southern direction. Geological Map of the study area is provided in Figure-4.

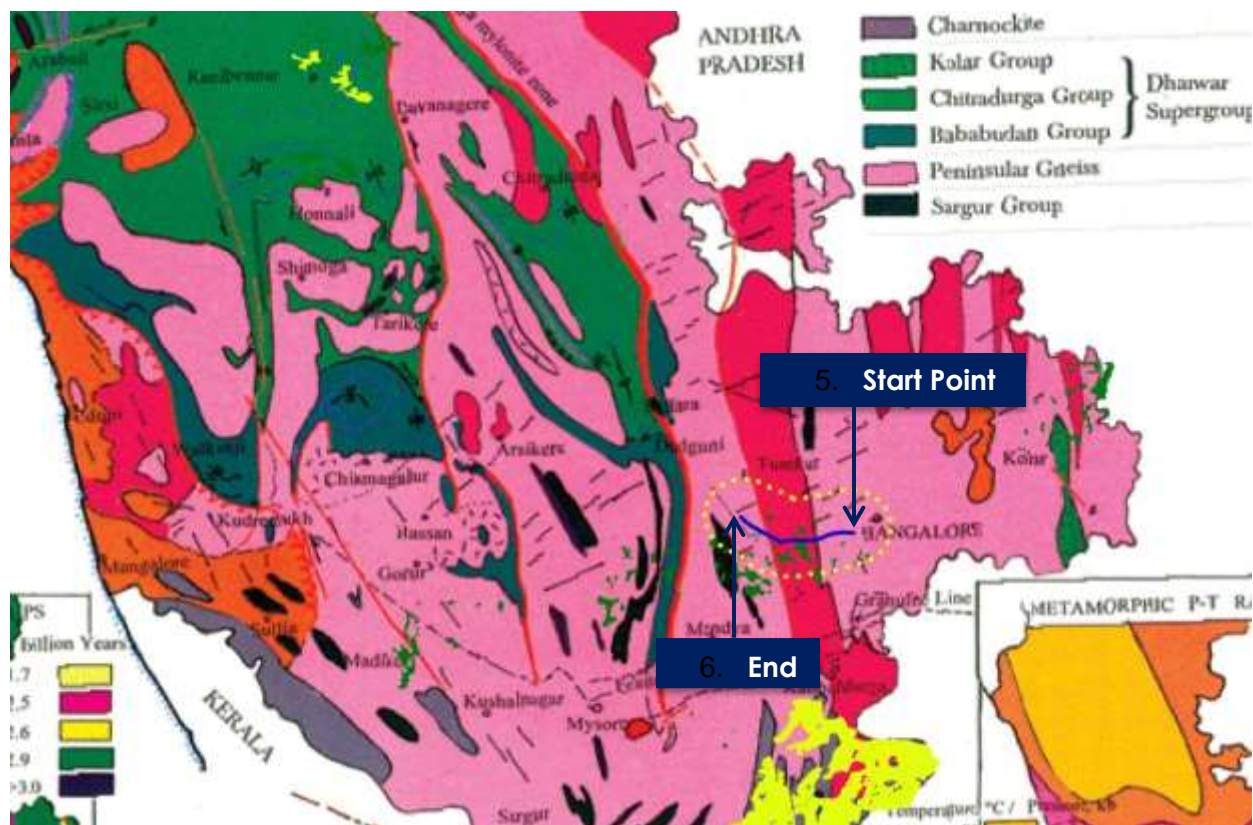


Figure 4 Geological Map of the Study Area

123. The general elevation of the study area varies from 750 to 920 m above mean sea level, while the general elevation of project corridor varies between 782-963 m. Slope of the area lies towards south to south east and most of rivulets are south flowing.

124. The soils of the project stretch are broadly classified into four categories viz (i). Loamy soil (ii) Lateritic soil (iii) Lateritic gravelly soil and (iv) Red sandy soil. Red loamy soils generally occur on undulating land slope on granite and granite gneisses. Lateritic soil occurs in undulating terrain forming plain to gently sloping topography of peninsular gneiss region. Lateritic gravelly soils occur in upland regions of lateritic soils, Red sandy soil occurs in undulating land slopes. Magadi taluka is mostly covered with red loamy soils derived from acidic rocks granites and granitic gneiss.



View of the Project Road near Ch km 32+000

D. Seismicity

125. The project area is located in 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

126. Drainage is controlled by topography. The drainage pattern of the area is a combination of parallel and dendritic. The study area is part of Cauvery river basin. River Arkavati and its numerous tributaries form an interconnected grid of drainage channels that finally connects Cauvery rivers. There is no perennial river in the study area

F. Agriculture and Irrigation Practices

127. 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 oil seed 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.



Agricultural Activity along Bangalore Magadi

G. Land Use

1. Method of Data Preparation

128. The land use/land cover has been presented in the form of a map prepared by using Survey of India Topographical sheet no. 57G/4, 57G/8, 57G/12, 57H/1, 57H/5 and 57H/9 (1:50,000 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 is provided in Annex 4.1 and Figure-6 below (Compressed Version). 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

129. 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 Segahalli, Thavarekere, Chohnayakana-halli, Thippagondanahalli and Magadi.

130. The land use pattern within 50 m on either side of the project road is agricultural (67.9%) followed by residential cum commercial area (24.9%), and only residential (7.3%). Within ROW the land use is mainly open land with trees by the side of the earthen shoulder



Settlement along the Project Road at Magadi

3. Land Use within the Study Area

131. The land use classification within approximately 15 km area of the project site is summarized in Table-31 and major land use types are graphically presented in Figure-5



Vegetation and Water body along the Project Road

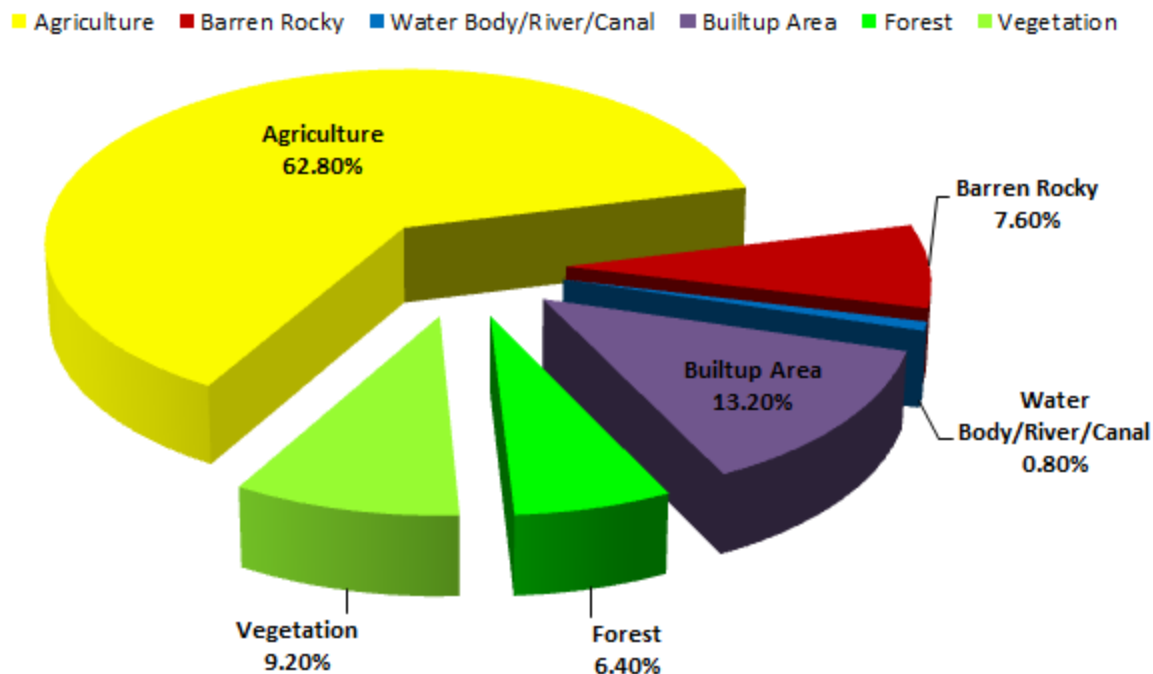


Figure 5 Land Use Classification of the Study Area

132. The project road starts from the outskirts of Bangalore City and passes through Magadi Town. Therefore, settlements and built up areas constitute 13.2% of land use within 15 km surroundings. Still, a whopping majority of 62.8% land is under agrarian use, followed by sparse vegetation (9.2%) and forests (6.4%).

Table 31 Area Statistics of Land Use/Land Cover Map

Land Use Classes	Sq. km	Percentage
Agriculture - Cropland	1,309.44	62.8
Barren - Rocky	159.26	7.6
Water Body, Rivers and Canal	17.02	0.8
Built up area	273.62	13.2
Forest	134.16	6.4
Sparse Vegetation	190.20	9.2
Total	1,655.86	100.0

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

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

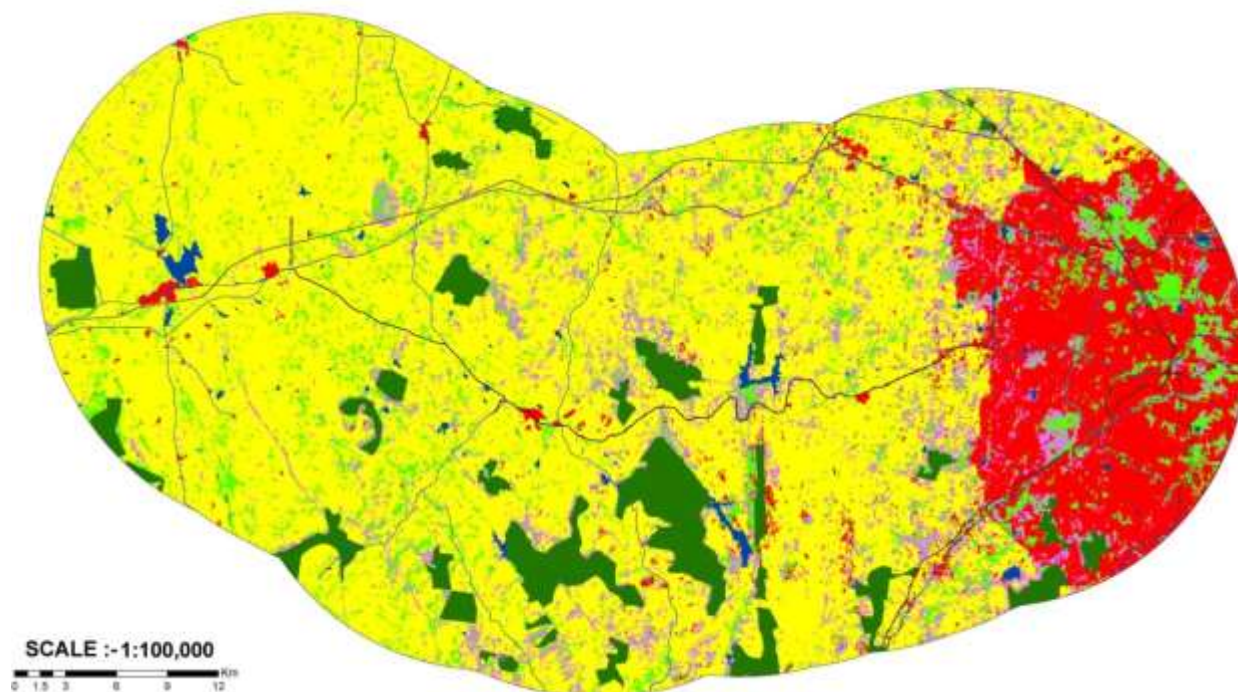


Figure 6 Land Use map of 15 km radius of the project area

H. Soil Quality

133. 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

134. The physico-chemical characteristics of soils within the study area were examined by obtaining soil samples from selected points and analyzing the same. One (1) sampling location within the study area was selected for studying soil characteristics. Details of the sampling stations are provided in Table-32

Table 32 Details of Soil Monitoring Stations

SN	Station Code	Place	Chainage (Km)	Side	Distance# (m)	Area category
1	SQ1	Magadi	45+450	LHS	25	Agricultural

Source: Field Survey in December 2015

Distance in meter from existing centerline

135. 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.



Photographs of Soil Sampling

2. Soil Characteristics of the Study Area

136. 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. The physico-chemical characteristics of the soils in the study area, as obtained from the analysis of the soil samples, are presented in Table-33 & Table-34. The results are compared with standard soil classification.

Table 33 Sand, Silt, Clay & Soil Porosity

Sl. No.	Station Code	Sand (%)	Silt (%)	Clay (%)	Porosity (%)	Soil Texture
1	SQ1	67	22	11	42.6	Sandy Loam

Source: Field Survey in December 2015

Table 34 Physico-Chemical Characteristics of Soil in the Study Area

SN	Parameters	Unit	Location Code: SQ1
1.	pH (Soil to Water Ratio1 : 5)	-	7.51
2.	Colour	-	Brown
3.	Bulk Density	gm/cm ³	1.52
4.	Conductivity (Soil to Water Ratio1: 5)	micro mhos/cm	248
5.	Moisture	%	14
6.	Potassium as K	mg/100gm	0.92
7.	Nitrogen as NO ₃ -N	mg/100gm	36
8.	Phosphorous as P	mg/100gm	85
9.	Chlorides		215
10.	Sodium	mg/100gm	14
11.	SAR	-	1.3
12.	Lead		6.5
13.	Sodium Sulphate	%	0.17
14.	Calcium Sulphate	%	0.005
15.	Organic Matter	%	1.8
16.	Iron as Fe	ppm	1.35
17.	Infiltration Rate	mm/hr.	1.08

Source: Field Survey in December 2015

137. It has been observed that the texture of soil is sandy loam with 67% sand content and only 11% clay content. The pH of the soils is found to be 7.51 indicating neutral soil which can hold moderate calcium and molybdenum salts but generally low in iron and boron nutrients. This kind of soil is moderately suitable for growing cereals such as wheat, oat and barley, while most of the other crops including corn and soybeans require slight pH correction towards the lower ranges. The studied pH range also indicates the suitability of the soils for optimum growth of blue green bacteria, which fixes atmospheric nitrogen and supports growth of other bacteria, Actinomycetes (range 6.5-9.5), which boost the fertility status of the soil.

138. The Electrical conductivity was low (248 $\mu\text{s}/\text{cm}$), indicating 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.

139. The organic matter was observed to be sufficient (1.8%). The sodium absorption ratio is moderate (1.3%), while the nitrogen content of the soil is sufficient. Therefore, it can be inferred that the overall fertility status of the soils within the study area is moderate.

I. Climate and Meteorology

1. Climatic Conditions of the Study Area

140. In the study area has a tropical climate with moderate summer, high rainfall and mild winter. The months between November to January are generally dry and cool. The month of April is the hottest with mean daily maximum temperature being above 33°C. Temperature drops with the onset of monsoon. Humidity is high (89%) during monsoon season. Visibility in winter months remains clear and mist rarely leads to foggy conditions.

141. Past meteorological data of nearest IMD Observatory at Bangalore, located at 13 km areal distance from the start point of the project road, is presented below for the period of 1951-1980 to establish the baseline climatic conditions of the area. The key parameters of collected meteorological data have been summarized in Table-35 below

Table 35 Summaries of Climatological Data (Based on IMD Records of 1951-80)

Parameter	IST	Monthly Range	Annual Mean/Total
Mean Daily Maximum Temperature (°C)		25.9 (Dec) – 33.6 (April)	29.0
Mean Daily Minimum Temperature (°C)		15.1 (Jan) – 21.5 (May)	18.6
Relative Humidity (%)	0830	63 (Mar) - 89 (Aug)	79
	1730	26 (Mar) – 67 (Aug)	52
Total Rainfall (mm)		2.7 (Jan) – 194.6 (Sep)	970.0
Wind Speed (km/h)		7.1 (Oct) – 13.8 (Jul)	9.8
Cloud Cover (all cloud oktas)	0830	1.7 (Mar) – 7.4 (Jul)	4.9
	1730	2.7 (Mar) – 7.1 (Jul)	5.1

Source: Climatological Data of Bangalore (Station 43295), Indian Meteorological Department

142. **Temperature:** A moist climate characterized by typical monsoon, tropical weather with moderately hot summers and mild winters is observed in the study area. High temperatures have been observed during the month of March to May when mean daily maximum temperature remains about 33°C and the mean daily minimum about 20.6°C. However, extreme temperatures have been recorded as high as 38°C in May occasionally.

143. With the onset of the monsoon in mid-June, there is appreciable drop in day temperature but that of night temperature is less. In October the temperature decreases. December is generally the coldest month with the mean daily maximum temperature at 26°C and the mean daily minimum at 15.6°C. Night during January are, however, slightly cooler than December. Lowest night temperatures in the cold seasons have been recorded to be dropped up to 8.5°C. The monthly ambient temperature profile in the study area is presented in Figure-7.

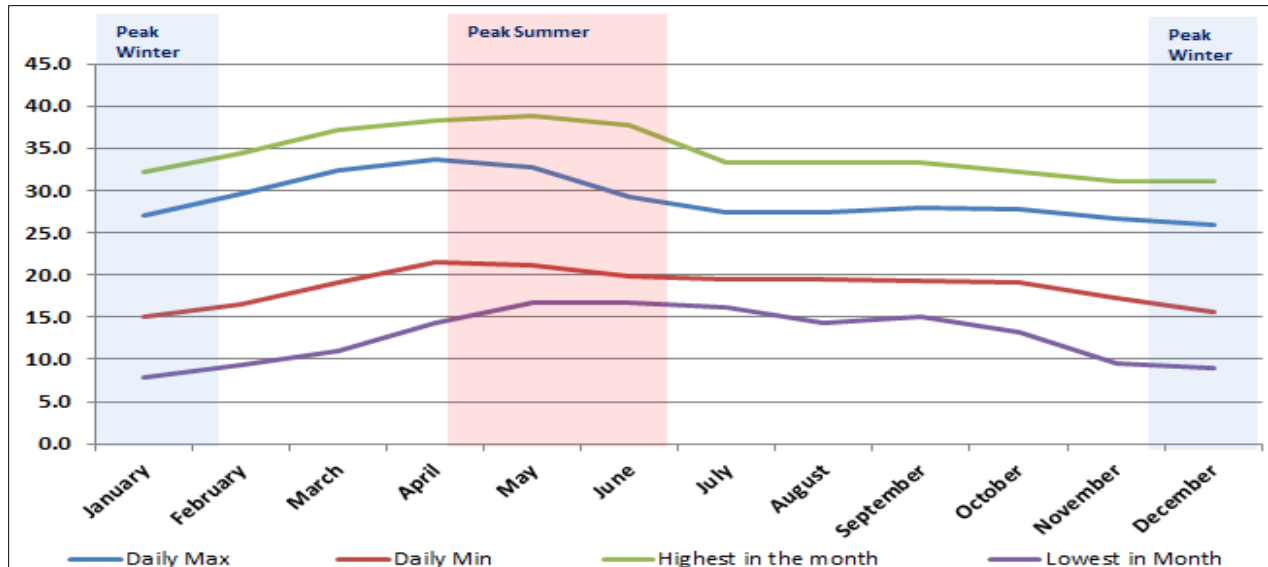


Figure 7 Monthly Ambient Temperature Profile

144. **Rainfall & Relative Humidity:** Normal annual rainfall is around 970 mm in the region. Historical data shows that moderate rains occur in the month of November due to NE monsoon. The southwest monsoon contributes around 54 percent of the annual rainfall. The Northeast Monsoon yields around 28 percent and the balance of around 18 percent results from the pre-monsoon and winter.

Table 36 Rainfall, Relative Humidity and Mean Wind Speed in the Study Area

Months	Monthly Rainfall	No of Rainy Days	Mean Wind Speed	RH 0830 Hours	RH 1730 Hours
January	2.7	0.2	9.5	78	40
February	7.2	0.5	9.2	68	31
March	4.4	0.4	8.5	63	26
April	46.3	3.0	7.5	71	34
May	119.6	7.0	9.4	77	48
June	80.8	6.4	13.6	84	61
July	110.2	8.3	13.8	88	67
August	137.0	10.0	12.3	89	67
September	194.8	9.3	9.5	87	64
October	180.4	9.0	7.1	84	66
November	64.5	4.0	7.7	79	61
December	22.1	1.7	9	80	53
Total	970.0	59.8	9.8	79	52

145. The average monthly rainfall, relative humidity and wind speed data and bar projections denoting incremental frequency and high/low values are provided in Table 4-6. September and October are the wettest months with over 180 mm monthly rainfall and 10 days rainy days on average. The post monsoon season often gets copious rains due to passing depressions. 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.

146. **Wind Speed:** 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.

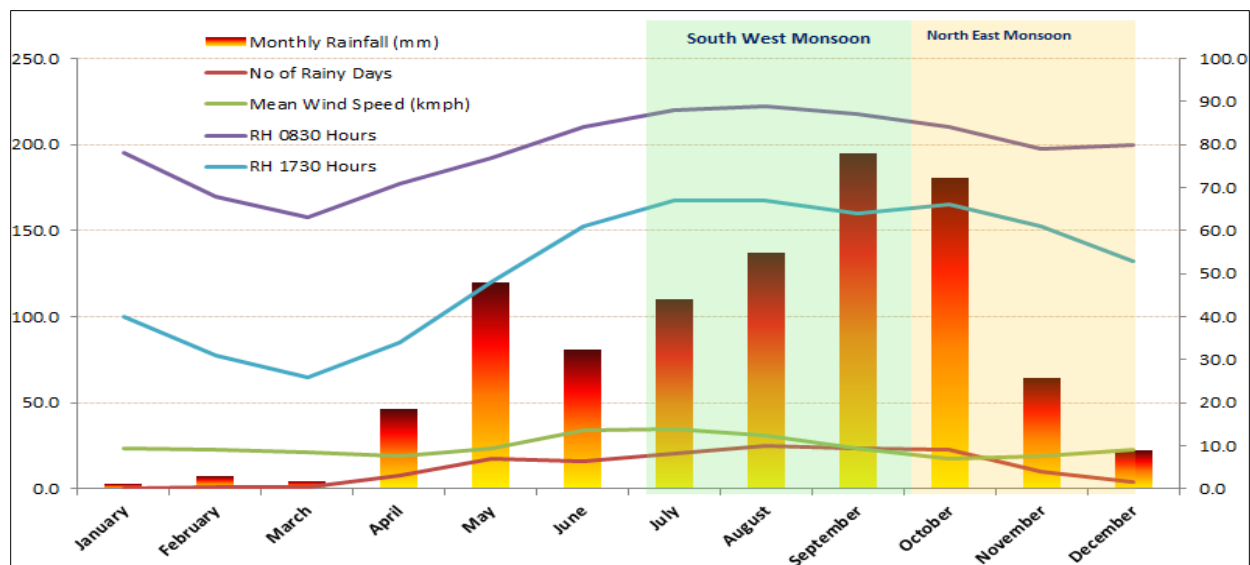


Figure 8 Monthly Rainfall, Rainy Days, Wind Speed and Relative Humidity

147. **Weather Extremes:** High summer temperature over 38°C occurs occasionally in the month of May and June. Highest temperature has been recorded to be 38.9°C in May 1931.

Table 37 Numbers of days with Extreme Weather Condition in the Study Area

Months	Weather Phenomena					Visibility#				
	Rain more than 0.3 mm	Hail	Thunder	Fog	Dust Storm	Up to 1 km	1-4 km	4-10 km	10-20 km	Over 20 km
January	0.5	0.0	0.0	2.5	0.0	0.7-0	2.2-0	8.5-0.3	12.4-4.2	7.2-26.5
February	0.9	0.0	0.3	0.7	0.0	0-0	1.2-0	8.3-0.2	12.1-4.1	6.4-23.7
March	0.8	0.0	1.1	0.2	0.0	0-0	2.8-0	8.8-0.7	8.9-6.3	10.5-24
April	5	0.0	6.7	0.1	0.0	0-0	0.4-0.2	8-1.2	10.3-7.3	11.3-21.3
May	10.3	0.1	10.6	0.0	0.0	0-0	0.4-0.1	5.7-1.8	13.5-9.9	11.4-19.2
June	11.7	0.2	4.0	0.0	0.0	0-0	0.4-0.1	6.4-1.1	15-11.4	8.2-17.4
July	16.8	0.0	2.3	0.1	0.0	0-0	0.7-0.4	7.5-2.1	18.5-14.3	4.3-14.2
August	16.4	0.0	2.4	0.2	0.0	0-0	1-0.2	7.6-2.5	18.9-13.5	3.5-14.8
September	13.6	0.0	5.9	0.3	0.0	0-0	0.8-0.3	7.2-1.4	16-11.3	6-17
October	12.7	0.0	5.9	1.2	0.0	0.1-0	1.5-0.1	6.9-1.9	15-11	7.5-18
November	7.2	0.0	1.0	1.1	0.0	0.1-0	1.6-0.2	7-1	15.4-11.1	5.9-17.7
December	3.3	0.0	0.1	1.7	0.0	0.1-0	1.7-0.1	7.8-0.4	16.4-9.5	5-21
Annual Mean	99.2	0.3	40.3	8.1	0.0	1-0	14.7-1.7	89.7-14.6	172.4-113.9	87.2-234.8

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

148. Moderately low temperatures had been recorded during winter months, the lowest being 7.8°C in January 1925. Dust Storms have not been reordered since last 65 years. However, thunders are frequent in May and September-October. Heaviest shower of 162.1 mm in 24 hours was received in the Aug 1890, while 522.3 mm rain was received in October 1956. On an average, the study area receives 0.3 mm or more rainfall in 100 days in a year. Winter is not associated with poor visibility. Table-37 shows the extreme weather data with bar projections denoting incremental frequency.

2. On-site Meteorological Monitoring

149. Bangalore-Somwarpet Road (SH-85) has been divided into two construction packages, namely (a) Package 1C-Bangalore - Magadi – Kunigal and (b) Package 2 Magadi to Somwarpet. As the on-site meteorological monitoring station was established in Nagamangala, which falls under Package 2, the results have been discussed in the IEE Report of Package 2 and have been omitted from this report.

J. Ambient Air Quality

1. Ambient Air Quality Monitoring Stations

150. M/s Mantec Environmental Laboratory (A NABL Accredited & MoEF Recognized laboratory) was engaged for ambient air quality monitoring. Three 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-38.

Table 38 Details of Ambient Air Quality Monitoring Stations

SN	Station	Place	Existing Chainage	Side	Distance # (m)	Land use
1	AQ1	Seegahali	16+300	LHS	60	Residential
2	AQ2	Tavarekere	23+950	LHS	32	Residential
3	AQ3	Magadi	49+300	RHS	60	Residential

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



Ambient Air Quality Monitoring at Site

2. Parameters Monitored & Monitoring Period

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

- Particulate matter of size less than 2.5 micron or PM_{2.5}
- Particulate matter of size less than 10 micron or PM₁₀
- Sulphur Dioxide (SO₂)
- Nitrogen Dioxide (NO₂)
- Carbon monoxide (CO)

152. Ambient air quality monitoring was conducted over one month period (Dec 15-Jan 16) at a frequency of twice a week at each station adopting a 24-hours schedule. CO has been measured 1-hourly. Ambient air quality monitoring methodology has been summarized in Table-39.

Table 39 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

153. 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} PM₁₀ SO₂ NO₂ and 1-hourly CO corresponding to air quality stations AQ1 and AQ3 are presented in Annex-4.4.

a. Particulate Matter of Size less than 2.5 micron or PM_{2.5}

Table 40 Summary of PM_{2.5} levels in Study Area

Station Code	Station Location	Area Category	PM _{2.5} (µg/m ³)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Seegahali	Residential & Rural	11.60-15.00	13.53	14.94	60
AQ2	Tavarekere		11.60-13.60	12.60	13.58	
AQ3	Magadi		15.00-22.00	18.13	21.86	
Overall of 3 locations			11.60-22.00	15.59	21.70	

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

154. Arithmetic mean of the 24-hourly average values of PM_{2.5} varied station-wise between 11.6-22.0 µg/m³ with overall mean of the 3 stations being 15.59 µg/m³. The 24-hourly average 98-percentile values of PM_{2.5} (max 21.86 µg/m³ at AQ3) at all the locations were observed to be within the limit of 60 µg/m³ for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009.

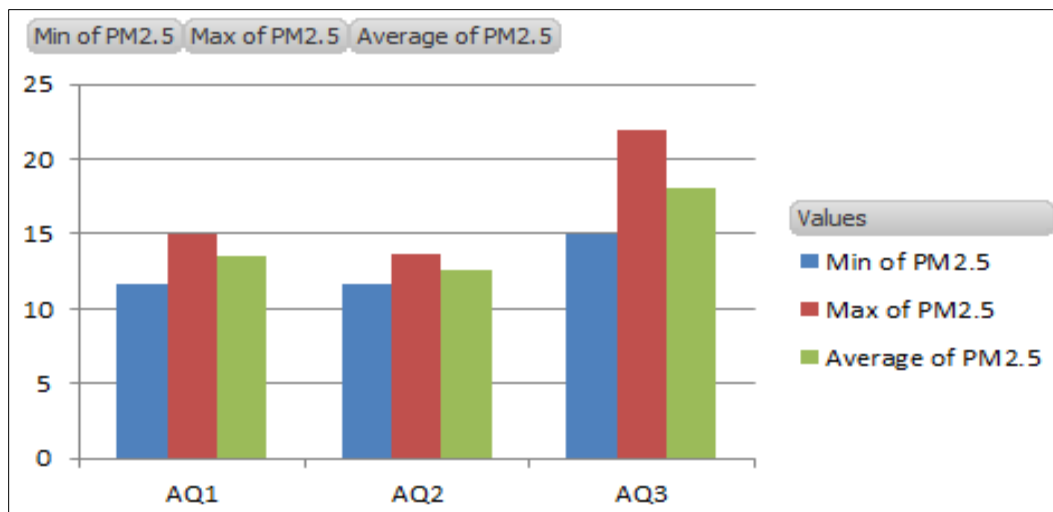


Figure 9 Variation in PM_{2.5} Levels

b. Particulate Matter of Size less than 10 micron or PM₁₀

Table 41 Summary of PM₁₀ levels in Study Area

Station Code	Station Location	Area Category	PM ₁₀ (µg/m ³)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Seegahali	Residential & Rural	66.00-74.00	69.50	73.76	100
AQ2	Tavarekere		58.00-68.00	63.00	67.88	
AQ3	Magadi		64.00-73.00	68.88	72.86	
Overall of 3 locations			58.00-74.00	67.56	73.70	

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

155. Arithmetic mean of the 24-hourly average values of PM₁₀ varied station-wise between 58-74 µg/m³. The overall mean for all stations was 67.56 µg/m³. The 24-hourly average 98-percentile values of PM₁₀ (max 73.76 µg/m³ at AQ1) at all the monitored locations were observed to be within the limit of 100 µg/m³ for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards.

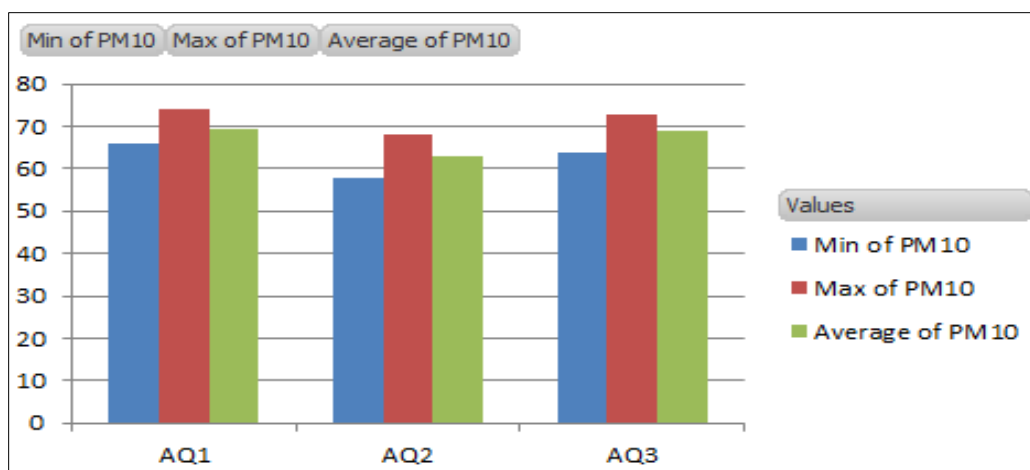


Figure 10 Variation in PM₁₀ Levels

c. Sulphur Dioxide (SO₂)

Table 42 Summary of SO₂ levels in Study Area

Station Code	Station Location	Area Category	SO ₂ (µg/m ³)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Seegahali	Residential & Rural	9.20-12.00	10.48	11.96	80
AQ2	Tavarekere		10.90-15.40	13.08	15.27	
AQ3	Magadi		5.30-8.60	6.90	8.59	
Overall of 3 locations			5.30-15.40	9.34	14.74	

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

156. Arithmetic mean of the 24-hourly average values of SO₂ varied station-wise between 5.3-15.40 µg/m³ with overall mean of the 3 stations being 9.34 µg/m³. The 24-hourly average 98-percentile values of SO₂ (max 15.27 µg/m³ at AQ2) at all the monitored were observed to be within the limit of 80 µg/m³ for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009.



Figure 11 Variation in SO₂ Levels

d. Nitrogen Dioxide (NO₂)

Table 43 Summary of NO₂ levels in Study Area

Station Code	Station Location	Area Category	NO ₂ (µg/m ³)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Seegahali	Residential & Rural	24.00-30.00	26.50	29.82	80
AQ2	Tavarekere		20.00-26.00	23.00	25.88	
AQ3	Magadi		14.00-26.00	20.00	25.72	
Overall of 3 locations			14.00-30.00	22.38	29.10	

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

157. Arithmetic mean of the 24-hourly average values of NO₂ varied station-wise between 14-30 µg/m³ with overall mean of the 3 stations being 22.38 µg/m³. The 24-hourly average 98-percentile values of NO₂ (max 29.82 µg/m³ at AQ1) at all the monitored were observed to be

within the limit of 80 $\mu\text{g}/\text{m}^3$ for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009.

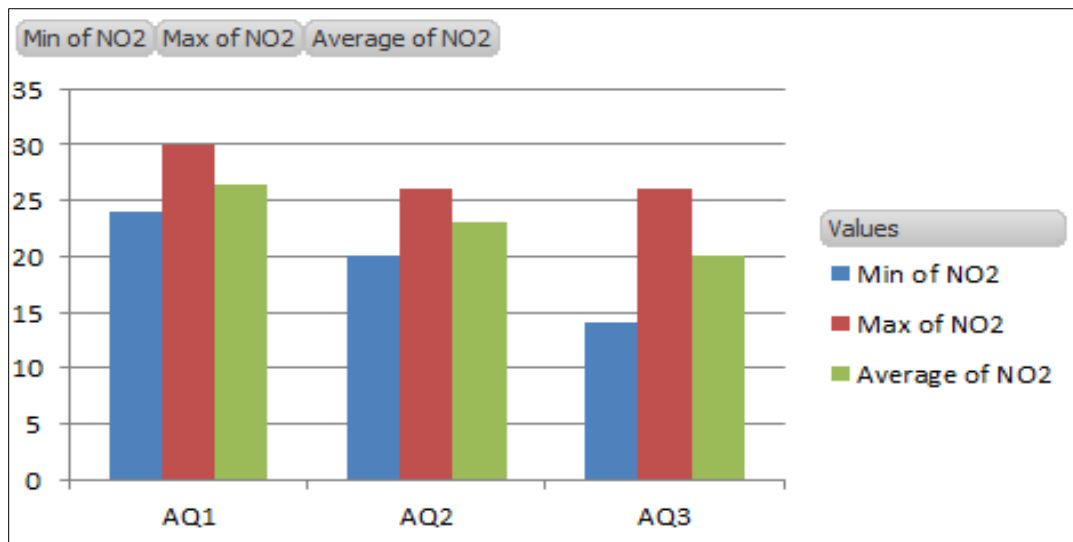


Figure 12 Variation in NO₂ Levels

e. Carbon monoxide (CO)

Table 44 Summary of CO levels in Study Area

Station Code	Station Location	Area Category	CO (mg/m ³)			
			Range	Mean	98%tile	Standard
AQ1	Seegahali	Residential & Rural	0.54-0.74	0.67	0.74	04
AQ2	Tavarekere		0.27-0.50	0.40	0.50	
AQ3	Magadi		0.63-0.75	0.68	0.74	
Overall of 3 locations			0.27-0.75	0.61	0.75	

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

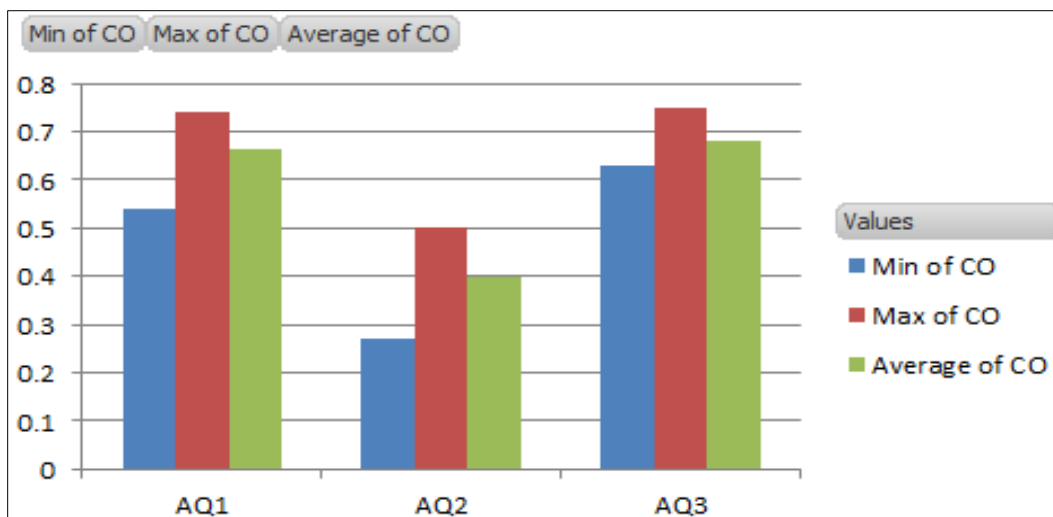


Figure 13 Variation in CO Levels

158. Arithmetic mean of the 24-hourly average values of CO varied station-wise between 0.24-0.75 mg/m³ with overall mean of the 3 stations being 0.61 mg/m³. The 24-hourly average 98-percentile values of CO (max 0.74 mg/m³ at both AQ1 & AQ3) at all the monitored locations were observed to be within the limit of 4 mg/m³ for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009.

Table 45 Statistical Analysis of Ambient Air Quality in the Study Area

Pollutant	AAQMS	Location	Mes	Min	Max	SD	p98	PTV _D ^N	PTV _B ^W
PM _{2.5} (µg/m ³)	AQ1	Seegahali	4	11.60	15.00	1.24	14.94	0	0
	AQ2	Tavarekere	4	11.60	13.60	0.82	13.58	0	0
	AQ3	Magadi	8	15.00	22.00	2.42	21.86	0	0
	Overall of 3 locations			16	11.60	22.00	3.16	21.70	0
PM ₁₀ (µg/m ³)	AQ1	Seegahali	4	66.00	74.00	2.96	73.76	0	0
	AQ2	Tavarekere	4	58.00	68.00	4.12	67.88	0	0
	AQ3	Magadi	8	64.00	73.00	2.80	72.86	0	0
	Overall of 3 locations			16	58.00	74.00	4.17	73.70	0
SO ₂ (µg/m ³)	AQ1	Seegahali	4	9.20	12.00	1.20	11.96	0	0
	AQ2	Tavarekere	4	10.90	15.40	1.60	15.27	0	0
	AQ3	Magadi	8	5.30	8.60	1.09	8.59	0	0
	Overall of 3 locations			16	5.30	15.40	2.90	14.74	0
NO ₂ (µg/m ³)	AQ1	Seegahali	4	24.00	30.00	2.29	29.82	0	0
	AQ2	Tavarekere	4	20.00	26.00	2.24	25.88	0	0
	AQ3	Magadi	8	14.00	26.00	3.74	25.72	0	0
	Overall of 3 locations			16	14.00	30.00	4.09	29.10	0
CO (mg/m ³)	AQ1	Seegahali	4	0.54	0.74	0.08	0.74	0	0
	AQ2	Tavarekere	4	0.27	0.50	0.08	0.50	0	0
	AQ3	Magadi	8	0.63	0.75	0.04	0.74	0	0
	Overall of 3 locations			16	0.27	0.75	0.14	0.75	0

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

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

159. As evident from Table-45 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

160. To assess the background noise levels in the study area ambient noise monitoring was conducted at two 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

161. 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-46.

Table 46 Details of Noise Monitoring Stations

SN	Station Code	Place	Chainage (Km)	Side	Distance# (m)	Area category
1	NQ1	Embassy Public School, Seegahali	16+250	LHS	30	Silence
2	NQ2	Magadi Town	49+400	RHS	25	Residential

Source: On-site Noise Monitoring during December 2015

Distance in meter from existing centerline

2. Methodology of Noise Monitoring

162. 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.

163. A-weighted equivalent continuous sound pressure level (L_{eq}) 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

164. The ambient noise levels of the study area are presented in Table-47. Ambient air quality standards in respect of noise are reproduced in Annex-3.1.

Table 47 Ambient Noise Levels of the Study Area

Station	Zone	L_{d10}	L_{d90}	L_{deq}	L_{n10}	L_{n90}	L_{neq}	L_{dn}	$L_{eq(24)}$	L_{Min}	L_{Max}
NQ1	Silence	66.9	56.6	66.7	66.5	42.9	45.6	55.1	67.8	42.9	66.9
NQ2	Resi	51.9	48.2	50.4	47.7	45.4	46.3	49.3	51.8	45.1	52.3

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)

165. The daytime (L_{deq}) and night time (L_{neq}) noise equivalent levels in the monitored silence location, NQ1 Embassy Public School shows that the ambient noise levels exceeds the stipulated Noise standards during both day and night time. The daytime (L_{deq}) noise equivalent

level in the monitored residential location NQ2-Magadi shows that the ambient noise levels are within the stipulated Noise standards, while night time equivalent levels exceeds slightly than the stipulated limits.

166. L_{90} values in day and night time are found to be 56.6 db(A) for NQ1 while the stipulated limit is 50 db(A). This signifies that noise levels exceeds 56 db(A) in 90% of the measured time during the day. The reason for such high noise may be attributed to high vehicular traffic in front of the school. L_{10} values in day time at NQ2 are found to be below the standard while the same for night time slightly exceeds the stipulated limits.

L. Surface Water Bodies , Rivers and Water Quality

167. There are 18 water bodies (pond, lake, reservoir, ditch) on either side of the project road; out of which, 11 are located on the right side and 7 are located on the left side of the project road. These water bodies get filled up during the rainy seasons and act as a natural rainwater store. List of water bodies located along the project road and their distances from the existing centerline are provided in Table-48.



Table 48 Lists of Water Bodies along the Project Road

SL	Particular	Existing Ch. km	Design Ch. Km	Distance# (m)	Side	Village	Use of Water	Length of the Water Bodies along the Road (m)
1.	Pond	23+800	23+800	50.4	RHS	Thavarekere	Livestock watering	*
2.	Tavarekere Lake	24+300	24+300	179.8	LHS	Thavarekere	Crop Irrigation, Domestic except drinking	*
3.	Pond	25+750	25+600	8.3	LHS	Devamachohalli	Crop Irrigation	148.0
4.	Pond	25+830	25+680	22.0	RHS	Devamachohalli	Crop Irrigation	84.0
5.	Thippagondanahalli Reservoir	32+500	32+000	170.0	RHS	Gangappanahalli	Drinking water supply, Crop Irrigation	*
6.	Pond	39+750	39+070	15.6	LHS	Bachenahatti	No use due to algal growth	22.0
7.	Road Side Ditch	39+960	39+300	6.7	RHS	Bachenahatti	Livestock watering	17.0
8.	Honnapura Kere (Pond)	46+270	45+500	6.4	RHS	Thirumali	Crop Irrigation	327.0
9.	Pond	46+400	45+640	35.3	LHS	Thirumali	Crop Irrigation	*
10.	Road Side Ditch	46+840	46+100	7.6	RHS	Thirumali	No use	40.0
11.	Pond	47+240	46+500	8.5	RHS	Thirumali	No use	72.0
12.	Hombalamma Lake	49+110	48+300	8.3	LHS	Magadi	No use	140.0
13.	Pond	51+000	50+200	156.7	RHS	Vaddarapaly	Crop Irrigation, Livestock watering	*
14.	Pond	-	53+400	15.5	RHS	Kaliya	Crop Irrigation	110
15.	Pond	-	53+500	185.0	LHS	Kaliya	Crop Irrigation	*
16.	Road Side Ditch	-	55+850	16.0	RHS	Kalarikaval	No use	10
17.	Pond	-	56+200	10.0	RHS	Kalarikaval	Livestock watering, Crop Irrigation	30
18.	Pond	-	64+460	16.0	LHS	Talekere	Crop Irrigation	45

Source: Field Survey conducted by ICT Pvt. Ltd.

Distance in meter from existing centerline;

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

1. Surface Water Quality Monitoring Stations

168. 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, 2 surface water quality monitoring stations (designated as SW1 & SW2) were selected. Details of the location of Surface Water Quality Stations are provided in Table-49.

Table 49 Details of Surface Water Quality Monitoring Stations

SN	Station Code	Place	Chainage (Km)	Side	Distance# (m)	Usage
1	SW1	Thippagonganahalli Reservoir	32+500	RHS	170	Drinking water supply, Crop Irrigation
2	SW2	Honnapura Kere (Pond)	46+270	RHS	6.4	Crop Irrigation

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

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

2. Surface Water Quality in the Study Area

170. The salient water quality parameters are statistically analyzed and presented Table-50 depicting minimum, maximum, arithmetic mean, standard deviation and percent time violations (PTV) with respect to Indian Surface Water Quality Standards i.e. the percentages of time the water quality parameters violate the permissible standards. Detailed Surface Water Quality Analysis results are provided in Table 4-51.

171. Temperature varied between 25.0-25.1°C. pH value of SW1 was found to be above neutral mark while that of SW2 is found to be alkaline but within the tolerance limit of 6.5-8.5. Conductivity varied between 286-734 μ mhos/cm with TDS ranging between 186-477 mg/l. While SW1 shows low values of conductivity and TDS indicating marginally mineralized water, SW2 shows moderate level of mineralization. However, both samples show the water is devoid of any industrial discharges.



172. Dissolved oxygen levels are found to be in the range of 5.6-5.8 mg/l, which is 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 2-16 mg/l while COD ranges are found be 44-58 mg/l. High values of BOD and COD signifies presence of decomposable and oxidizable organic matter in the water resulting lowering of dissolved oxygen levels.



173. Total hardness values were observed to vary in the range of 104-225 mg/l, well below the

prescribed limit of 300 mg/l for surface water. Oil & grease and nitrates remain undetected in all samples.

Table 50 Salient Surface Water Quality Features

SN	Parameter	Range	AM	SD	PTV
1.	pH	7.89-8.27	8.08	0.19	0
2.	DO (mg/l)	5.6-5.8	5.7	0.1	100
3.	BOD (3 days at 27°C) (mg/l)	14-18	16	2	100
4.	TDS (mg/l)	186-477	331.5	145.5	0
5.	Total hardness (mg/l as CaCO ₃)	104-225	164.5	60.5	0
6.	Nitrate nitrogen (mg/l as NO ₃)	0.31-1.6	0.955	0.645	0
7.	Iron (mg/l as Fe)	0.07-0.08	0.075	0.005	0
8.	Fluoride (mg/l as F)	0.24-0.28	0.26	0.02	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 51 Surface Water Quality Analysis Results

Sl. No.	Parameters	Units of Measurements	SW1	SW2	Tolerance Limits as per IS:2296 (Class-A)
1.	pH	-	7.89	8.27	6.5-8.5
2.	Temperature	°C	25	25.1	---
3.	Conductivity	µmhos/cm	286	734	---
4.	Colour	Hazen Units	<5	<5	10
5.	Turbidity	NTU	1.6	3.2	---
6.	Total Hardness as CaCO ₃	mg/l	104	225	300
7.	Total Dissolved Solids	mg/l	186	477	500
8.	Total Suspended Solids	mg/l	9	12	---
9.	Sodium as Na	mg/l	7	33	---
10.	Potassium as K	mg/l	1	4	---
11.	Calcium as CaCO ₃	mg/l	43	99	200
12.	Magnesium as CaCO ₃	mg/l	61	126	100
13.	Dissolved Oxygen	mg/l	5.8	5.6	6.0
14.	COD	mg/l	58	44	---
15.	BOD 3 days at 27°C	mg/l	18	14	2.0
16.	Chloride as Cl	mg/l	14	31	250
17.	Sulphate as SO ₄	mg/l	2.1	16.5	400
18.	TKN as N	mg/l	0.6	1.9	---
19.	Nitrate as NO ₃	mg/l	0.31	1.6	20
20.	Iron as Fe	mg/l	0.07	0.08	0.3
21.	Manganese as Mn	mg/l	<0.02	<0.02	0.5
22.	Cadmium as Cd	mg/l	<0.001	<0.001	0.01
23.	Total Arsenic as As	mg/l	<0.01	<0.01	0.05
24.	Total Chromium as Cr	mg/l	<0.05	<0.05	0.05
25.	Copper as Cu	mg/l	<0.01	<0.01	1.5
26.	Mercury as Hg	mg/l	<0.001	<0.001	0.001
27.	Lead as Pb	mg/l	<0.01	<0.01	0.1
28.	Zinc as Zn	mg/l	0.17	0.31	15
29.	Boron as B	mg/l	0.28	0.24	---
30.	Fluoride as F	mg/l	0.24	0.28	1.5
31.	Chlorine	mg/l	ND	ND	---

Sl. No.	Parameters	Units of Measurements	SW1	SW2	Tolerance Limits as per IS:2296 (Class-A)
32.	Phenolic Compound	mg/l	<0.001	<0.001	0.002
33.	Surfactants	mg/l	<0.05	<0.05	---
34.	Phosphate as PO ₄	mg/l	0.05	0.07	---
35.	SAR	mg/l	0.3	0.95	---
36.	Total Coliform	MPN/100ml	7245	3880	50
37.	Fecal Coliform	MPN/100ml	852	460	---

Source: On-site Water Quality Monitoring in December 2015
Tolerance Limit as per IS:2296 (Class-A)

174. Chloride and sulphate contents were 14-31 mg/l and 2.1-16.5 mg/l respectively. While-calcium content varied between 43-99 mg/l, magnesium ranged between 61-126 mg/l. Levels of iron was 0.07-0.08 while arsenic, chromium, cadmium, copper, manganese and mercury are found to be low detectable limit. Both samples are found to be high in total and fecal coliforms and therefore not suitable for human use in any manner.

175. The water quality results show the surface waters in the study area are devoid of any extraneous chemical contamination. Toxic or organic constituents are not detected in samples. However, with high coliform count, high BOD levels and low dissolved oxygen indicate 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 Watre Quality in the Study Area

176. 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

177. M/s Mantec Environmental Laboratory (A NABL Accredited & MoEF Recognized laboratory) was engaged for collection of ground water samples and analysis. 2 ground water quality monitoring stations (designated as GW1 and GW2) 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-52.

Table 52 Details of Ground Water Quality Monitoring Stations

SN	Station Code	Place	Chainage (Km)	Side	Distance# (m)	Usage
1	GW1	Seegahali	17+800	RHS	50	Drinking & domestic
2	GW2	Magadi	49+700	RHS	45	

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

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

2. Ground Water Quality in the Study Area

179. Salient features of ground water quality monitoring results are presented in Table-53. The ground water quality monitoring results are statistically analyzed in Table-54.

Table 53 Salient Ground Water Quality Features

SN	Parameter	Range	AM	SD	PTV
1.	pH	7.6-8.04	7.82	0.2	0
2.	TDS (mg/l)	766-1497	1131.5	365.5	0
3.	Total hardness (mg/l as CaCO ₃)	475-562	518.5	43.5	0
4.	Chloride (mg/l as Cl ⁻)	98-178	138	40.0	0
5.	Iron (mg/l as Fe)	0.22-0.37	0.295	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).

180. 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 7.6-8.04, 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 the both samples are observed to high (475-562 mg/l) and higher than the drinking water quality standards for desirable limits (200 mg/l) but marginally below the acceptable limits of 600 mg/l in absence of alternative sources. Chloride and sulphate contents were 98-178 mg/l and 28.5-69.5 mg/l respectively. While calcium content for both samples are around 86.4 mg/l, magnesium ranged between 62.9-84.0 mg/l. Heavy metals except Boron remain undetected in the samples. The fluoride levels are also found to be within the stipulated standards. All these parameters were generally within the tolerance limits for drinking water except hardness.

Table 54 Ground Water Quality Analysis Results

Sl. No.	Parameters	Units of Measurements	GW1	GW2	Indian Standard 10500:2012		WHO Limits
					Desirable	Permissible	
1.	pH	-	8.04	7.6	6.5-8.5	No relaxation	-
2.	Temperature	°C	25	25	-	-	-
3.	Conductivity	µmhos/cm	2303	1178	-	-	-
4.	Turbidity	NTU	4.3	3.8	1	5	-
5.	Total Hardness as CaCO ₃	mg/l	562	475	200	600	-
6.	Total Alkalinity as CaCO ₃	mg/l	823	366	200	600	-
7.	Total Dissolved Solids	mg/l	1497	766	500	2000	-
8.	Sodium as Na	mg/l	170	23	-	-	-
9.	Potassium as K	mg/l	21	3	-	-	-
10.	Calcium as Ca	mg/l	86.4	86.4	75	200	-
11.	Magnesium as Mg	mg/l	84	62.9	30	100	-
12.	Chloride as Cl	mg/l	178	98	250	1000	-
13.	Sulphate as SO ₄	mg/l	28.5	69.5	200	400	-

Sl. No.	Parameters	Units of Measurements	GW1	GW2	Indian Standard 10500:2012		WHO Limits
					Desirable	Permissible	
14.	Nitrate as NO ₃	mg/l	6.4	5.9	45	No relaxation	50
15.	Iron as Fe	mg/l	0.37	0.22	0.3	No relaxation	-
16.	Manganese as Mn	mg/l	<0.02	<0.02	0.1	0.3	-
17.	Cadmium as Cd	mg/l	<0.001	<0.001	0.003	No relaxation	0.003
18.	Total Arsenic as As	mg/l	<0.01	<0.01	0.01	0.05	0.01
19.	Total Chromium as Cr	mg/l	<0.05	<0.05	0.05	No relaxation	0.05
20.	Copper as Cu	mg/l	<0.01	<0.01	0.05	1.5	2
21.	Mercury as Hg	mg/l	<0.001	<0.001	0.001	No relaxation	0.006
22.	Lead as Pb	mg/l	<0.01	<0.01	0.01	No relaxation	0.01
23.	Zinc as Zn	mg/l	0.48	0.34	5	15	-
24.	Boron as B	mg/l	ND	ND	0.5	1	2.4
25.	Fluoride as F	mg/l	0.78	0.58	1	1.5	1.5
26.	Total Coliform	MPN/100ml	Absent	Absent	Absent	Absent	Absent

Source: On-site Water Quality Monitoring in December 2015

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

181. From above it can be concluded that the ground water, in general, is hard in nature and the physico-chemical quality satisfies the permissible limit as stipulated in Drinking Water Standards (IS 10500:2012).

3. Ground Water Availability

182. In Bangalore Urban district, ground water is mainly developed through dug wells, dug cum bore-wells, bore-wells for irrigation, industrial and domestic purposes. In recent years, due to haphazard urbanization, exponential growth in population and industrial units, demand for water has resulted in indiscriminate drilling of bore wells by individual households, business establishments and industries. This has resulted in depletion of ground water levels & over exploitation of the ground water resources in the district.

183. Presently, water supply to the core area of about 220 sq. km is mainly through surface water schemes of Cauvery River. This is done by State Govt. Department like Bangalore Water Supply and Sewerage Board (BWSSB) with BBMP limits. However, in the outer sub urban area of 500 sq. km within BBMP limit, there is no piped water supply from Cauvery River and the water requirement is mainly met from groundwater. As a result, the exploitation of ground water is more in the outer peripheral area than the core area. On the other hand, ground water is the main source for all types of irrigation in the district.

184. From the assessment of ground water resources, it is seen that all the taluks are categorized as over exploited and in principle there is no balance ground water resources left for future development, except some of the isolated patches.

185. In Ramanagara district, bore wells are the major source of drinking water supply. 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.

186. 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.

(Source: Ground Water Information Booklet of CGWB)

N. Ecology and Biodiveristy

1. Introduction

187. The Project area is characterized by open countryside predominately plain terrain however small section from Thavarekere towards Magadi passes through rolling 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.

188. Road side plantation consist of *Azadirachta indica* (Bevu), *Ficus benghalensis* (Ala), *Ficus religiosa* (Arali), *Ficus religiosa* (Peepal), *Pongamia pinnata* ((Karanj), *Leucaena leucocephala* (Subabool), *Tamarindus indica* (Hunse), *Syzygium cumini* (Nerale), *Albizia lebbeck* (Siris), *Delonix regia* (Gulmohar), *Cassia siamea* (Kassod), *Bauhinia racemosa* (Banne) *Peltophorum pterocarpum* (Copper pod), *Eucalyptus.sps* etc.

189. Major plantation in agricultural land comprises of *Cocos nucifera* (Coconut) and *Areca catechu* (Areca nut). Other species planted are *Mangifera indica* (Mango), *Psidium guajava* (Guava), *Musa paradisiaca* (Banana), *Annona squamosa* (Sitaphal), *Artocarpus heterophyllus* (Jack fruit) *Carica papaya* (Papaya) and *Tamarindus indica* (Hunse). Some farmers also raise plantation of *Eucalyptus* and *Casuarina*. The major crops grown in the region are ragi, rice, sugarcane, pulses (horse gram tur, cowpea green gram, black gram, avare) and oilseeds (groundnut and sesame). Other crops grown are Sunflower, Jowar and Maize. Vegetables such as Tomato, Gourd varieties, Brinjal, Ladies finger, etc are grown. Agriculture is dependent on rainfall, river, well and tank irrigation. Paddy and sugarcane constitute chief crops grown under canal irrigation

2. Road Side Trees

190. The number of roadside trees within existing row is estimated to be 1,967. Side and girth size wise distribution of existing trees are provided in Table-55. Chainage wise details of existing trees are provided in Annex 4.4.

Table 55 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	158	250	182	97	192	879
LHS	150	181	194	151	412	1,088
	308	431	376	248	604	1,967

Source: Field Survey conducted by ICT Pvt. Ltd.

3. Green Tunnels and Giant Trees

191. Green Tunnels: At some locations Green tunnels are formed along the road. These tunnels provide shade, reduce heat effect, reduce glaring of road and provide overall cooling. Species observed in the green tunnel mainly includes *Ficus religiosa*, (Pipal), *Ficus benghalensis* (Banyan), *Peltophorum pterocarpum* (Copper pod) and *Delonix regia* (Gulmohar). The stretches will be impacted due to widening activity. The location of green tunnel is given in Table-56. Location of Green Tunnel along the project road has been shown on the google image and presented in Annex-4.5.



View of Green Tunnel along the Project Road

Table 56 Location of Green Tunnels along the Project Road

Sl. No.	GPS Reading		Chainage Km		Length (m)
	Start Point	Endpoint	From	To	
1.	12°58'45.10"N 77°26'3.00"E	12°58'41.74"N 77°25'54.12"E	19+840	20+125	0.285
2.	12°58'0.40"N 77°23'14.80"E	12°57'57.29"N 77°23'12.85"E	25+410	25+525	0.115
3.	12°57'14.78"N 77°18'16.60"E	12°57'17.60"N 77°18'14.00"E	39+310	39+430	0.120
4.	12°56'34.42"N 77°15'31.40"E	12°56'34.58"N 77°15'28.09"E	45+300	45+400	0.100
5.	12°57'4.69"N 77°13'56.77"E	12°57'5.27"N 77°13'51.66"E	48+475	48+635	0.160
6.	12°57'6.00"N 77°13'48.00"E	12°57'7.20"N 77°13'39.40"E	48+740	49+000	0.260
7.	12°58'13.13"N 77°12'1.35"E	12°58'15.04"N 77°11'58.55"E	51+900	52+000	0.100
8.	12°58'16.84"N 77°11'56.00"E	12°58'18.63"N 77°11'53.38"E	52+100	52+200	0.100
9.	12°58'21.33"N 77°11'49.31"E	12°58'23.21"N 77°11'46.52"E	52+345	52+445	0.100
10.	12°58'59.22"N 77°11'7.29"E	12°59'2.93"N 77°11'4.65"E	54+085	54+220	0.135
11.	13° 0'18.50"N 77° 8'39.68"E	13° 0'20.09"N 77° 8'34.27"E	59+360	59+530	0.170
					1.645

Source: Field Survey conducted by ICT Pvt. Ltd.

192. Giant Trees: Field survey was conducted to identify the location of giant trees. 275 giant trees are found along the project road, out of which 158 trees are on the left side and 117 trees are on the right side.



193. 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.4.4.4 and Table-A.4.4.5 of Annex 4.4.

1. Biodiversity Survey

194. Biodiversity survey was conducted in the month of December, 2015 to study the flora and fauna of the project area. Before conducting the assessment work reconnaissance survey of the entire road stretch was made and sampling was done in each vegetation type. Three sample plots of 100 m x 10 m were laid for the purpose of biodiversity assessment. The sample plots were laid around an interval of 10 to 15 km 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-57.

Table 57 GPS co-ordinates and altitude for the Sample plots

Sample Plots	Latitude	Longitude	Altitude (m)	Vegetation Type
1	12° 50' 53"	77° 03' 20"	812	Fallow agriculture land
2	12° 57' 35"	77° 19' 14"	840	Fallow agriculture land
3	12° 58' 43"	77° 25' 57"	859	Fallow agriculture land

Source: Biodiversity Study conducted by ICT Pvt. Ltd.

195. 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.

196. *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, 1984¹, Gurudev, 2002²) 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. 69 floral species were identified, out of which, 23 were tree species, 24 shrubs and 22 herb species (Plate 1, 2 & 3). The list of floral species

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

along with the status as per International Union for Conservation of Nature (IUCN), red list of threatened species is provided in Table-58

Table 58 List of Flora recorded during Survey

SI. No.	Scientific Name	Common Name	IUCN category
1.	<i>Acacia auriculiformis</i>	Earleaf acacia	Least Concern
2.	<i>Acacia catechu</i>	Black cutch	NE
3.	<i>Acacia nilotica</i>	Babool	NE
4.	<i>Albizia lebbek</i>	Siris	NE
5.	<i>Annona squamosa</i>	Custared Apple	NE
6.	<i>Azadirachta indica</i>	Neem	NE
7.	<i>Butea monosperma</i>	Palash	NE
8.	<i>Cassia siamea</i>	Golden shower	NE
9.	<i>Delonix regia</i>	Gulmohar	Least Concern
10.	<i>Diospyros melanoxylon</i>	East Indian Ebony	NE
11.	<i>Eucalyptus tereticornis</i>	Forest Red Gum	NE
12.	<i>Ficus benghalensis</i>	Banyana	NE
13.	<i>Ficus religiosa</i>	Pipal	NE
14.	<i>Grevillea robusta</i>	Silver Oak	NE
15.	<i>Leucaena leucocephala</i>	Subabul	NE
16.	<i>Morinda tinctoria</i>	Indian mulberry	NE
17.	<i>Peltophorum pterocarpum</i>	Copper pod	NE
18.	<i>Pongamia pinnata</i>	Karanj	NE
19.	<i>Psidium guajava</i>	Guava	NE
20.	<i>Samanea saman</i>	Rain Tree	NE
21.	<i>Syzygium cumini</i>	Jamun	NE
22.	<i>Tamarindus indica</i>	Imli	NE
23.	<i>Vitex altissima</i>	Myrole	NE
Shrubs			
24.	<i>Acacia concinna</i>	Soap pod	NE
25.	<i>Agave americana</i>	American aloe	Least Concern
26.	<i>Argyrea cuneata</i>	Purple morning glory	NE
27.	<i>Calotropis procera</i>	French Cotton	NE
28.	<i>Canthium parviflorum</i>	Kadbar	NE
29.	<i>Cassia tora</i>	Coffee cassia	NE
30.	<i>Chromolaena odorata</i>	Siamweed	NE
31.	<i>Dodonaea viscosa</i>	Hop-bush	NE
32.	<i>Jasminum ritchiei</i>	Jasmine	NE
33.	<i>Jatropha curcas</i>	Physic nut	NE
34.	<i>Lantana camara</i>	Ghaneri	NE
35.	<i>Opuntia dillenii</i>	Nagphani	Least Concern
36.	<i>Pterolobium hexapetalum</i>	Baadubakka	NE
37.	<i>Rhus mysorensis</i>	Mysore Sumac	NE
38.	<i>Securinega virosa</i>	Dalme	NE
39.	<i>Sida acuta</i>	Blue okra	NE
40.	<i>Sida cordifolia</i>	Bala panchaang	NE
41.	<i>Sida rhombifolia</i>	Queensland hemp	NE
42.	<i>Solanum indicum</i>	Ban Tobacco	NE
43.	<i>Stachytarpheta indica</i>	Kaadu uttarani	NE
44.	<i>Stylosanthes fruticosa</i>	Pencil flower	NE
45.	<i>Tarenna asiatica</i>	Paapatige gida	NE
46.	<i>Vicoa indica</i>	Sonkadi	NE
47.	<i>Ziziphus oenoplia</i>	Kakal-ber	NE

Sl. No.	Scientific Name	Common Name	IUCN category
Herbs and Grasses			
48.	<i>Achyranthes aspera</i>	Prickly Chaff-flower	NE
49.	<i>Asparagus racemosus</i>	Shathaavari	NE
50.	<i>Commelina benghalensis</i>	Tropical Spider wort	Least Concern
51.	<i>Cynodon dactylon</i>	Bermuda grass	NE
52.	<i>Desmodium triflorum</i>	Matty desmodium	Least Concern
53.	<i>Dolichos falcatus</i>	Kaduhurali	NE
54.	<i>Evolvulus alsinoides</i>	English speedwheel	NE
55.	<i>Hemidesmus indicus</i>	Nannari	NE
56.	<i>Hybanthus enneaspermus</i>	Ratanpurus	NE
57.	<i>Leucas aspera</i>	Chhota-halkusa	NE
58.	<i>Mimosa pudica</i>	Touch me not	Least Concern
59.	<i>Mitracarpous vertisilata</i>	Girdlepod	NE
60.	<i>Ocimum americanum</i>	Jangali-tulsi	NE
61.	<i>Parthenium hysterophorus</i>	Carrot grass	NE
62.	<i>Orthosiphon diffuse</i>	Cats whisker	NE
63.	<i>Phyllanthus amara</i>	Bhumi-amlam	NE
64.	<i>Phyllanthus urinaria</i>	Hazarmani	NE
65.	<i>Spilanthes acmella</i>	Toungue cleaner	NE
66.	<i>Tinospora cordifolia</i>	Heart-leaved Moonseed	NE
67.	<i>Tridax procumbens</i>	Coatbuttons	NE
68.	<i>Tylophora asthmatica</i>	Indian Ipecac	NE
69.	<i>Vernonia cinerea</i>	Ash-coloured fleabane	NE

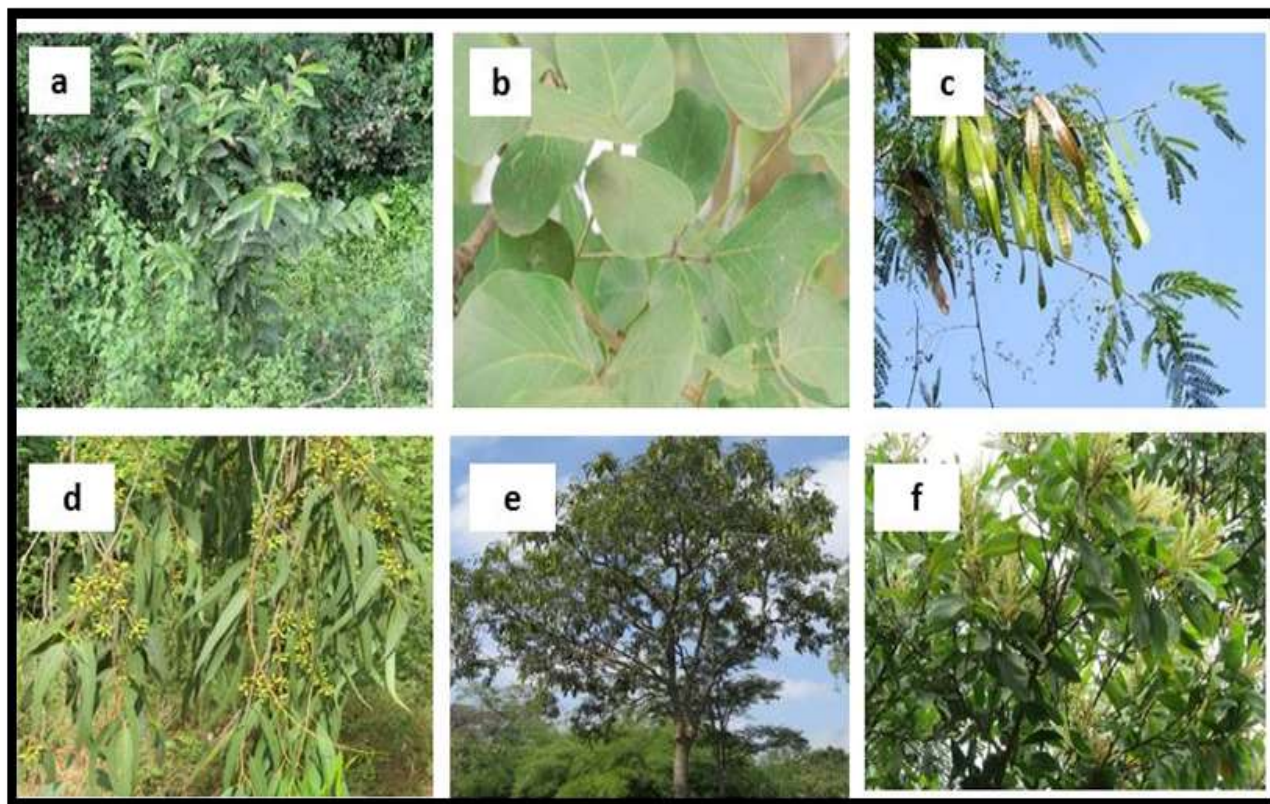


Plate 1: Tree species. a. *Psidium guajava*, b. *Butea monosperma*, c. *Leucaena leucocephala*, d. *Eucalyptus tereticornis*, e. *Albizia lebbek*, f. *Acacia auriculiformis*

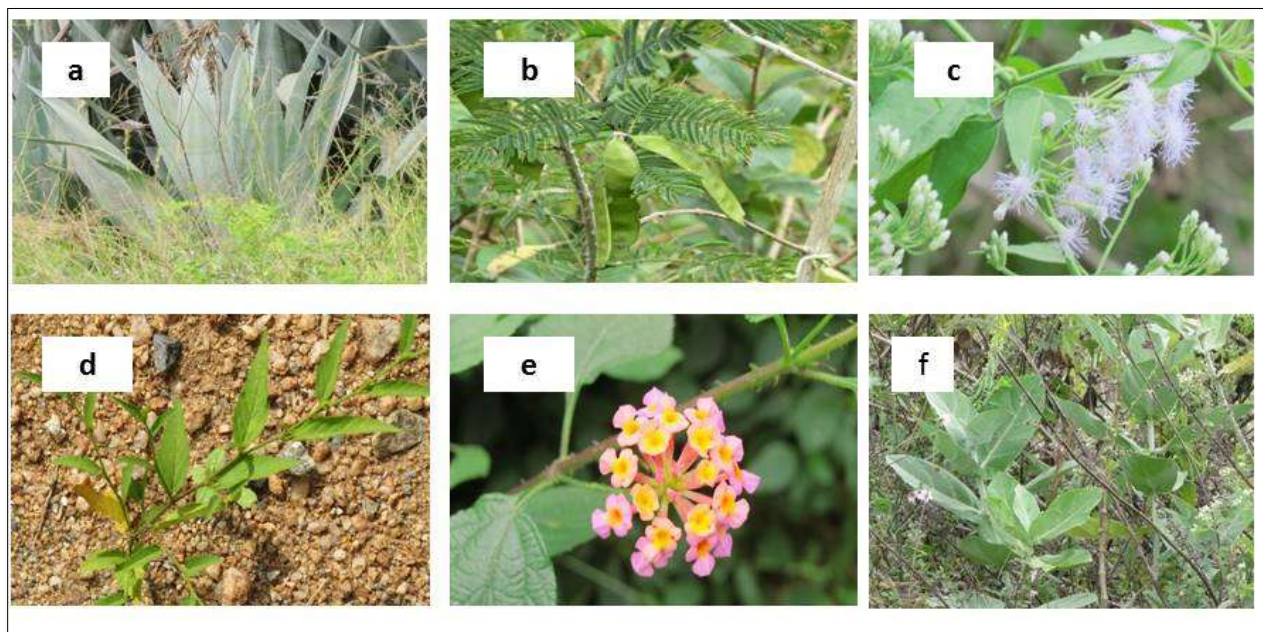


Plate 2: Shrub species a. *Agave americana* b. *Acacia concinna*, c. *Chromolaena odorata*, d. *Sida acuta*. e. *Lantana camara*, f. *Calotropis procera*

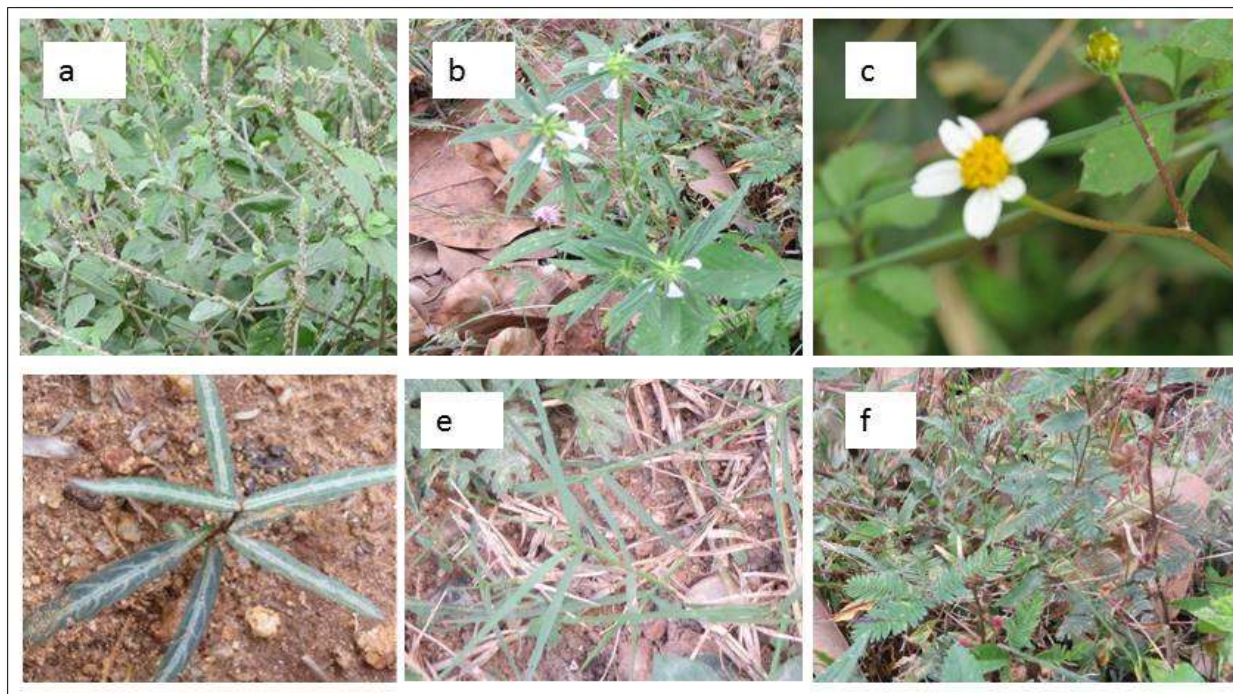


Plate 3: Herb species a. *Achyranthes aspera*, b. *Leucas aspera*, c. *Tridax procumbens*, d. *Leucas aspera*, e. *Cynodon dactylon*, f. *Mimosa pudica*

197. All species recorded are common in distribution. No threatened species of flora has been recorded during the survey. 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-4.6 for trees (Table-A.4.6.1), shrubs (Table-A.4.6.2) and herb (Table-A.4.6.3). *Pongamia pinnata* was the dominant tree species with 19.33 IVI followed by *Tamarindus indica*, *Albizia lebbeck*, *Ficus benghalensis*, *Leucaena leucocephala*, *Acacia catechu*, *Azadirachta indica*, *Diospyros melanoxylon*, *Peltophorum pterocarpum*, *Cassia siamea* and other species. Abundance calculated for the tree species inferred that *Azadirachta indica* and *Diospyros melanoxylon* were having highest abundance value of 8.00 compared to other species.

198. Assessment of shrub species revealed that *Stachytarpheta indica* was the dominant species with an IVI of 16.94 followed by *Lantana camara*. Other species with higher IVI were *Securinega virosa*, *Pterolobium hexapetalum*, *Sida acuta*, *Argyreia cuneate*, *Canthium parviflorum*, *Ziziphus oenoplia*, *Agave americana*, etc. The species abundance for individual shrub reveals that *Stachytarpheta indica* was having highest abundance value of 16.00. IVI for the herb species show that *Hybanthus enneaspermus* was dominating species with an IVI of 19.09. The species was followed by *Cynodon dactylon*, *Dolichos falcatus*, *Parthenium hysterophorus*, *Achyranthes aspera*, *Asparagus racemosus*, *Phyllanthus urinaria*, *Desmodium triflorum*, *Evolvulus alsinoides*, *Tridax procumbens*, etc. The species abundance was calculated for herb species and it is prudent to mention that *Parthenium hysterophorus* was having highest abundance value of 17.50

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

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

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

200. The estimated values of Shannon's diversity index are presented in Table-59. In the present assessment, the Shannon's diversity index for tree species was 3.03, for shrubs 2.93 and for herbs 2.88. 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, 1975³) and is nearer to the range (2.557 to 3.375) reported for permanent preservation plots at Western Ghats of Karnataka (Karthik, 2009⁴) and 2.31 to 3.30 for the Western Ghats of Southern Karnataka (Sarkar *et al.*, 2011⁵).

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

Table 59 Shannon's Diversity Index

SN	Flora	Shannon's Diversity Index
1	Tree	3.03
2	Shrub	2.93
3	Herb	2.88

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

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

202. Where, pi is proportion of important value of the ith species (pi =ni / N, ni is the important value index of ith 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 Simpson's values are an indicator of higher diversity. The calculated Simpson's index indicated that the tree diversity was more compared to shrubs and herbs (Table-60).

Table 60 Simpson's Index

S.No.	Flora	Simpson's Index
1	Tree	0.04
2	Shrub	0.06
3	Herb	0.06

Source: Biodiversity Study conducted by ICT Pvt. Ltd

203. **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 48 faunal species were identified in the project area during field survey out of which 17 are avian species, 28 insects, 2 (two) mammals and 1 (one) reptile. 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 Table-61.

Table 61 List of Faunal Species identified in the Project Area

S. No.	Scientific Name	Common Name	WLPA Schedule	IUCN category
Mammals				
1.	<i>Fumambulus palmarum</i>	Three striped squirrel	NA	Least Concern
2.	<i>Herpestes edwardsii</i>	Common mongoose	Schedule II	Least Concern
Reptile				
3.	<i>Calotes versicolour</i>	Garden lizard	NA	Least Concern
Aves				
4.	<i>Acridotheres tristis</i>	Common myna	Schedule IV	Least Concern
5.	<i>Bubulcus ibis</i>	Cattle egret	Schedule IV	Least Concern
6.	<i>Corvus macrorhynchos</i>	Jungle crow	Schedule IV	Least Concern
7.	<i>Corvus splendens</i>	House crow	Schedule V	Least Concern
8.	<i>Cuculus micropterus</i>	Indian cuckoo	Schedule IV	Least Concern
9.	<i>Dicaeum agile</i>	Thick billed flowerpecker	Schedule IV	Least Concern
10.	<i>Dicrurus paradiseus</i>	Rocket tailed drongo	Schedule IV	Least Concern
11.	<i>Dinopium javanense</i>	Golden backed	Schedule IV	Least Concern

S. No.	Scientific Name	Common Name	WLPA Schedule	IUCN category
		woodpecker		
12.	<i>Halcyon smyrnensis</i>	White breasted kingfisher	Schedule IV	Least Concern
13.	<i>Haliastur indus</i>	Bhramini Kite	Schedule I	Least Concern
14.	<i>Ictinaetus malayensis</i>	Black Eagle	Schedule I	Least Concern
15.	<i>Psilopogon haemacephalus</i>	Coppersmith barbet	Schedule IV	Least Concern
16.	<i>Megalaima viridis</i>	White cheeked barbet	Schedule IV	Least Concern
17.	<i>Muscicapa dauurica</i>	Asian brown flycatcher	Schedule IV	Least Concern
18.	<i>Nectarinia zeylonica</i>	Purple rumper sunbird	Schedule IV	Least Concern
19.	<i>Psittacula krameri</i>	Rose ringed parakeet	Schedule IV	Least Concern
20.	<i>Saxicola caprata</i>	Pied bushchat	Schedule IV	Least Concern
Insects				
21.	<i>Apis dorsata</i>	Rock bee	NA	NE
22.	<i>Apis cerana</i>	Indian bee	NA	NE
23.	<i>Atrophaneura aristolochiae</i>	Common rose	NA	NE
24.	<i>Atrophaneura hector</i>	Crimson rose	NA	NE
25.	<i>Castalius rosimon</i>	Common pierrot	NA	NE
26.	<i>Catopsilia pomona</i>	Common emigrants	NA	NE
27.	<i>Chorthippus brunneus</i>	Grass hopper	NA	Least Concern
28.	<i>Colotis etrida</i>	Small orange tip	NA	NE
29.	<i>Coptotermes formosanus</i>	Termite	NA	NE
30.	<i>Danaus chrysippus</i>	Plain tiger	NA	NE
31.	<i>Delias eucharis</i>	Common jezebel	NA	NE
32.	<i>Euploea core</i>	Common indian crow	NA	Least Concern
33.	<i>Eurema brigitta</i>	Small grassy yellow	NA	Least Concern
34.	<i>Eurema hecabe</i>	Common grassy yellow	NA	NE
35.	<i>Freyeria trochylus</i>	Grass jewel	NA	NE
36.	<i>Hypolimnas misippus</i>	Danda id eggfly	NA	Least Concern
37.	<i>Ischnura hecaterostica</i>	Damson fly	NA	NE
38.	<i>Ixias marianne</i>	White orange tip	NA	NE
39.	<i>Junonia iphita</i>	Chocolate pansy	NA	NE
40.	<i>Neptis hylas</i>	Common sailer	NA	NE
41.	<i>Papilio polytes</i>	Common mormon	NA	NE
42.	<i>Phalanta phalanta</i>	Common leopard	NA	NE
43.	<i>Psuedocoladenia dan</i>	Fulvous pied flat	NA	NE
44.	<i>Sympetrum flavolum</i>	Dragon fly	NA	NE
45.	<i>Tirumala septentrionis</i>	Dark blue tiger	NA	NE
46.	<i>Vanessa cardui</i>	Painted lady	NA	NE
47.	<i>Xylocopa violacea</i>	Carpenter bee	NA	NE
48.	<i>Zizeeria karsandra</i>	Dark grass blue	NA	NE

Source: Biodiversity Study conducted by ICT Pvt. Ltd.

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

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

204. Two Avian species *Haliastur indus* (Bhramini Kite) and *Ictinaetus malayensis* (Black Eagle) belong to Schedule I category as per Wildlife Protection Act, 1972, 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. Both the schedule I species *Haliastur indus* (Bhramini Kite) and *Ictinaetus malayensis* (Black Eagle) 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. **None of the species found in the project area fall**

under the threatened category as per IUCN red list. All the evaluated species are in Least Concern Category.

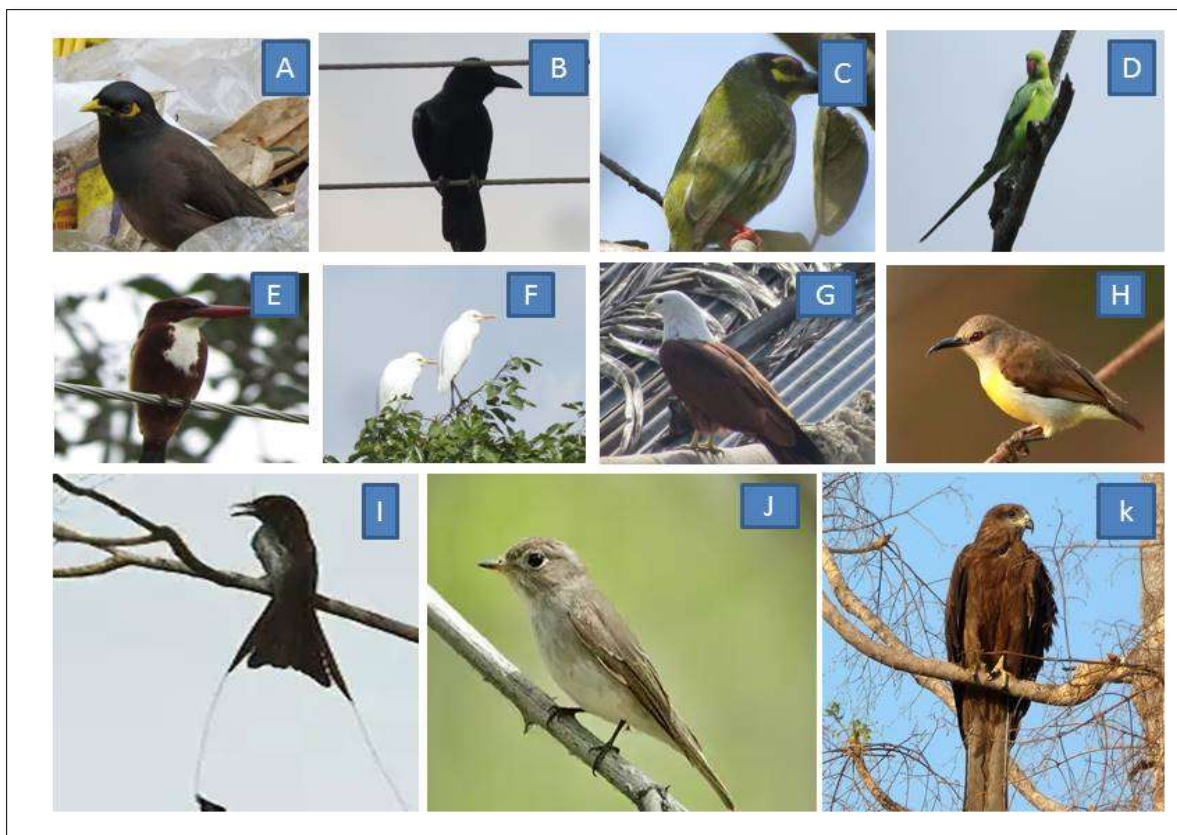


Plate 4.- a. Common myna, b. Common crow, c. Coppersmith barbet, d. Rose ringed parakeet, e. White breasted kingfisher, f. Cattle egret, g. Bhramini kite, h. Purple rumper sunbird, i. Rocket tailed drongo, j. Asian brown flycatcher, k. Black Eagle

205. 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 4.6 (Table-A.4.6.4). Biodiversity Index has been calculated, Shannon's Diversity Index and Simpson's Index is presented in Table-62.

Table 62 Shannon and Simpson Index

Shannon's Diversity Index (H)	Simpson's Index (D)
3.03	0.08

Source: Biodiversity Study conducted by ICT Pvt. Ltd.

4. Protected Areas

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

5. Forest

207. The project road does not pass through any Forest area. Forest of the study 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.

208. The 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

209. The main species of Dry Thorn forest are Zizyphus sps Acacia sps, Gymnosporia montana. The ground flora consists of Cassia auriculata, Dodonea viscosa and Randia sps. 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. Exotics species Parthenium hysterophorous is posing a serious problem.

210. Forest Department has done plantations, species such as Eucalyptus sps. Acacia auriculiformis, Pongamia pinnata (Honge), Cassia siamea (Seemethamgadi), Albizia amara (Chujjalu), Acacia ferruginea (Banni), 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 especially Casuarina and Eucalyptus are springing in the area, owing to the increased demand for fuel and the easy mode of rearing this species. The list of forest species found in natural forest is presented in Annex 4.7 (Table – A.4.7.1).

211. On review of Forest working plan it is found that the mammalian species dwelling in the forest area comprise of Leopard (Panthera pardus), Elephant (Elephas maximus), Bonnet Macaque (Macaca radiata), Common Mongoose (Herpestes edwardsii), Wild boar (Sus scrofa), Indian porcupine (Hystrix Indica), Jackal (Canis aureus). The list of wildlife of the Forest division (Bangalore rural and urban) is presented in Annex 4.7 (Table – A.4.7.2). During Public consultation in the project area, people have reported that there are no wildlife species observed near road side.

O. Educational, Medical and Religious Properties

212. **Educational Institutions:** 38 educational institutions are located on either side of the project road; out of which, 16 are located on the right side and 22 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-63.

Table 63 List of Educational Institutions along the Project Road

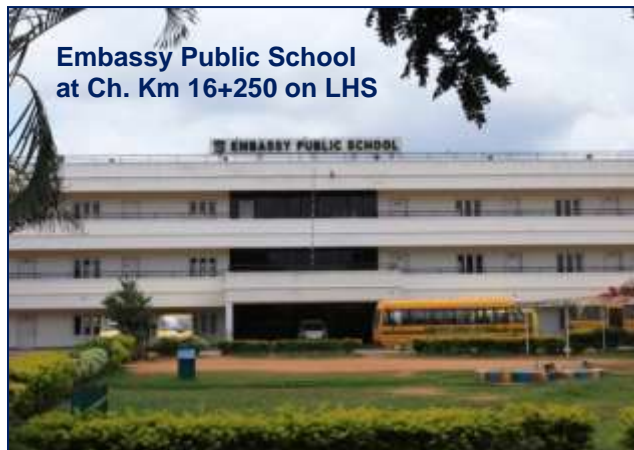
S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1.	Embassy Public School	Kachohalli	16+250	16+250	LHS	10.5
2.	Janaganga International School	Channenahalli	19+400	19+400	RHS	15.0
3.	Skill Development Center	Channenahalli	20+000	20+000	RHS	29.1
4.	Sri Vani Education Centre	Kachohalli	16+500	16+500	RHS	300.6
5.	Vidyashankar School	Machohalli	17+300	17+300	RHS	103.7
6.	Vidha Shankar College	Machohalli	17+300	17+300	RHS	244.4
7.	Janseva Vidyakendra	Channenahalli	20+000	20+000	LHS	97.0
8.	Govt. Primary School	Channenahalli	20+880	20+880	RHS	44.0
9.	Govt. Primary School	Honniganahatti	21+400	21+400	LHS	14.0
10.	SVN Convent & High School	Honniganahatti	21+480	21+480	RHS	12.0

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
11.	VES Model Convent School	Thavarekere	23+200	23+200	LHS	16.0
12.	Govt. Primary & Middle School	Thavarekere	23+755	23+755	LHS	12.0
13.	Panchamuki Ganapathi High School	Thavarekere	23+485	23+485	LHS	58.7
14.	Mahn Anjandri Vidya Kendra	Thavarekere	24+500	24+500	LHS	241.9
15.	Govt. School (Closed)	Devamachohalli	26+455	26+300	LHS	11.4
16.	Govt. Primary School	Cholanayakanahalli	30+390	30+043	RHS	51.8
17.	Govt. Primary School	Cholanayakanahalli	30+400	30+055	LHS	13.0
18.	Govt. Primary School	Gangappanahalli	31+500	31+050	LHS	12.5
19.	ICDS (Aanganwadi)	Syananboganahalli	36+700	36+080	LHS	12.5
20.	Govt. Primary School	Syananboganahalli	36+720	36+100	LHS	19.5
21.	Angels Nightngale Public School	Bachenahatti	38+275	37+650	LHS	15.0
22.	ICDS (Aanganwadi)	Bachenahatti	39+400	38+715	LHS	12.0
23.	Govt. Primary School	Bachenahatti	39+735	39+060	RHS	11.5
24.	Govt. PU College	Bachenahatti	39+680	39+000	LHS	55.5
25.	Govt. High School	Bachenahatti	40+600	39+900	LHS	11.4
26.	Govt. Primary School	Thagachikuppe	41+440	40+700	RHS	8.0
27.	Govt. Primary School	Marlagondla	42+080	41+340	LHS	13.5
28.	Govt. Primary School	Marlagondla	43+790	43+040	LHS	114.4
29.	Govt. Primary School	Karla Mangla	44+575	43+825	RHS	20.5
30.	Govt. Higher Primary School	Magadi	48+040	47+240	RHS	7.0
31.	Moulana Aazad Residential School	Magadi	49+700	48+900	LHS	50.0
32.	Govt. Higher Primary School	Vaddarapaly	51+350	50+550	LHS	61.3
33.	Kiran Balakiyara Vasathi Nilay (Hostel)	Vaddarapaly	51+770	50+958	LHS	13.4
34.	Govt. Higher Primary School	Chandurayanahalli	-	52+475	RHS	9.0
35.	Udigadikeshwara Swaminatha High School	Kaliya	-	54+600	RHS	36.0
36.	Govt. Higher Primary School	Kalarikaval	-	56+825	RHS	9.7
37.	Govt. Higher Primary School	Kenchanahalli	-	60+930	LHS	8.9
38.	Govt Lower Primary School	Chikka Mudigere	-	61+850	RHS	7.8

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

Distance in meter from existing centerline

* Realignment / bypass proposed in this section



213. **Religious Places:** 72 religious places are located on either side of the project road, out of which 41 religious places are located on the right side and 31 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-64.

Table 64 List of Religious Places along the Project Road

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1.	Krishna Temple	Kachohalli	15+690	15+690	LHS	36.5
2.	Balaji Temple	Kachohalli	15+800	15+800	LHS	5.5
3.	Road side Mini Worship Place (Hanuman)	Kachohalli	16+000	16+000	RHS	8.0
4.	Sani Temple	Kachohalli	16+200	16+200	RHS	10.2
5.	Road side Mini Worship Place (Hanuman)	Machohalli	16+810	16+810	LHS	7.6
6.	Huliyuramma Temple	Machohalli	17+150	17+150	LHS	14.6
7.	Hanuman Temple	Machohalli	17+260	17+260	RHS	8.0
8.	Ganesh Temple	Machohalli	17+980	17+980	LHS	18.8
9.	Road Side Mini Worship Place	Kadabagere	18+675	18+675	RHS	15.3
10.	Mookambika Temple	Kachohalli	16+500	16+500	RHS	66.4
11.	Ganesh Temple	Kadabagere	18+500	18+500	RHS	95.5
12.	Hanuman Temple	Channenahalli	20+600	20+600	RHS	59.6
13.	Hanuman Temple	Kurubarahalli	21+930	21+930	RHS	13.5
14.	Munieshwara (Shiv) Temple	Kurubarahalli	22+220	22+220	LHS	34.6
15.	Road side Mini Worship Place	Thavarekere	23+495	23+495	RHS	10.8
16.	Panchmukhi Vinayak Temple	Thavarekere	23+515	23+515	RHS	21.1
17.	Temple	Thavarekere	24+450	24+450	LHS	47.1
18.	Road Side Mini Worship Place (Nag Dev)	Thavarekere	24+895	24+895	RHS	15.5
19.	Idgah	Baichaguppe	24+960	24+950	LHS	32.9
20.	Sani Temple	Baichaguppe	25+080		LHS	14.1
21.	Hanuman Temple	Devamachohalli	26+480	26+325	LHS	16.8
22.	Marenhali Anjenaeta Swamy Temple	Marenahalli	29+050		RHS	77.2
23.	Maramm Temple (Small)	Cholanayakanahalli	30+400	30+055	RHS	10.9
24.	Vinayak Temple	Cholanayakanahalli	30+395	30+050	RHS	14.6
25.	Nandi Temple	Cholanayakanahalli	30+425	30+080	RHS	21.5
26.	Hanuman Temple	Cholanayakanahalli	30+445	30+090	RHS	28.3
27.	Shiv Temple (Ishwara)	Cholanayakanahalli	30+455	30+100	RHS	26.4
28.	Maramma Temple	Cholanayakanahalli	30+455	30+100	RHS	16.6
29.	Temple	Gangappanahalli	31+660	31+240	RHS	76.2
30.	Road Side Mini Worship Place (Nag Dev)	Tippagondanahalli	33+840	33+385	LHS	22.3
31.	Road Side Mini Worship Place (Hanuman)	Tippagondanahalli	33+845	33+390	LHS	22.9
32.	Vinayak Temple	Syananboganahalli	35+530	34+900	LHS	21.6

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
33.	Temple	Syananboganahalli	36+750	36+130	LHS	43.6
34.	Ayyappa Swamy Temple	Syananboganahalli	36+745	35+125	RHS	13.8
35.	Sani Temple	Bachenahatti	38+400		LHS	17.1
36.	Sani Temple	Bachenahatti	39+645	38+975	RHS	7.7
37.	Sani Temple	Thagachikuppe	41+265	40+550	LHS	24.1
38.	Road side Mini Worship Place	Thagachikuppe	41+460	40+720	RHS	11.4
39.	Road side Small Hanuman Temple	Marlagondla	42+840	42+100	RHS	39.9
40.	Shree Lakshimivenkateswara Swmy Temple	Marlagondla	42+960	42+200	RHS	13.1
41.	Hanuman Temple	Marlagondla	43+760	43+010	RHS	5.5
42.	Hanuman Temple	Karla Mangla	44+255	43+500	LHS	73.2
43.	Road side Mini Worship Place	Karla Mangla	44+560	43+810	RHS	9.3
44.	Sani Temple	Karla Mangla	44+585	43+835	RHS	19.1
45.	Road side Small Hanuman Temple	Karla Mangla	45+015	44+265	LHS	9.6
46.	Lakshmi Venkateshwara Temple	Thirumali	46+740	45+965	LHS	53.3
47.	St. Anthony'S Church-Magadi	Thirumali	47+700	46+900	LHS	12.3
48.	Shree Ranga Nath Swamy Temple	Thirumali	47+400	46+700	RHS	747.7
49.	Small Hanuman Temple	Magadi	47+965	47+162	LHS	6.3
50.	Vinayak Temple	Magadi	48+000	47+200	RHS	5.8
51.	Road side Mini Worship Place	Magadi	48+900	48+090	LHS	9.2
52.	Road side Mini Worship Place (Nag Dev)	Magadi	49+100	48+290	RHS	9.3
53.	Mosque	Magadi	49+700	48+900	RHS	14.7
54.	Vinayak Temple	Magadi	49+985	49+185	RHS	10.4
55.	Nandi Temple	Vaddarapaly	50+375	49+565	LHS	16.6
56.	Sani Temple	Vaddarapaly	50+640	49+835	LHS	14.5
57.	Road Side Mini Worship Place	Vaddarapaly	50+650	49+845	LHS	14.0
58.	Temple	Vaddarapaly	50+600	49+800	LHS	114.7
59.	Ganesh Temple	Vaddarapaly	51+000	50+200	LHS	52.2
60.	Someshwara Temple	Vaddarapaly	51+300	50+500	LHS	91.0
61.	Road side Mini Worship Place	Vaddarapaly	51+700	50+885	RHS	7.6
62.	Worship Platform	Hosahalli	-	51+050	RHS	18.0
63.	Mini Worship Place (Gram Devta)	Voddarapalya	-	51+615	LHS	8.1
64.	Gram Devta Temple	Chandurayanahalli	-	52+360	RHS	9.3
65.	Dargah	Chandurayanahalli	-	53+072	LHS	25.0

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
66.	Idgah	Kaliya	-	53+510	RHS	10.1
67.	Mosque	Kalarikaval	-	57+580	RHS	20.0
68.	Hanuman Temple	Kalarikaval	-	58+050	RHS	8.0
69.	Shaneshwara Swamy Temple	Kenchanahalli	-	60+735	RHS	12.9
70.	Ramanjaneya Swamy Temple	Kenchanahalli	-	60+920	RHS	30.0
71.	Basavanna Temple	Iyandhalli	-	63+430	RHS	18.1
72.	Anjaneya Swami Temple	Talekere	-	65+975	LHS	12.0

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

Distance in meter from existing centerline



214. **Medical Facilities:** There are 2 hospitals, 1 primary health centres and 3 veterinary hospital along the project road; out of *which* 3 are located on the right side and remaining 3 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-65.

Table 65 List of Medical Facilities along the Project Road

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1.	Pooja Hospital	Machohalli	17+270	17+270	RHS	13.4
2.	Primary Health Center	Thavarekere	23+800	23+800	LHS	12.0
3.	Amma Hospital	Thavarekere	24+170	24+170	RHS	16.0
4.	Veterinary Hospital	Magadi	49+400	48+600	RHS	48.9
5.	Veterinary Hospital	Kaliya	-	54+820	LHS	10.1
6.	Veterinary Hospital	Hosapalya	-	59+300	LHS	17.5

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

Distance in meter from existing centerline

* Realignment / bypass proposed in this section

215. **Bore-well and Hand Pump:** There are 47 bore-wells, 7 hand pumps and 9 overhead water tanks are located along the side of the project road.

P. Archaeological Sites

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

Q. Demographic Details of Affected Population

1. General Socio-economic Profile of Project Districts

217. The project road passes through Bangalore Urban and Ramanagara districts in Karnataka. According to the 2011 census, the total population of Bangalore Urban and Ramanagara districts is 9.6 million and 1 million respectively. 9.06% of the population of Bangalore district lives in rural areas, and 75.27% of the population of Ramanagara district lives in rural areas. The income levels of majority (46.77%) of APs are above Rs. 100,000 annually. Majority (23.64%) of the households are engaged in *business* and the next major economic activity is agriculture in which (23.53%) are engaged. The majority (88.65%) of the APs is Hindus. With regard to social category of APs, the majority (57.90%) is of Other Backward Class (OBC) category, 16.33% are General and 5.73% are Scheduled Caste (SC). The socio-economic information of affected persons (APs) has been collected from the census survey of 100% structures and land and the key findings are presented in this section.

2. Total Affected Households

218. The data reveals that as many as total 1,083 households are likely to be affected due to the upgradation of the existing road. As per the census survey, 336 structures households, 560 land owners households, 181 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-66.

Table 66 Number of Affected Households

Sl.No.	Type of Households	Number of Households	Number of Families*
1	Structure Owners	336	802
2	Tenants	181	306
3	Employees	6	8
4	Land Owners	560	1,175
	Total	1,083	2,291

Source: Census Survey 2015-16

*Family as defined in RFCTLARRA, 2013.

3. Number of Affected Persons (APs)

219. There are 4,723 APs being affected which includes both structures affected and due to loss of land, which includes 2,424 (51.32%) males and 2,299 (49.68%) females. The average household size is 4.2 and the sex ratio among APs is 977. The details of APs being affected in the project are summarized in Table-67.

Table 67 Number of Affected Persons

Sl. No.	Categories of APs	Number of Affected Persons	Percentage (%)
1	Male	2,424	51.32
2	Female	2,299	49.68
Total		4,723	100

Source: Census Survey 2015-16

4. Religious Category

220. Social customs and traditions play a major role in determining the socio-economic development as well as occupational pattern in the influence area. Keeping this in mind, an initial analysis was conducted to understand the religious profile of the PAPs within the corridor of impact. The majority of PAHs belong to the Hindu religion (85.78%), 9.88% of the PAHs are Muslims and 0.09% belong to the Christian religion. However, nearly 4.25% of households did not *respond* to the question related to religion. The trend shows that Hindu communities dominate the project road. Table-68 delineates the religious categories of the affected households.

Table 68 Religious Categories of PAHs along the Project Road

Sl. No.	Religious Group	No. of Households	Percentage (%)
1	Hindu	929	85.78
2	Muslim	107	9.88
3	Christian	1	0.09
4	NA/NR	46	4.25
Total		1083	100

Source: Census Survey, 2015-16

5. Social Categories

221. As per the census survey of all of the 1083 affected households, the social stratification of the project area shows *that* 143 households (13.20%) are from general category, 691 households (63.80%) are from other backward class (OBC), 60 households (5.54%) are from scheduled caste (SC), and 26 household (2.40%) are from scheduled tribe (ST) category. The details of social categories in the project area are presented in Table-69.

Table 69 Social Categories of the PAHs

Sl. No.	Type of Social Category	No. of Households	Percentage (%)
1	General	143	13.20
2	Other Backward Class	691	63.80
3	Scheduled Caste	60	5.54
4	Scheduled Tribe	26	2.40
5	NA/NR	163	15.05
Total		1,083	100

Source: Census Survey 2015-16

6. Annual Income

222. The census data revealed that 67 affected households (6.19%) earn income that is up to Rs. 30,000. Most households 525 (48.48%) earn above Rs.1,00,000 annually, while 18.37% households did not respond. The average income level of households is summarized in Table-70.

Table 70 Annual Income Level of the Affected Households

Sl. No.	Annual Income	No. of Households	Percentage (%)
1	24,001 to 30,000	67	6.19
2	30 001 to 40,000	33	3.05
3	40,001 to 50,000	46	4.25
4	50,001 to 60,000	63	5.82
5	60,001 to 70,000	15	1.39
6	70,001 to 80,000	59	5.45
7	80,001 to 90,000	33	3.05
8	90,001 to 1,00,000	43	3.97
9	Above 1,00,000	525	48.48
10	NA/NR	199	18.37
Total		1083	100

Source: Census Survey 2015-16

7. Educational Status

223. A significant percentage of the affected households (24.01%) are illiterate, 9.42% are up to middle school, 11.17% are below matric, 20.87% affected persons are Matric (10th standard), 10.06% are up to graduate level. The details are summarized in Table-71.

Table 71 Educational Status of Affected Population

Sl. No.	Type of Educational Category	No. of Household	Percentage (%)
1	Illiterate	260	24.01
2	Literate	80	7.39
3	Up to middle (7th standard)	102	9.42
4	Below Matric (Below 10th standard)	121	11.17
5	Matric (10th standard)	226	20.87
6	Up to graduate	109	10.06
7	Above Graduate	56	5.17
8	NA/NR	129	11.91
Total		1083	100

Source: Census Survey 2015-16

8. Occupational Status

224. The findings of census survey revealed that out of 1083 affected households, 29.55% households are engaged in agriculture, 0.92% are agriculture labour, 4.89% are daily wage earner, and 32.69% households are doing business as their main occupation. The details of occupational status of affected households are summarized in Table-72.

Table 72 Occupational Status of Affected Households

Sl. No.	Occupation	No. of Households	Percentage (%)
1	Agriculture	320	29.55
2	Agriculture labour	10	0.92

Sl. No.	Occupation	No. of Households	Percentage (%)
3	Daily wage	53	4.89
4	Private employee	98	9.05
5	Salaried Govt.	53	4.89
6	Unemployed	87	8.03
7	Business	354	32.69
8	NA	108	9.97
Total		1083	100

Source: Census Survey 2015-16

9. Women Headed Households

225. Out of 1,083 affected households, only 45 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 73 Number of Women Headed Households

Sl. No.	Properties	No. of Women Headed Household	Percentage (%)
1	Land	24	53.33
2	Structure	21	46.67
Total		45	100

Source: Socio Economic Survey, 2015-16

V. ANALYSIS OF ALTERNATIVES

A. General

226. 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.

227. The initial section of the project road up to Tavarekere junction is having substantial length of good geometry and existing right of way for improvement with minimum design speed. However, the project road after Tavarekere is having substandard horizontal and vertical geometry. There are about 44 nos Horizontal curves having radius less than 150m with a design speed of less than the minimum 80 kmph stipulated in code. Hence to minimize R&R (Rehabilitation and *resettlement*) impact and to provide safety to road users, realignments have been proposed. In addition to the following two major locations, there are 10 other locations having substandard horizontal curve along the existing road which have been proposed for curve improvement as per standards. The details of the proposed major realignment are tabulated below:

Table 74 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	Bychaguppe Junction	24+700	25+756	1.056	24+700	25+600	0.900
2	Tippagondanehalli	33+837	35+135	1.298	33+383	34+500	1.117

228. The study and analysis has been based upon Google Aerial view and ground verification of the possible alignments. A 4-lane divided highway with 14 m wide carriageway and 1.5 m wide shoulder on both sides with proposed ROW of minimum 38 m has been proposed for all the realignments.

B. "With" and "Without" Project Scenarion

229. The Project road between Bengaluru and Magadi forms an important connectivity for two major districts Bengaluru Urban & Ramanagra, which is an existing two lane road 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.



Congested stretch of Magadi Town

230. It has been noted that this section has higher number of accidents every year as section has very sharp curves not confirming to IRC standards for both Horizontal and Vertical. The project road has been experiencing substantially higher traffic also. The traffic along this segment is likely to grow further in the future due to its close proximity to Bengaluru town and the improvement as entire corridor might also lead to some diversion of traffic currently using parallel road network. It is also observed that people commute to work in Bengaluru city from distance *places* like Magadi and with space constraint in Capital city rapid urbanization in first few Kilometers of project road is observed. To address the issue the improvement proposal drawn is 4-lane divided carriageway with paved shoulders on both sides in rural section and 4-lane divided carriageway with footpath and drain on both sides at locations alignment passing through settlement location as tabulated below:

Table 75 Location of Settlements

Chainage (Km)		Length (Km)	Type	Remarks
From	To			
15+325	23+200	7.875	Urban	Seegahalli Town
23+200	23+675	0.475	Urban	Flyover Approach (Thavarekere Town)
23+675	23+954	0.279	Urban	Elevated Section (Thavarekere Town)
23+954	24+500	0.546	Urban	Flyover Approach (Thavarekere Town)
26+100	26+600	0.500	Urban	Deomacharly Village
29+900	30+031	0.131	Urban	Chollanayakanahalli Village
30+031	30+200	0.169	Urban	Chollanaya kanahalli Village
35+850	36+200	0.350	Urban	Shan Boganahali Village
38+600	39+200	0.600	Urban	Bhachenahatti Village
41+200	41+400	0.200	Urban	Chikkathurpalya
46+900	51+000	4.100	Urban	Magadi Town

231. The proposed improvement would help in capacity augmentation and further safer movement of goods and people. The proposed improvement also ensure construction of new 4-lane Bridge structures where the existing bridges are structurally week and additional 2-lane bridge besides existing wherever existing bridges are found to be in good condition. Also for bridges 100-year return storm considered for design and improvement proposal drawn accordingly to meet the requirements. Thus, improvement of drainage facilities along project roads in form of increased waterway vent for bridge structures and improvement proposal drawn

for existing cross drainage structures would ensure quick disposal of storm water and improve living conditions of settlers in the vicinity. The improvement proposal further ensures provision of road side facilities which include road side furniture's such as signages, restricted speed limits and other valuable information for road users. The facilities also include provision of Bus laybys which would ensure passengers safety and non-disruption of through traffic when busses stop at designated locations. Provision of flyover in the congested Thaverekere settlement at the main junction approx. design change 23+875, would improve traffic circulation and also safety of the highway users. The major advantage of the proposed improvement proposal is the project road will improve network traffic movement and also easy access and boost tourism in the vicinity. The project road is further connected to Somwarpet and Coorg region which happens to be major tourist attraction as such improvement of entire corridor would facilitate travelers to reach these destinations in lesser time. The proposed improvement proposal would facilitate connectivity to Major towns for business, Medical requirement, educational facilities, employment opportunities and market for finished goods also would ensure safer movement of goods and people. 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-76. 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. If the project is not implemented, the existing bad pavement of the corridor will deteriorate further. Increased air pollution, due to bad road condition, slow moving traffic and congestion will increase. Noise levels will rise due to deterioration of the pavement as well as increased honking. Without the improvement, the traffic would continue to pose a safety risk for the road users.

232. There is little increase in the pollution levels during construction. Dust and particulate matter during construction will affect the air quality on a short-term basis. However, Potential benefits of the proposed road improvements are substantial and far reaching both in terms of the geographical spread and time. 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.

Table 76 "With" and "Without" Project Scenario

With Project		Without Project	
Impacts		Impacts	
Positive	Negatives	Positive	Negative
<ul style="list-style-type: none"> • With the improvement of road surface, the traffic congestion due to obstructed movement of vehicles will be minimized and thus wastage of fuel and emissions from the vehicles will be reduced reducing air pollution • Improvement in ecology through compensatory 	<ul style="list-style-type: none"> • Minor changes in land use pattern • Loss of some properties and livelihood • Removal of vegetative cover along the road • Increase in air pollution due to 	Nil	<ul style="list-style-type: none"> • Increase in travel time • Increase in fuel consumptions • Increase in dust pollution & vehicular emission • Increase in accident rate • Overall economy of the State will be affected. • Further deterioration of

With Project		Without Project	
Impacts		Impacts	
Positive	Negatives	Positive	Negative
afforestation <ul style="list-style-type: none"> Enhanced trade and commerce. The dust clouds associated with vehicles movement on tracks/earth roads will also be eliminated. Providing better level of service in terms of improved riding quality and smooth traffic flow. Reduction in accident rate Reduced transportation costs and increased access to markets Access to new employment opportunities Employment to local workers during the execution of the project Better access to health care centers and other social services Improved quality of life Strengthening of local economies and local industries. 	<ul style="list-style-type: none"> increased vehicular traffic Short term increase in dust due to earth work during construction at micro-level Increase in noise pollution during construction phase 		the project road <ul style="list-style-type: none"> Increased vehicle operation cost Reduced employment/ economic opportunities Arrest of possible significant enhancement and economic development of the region Land degradation, dust pollution and damage to agricultural land, contamination in water bodies due to vehicles traveling along multiple tracks on the open ground In absence of the project, it will be difficult for the state to finance such a massive improvement of the road infrastructure from its own resources.

C. Analysis of Alternatives

1. Bichaguppe Junction Realignment

233. The project road turns right ward at km 24+700 before Bychaguppe crossing with horizontal curve radius of about 100 m. The road leading to Bychaguppe village, takes off with T junction just after another horizontal curve of radius 140 m. A pipe line also running parallel on left side, which is about 25 m from existing road. Further the project road moves leftward at Km 25+300 with radius of 107 m. There are some residential structures along the road at this junction. Improvement towards right side is not possible due to presence of pipe line whereas improvement on left side will involve acquisition of residential and religious structures.



234. Thus the section from Km 24+700 to Km 25+756 (existing) has 4 very poor horizontal curves within a short length. Hence, to improve safety of the road users, geometric improvement in form of realignment has been proposed for a length of 900 m from Km 24+700 to Km 25+600.

Further due to the realignment, the road length has also been reduced by 150m. The proposed realignment on google Imagery is shown in Figure-14.



Figure 14 Proposed Bychaguppe Junction Realignment

2. Realignment near Tippagondanehalli

235. There are seven continuous substandard horizontal curves within a length of about 1.3 km from km. 33+837 to km. 35+135 (existing). The horizontal curve radii are of about 50 m to 200 m. Further the alignment crosses Akravathi River with a bridge of about 71 m. Due to the existing substandard curve, the bridge approaches are an accident prone area and is a black spot where number of *accidents* has happened in the past. Hence considering the safety and to reduce the series of curves, realignment has been proposed from Km 33+383 to Km 34+500. The proposed realignment on google Imagery is shown in Figure-15.



View of Sharp Curve at 34+200



**View of blind curve at Km 34+400
on bridge approach**



Figure 15 Proposed Realignment near Tippagondanehalli

VI. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Introduction

236. 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

237. **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 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.

238. Impacts:

- Disfiguration & change in existing profile of the land due to realignment
- 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
- Establishment of Construction Camp

239. **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.

240. **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-77.

Table 77 Raw Materials Requirement during Construction

Sl. No.	Item & Unit	Quantity	Mode of Transport	Source
1.	Blue metal (m ³)	620,000	Truck	Pre-identified quarry areas
2.	Sand (m ³)	420,000	Truck	Pre-identified quarry areas
3.	Cement (MT)	30,700	Truck	Local traders
4.	Bitumen (MT)	11,000	Truck	Refinery
5.	Diesel (liters)	6,002,000	Tanker	Local petrol pumps
6.	Steel (MT)	5,855	Truck	Local traders
7.	Earth (m ³)	1,534,440	Truck	Identified Borrow areas / generated from cutting

241. **Construction of Borrow Areas:** about 15,34,440 cubic meter of earth materials is to be used for the project road. This will 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 16,65,915 Cum, which is more than the quantity of earth required for construction. Additional quantity of earth may be utilized for plantation, in bitumen disposal pit, re-development of quarry area etc.

242. **Establishment of Crushers:** Contractor will be required to establish 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.

243. **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)

244. 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.

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

2. Soil

246. **Impacts: Soil Erosion:** Erosion of topsoil can be considered a moderate, direct and long term negative impact resulting from construction and maintenance of the road. Erosion problems may occur on newly constructed slopes 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 18.175 km, out of which height of embankment is more than 3.0 m for a length of 7.950 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.

247. **Construction of Bridges & Culverts:** Along the corridor reconstruction / widening of a number of bridges (1 major bridge, 8 minor bridges) and culverts (202) is 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

248. **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

249. Operation of hot mix plant

- Storage and stock yards of bitumen and
- Form various activities in the labour camps

250. **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 Top Soil Conservation and Reuse" as given in Annex-8.1.

251. **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-8.3.

252. **Disposal of Bituminous Waste:** Non reusable bituminous waste to be dumped in 30 cm thick clay lined pits with the top 30 cm layer covered with good earth for supporting vegetation growth over a period only after obtaining permission of IE. Details of bituminous waste generated *from* the proposed project road, number of Bitumen Disposal Pits (of volume 547 Cum) required for the disposal and typical drawing of disposal pit are given below and cost of the pit is covered in the EMP budget.

Name of the Project Road	Bengaluru - Magadi - Kunigal
Quantity of Bituminous waste generated (m ³)	14,635 Cum
No. of Bitumen Disposal Pits required	27

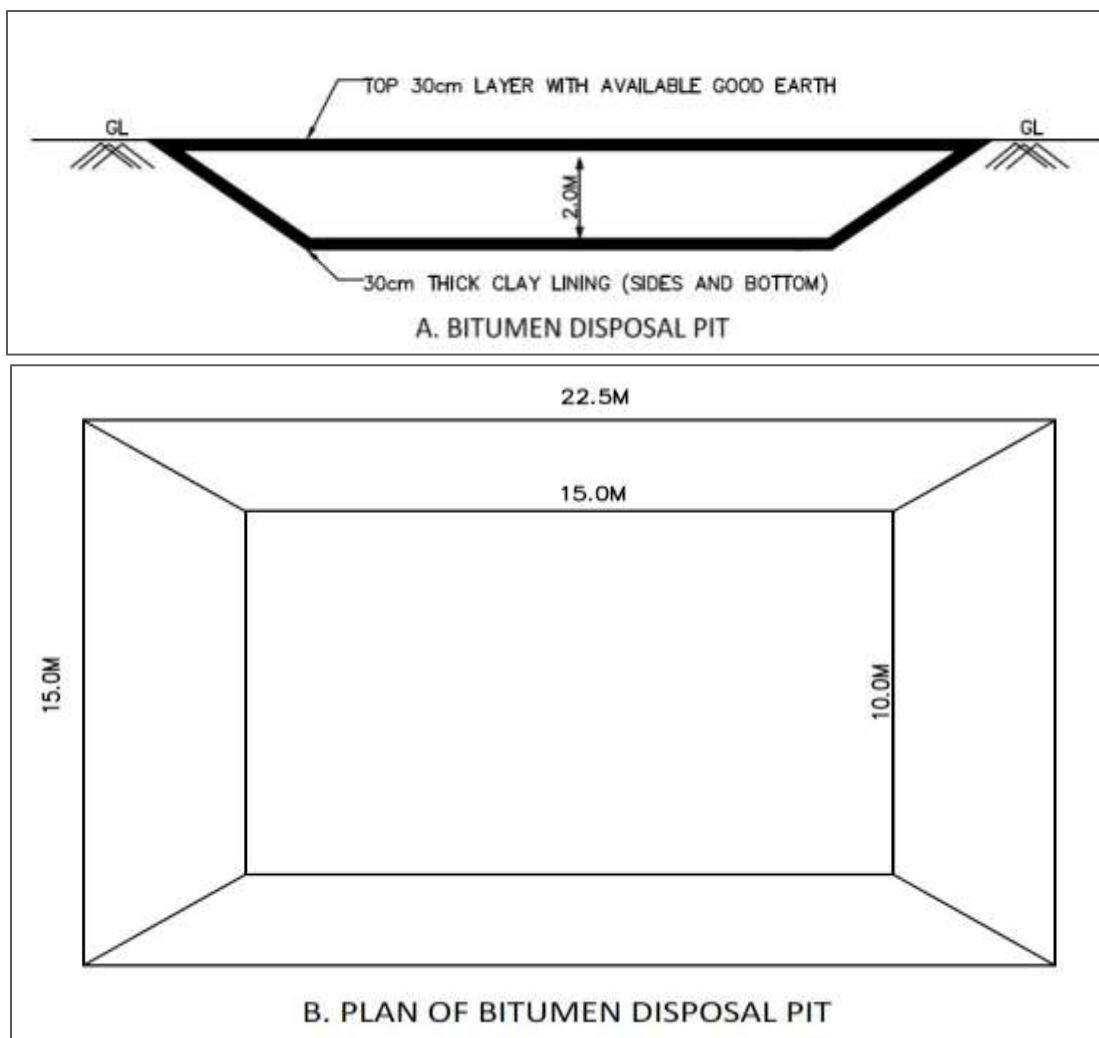


Figure 16 Typical Drawing of Bitumen Disposal Pit

- 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 sloped towards to adjacent edges towards the road. A drain will take all the spilled material to the oil interceptor.

3. Land Use

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

254. 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 workforce and supplier who are likely to construct temporary tents in the vicinity.

255. **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

256. **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.

257. **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. 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.

258. **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

259. **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

260. The project road runs through plain & rolling terrain. It crosses Arkavathi River at Ch. km 33+800 and natural drainage channel / local *stream* at six locations. During heavy rainfall these natural drainage channels carry swift flow. As the existing CD structures and 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.

261. Impacts:

- Change in drainage pattern of the land around realignment
- 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

262. 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 road is 44,778 m (22,389 m on either side) and the length of unlined drain is 55,760 m (27,880 m 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
- All bridges have been designed for a return period of 100 years
- Structures which fail against 100 years flood have been recommended for replacement with a new one.
- 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) are taken up during the lean flow periods in summer to minimize the impacts on drainage.
- Construction work near 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

263. Impacts: 8 hand pump, 3 water tank, 2 water tap, 2 open well and 1 bore-well with mini water tank will be affected.

264. **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

265. **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-78.

Table 78 Breakup of Fresh Water Requirement during Construction

S N	Purpose	Quantity (KL)
1.	For road construction:	14,23,000
	a) Construction related to earthwork	
	b) Construction of GSB	
	c) Construction of WMM	
	d) Bridges, culverts, retaining walls & other structures	
2.	Dust suppression	8,000
3.	For drinking & other household purpose #	14,000
	Total	1,445,000

266. **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 sanctions and approvals by the Ground Water Department has to be obtained by the Contractor
- Wastage of water during the construction should be minimized

4. Water Quality267. **Impacts: Construction Phase**

- 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

268. **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.

269. **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. 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.

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

271. **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.

272. **Ground Water Recharge Pit/ Rainwater Harvesting Structures** and silt fences has been proposed near river and local stream crossings to improve the water table in this region and conserve water bodies. It has been observed from the past meteorological data of IMD, total number of **rainy days** in the project area is **59.8 days** and total **annual rainfall is 970 mm**. Ground Water Recharge Pit has been proposed at **10 locations (Table-79)**. 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 pit is given in **Annex-8.24**.

Table 79 Proposed Location of Ground Water Recharge Pit

Design Ch. Km	Village	Description
29+100	Marenahalli	Near local stream
30+900	Cholanayakanahalli	Near local stream
33+700	Tippagondanahalli	Near Arkavathi River
40+400	Thagachikuppe	Near local stream
41+550	Marlagondla	Near local stream
43+300	Marlagondla	Near local stream
44+000	Marlagondla	Near local stream
53+400	Kaliya	Near water body
60+000	Kenchanahalli	Agricultural field
65+300	Talekere	Agricultural field

273. **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.

274. **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

275. **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 23 to 25 m in built-up areas and 38 to 40 m in rural / open country area. There are 11 water bodies, which are located within the COI (Table-80).
- All 11 water bodies have been saved by providing toe wall / change in engineering design or through realignment. Therefore, there will be no impact on surface water bodies

Table 80 List of Water Bodies Located within the COI

SL	Particular	Existing Ch. km	Design Ch. Km	Distance# (m)	Side	Village	Affected Status	Remarks
1.	Pond	25+750	25+600	8.3	LHS	Devamachohalli	Not Affected	Retaining wall
2.	Pond	25+830	25+680	22.0	RHS	Devamachohalli	Not Affected	Retaining Wall
3.	Pond	39+750	39+070	15.6	LHS	Bachenahatti	Not Affected	
4.	Road Side Ditch	39+960	39+300	6.7	RHS	Bachenahatti	Not Affected	Toe wall
5.	Honnapura Kere (Pond)	46+270	45+500	6.4	RHS	Thirumali	Not Affected	Retaining wall
6.	Road Side Ditch	46+840	46+100	7.6	RHS	Thirumali	Not Affected	Toe wall
7.	Pond	47+240	46+500	8.5	RHS	Thirumali	Not Affected	Realignment
8.	Hombalammana Lake	49+110	48+300	8.3	LHS	Magadi	Not Affected	
9.	Pond	-	53+400	15.5	RHS	Kaliya	Not Affected	
10.	Pond	-	56+200	10.0	RHS	Kalarikaval	Not Affected	
11.	Pond	-	64+460	16.0	LHS	Talekere	Not Affected	

Distance in meter from existing centerline

6. Enhancement of Water Body

276. Enhancement measures have been proposed for roadside pond located at Thirumali village at design chainage km 45+500 on the right side of the project road (Table-81). The pond water is utilized for irrigation purpose. The pond is located 6.4 m away from the project road and length of the pond along the road is 327 m.

Table 81 Water Bodies Proposed for Enhancement

SL	Particular	Existing Ch. km	Design Ch. Km	Distance# (m)	Side	Village
1.	Honnapura Kere (Pond)	46+270	45+500	6.4	RHS	Thirumali

Distance in meter from existing centerline



View of the Water Body Honnapura Kere (Pond) proposed for Enhancement

277. 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

278. Phyco-Remediation using NUALGI: During the site visit, algal growth is observed in various ponds along the project road and local villagers also informed that the quality of water of these ponds is very poor. Therefore, Phyco-Remediation using NUALGI is proposed to improve the water quality of the following ponds, which also include the pond proposed for enhancement (Table-81).

Table 82 Water Bodies selected for Phyco-Remediation

SL	Particular	Existing Ch. km	Design Ch. Km	Distance# (m)	Side	Village
1.	Pond	39+750	39+070	15.6	LHS	Bachenahatti
2.	Road Side Ditch	39+960	39+300	6.7	RHS	Bachenahatti
3.	Honnapura Kere (Pond)	46+270	45+500	6.4	RHS	Thirumali



View of the Pond and Road side Ditch where algal growth observed

279. Phyco- remediation is the use of algae to remediate polluted waters. Among all the algae, diatoms are the most prolific photosynthesizers because of their silica shells, which are translucent. This helps the diatoms to photosynthesize even in low light conditions. 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 CO₂ 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 CO₂ 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.

280. 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. 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

281. 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.

282. Undesirable gaseous pollutants will be generated mostly by the automobile traffic and construction machineries. Pollutants of primary concern include PM_{2.5} 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.

283. **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

284. **Mitigation Measures:**

a. Dust Control:

- Proper and prior planning and appropriate sequencing and scheduling of all major construction activities will be done, and timely availability of infrastructural supports needed for construction will be ensured to shorten the construction period vis a vis reduce pollution.
- Construction materials will be stored in covered godowns or enclosed spaces to prevent the windblown fugitive emissions.
- Truck carrying soil, sand and stone will be duly covered to avoid spilling.
- Adequate dust suppression measures such as regular water sprinkling on unpaved haul roads & vulnerable areas of the construction sites from trucks or other suitable means will be undertaken to control fugitive dust during material handling & hauling activities particularly near habitation especially in the dry seasons.

b. Emission Control

- 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 by increasing the surface area of bitumen or by reducing the surface tension at the aggregate bitumen interface with use of certain additives, thereby making the mixing possible at much lower temperature, saving energy and releasing less pollutants in the atmosphere. It is proposed to follow IRC Guideline on the subject.
- 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. as well as 300 m from the road. 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.

285. **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. 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

286. 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.

287. **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.

288. **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.

289. **Homogeneous Traffic Sections:** Based on the traffic study the entire project road (Bengaluru – Magadi - Kunigal) was divided into 3 homogenous sections, as detailed under:

290. **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. 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-17 to Figure-43**.

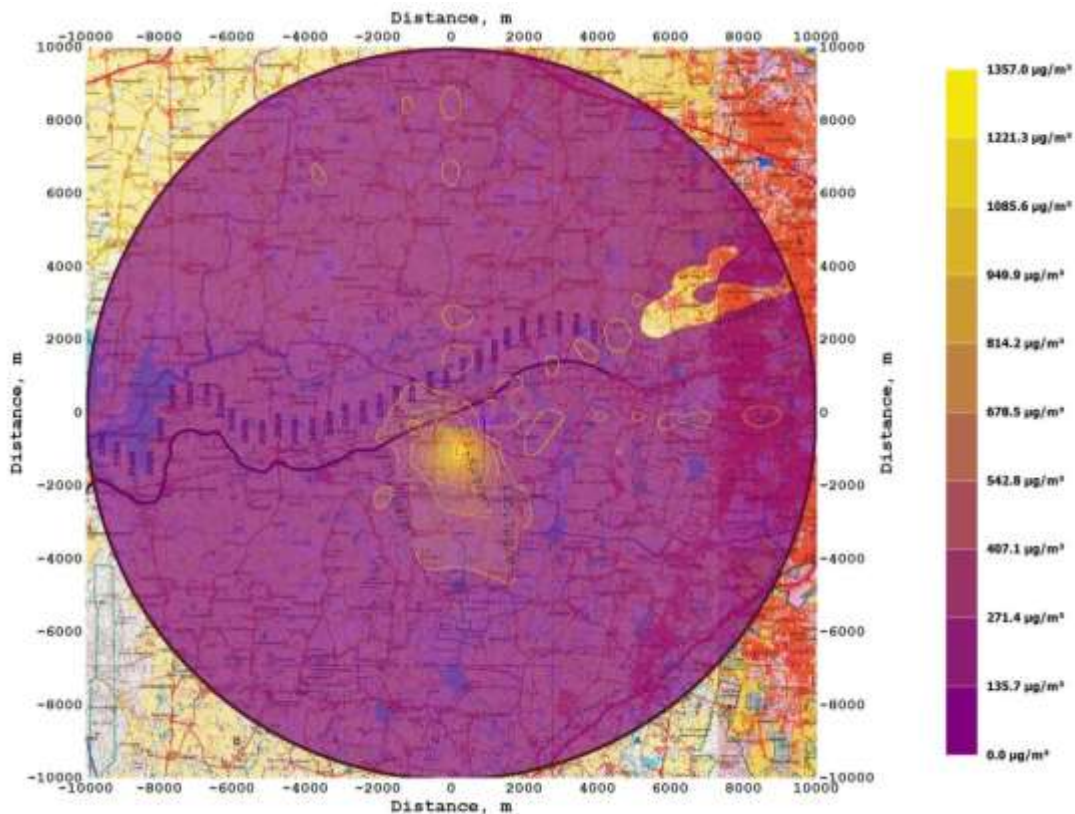


Figure 17 Predicted CO Levels in Traffic Section I for the Base Year 2015

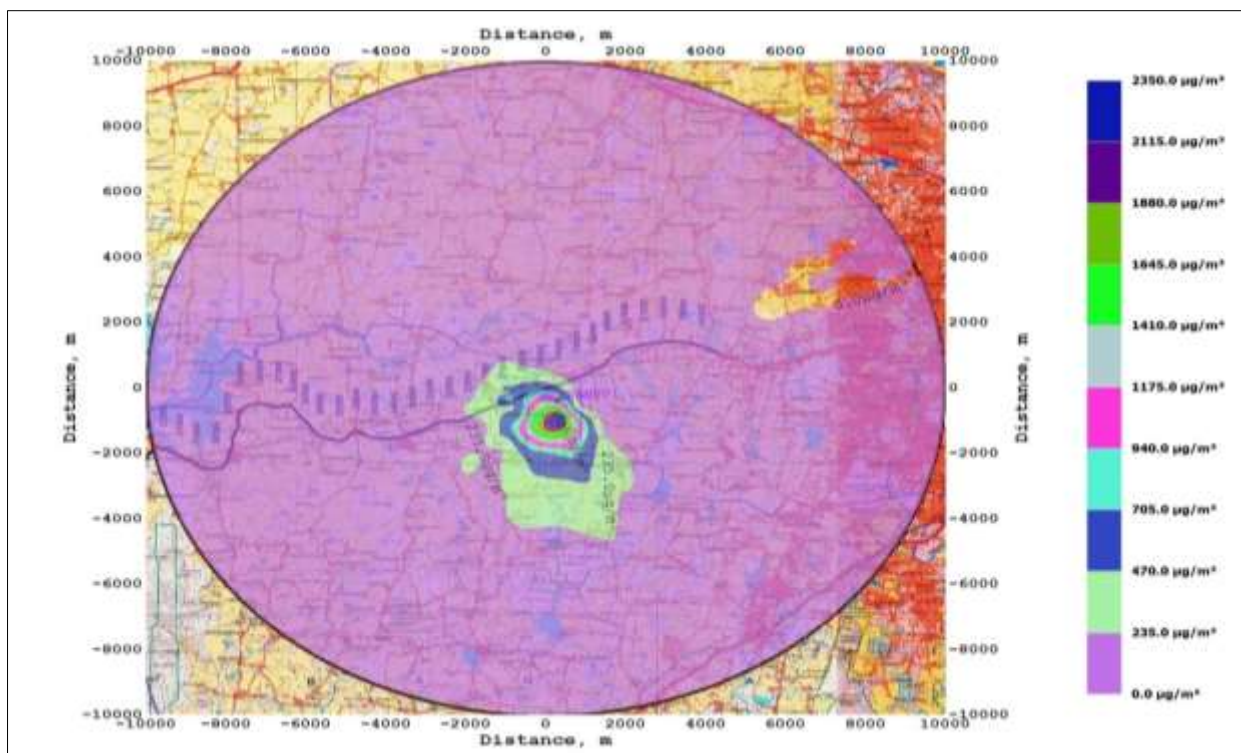


Figure 18 Predicted CO Levels in Traffic Section I for the Year of Operation 2020

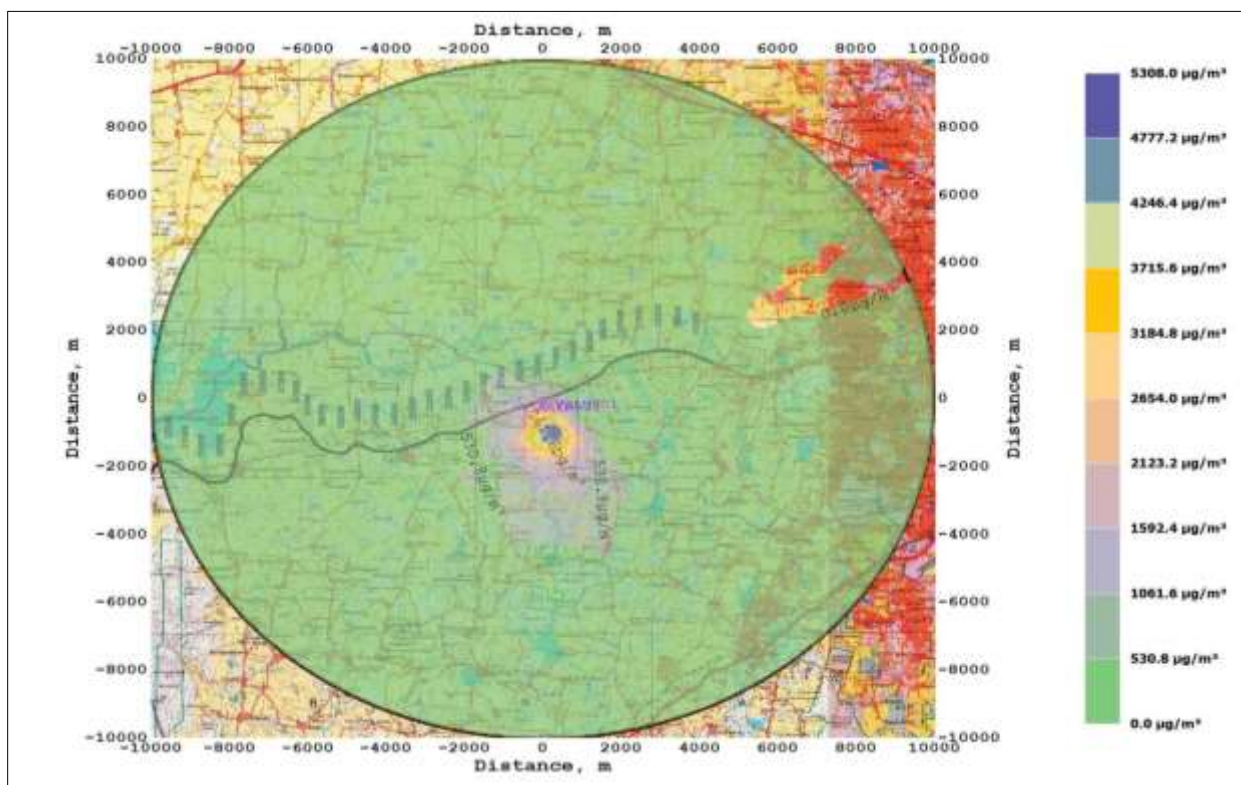


Figure 19 Predicted CO Levels in Traffic Section I for the Year 2040

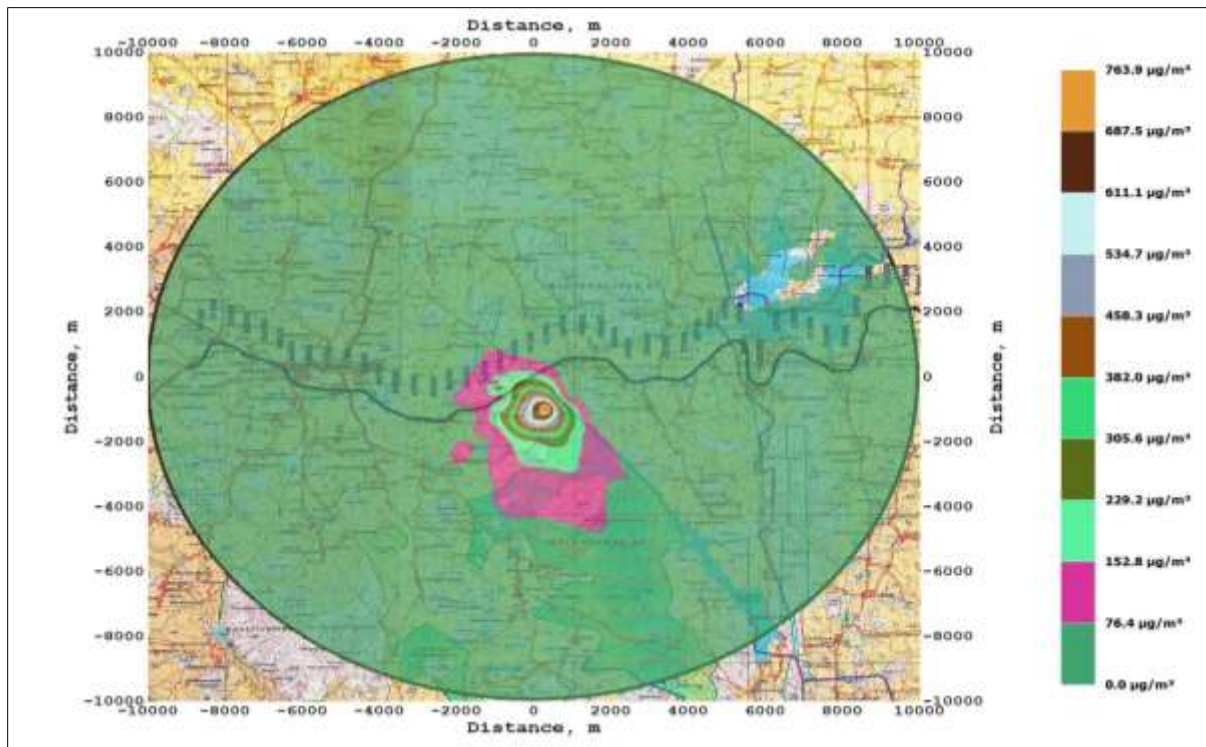
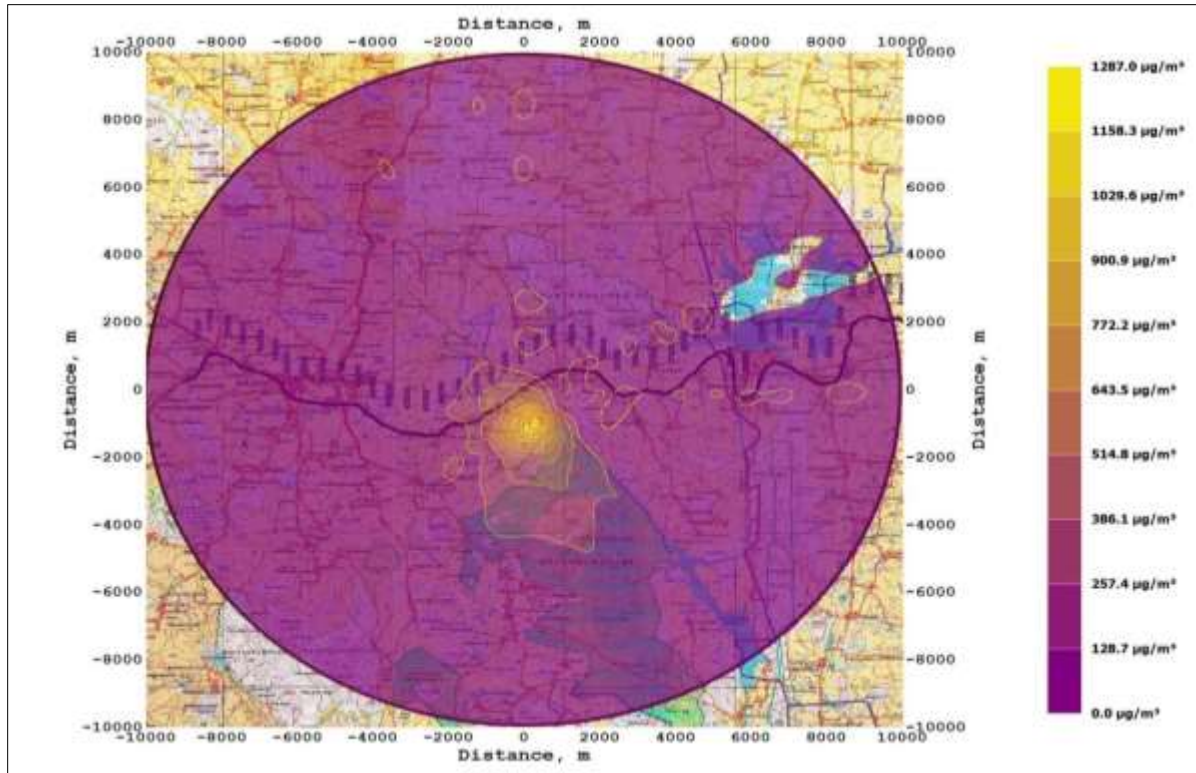


Figure 20 Predicted CO Levels in Traffic Section IIA for Base Year 2015

Figure 21 Predicted CO Levels in Traffic Section IIA for the Year of Operation 2020

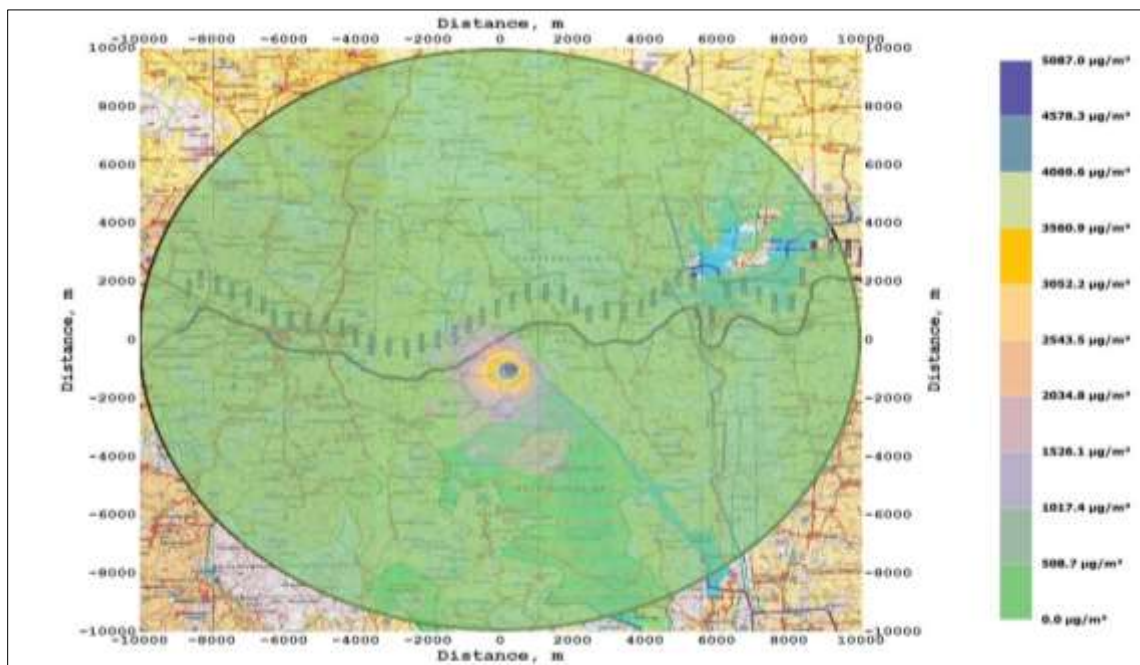


Figure 22 Predicted CO Levels in Traffic Section IIA for the Year 2040

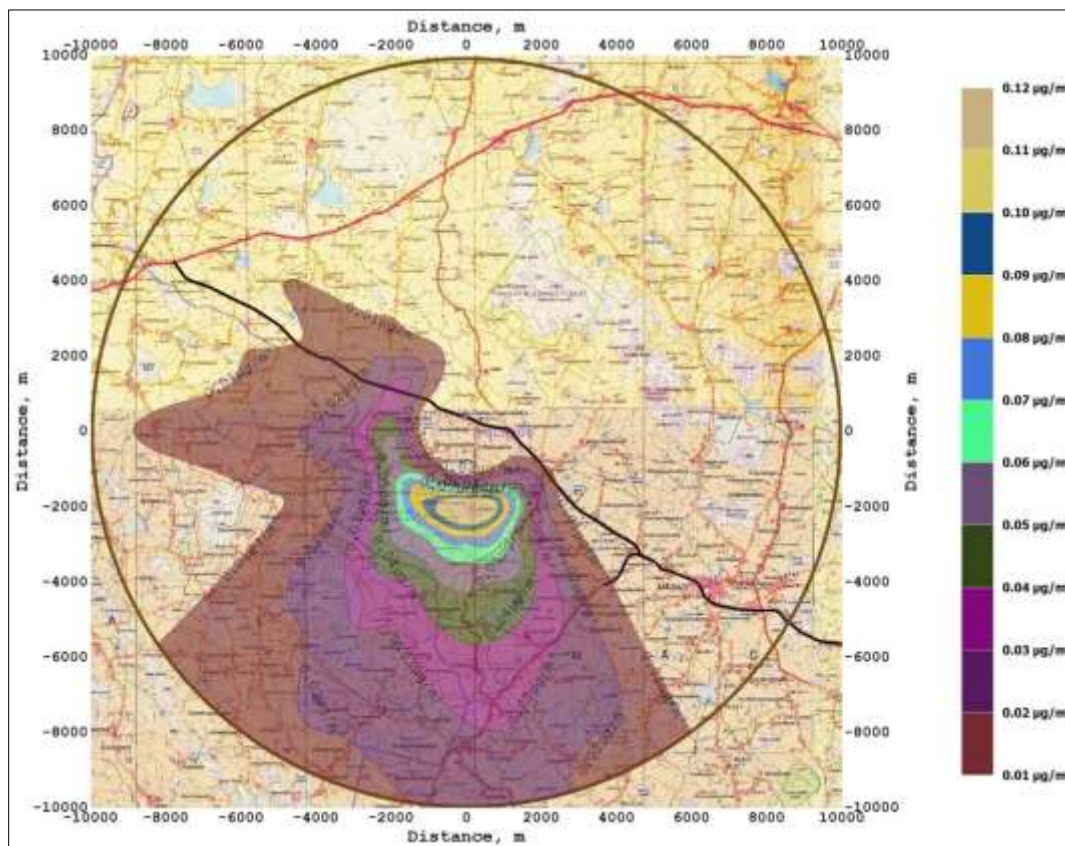


Figure 23 Predicted CO Levels in Traffic Section IIB for Base Year 2016

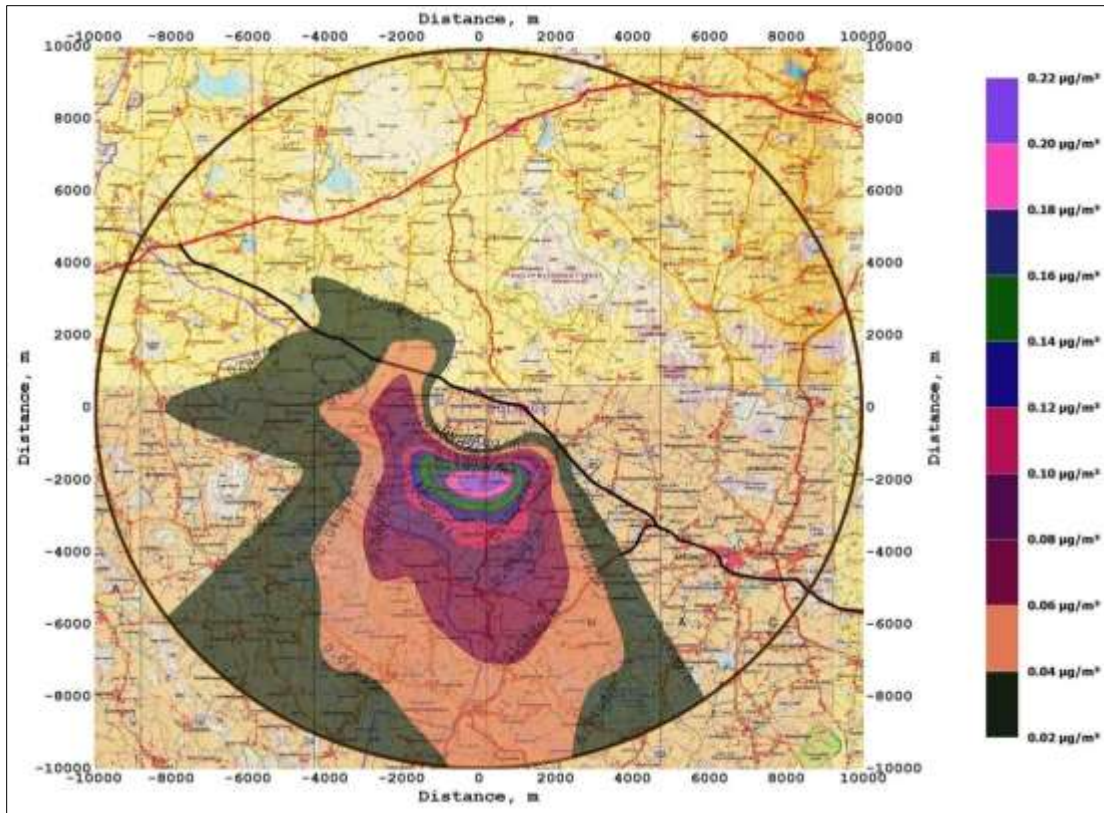


Figure 24 Predicted CO Levels in Traffic Section IIB for the Year of Operation 2020

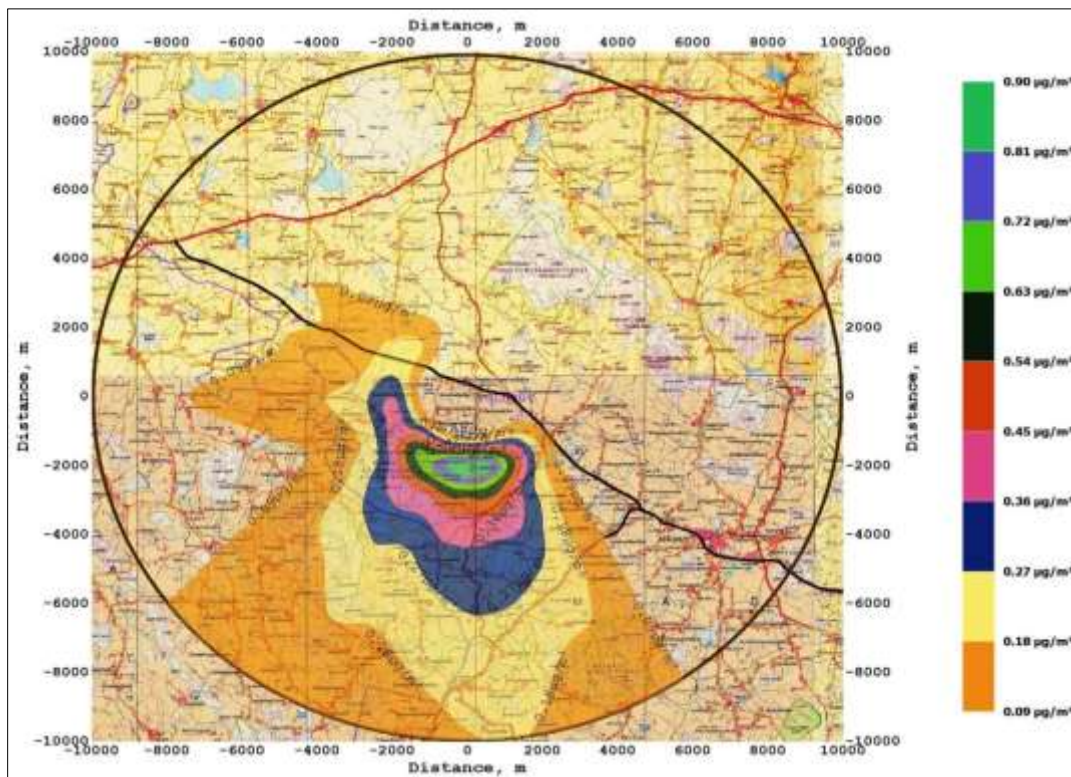


Figure 25 Predicted CO Levels in Traffic Section IIB for the Year 2040

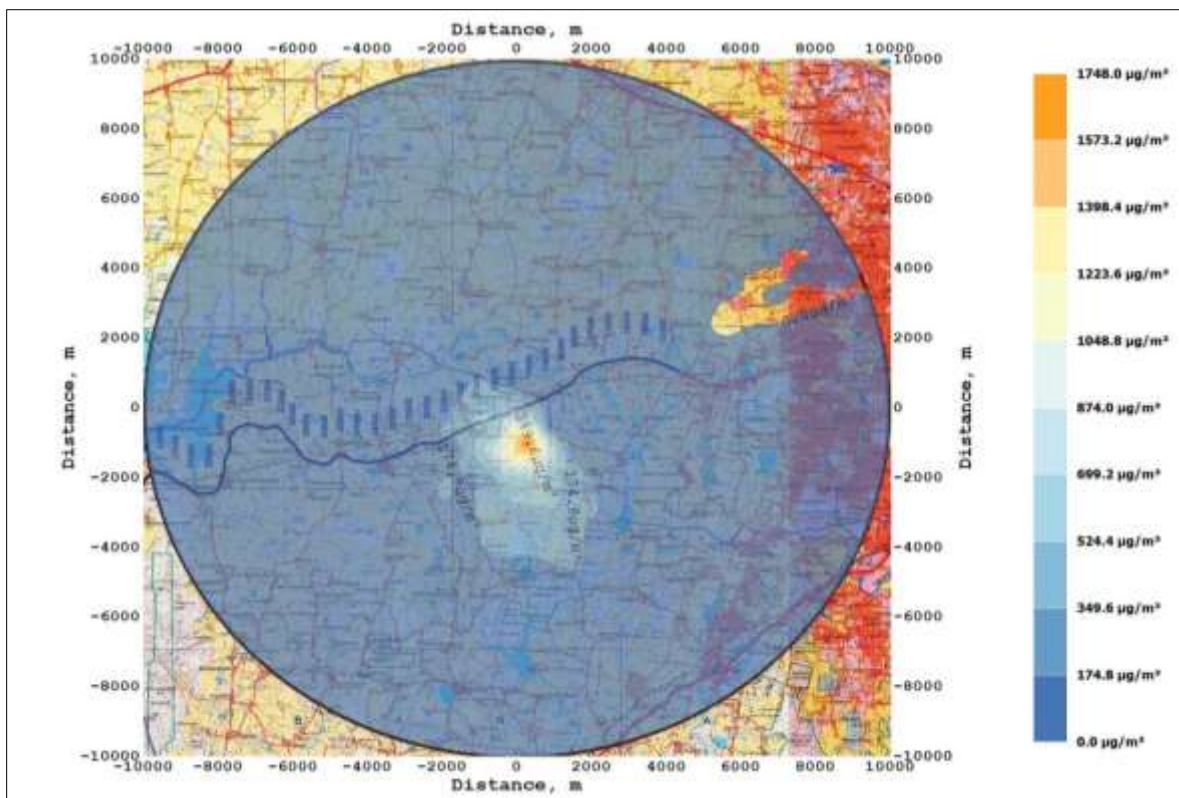


Figure 26 Predicted NO_x Levels in Traffic Section I for Base Year 2015

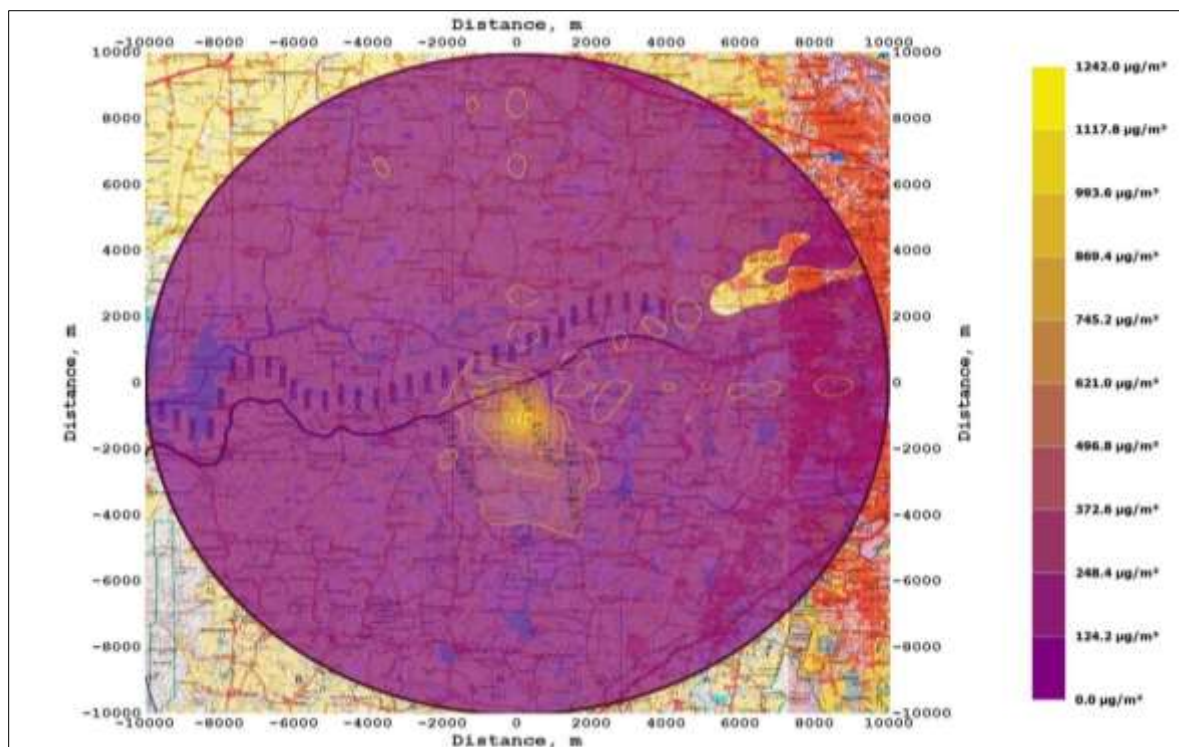


Figure 27 Predicted NO_x Levels in Traffic Section I for the Year of Operation 2020

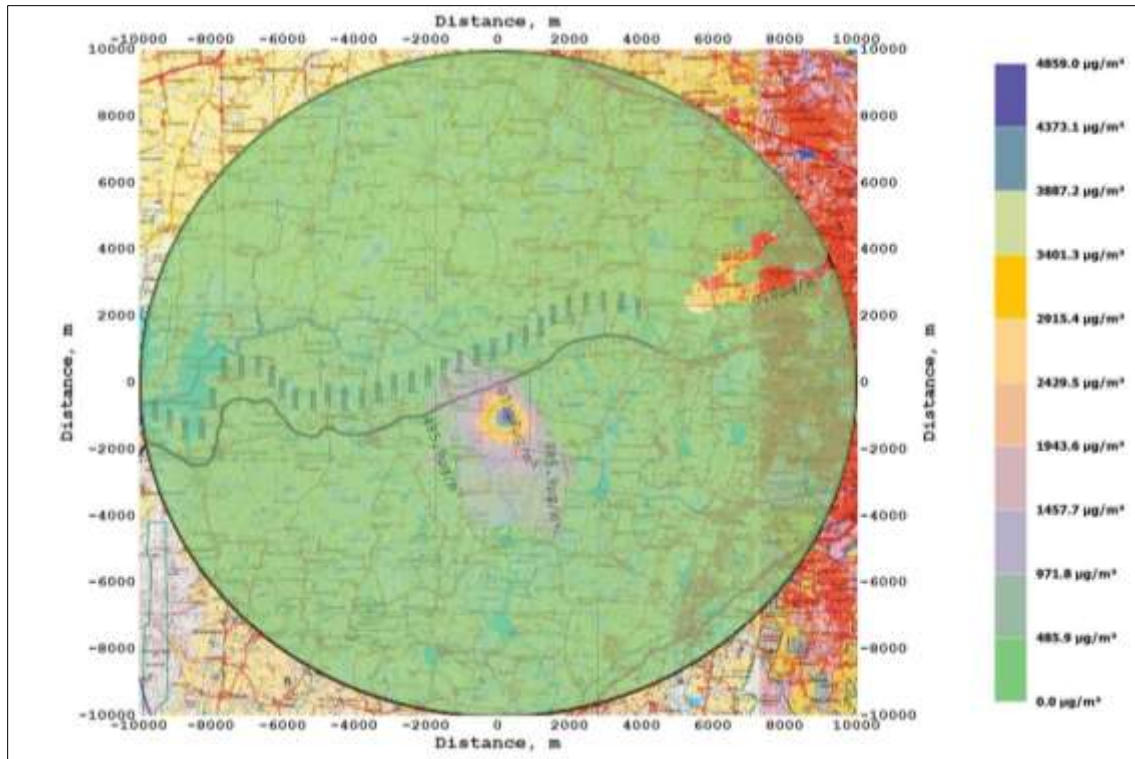


Figure 28 Predicted NO_x Levels in Traffic Section I for the Year 2040

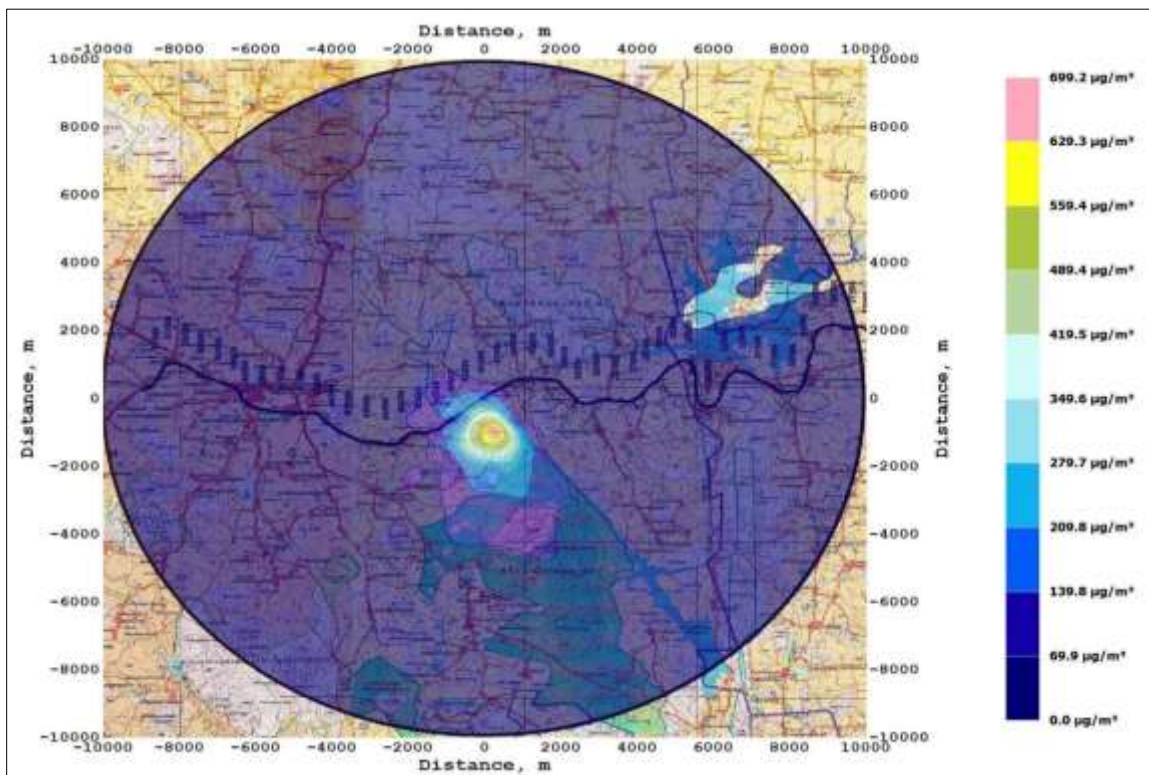


Figure 29 Predicted NO_x Levels in Traffic Section IIA for Base Year 2015

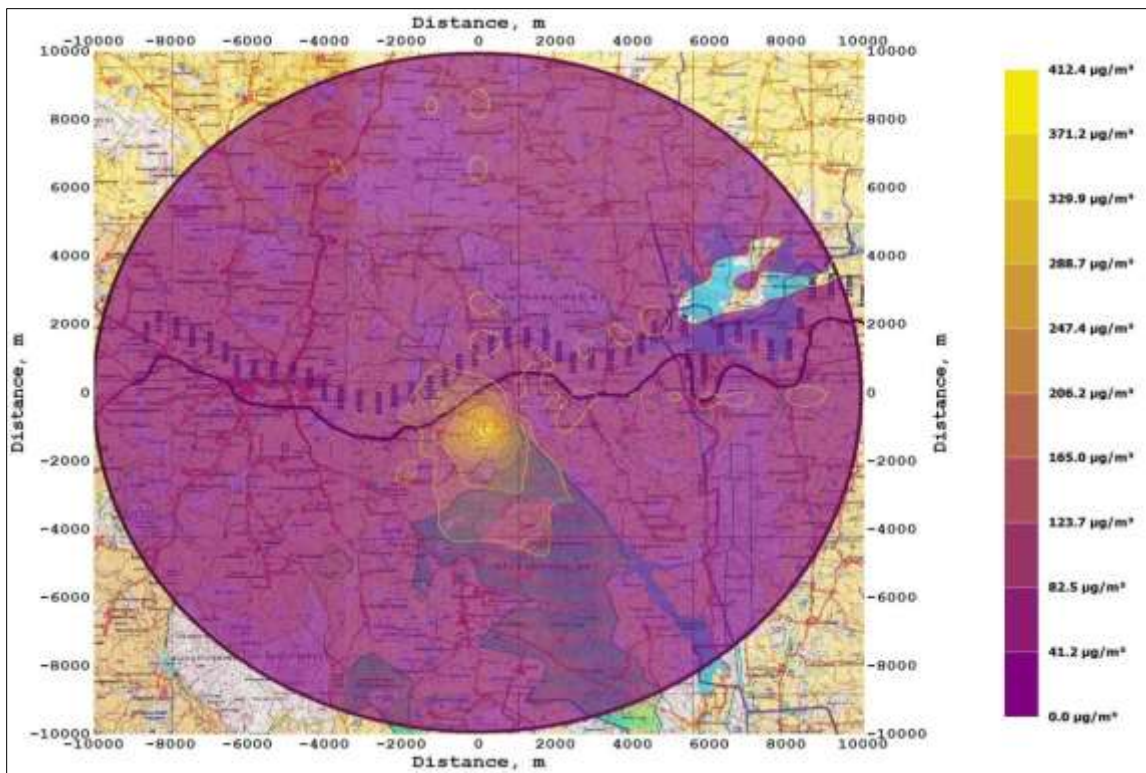


Figure 30 Predicted NO_x Levels in Traffic Section IIA for the Year of Operation 2020

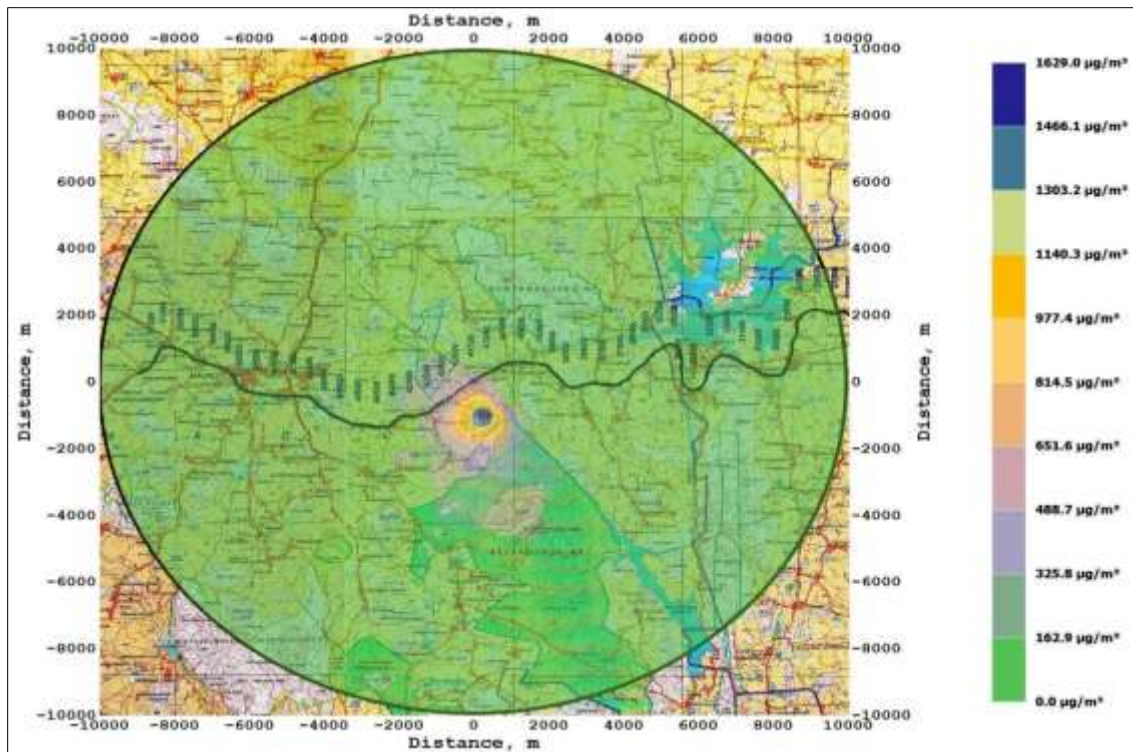


Figure 31 Predicted NO_x Levels in Traffic Section IIA for the Year 2040

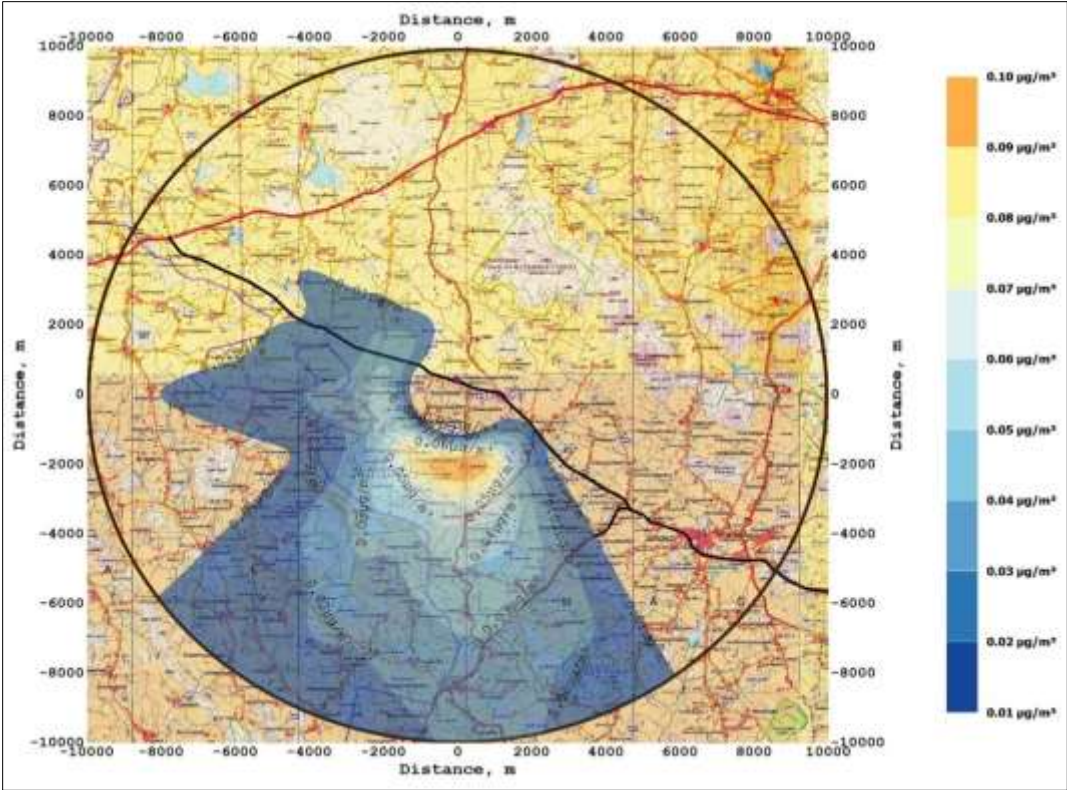


Figure 32 Predicted NO_x Levels in Traffic Section IIB for Base Year 2016

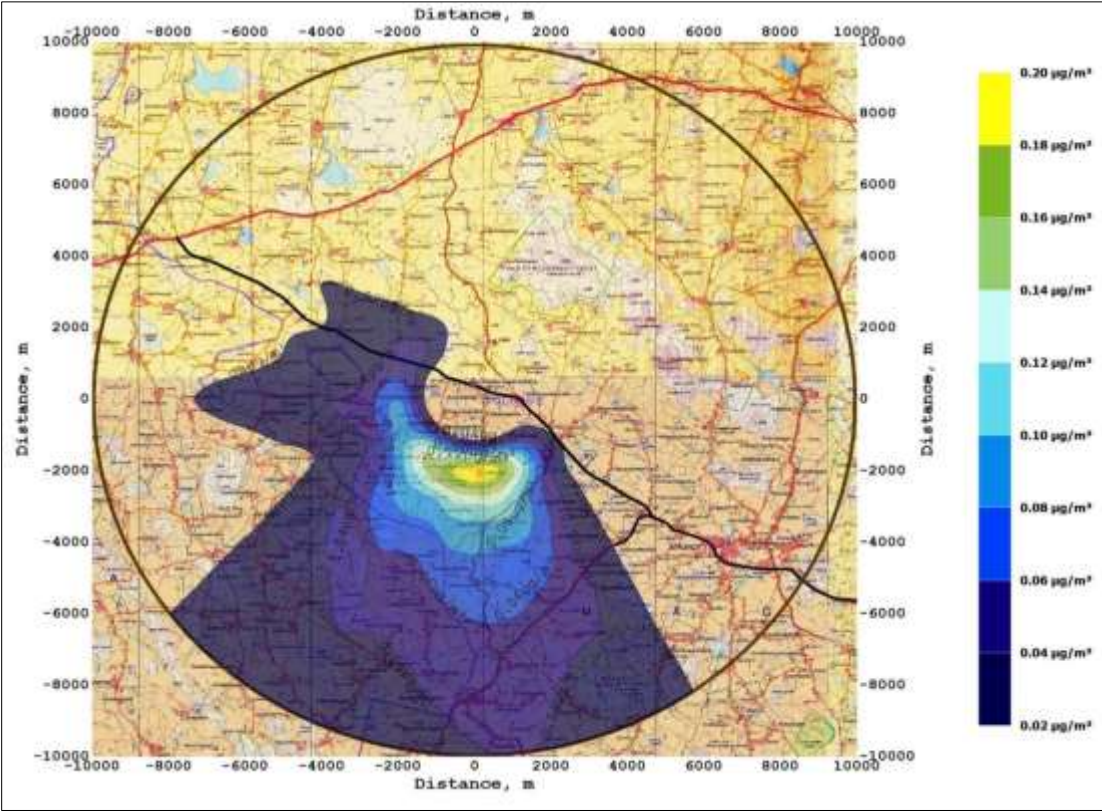


Figure 33 Predicted NO_x Levels in Traffic Section IIB for the Year of Operation 2020

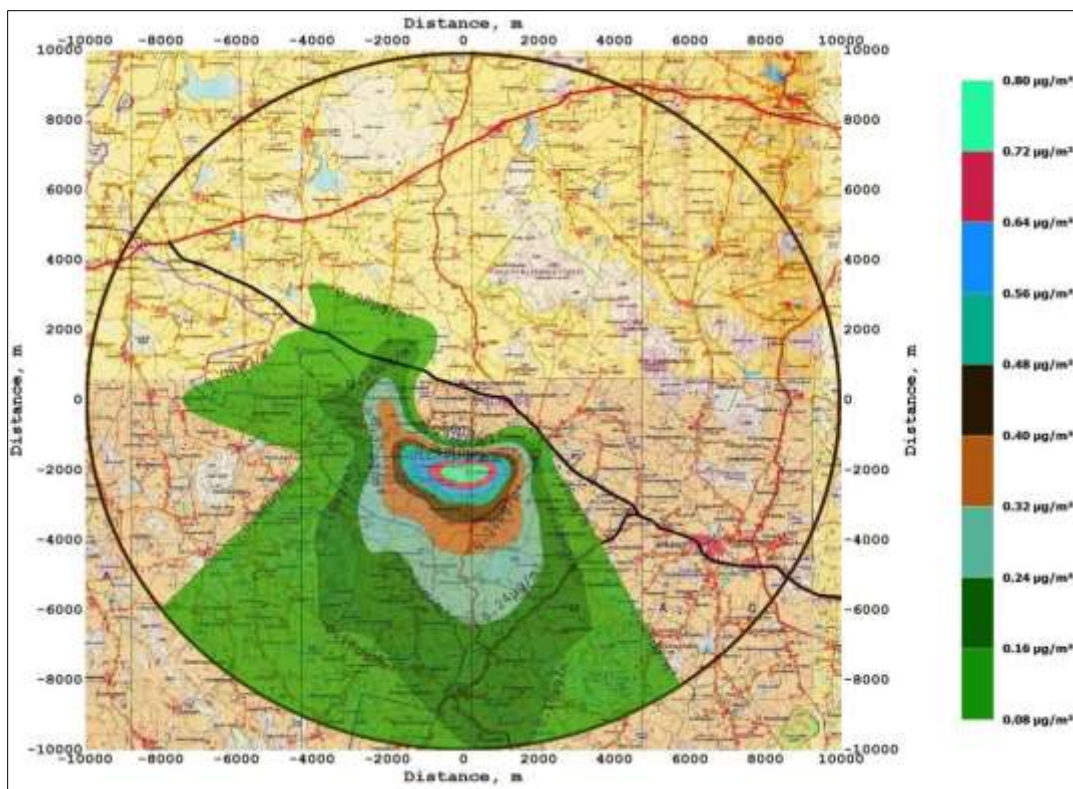


Figure 34 Predicted NO_x Levels in Traffic Section IIB for the Year 2040

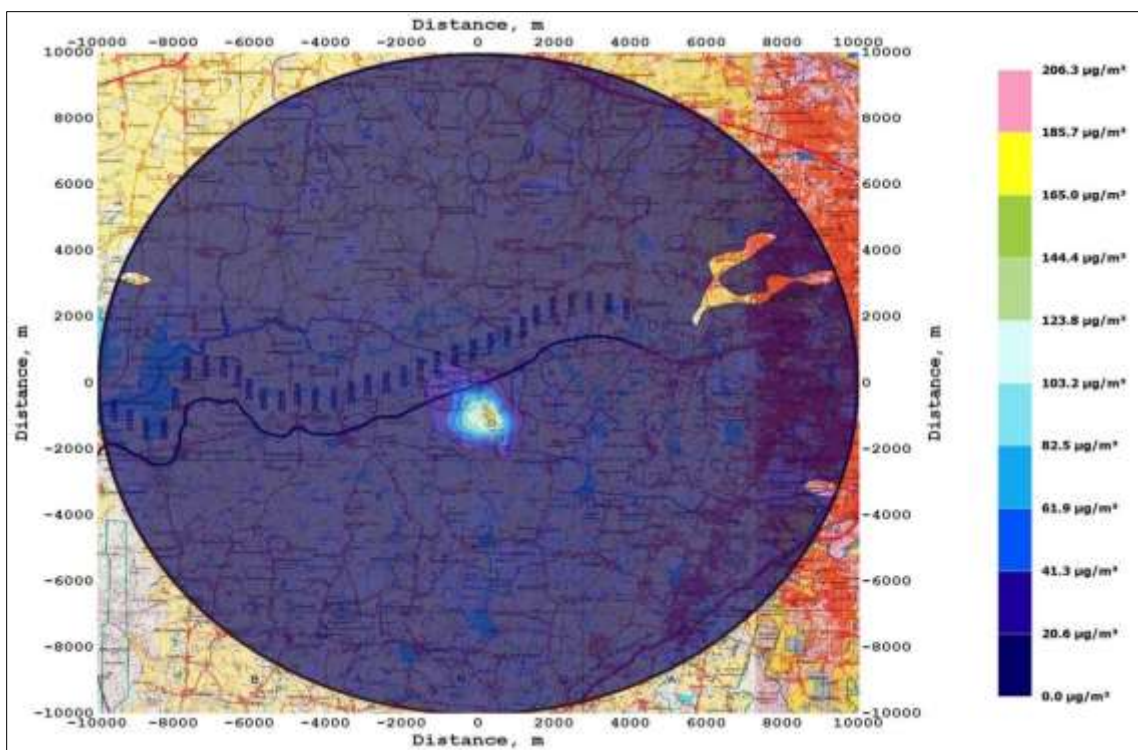


Figure 35 Predicted PM Levels in Traffic Section I for Base Year 2015

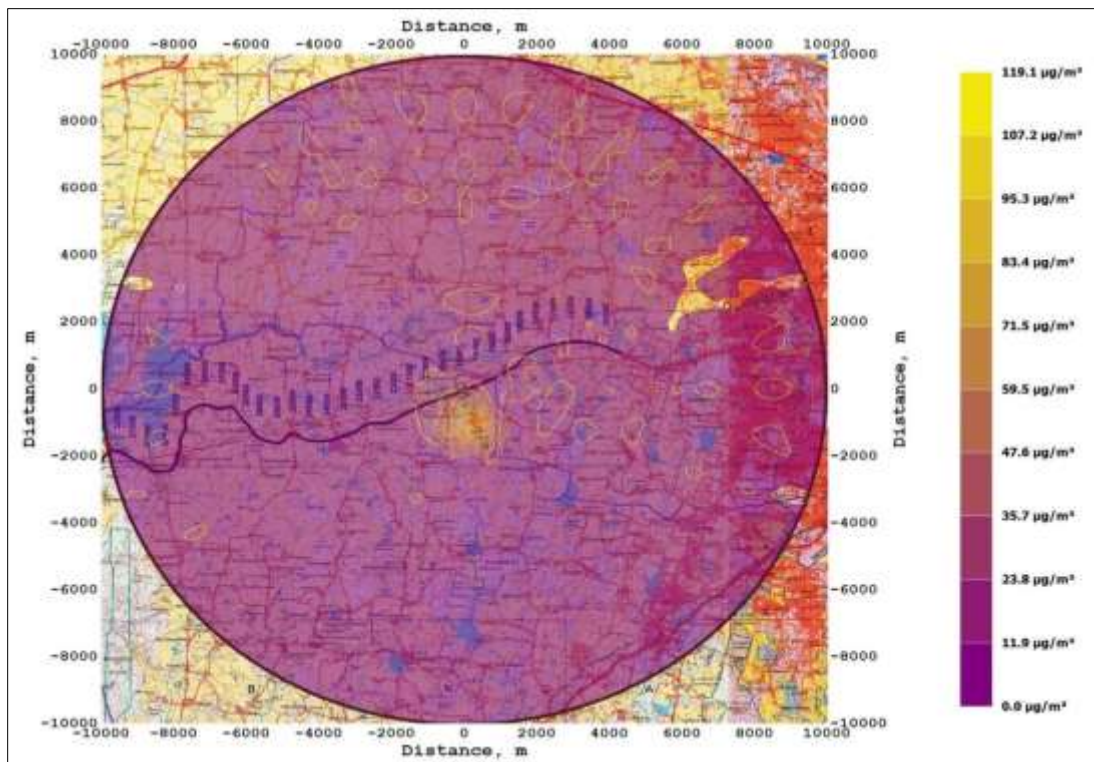


Figure 36 Predicted PM Levels in Traffic Section I for the Year of Operation 2020

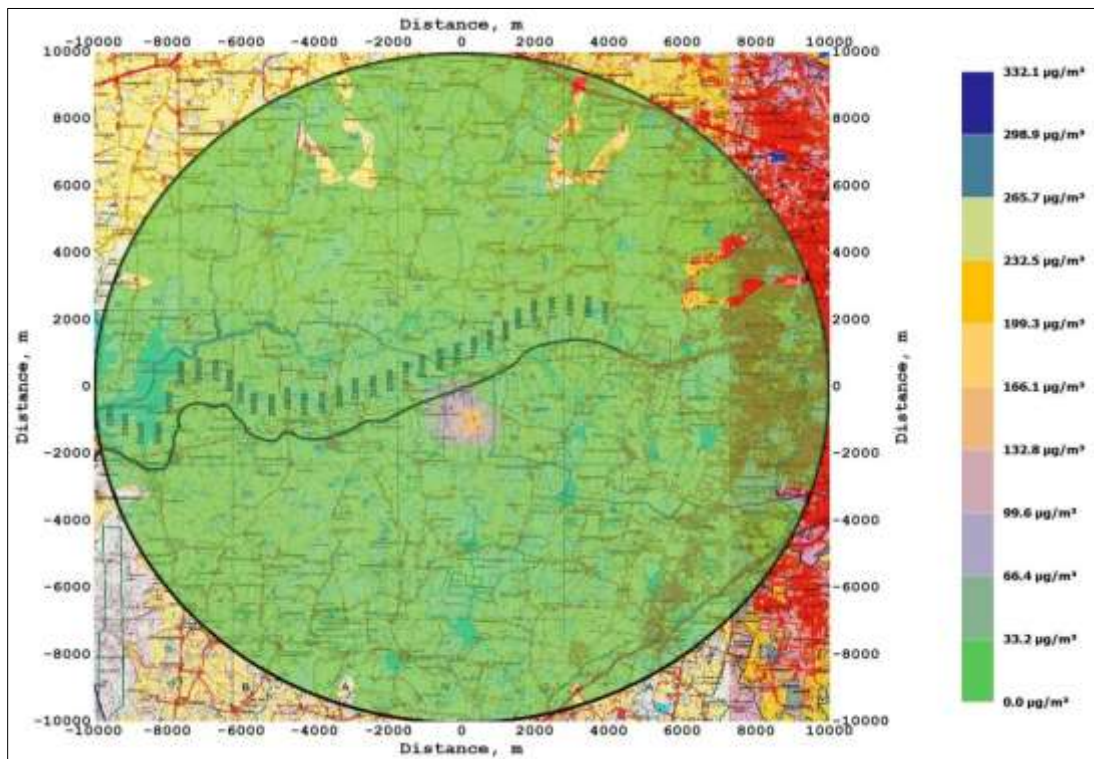


Figure 37 Predicted PM Levels in Traffic Section I for the Year 2040

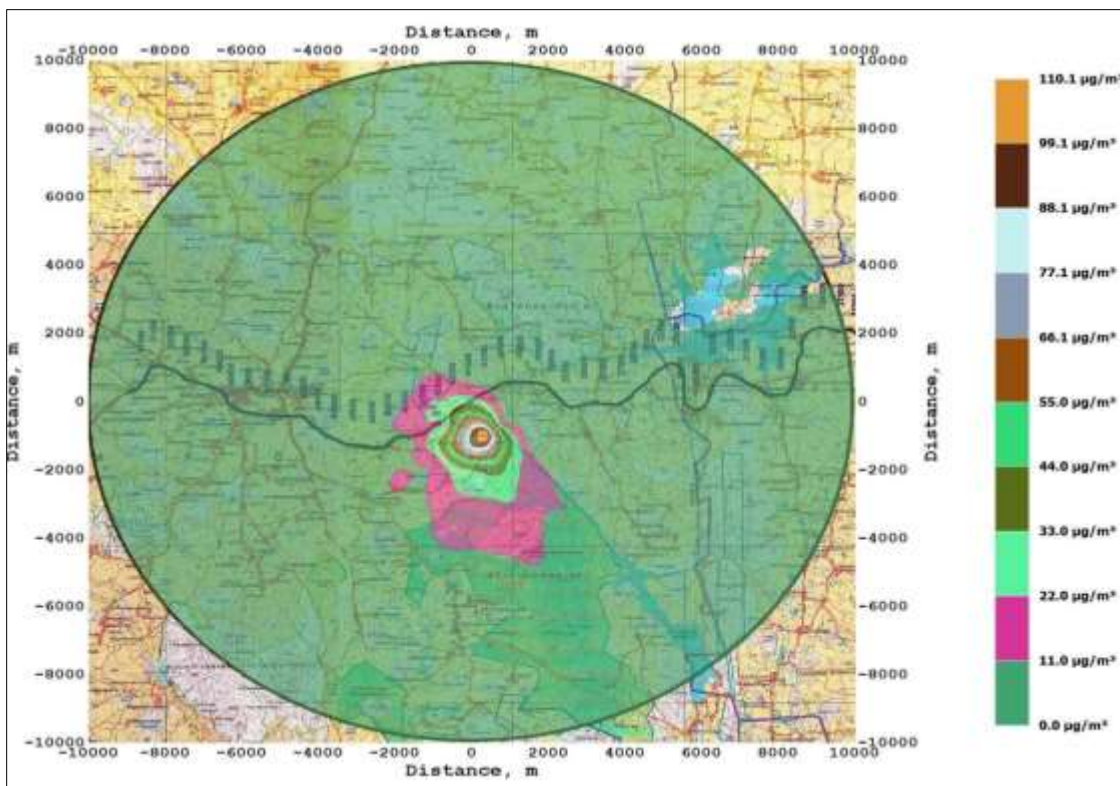


Figure 38 Predicted PM Levels in Traffic Section IIA for Base Year 2015

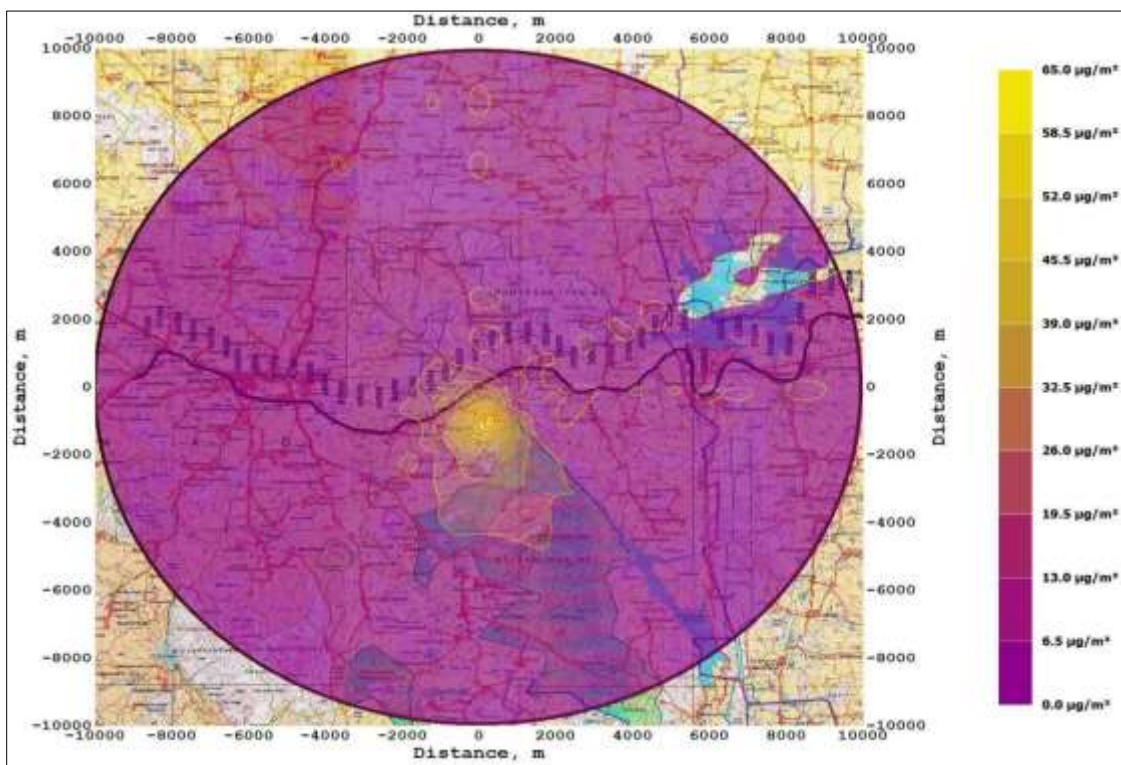


Figure 39 Predicted PM Levels in Traffic Section IIA for the Year of Operation 2020

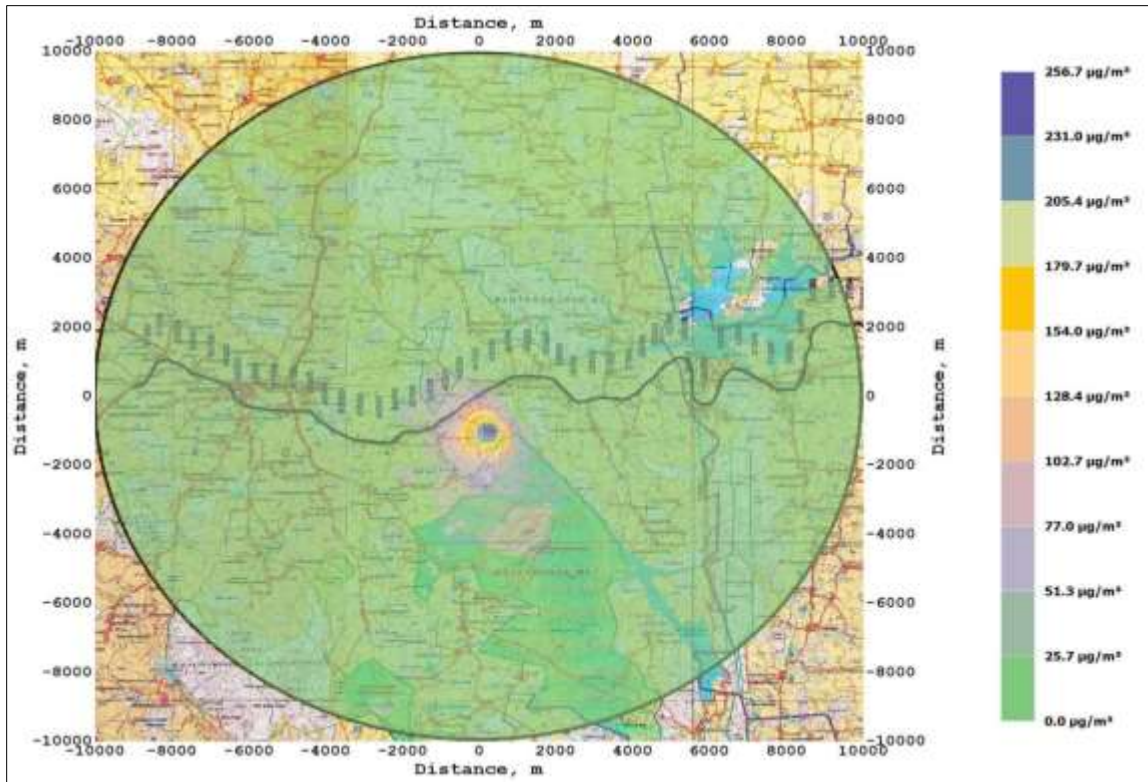


Figure 40 Predicted PM Levels in Traffic Section IIA for the Year 2040

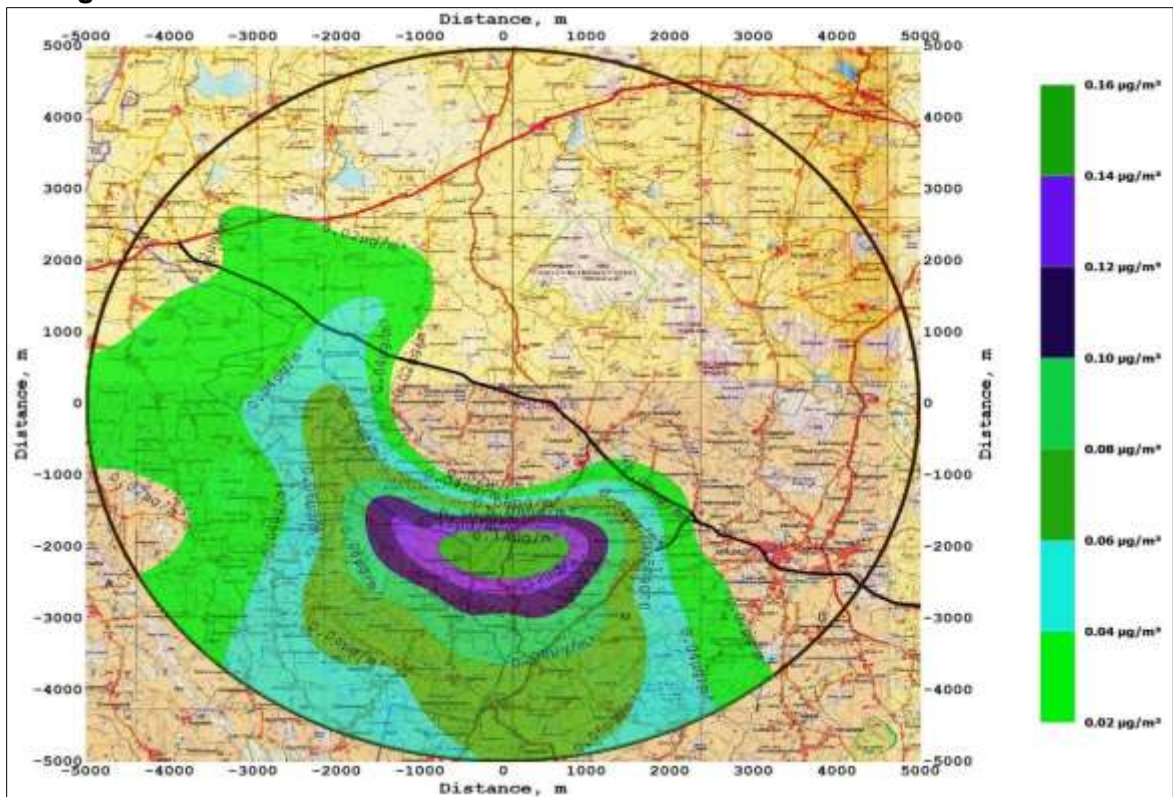


Figure 41 Predicted PM Levels in Traffic Section IIB for Base Year 2016

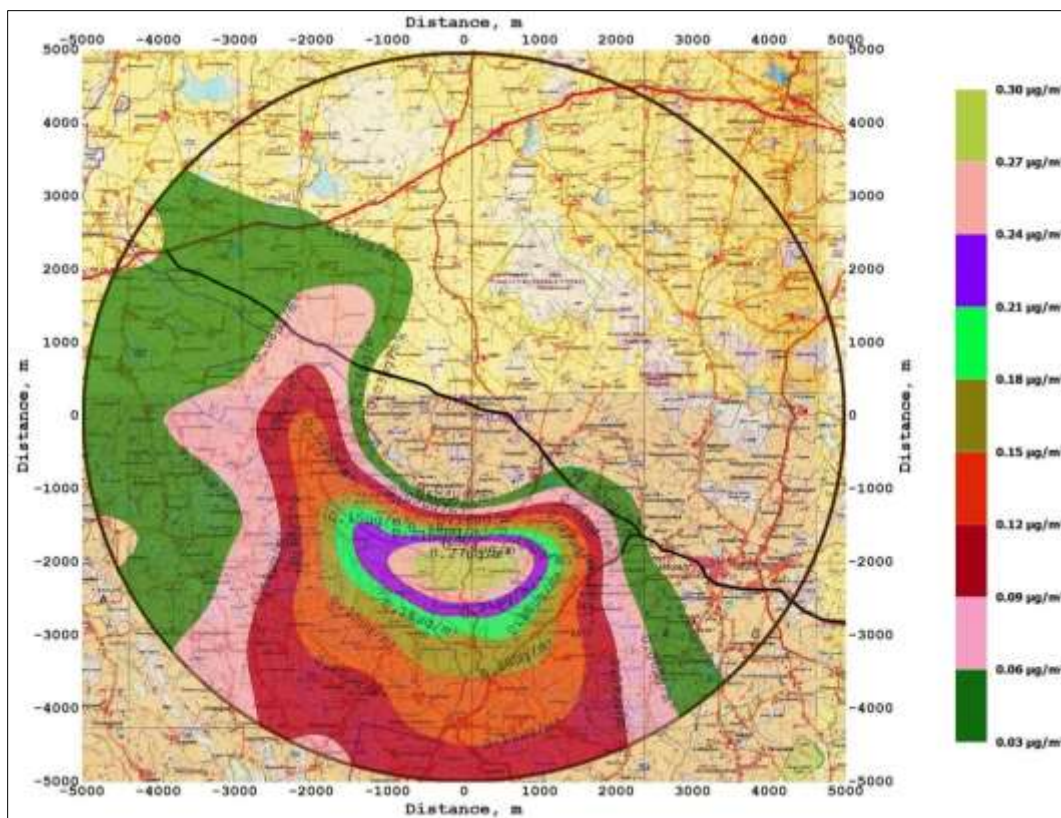


Figure 42 Predicted PM Levels in Traffic Section IIB for the Year of Operation 2020

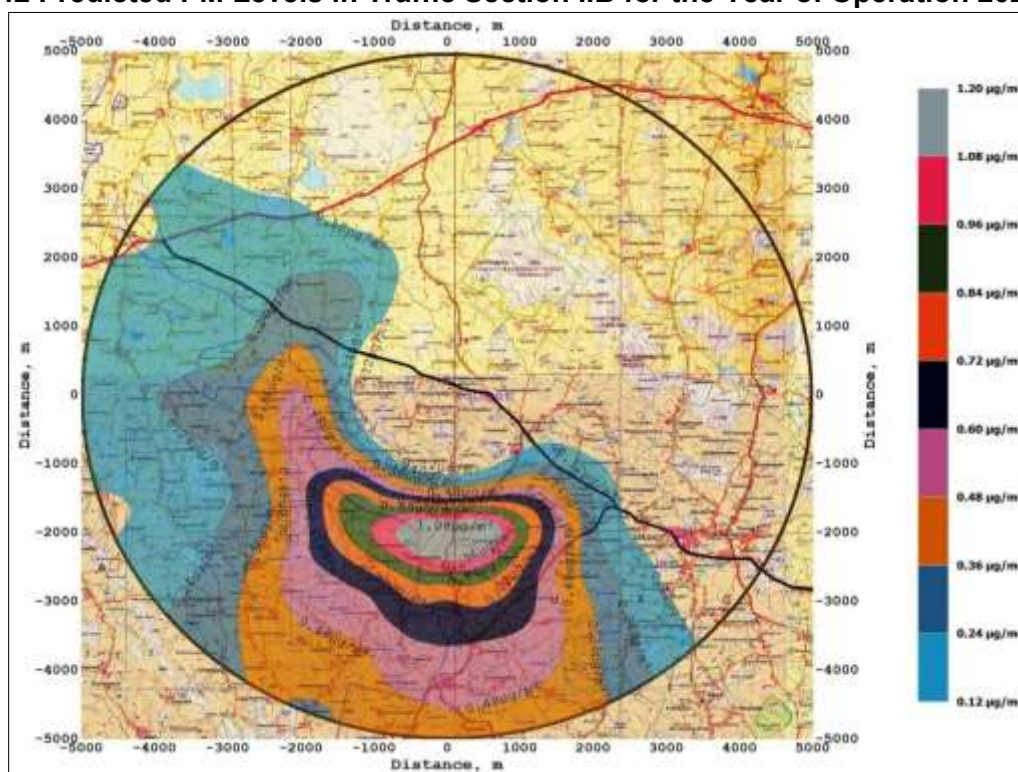


Figure 43 Predicted PM Levels in Traffic Section IIB for the Year 2040

291. **Prediction Results.** Analyses of modeling results ascertain that the predicted level of concentrations for all parameters along the project road in three 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 gravitational forces. 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 4-lane road. Thereafter, the concentration will gradually increase with the increase in the traffic flow.

292. **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,

293. 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 PM₁₀. 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.

294. 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]

σ_y = Standard deviation in y direction [L]

σ_z = 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]

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

296. **Receptors:** The complete road alignment has been drawn with respect to UTM coordinates. 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.

297. **Predicted Ground Level Concentrations:** The prediction of maximum ground level concentration on each road section has been carried out. The prediction for CO was conducted for 8-hourly concentrations, whereas for NO_x, SO₂ and PM₁₀, it was conducted for 24 hourly concentrations. Predicted concentrations on four homogenous section of the Project for CO, NO_x, and PM₁₀ and their spread around the road sections have been presented in **Figure-44** to **Figure-49**.

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

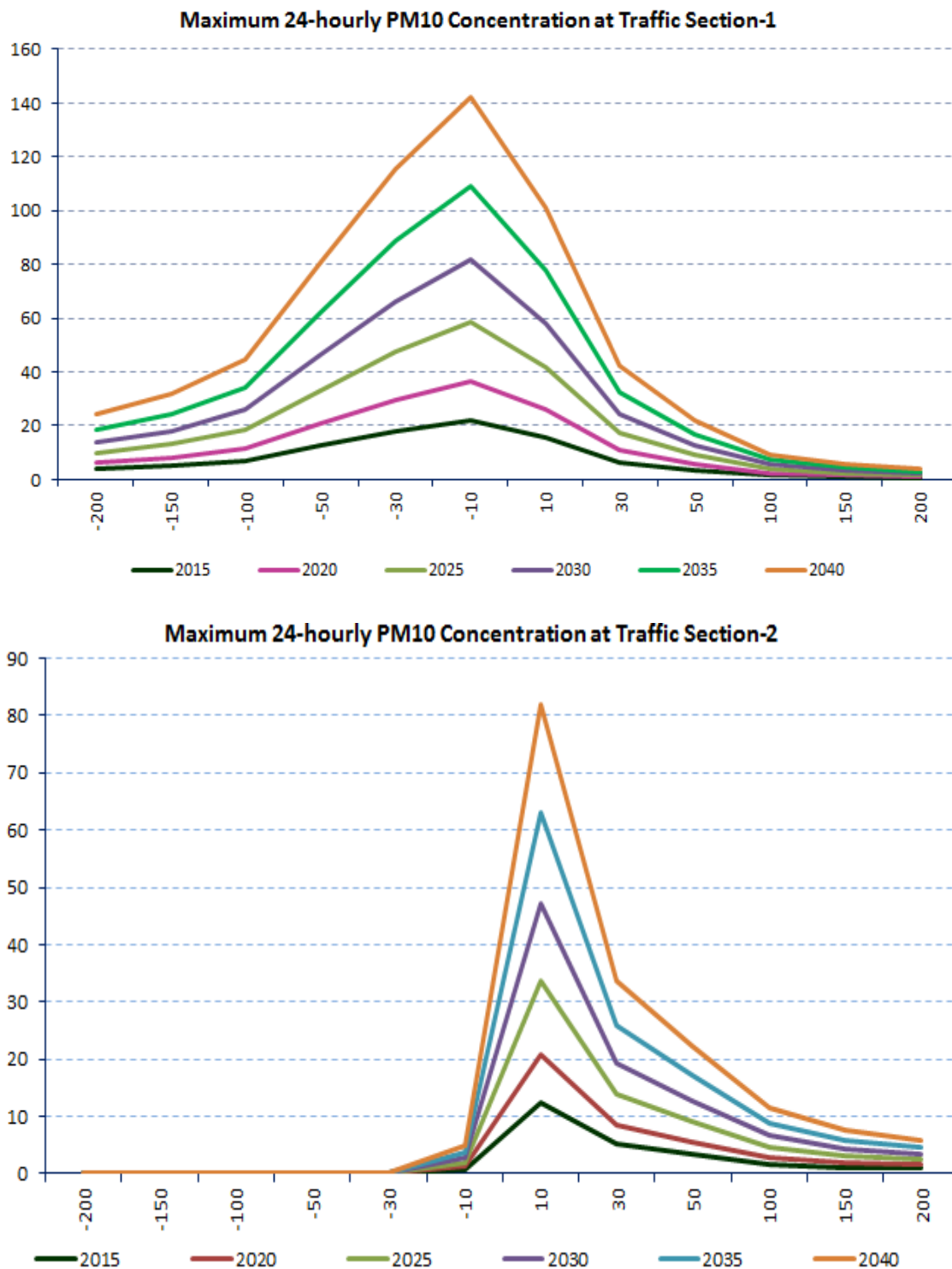


Figure 44 Maximum 24 Hourly PM₁₀ Concentration at Traffic Section-I and IIA

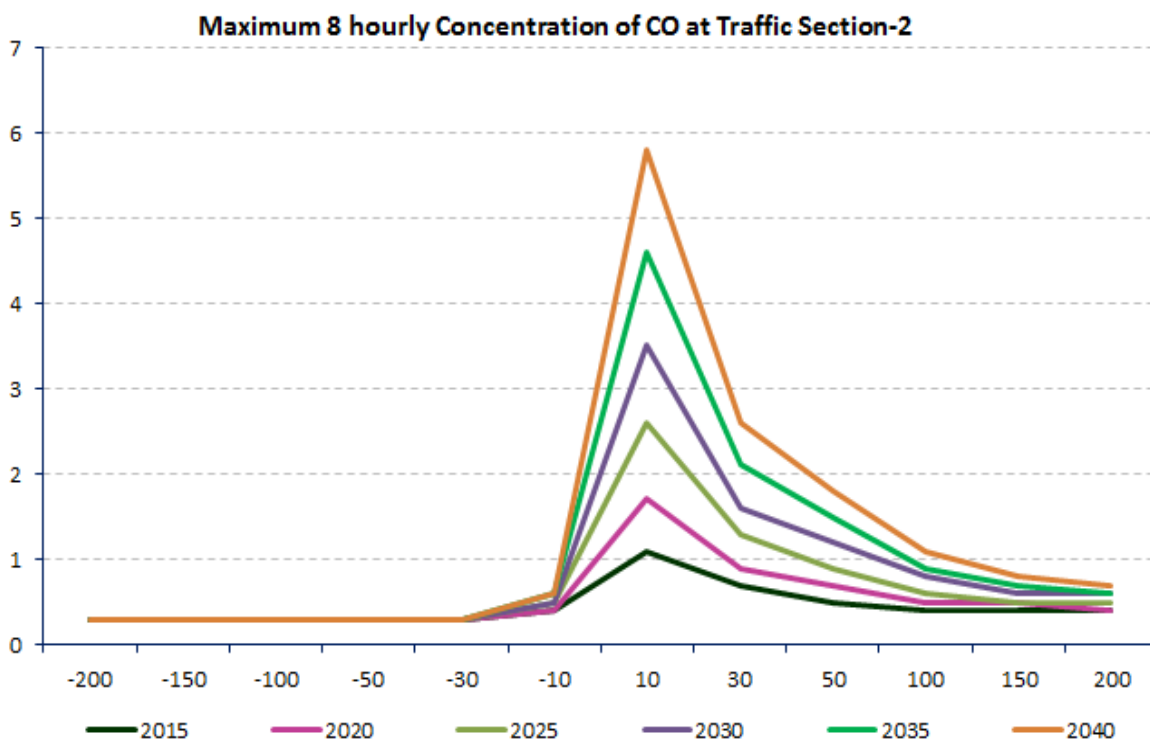
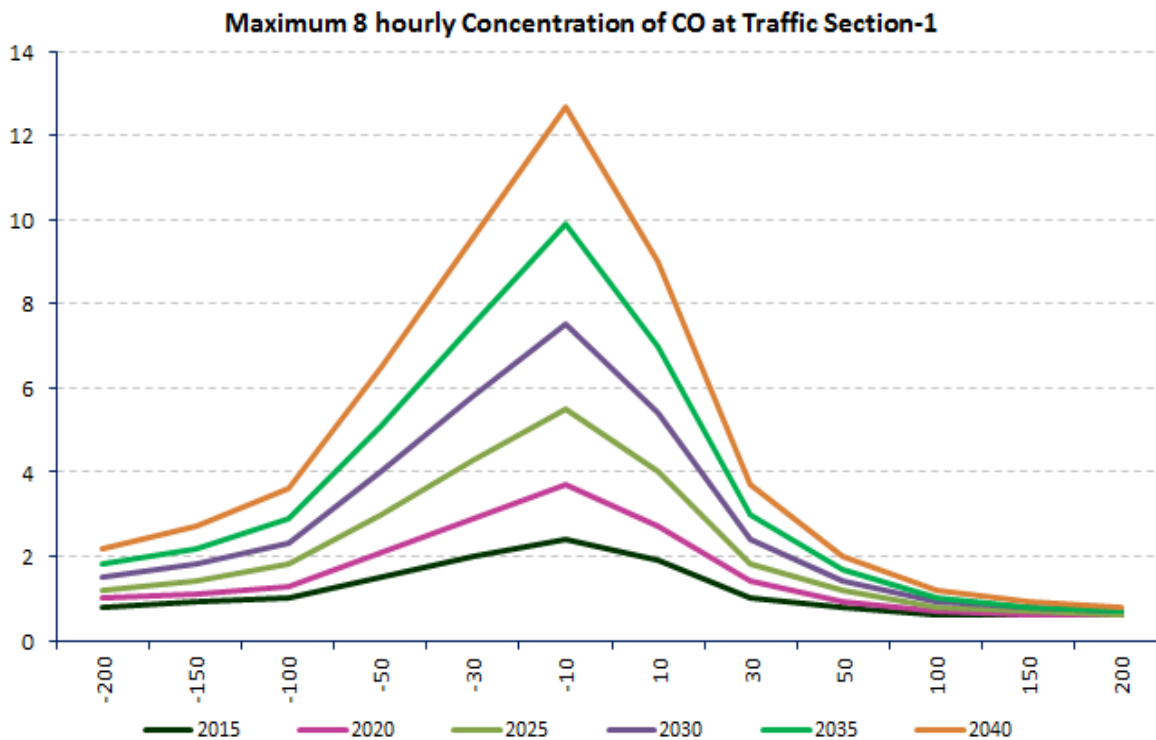


Figure 45: Maximum 24 Hourly CO Concentration at Traffic Section-I and IIA

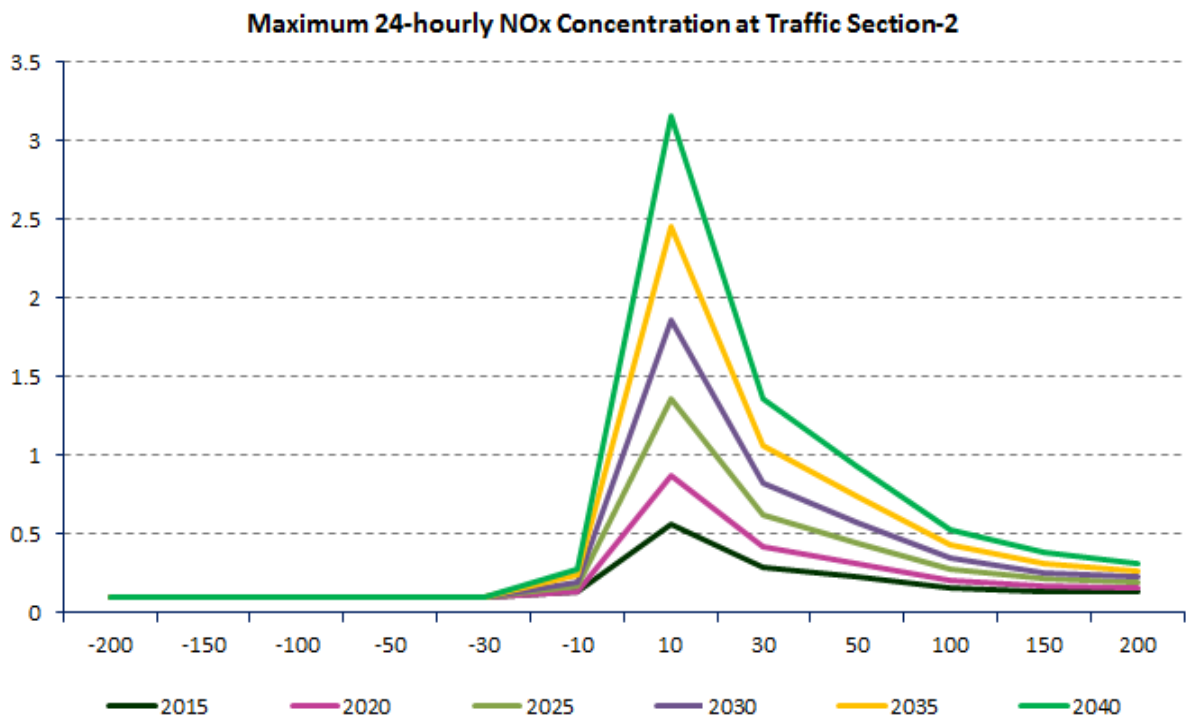
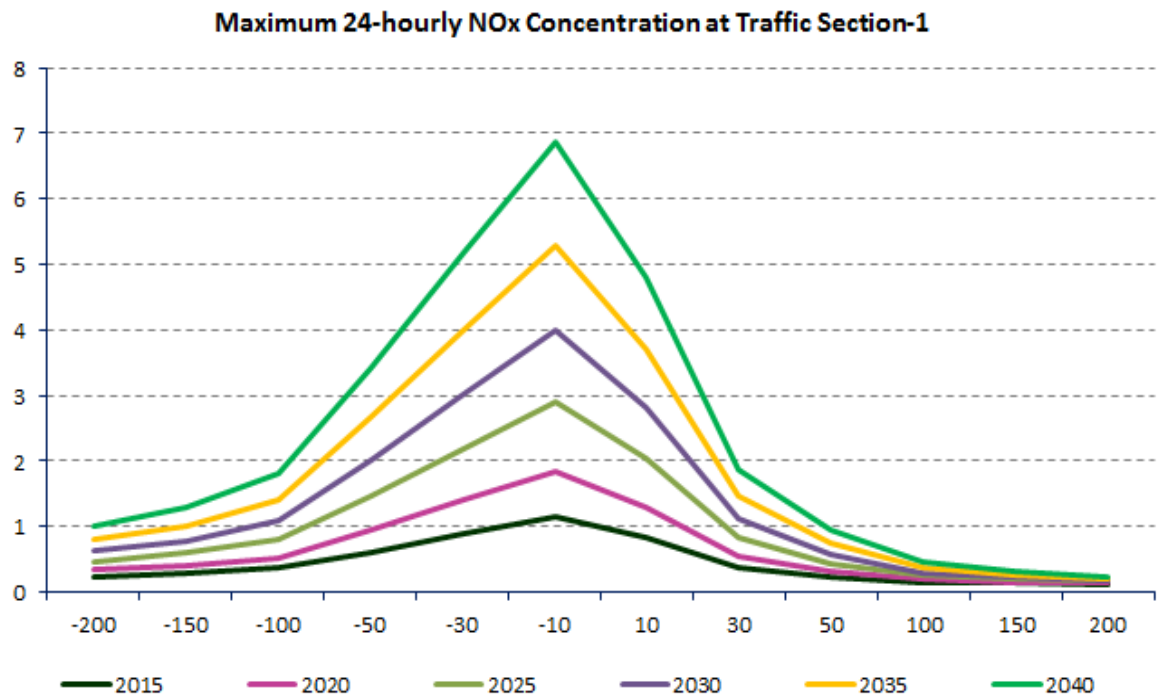


Figure 46 Maximum 24 Hourly NO_x Concentrations at Traffic Section-I and IIA

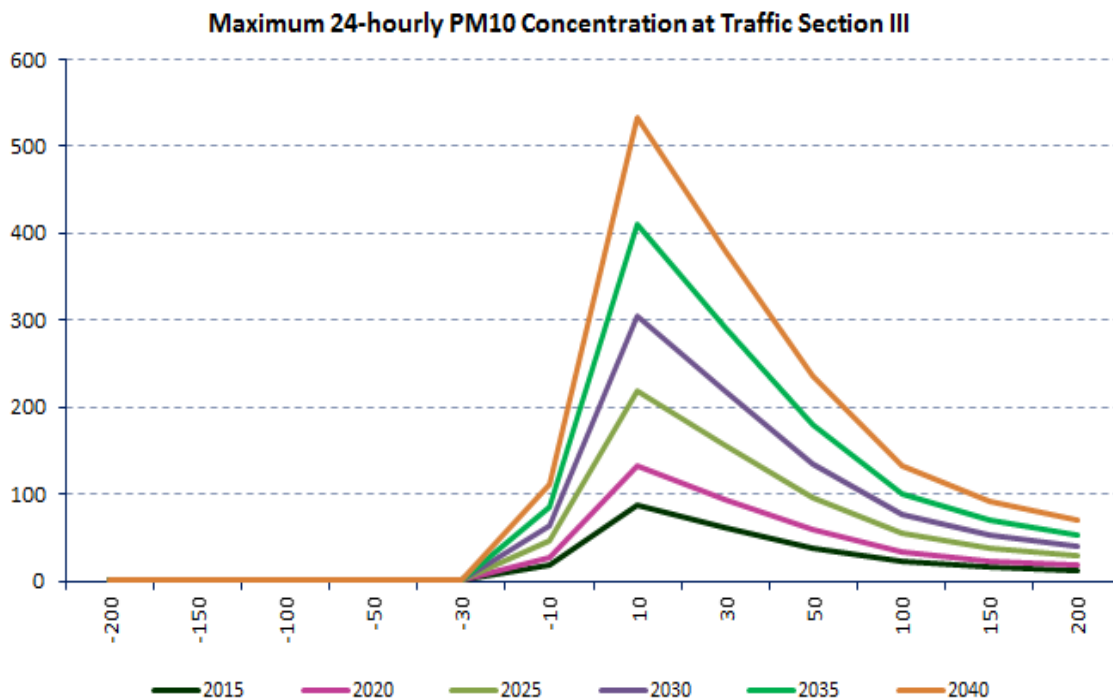


Figure 47 Maximum 24 Hourly PM₁₀ Concentration at Traffic Section-IIB

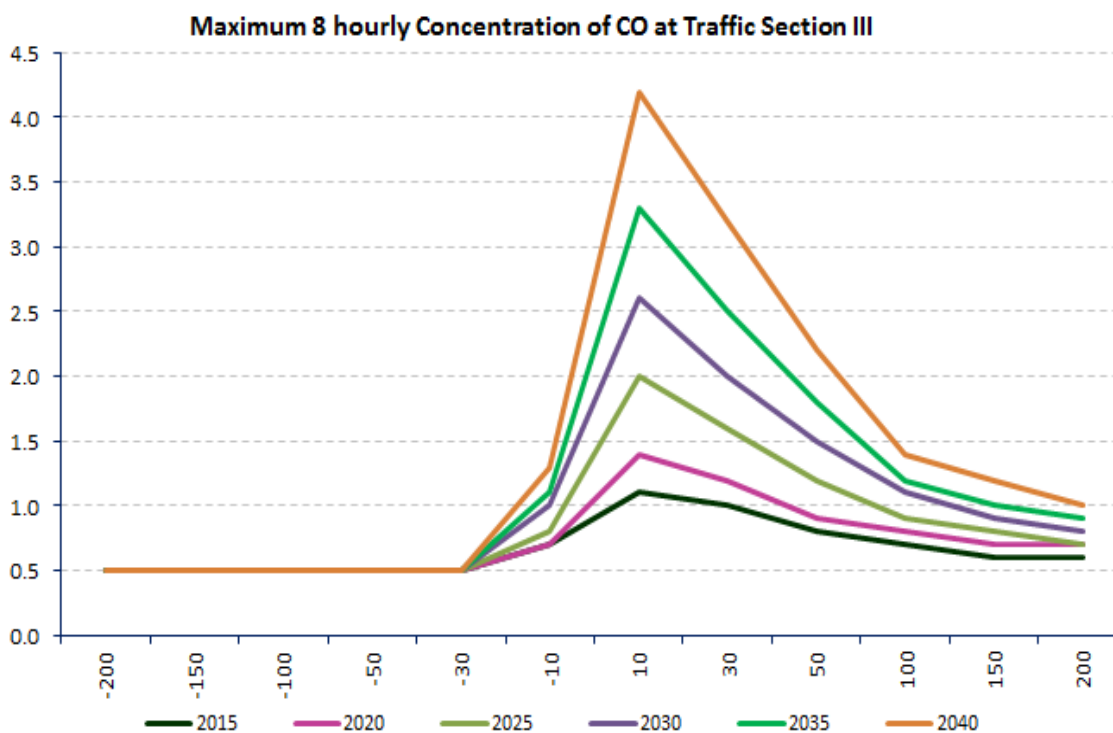


Figure 48 Maximum 24 Hourly CO Concentration at Traffic Section-IIB

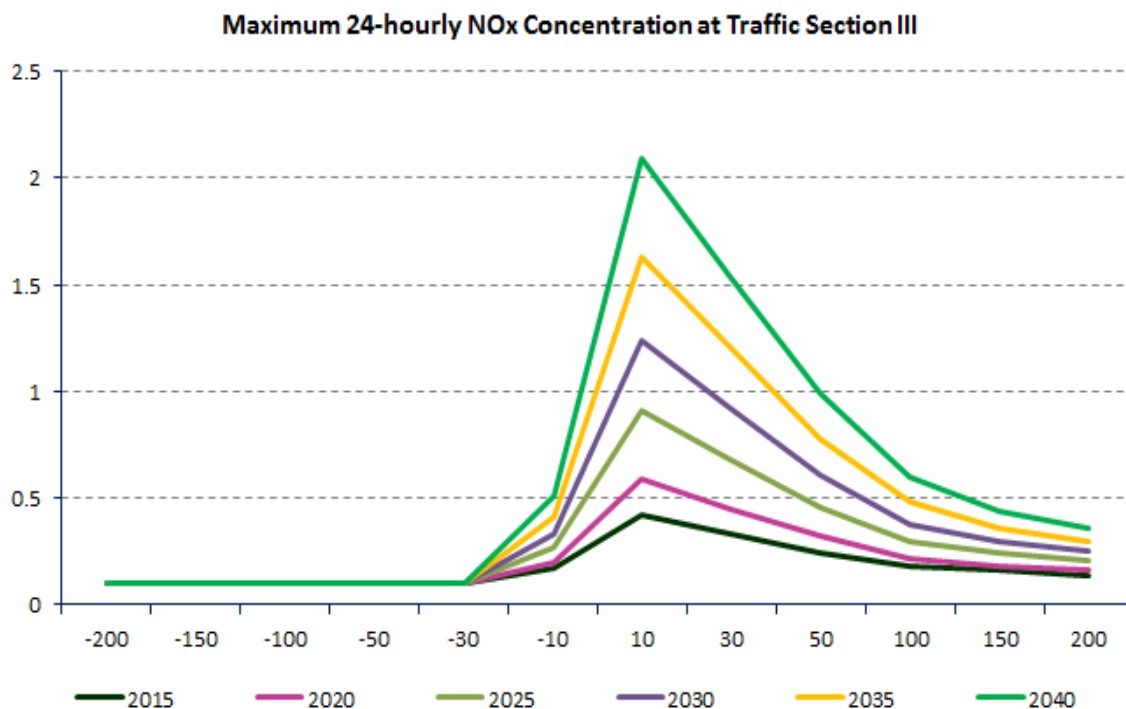


Figure 49: Maximum 24 Hourly NO_x Concentrations at Traffic Section-II B

299. 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

300. **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

301. 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.

302. 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.

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

304. 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 83 Typical Noise Level of various activities associated with Highway Projects

Sl. No.	Construction Activity	Noise Level dB(A)
1.	Grading & Clearing	84
2.	Excavation	89
3.	Foundations	88
4.	Erection	79
5.	Finishing	84

Note: Measured at Leq assuming 70 dB(A) ambient noise level

305. 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 84 Typical Noise Level of Principal Construction Equipment

Clearing		Structure Construction	
Equipment	Noise Level dB(A)	Equipment	Noise Level dB(A)
Bulldozer	80	Crane	75-77
Front end loader	72-84	Welding generator	71-82
Jack hammer	81-98	Concrete mixer	74-88
Crane with ball	75-87	Concrete pump	81-84
		Concrete vibrator	76
Excavation & Earth Moving		Air compressor	74-87
Bulldozer	80	Pneumatic tools	81-98
Backhoe	72-93	Bulldozer	80
Front end loader	72-84	Cement & dump trucks	83-94
Dump truck	83-94	Front end loader	72-84
Jack hammer	81-98	Dump truck	83-94

Clearing		Structure Construction	
Equipment	Noise Level dB(A)	Equipment	Noise Level dB(A)
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

306. 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).

$$SPL2 = SPL1 - 20\log_{10}(r_2/r_1)$$

Where, SPL1 and SPL2 are the sound pressure levels at distance r_1 and r_2 respectively.

307. 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 stationary source to meet the permissible noise limits during day time for different land use categories are given in Table-85.

Table 85 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

308. 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.

309. **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.

310. **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. 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

311. 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 (67.9%) followed by residential & commercial area (24.9%) and only residential area (7.3%). 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.

312. **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.

313. **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-50).

314. 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

⁶ U.S. Department of Transportation, Federal Highway Administration

stiffness from traffic loading. Finally, as the asphalt surface wears over time, the coarse aggregate becomes exposed which causes an increase in noise.

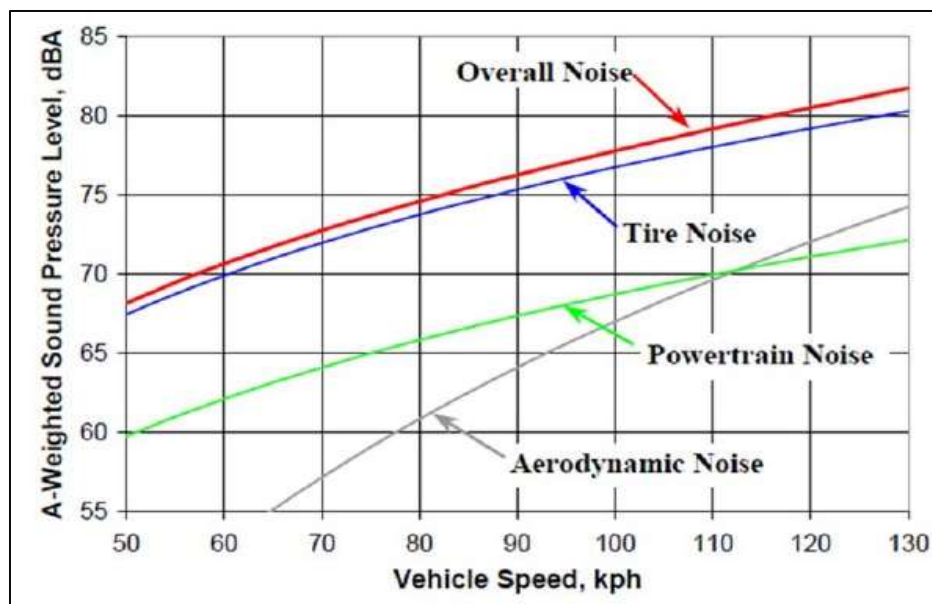


Figure 50 Comparison of Noise Level Separated by Component [Donovan, 2007]

315. **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 16 educational institutions. List of sensitive receptors where noise barrier has been proposed is given in Table-86:

Table 86 Location of Sensitive Receptors where Noise Barrier proposed

Sl. No.	Particulars	Village	Design Ch.	Dist. (m)	Height of Noise Barrier (m)	Length of Noise Barrier (m)
1.	Embassy Public School	Kachohalli	16+250	10.5	3.0	50.0
2.	Janaganga International School	Channenahalli	19+400	15.0	3.0	68.0
3.	Govt. Primary School	Chennanahalli	20+880	44.0	3.0	42.0
4.	Govt. Primary School,	Honnaganahatti	21+400	14.0	3.0	72.0
5.	SVN Convent & High School,	Honnaganahatti	21+480	12.0	3.0	23.0
6.	VES Model Convent School,	Tavarekere	23+200	16.0	3.0	47.0
7.	Govt. Primary & Middle School,	Tavarekere	23+755	12.0	3.0	42.0
8.	Govt. Primary School,	Cholnayakanahalli	30+055	13.0	3.0	27.0
9.	Govt. Primary School,	Gangapanhalli	31+050	12.5	3.0	16.0
10.	Govt. Primary School	Syananboganahalli	36+100	19.5	3.0	39.0
11.	Angels Nightingale Public School	Bachenahatti	37+650	15.0	3.0	33.0

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 LA_{eq} (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*).

Sl. No.	Particulars	Village	Design Ch.	Dist. (m)	Height of Noise Barrier (m)	Length of Noise Barrier (m)
12.	Govt. Primary School	Bachenahatti	39+060	11.5	3.0	42.0
13.	Govt. High School	Bachenahatti	39+900	11.4	3.0	57.0
14.	Govt. Primary School	Karla Mangla	43+825	20.5	3.0	55.0
15.	Govt. Higher Primary School,	Magadi Town	47+240	7.0	3.0	47.0
16.	Govt. Higher Primary School	Kenchanahalli	60+930	8.9	3.0	26.0
Total Length of Noise Barrier						686.0

316. 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.

317. 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-87 and results of CRTN model is graphically presented (Figure-51 to 55) and Noise Contours near the sensitive receptors is shown (Figure 56 to 60) for 5 sensitive receptors for the year 2015, 2020 and 2040.

Table 87 Sensitive Receptor Wise Predicted Noise Levels⁸

Year→	2015	2020	2025	2030	2035	2040
Embassy Public School (ICSE), Kachohalli Village						
Traffic Noise in dB(A)	73.9	76.1	78.1	79.6	80.9	82
Noise at Receptor w/o Noise Barrier dB(A)	64.1	66.3	68.3	69.8	71.1	72.2
Noise at Receptor with Noise Barrier dB(A)	53.5	55.7	57.7	59.2	60.5	61.6
Reduction (dBA)	-10.6	-10.6	-10.6	-10.6	-10.6	-10.6
Janaganga International School, Channenahalli Village						
Traffic Noise in dB(A)	73.9	76.1	78.1	79.6	80.9	82
Noise at Receptor w/o Noise Barrier dB(A)	74.1	76.3	78.3	79.8	81.1	82.2
Noise at Receptor with Noise Barrier dB(A)	59.6	61.8	63.8	65.3	66.6	67.7
Reduction (dBA)	-14.5	-14.5	-14.5	-14.5	-14.5	-14.5
Govt. Primary School, Chennanahalli Village						
Traffic Noise in dB(A)	74.6	76.8	78.8	80.3	81.6	82.7
Noise at Receptor w/o Noise Barrier dB(A)	65.9	68.1	70.1	71.6	72.9	74
Noise at Receptor with Noise Barrier dB(A)	56.6	58.8	60.8	62.3	63.6	64.7
Reduction (dBA)	-9.3	-9.3	-9.3	-9.3	-9.3	-9.3
Govt. Primary School, Honnaganahatti Village						
Traffic Noise in dB(A)	74.4	76.6	78.6	80.1	81.4	82.5
Noise at Receptor w/o Noise Barrier dB(A)	76.2	78.4	80.4	81.9	83.2	84.3
Noise at Receptor with Noise Barrier dB(A)	60.6	62.8	64.8	66.3	67.6	68.7
Reduction (dBA)	-15.6	-15.6	-15.6	-15.6	-15.6	-15.6
SVN Convent & High School, Honnaganahatti Village						
Traffic Noise in dB(A)	74.4	76.6	78.6	80.1	81.4	82.5

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 Embassy Public School (ICSE), Kachohalli Village in 2040, the $LA_{eq, 1h}$ is only equivalent to 77.85 dB (A).

Year→	2015	2020	2025	2030	2035	2040
Noise at Receptor w/o Noise Barrier dB(A)	75.4	77.6	79.6	81.1	82.4	83.5
Noise at Receptor with Noise Barrier dB(A)	59.8	62	64	65.5	66.8	67.9
Reduction (dBA)	-15.6	-15.6	-15.6	-15.6	-15.6	-15.6
VES Model Convent School, Tavarekere						
Traffic Noise in dB(A)	73.9	76.1	78.1	79.6	80.9	82
Noise at Receptor w/o Noise Barrier dB(A)	70.9	73.1	75.1	76.6	77.9	79
Noise at Receptor with Noise Barrier dB(A)	58.4	60.6	62.6	64.1	65.4	66.5
Reduction (dBA)	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5
Govt. Primary & Middle School, Tavarekere						
Traffic Noise in dB(A)	73.9	76.1	78.1	79.6	80.9	82
Noise at Receptor w/o Noise Barrier dB(A)	67.3	69.5	71.5	73	74.3	75.4
Noise at Receptor with Noise Barrier dB(A)	55.5	57.7	59.7	61.2	62.5	63.6
Reduction (dBA)	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8
Govt. Primary School, Cholnayakanahalli Village						
Traffic Noise in dB(A)	70.6	72.9	75	76.5	77.7	78.8
Noise at Receptor w/o Noise Barrier dB(A)	71.8	74.1	76.2	77.7	78.9	80
Noise at Receptor with Noise Barrier dB(A)	57.6	59.9	62	63.5	64.7	65.8
Reduction (dBA)	-14.2	-14.2	-14.2	-14.2	-14.2	-14.2
Govt. Primary School, Gangapanhalli Village						
Traffic Noise in dB(A)	71.6	73.9	76	77.5	78.7	71.6
Noise at Receptor w/o Noise Barrier dB(A)	69.4	71.7	73.8	75.3	76.5	69.4
Noise at Receptor with Noise Barrier dB(A)	55.8	58.1	60.2	61.7	62.9	55.8
Reduction (dBA)	-13.6	-13.6	-13.6	-13.6	-13.6	-13.6
Govt. Primary School, Syananboganahalli Village						
Traffic Noise in dB(A)	79.8	71.6	73.9	76	77.5	78.7
Noise at Receptor w/o Noise Barrier dB(A)	77.6	71.3	73.6	75.7	77.2	78.4
Noise at Receptor with Noise Barrier dB(A)	64	53.8	56.1	58.2	59.7	60.9
Reduction (dBA)	-13.6	-17.5	-17.5	-17.5	-17.5	-17.5
Angels Nightingale Public School, Bachenahatti Village						
Traffic Noise in dB(A)	70.6	72.9	75	76.5	77.7	78.8
Noise at Receptor w/o Noise Barrier dB(A)	68.2	70.5	72.6	61.2	75.3	76.4
Noise at Receptor with Noise Barrier dB(A)	55.3	57.6	59.7	74.1	62.4	63.5
Reduction (dBA)	-12.9	-12.9	-12.9	12.9	-12.9	-12.9
Govt. Primary School, Bachenahatti Village						
Traffic Noise in dB(A)	71.1	73.4	75.5	77	78.2	79.3
Noise at Receptor w/o Noise Barrier dB(A)	67.1	69.4	71.5	73	74.2	75.3
Noise at Receptor with Noise Barrier dB(A)	54.5	56.8	58.9	60.4	61.6	62.7
Reduction (dBA)	-12.6	-12.6	-12.6	-12.6	-12.6	-12.6
Govt. High School, Bachenahatti Village						
Traffic Noise in dB(A)	71.2	73.5	75.6	77.1	78.3	79.43
Noise at Receptor w/o Noise Barrier dB(A)	65.6	67.9	70	71.5	72.7	73.8
Noise at Receptor with Noise Barrier dB(A)	53.7	56	58.1	59.6	60.8	61.9
Reduction (dBA)	-11.9	-11.9	-11.9	-11.9	-11.9	-11.9
Govt. Primary School, Karla Mangla Village						
Traffic Noise in dB(A)	71.5	73.8	75.9	77.4	78.6	79.7
Noise at Receptor w/o Noise Barrier dB(A)	68.3	70.6	72.7	74.2	75.4	76.5
Noise at Receptor with Noise Barrier dB(A)	55.8	58.1	60.2	61.7	62.9	64
Reduction (dBA)	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5
Govt. Higher Primary School, MagadiTown						
Traffic Noise in dB(A)	71.7	74	76.1	77.6	78.8	79.9
Noise at Receptor w/o Noise Barrier dB(A)	72.7	75	77.1	78.6	79.8	80.9
Noise at Receptor with Noise Barrier dB(A)	55.6	57.9	60	61.5	62.7	63.8

Year→	2015	2020	2025	2030	2035	2040
Reduction (dBA)	-17.1	-17.1	-17.1	-17.1	-17.1	-17.1
Govt. Higher Primary School, Kenchanahalli						
Traffic Noise in dB(A)	66	70.5	72.7	73.9	75.2	76.4
Noise at Receptor w/o Noise Barrier dB(A)	64.5	69	71.2	72.4	73.7	74.9
Noise at Receptor with Noise Barrier dB(A)	50.1	54.6	56.8	58	59.3	60.5
Reduction (dBA)	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3

318. 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.

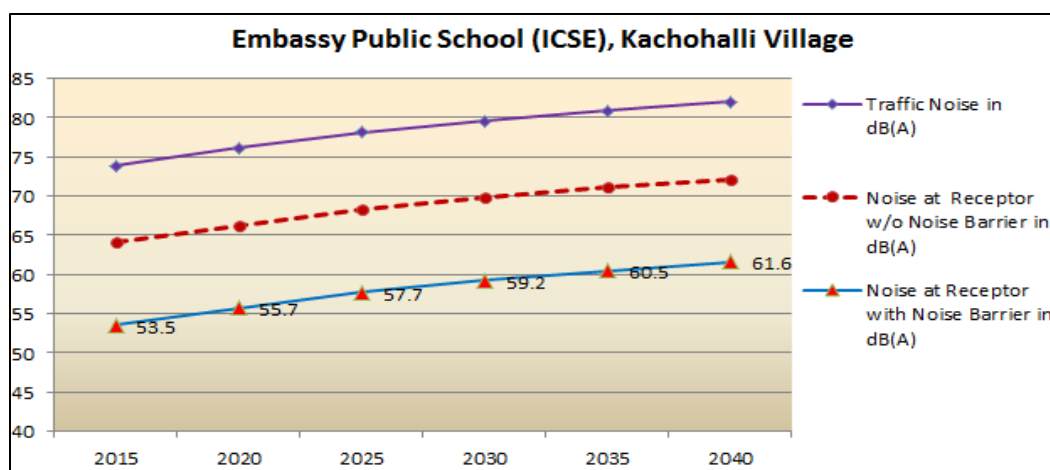


Figure 51 Noise Level at Embassy Public School (ICSE), Kachohalli Village with & without Noise Barrier

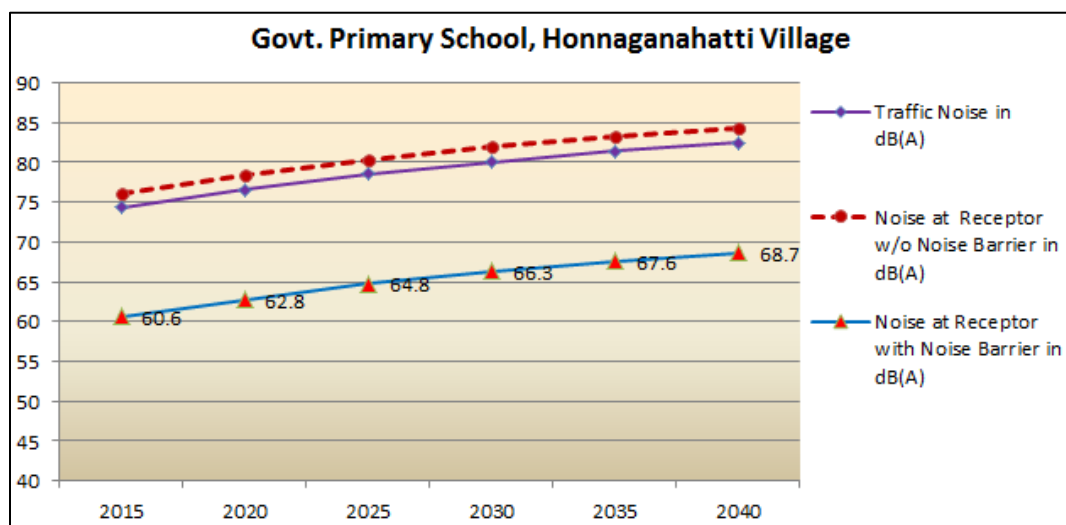


Figure 52 Noise Level at Govt. Primary School, Honnaganahatti Village with & without Noise Barrier

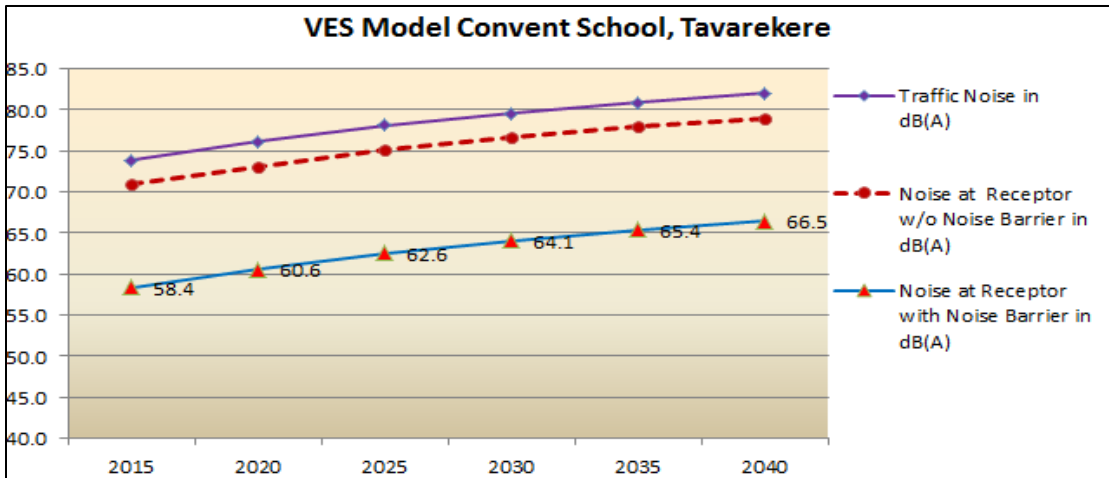


Figure 53 Noise Level at VES Model Convent School, Tavarekere with & without Noise Barrier

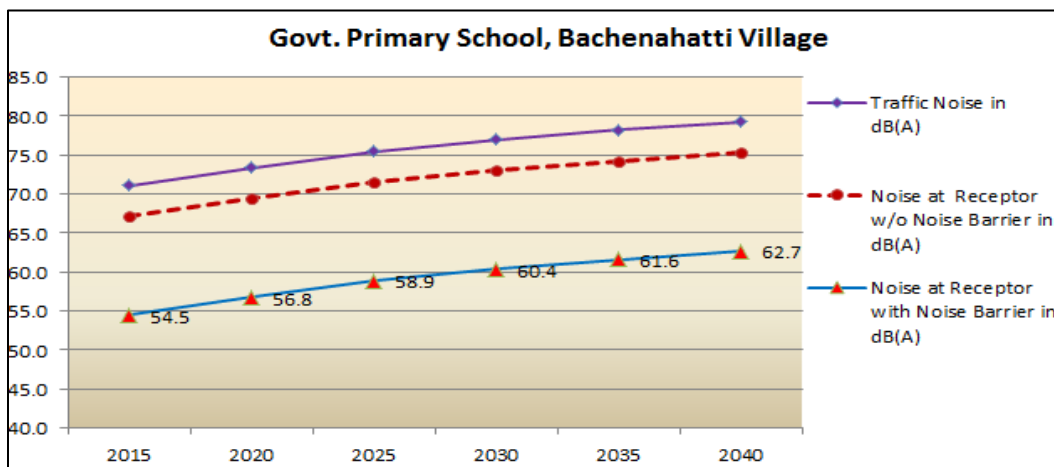


Figure 54 Noise Level at Govt. Primary School, Bachenahatti Village with & without Noise Barrier

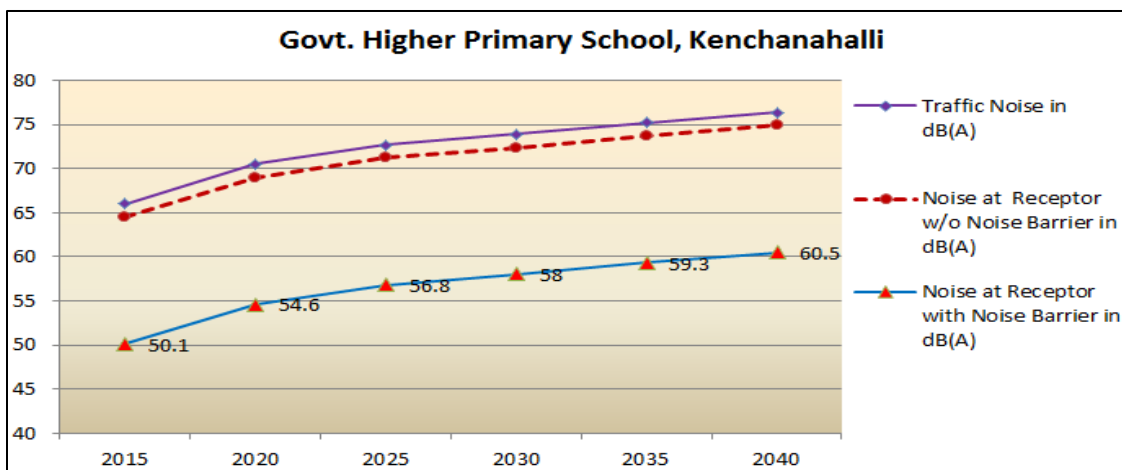


Figure 55 Noise Level at Govt. Higher Primary School, Kenchanahalli, with & without Noise Barrier

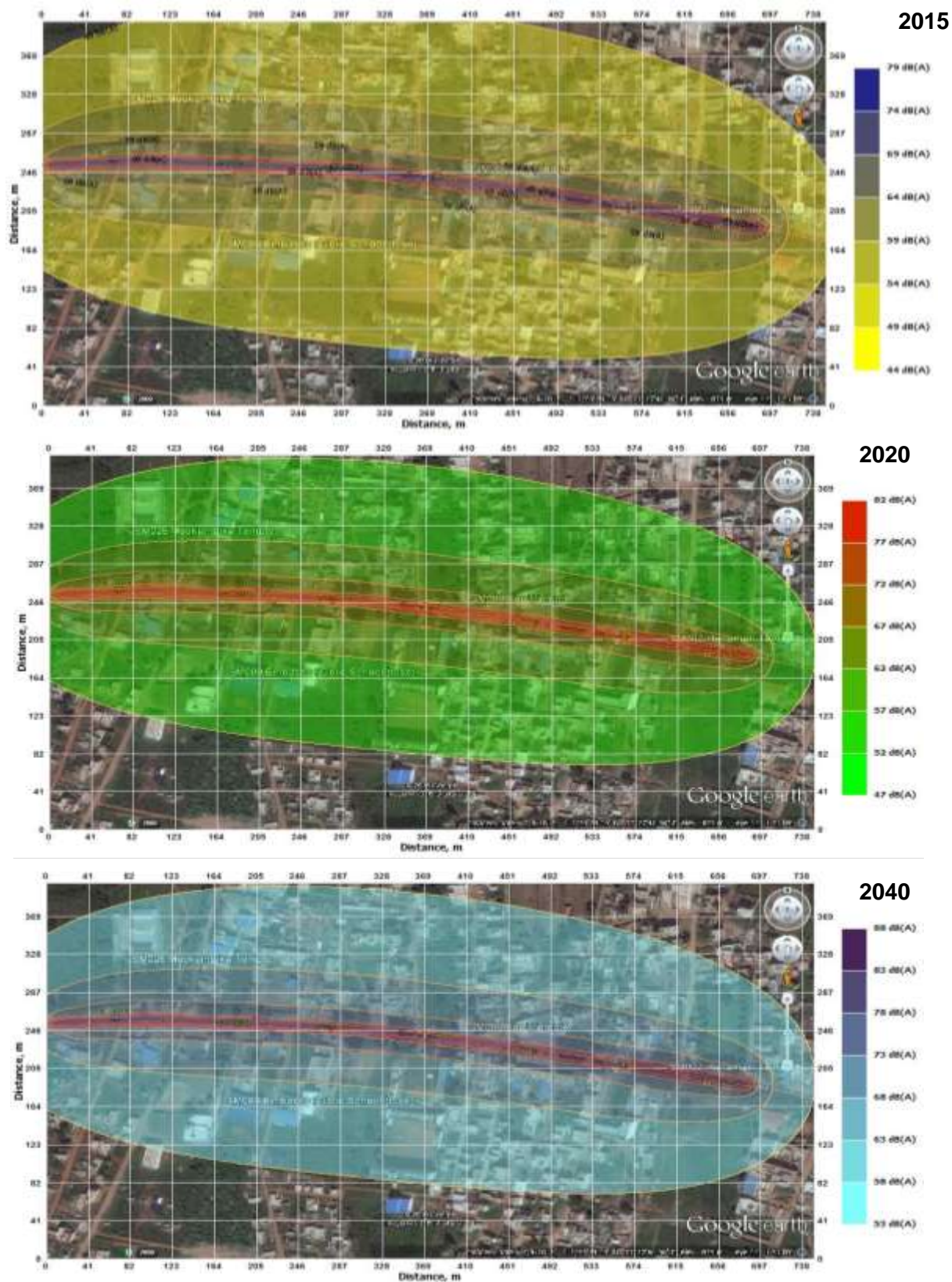


Figure 56 Noise Contour at Embassy Public School (ICSE), Kachohalli

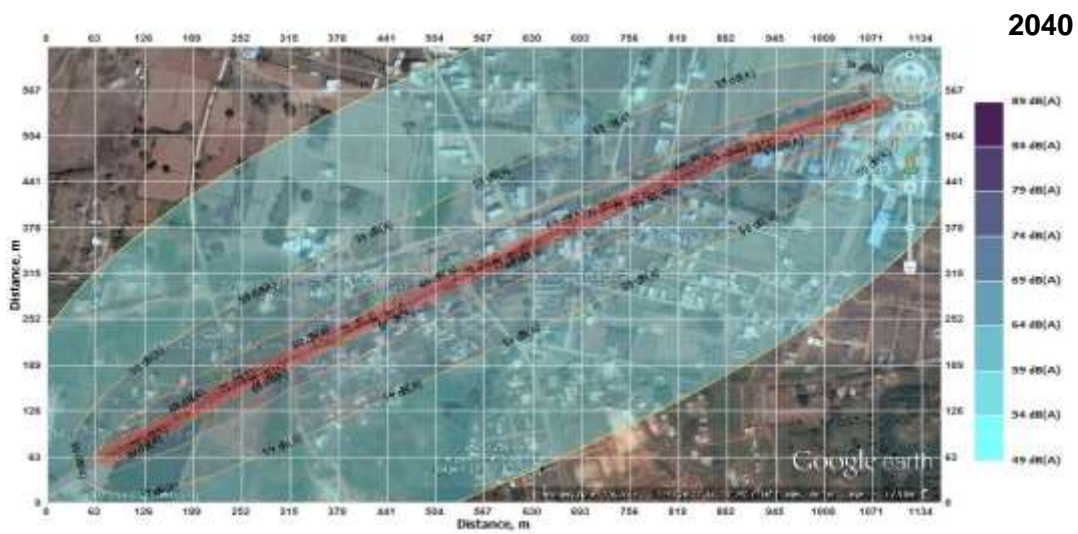
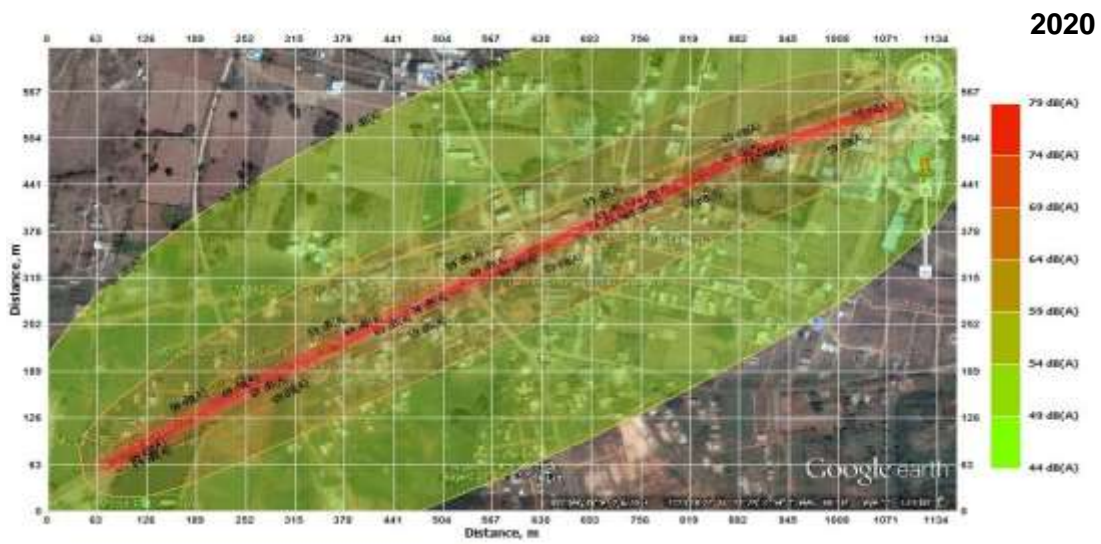
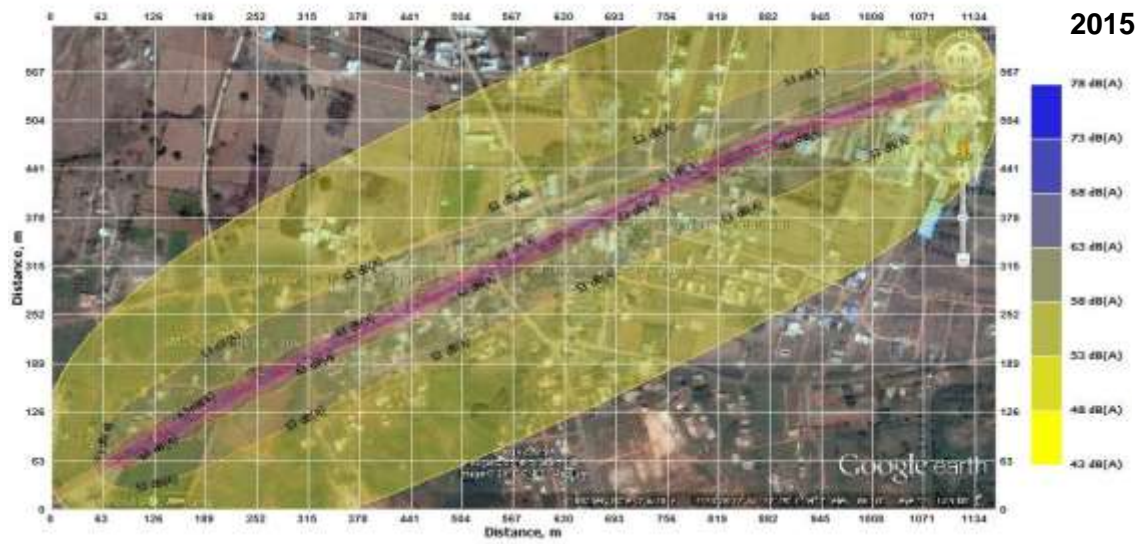


Figure 57 Noise Contour at Govt. Primary School, Honnaganahatti Village

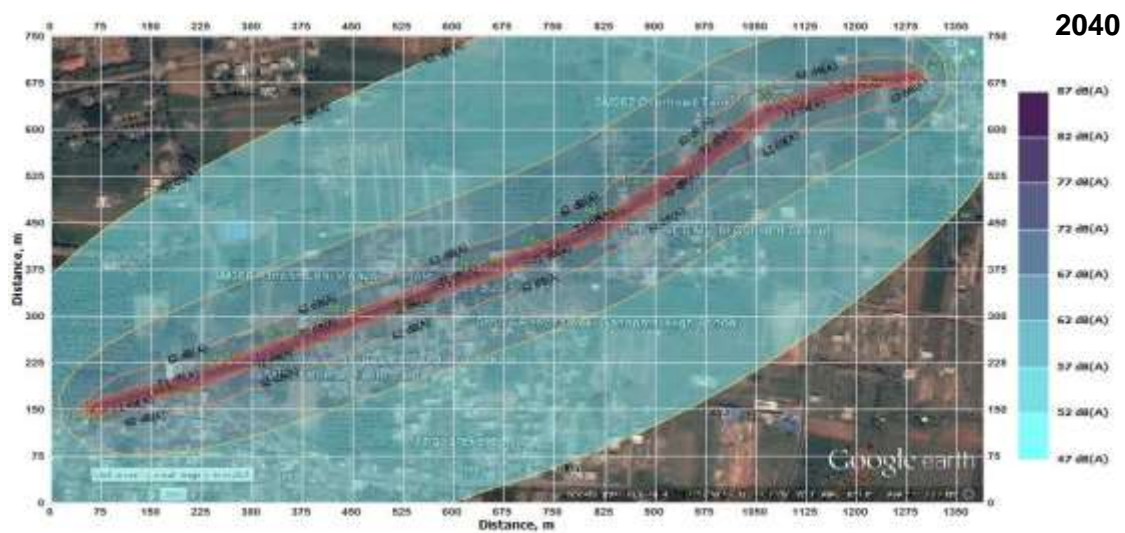
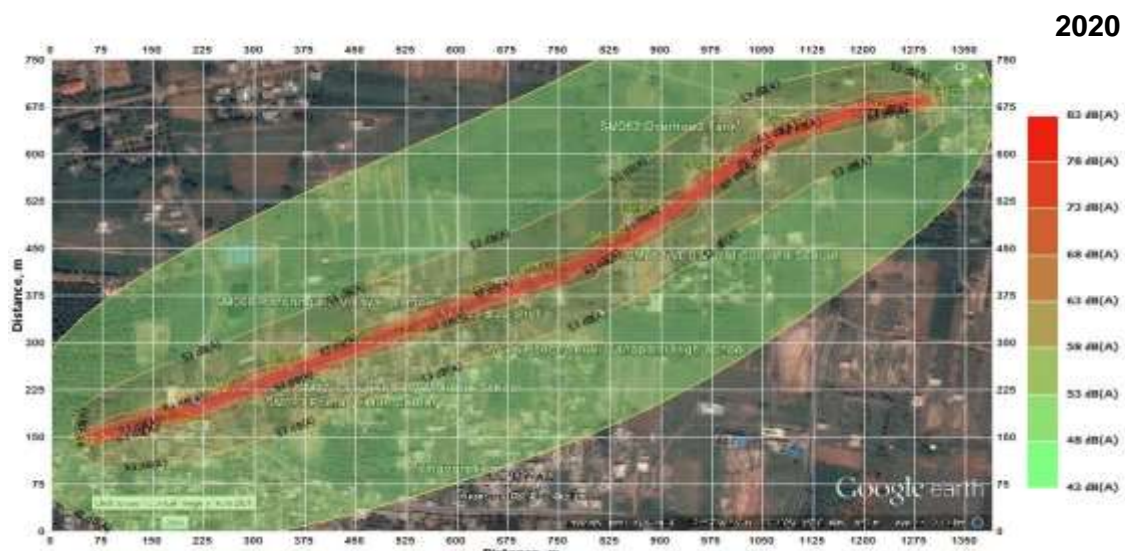
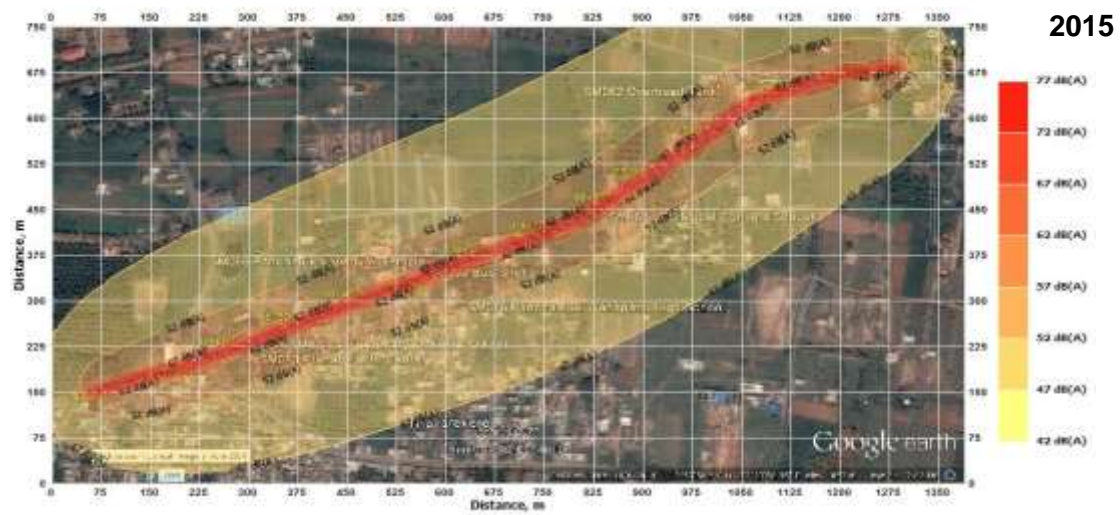


Figure 58 Noise Contour at VES Model Convent School, Tavarekere

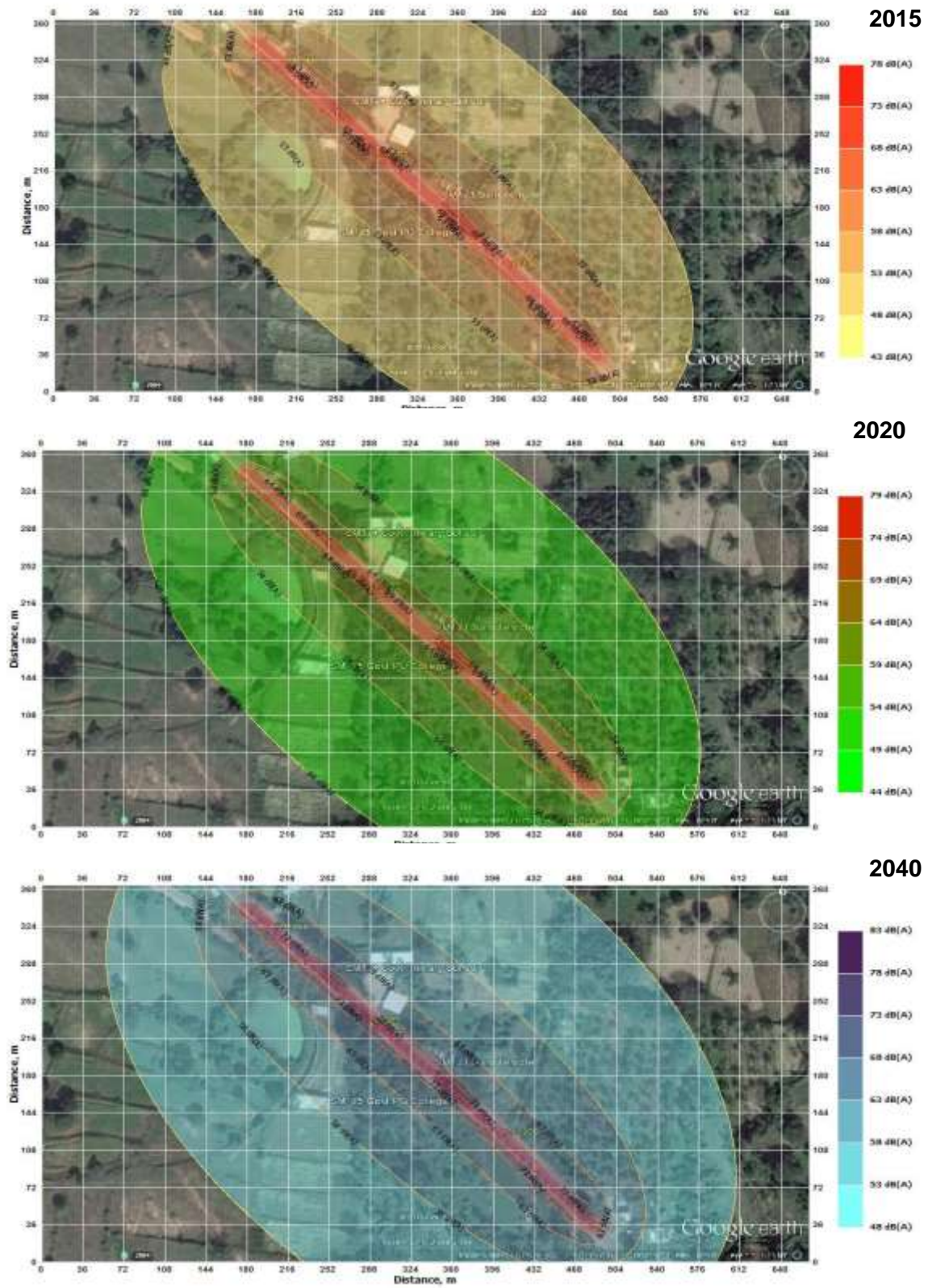
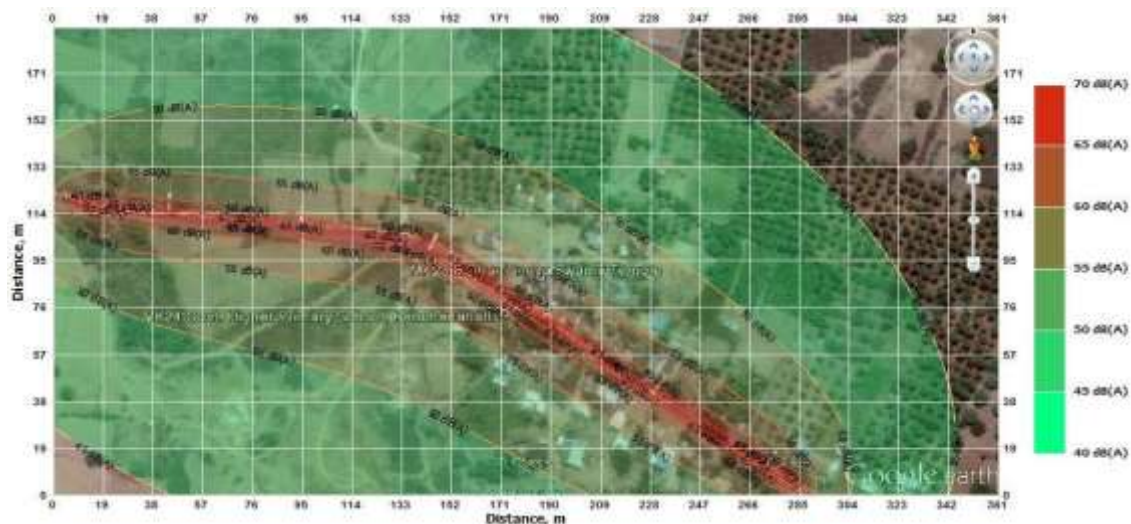
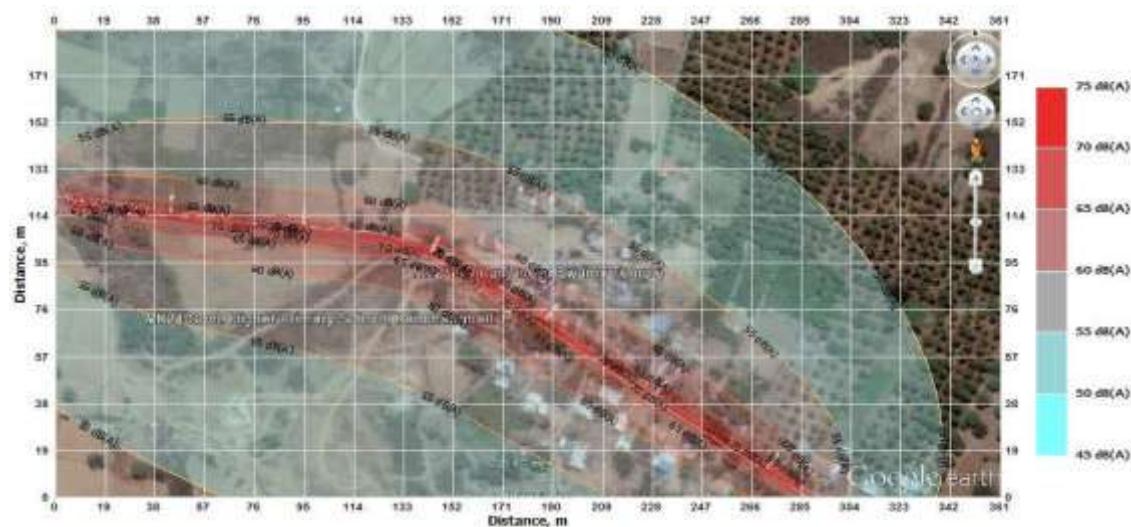


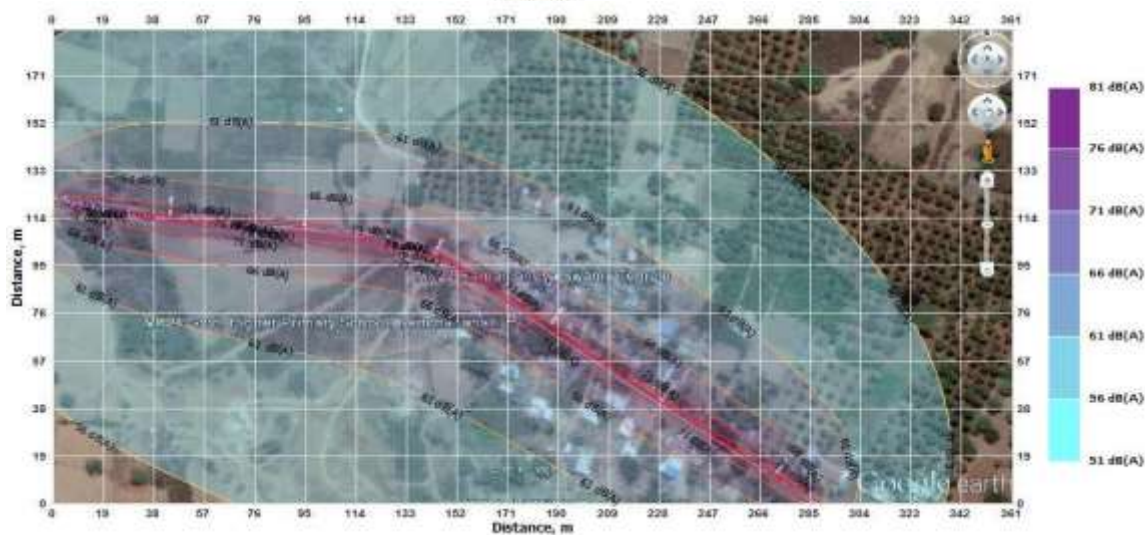
Figure 59 Noise Contour at Govt. Primary School, Bachenhatti



2016



2020



2040

Figure 60 Noise Contour at Govt. Higher Primary School, Kenchanahalli

3. Noise Barrier

319. 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

320. Various Noise Barrier Materials: Noise barriers are a necessary structure along the highway to protect the sensitive receptors from excessive road noise. There are many different materials from which noise barriers can be constructed such as brick, concrete, plastic, wood, mixed type (existing wall, top up with dense fibre/polyethylene wall) high density fibre/polyethylene etc. Each of the materials used to construct noise barrier has advantages and disadvantages both acoustically and aesthetically. Several studies have been conducted to identify the noise barrier material that produced the greatest noise reduction. It can be concluded from literature review that:

- Absorptive wall materials absorbed more sound energy than a standard reflective material
- Concrete noise abatement walls yields a mean insertion loss of 18.54 dB, which is maximum in comparison to the other materials such as Fiberglass (17.35 dB), Wood (13.60 dB) Acoustic Fabric Fence materials (11.62 dB), Earthen Berms (12.93 dB) etc.

321. 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.

322. 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

323. 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.

324. 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.

325. 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.

326. In order to determine the effectiveness of noise barriers, ambient noise levels were recorded on either side of the noise barrier i.e. at the edge of noise barrier towards roadside and at the nearest wall of the sensitive receptor, but away from noise barrier, falling in the same straight line and perpendicular to road. The noise levels monitored at these noise barrier locations were carried out over 8 hours during the daytime (6 a.m. to 10 p.m.) as per the stipulated guidelines. The test results of the ambient noise levels monitored at these noise barrier locations along with the minimum, maximum and mean values recorded during the monitoring period are summarized in Table-88.

Table 88 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,	14.03.2012	Govt. School,	10.00 a.m. to	70.41	62.51	11.22

Name of Link & Link No	Monitoring Date	Sampling Location	Monitoring Duration	Monitoring in front of Barrier (Road Side)	Monitoring behind Noise Barrier	% Reduction
				Leq* dB (A) (Mean)	Leq* dB (A) (Mean)	
T8		Aladakatti	7.00 p.m.			
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.

327. 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.

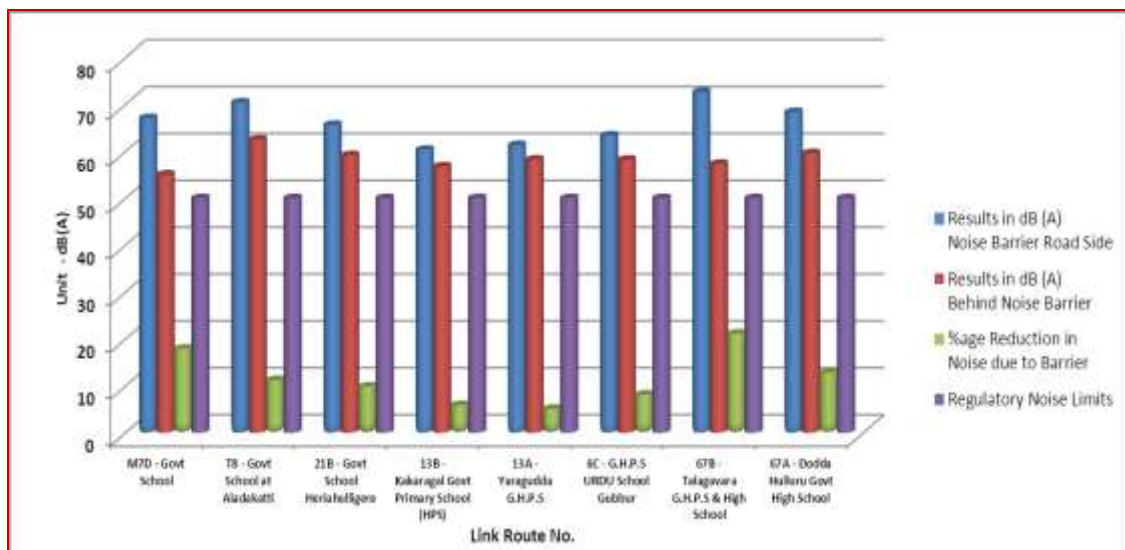


Figure 62 Noise Level Monitoring Results at Selected Noise Barrier Locations

F. Flora

1. Construction Phase

328. 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.

329. **Felling of Roadside Trees:** Efforts were made to minimize the number of trees to be felled. Considering the need to minimize land acquisition, concentric widening of existing carriageway (4-lane divided carriageway with paved shoulder) is adopted for majority of the section. Approximately 1,658 trees are required to be felled for the improvement of the road. However, this number may reduce 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 of *Ficus benghalensis* (Banyan), *Ficus religiosa*, (Peepal), *Azadirachta indica* (Neem), *Pongamia pinnata* (Karanj), *Syzigium cumini* (Jamun), *Eucalyptus teriticornis* (Eucalyptus), *Tamarindus indica* (Tamarind) etc. Girth-size wise distribution of trees to be felled along both side of the road is presented in Table-89.

Table 89 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	130	218	165	85	154	752
LHS	122	157	164	151	312	906
	252	375	329	236	466	1,658

330. **Green Tunnel:** Efforts were made to save green tunnel along the project road and this issue was also discussed during public consultation. In Bengaluru to Magadi road, 4-lane divided carriageway with paved shoulder has been proposed for the entire stretch. To minimise the impacts on residential, commercial, religious and educational structures as well as to minimise the acquisition of fertile agricultural land, concentric widening has been proposed. Most of the trees along with project road are located within 1-1.5 m from the existing blacktop. Therefore, to minimise the social impacts, green tunnel could not be saved in Bengaluru to Magadi road.

331. 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, realignments with geometric improvements, provision of highway facilities. Out of the total 50.689 km length of project road 40.093 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, 23 m to 25 m ROW has been proposed to minimize social impact, where no space is available for plantation. Chainage wise length of the project road, where no space available for plantation (17.558 km stretch) is presented in Table-90:

Table 90 Chainage wise Length where no space available for Plantation

Sl. No.	Design Chainage		Length (km)	Cross Section Type	Description
	From	To			
1	15+325	23+200	7.875	TCS-5	4 land divided highway w/o service road
2	23+200	23+675	0.475	TCS-8	4-lane divided flyover with slip road
3	23+675	23+954	0.279	TCS-7	4-lane divided elevated road with slip road
4	23+954	24+500	0.546	TCS-8	4-lane divided flyover with slip road
5	26+100	26+600	0.500	TCS-5	4 land divided highway w/o service road
6	29+900	30+031	0.131	TCS-6	4 land divided highway w/o service road
7	30+031	30+200	0.169	TCS-5	4 land divided highway w/o service road
8	32+200	32+560	0.360	TCS-4	4 land divided highway w/o service road (Hilly Area)
9	32+560	33+383	0.823	TCS-3	4 land divided highway w/o service road (Hilly Area)
10	34+100	34+500	0.400	TCS-4	4 land divided highway w/o service road (Hilly Area)
11	35+100	35+460	0.360	TCS-4	4 land divided highway w/o service road (Hilly Area)
12	35+460	35+850	0.390	TCS-3	4 land divided highway w/o service road (Hilly Area)
13	35+850	36+200	0.350	TCS-5	4 land divided highway w/o service road
14	38+600	39+200	0.600	TCS-5	4 land divided highway w/o service road
15	41+200	41+400	0.200	TCS-5	4 land divided highway w/o service road
16	46+900	51+000	4.100	TCS-5	4 land divided highway w/o service road
	Total Length (Km)		17.558		

332. Total length of the project road is 50.689 km and effective length available for plantation is 33.131 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 33.131 km stretch, 6,626 trees shall be planted on both sides of the project road.

333. Due to the space constrain, 3,587 trees are proposed to be planted in local community area, local schools, partnership with participatory forestry schemes or in degraded revenue land. Detail of plantation provided in Tree Plantation Strategy (Annex-8.12).

334. **Plantation in Oxbow land** has also been proposed. After the realignment, land of the existing road will be given to the forest department for plantation of trees as per standard tree plantation program approved by the Forest Department, GoK.

Table 91 Location of Oxbow Land

Sl. No.	Name of Town/Village	Design Chainage Km		Length (km)
		Start	End	
1	Cholanayakanahalli	29+150	29+320	0.170

335. Total area of the oxbow land is **0.5 ha** and as per the arrangement of Forest department with PIU-KSHIP, **100 trees** will be planted in oxbow land (200 trees per ha)

- Total number of trees will be planted : 10,313 trees (1:6)
- Road side plantation : 6,626 trees
- Plantation in community area, schools etc. : 3,587 trees
- Plantation in oxbow land : 100 trees

336. 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.

337. Species suggested for plantation are provided in the Table-92.

Table 92 Tree Species suggested for Plantation near Forest

S. No	Species	Value	Visitors*
1.	<i>Tamarindus indica</i>	Nectar, Fruits	I,B,M
2.	<i>Butea monosperma</i>	Nectar, Dust & Pollution Control	I,B,M
3.	<i>Ficus microcarpa</i>	Fruit	I,B,M
4.	<i>Mangifera indica</i>	Nectar, Fruits & Pollution Control	I,B,M
5.	<i>Phoenix sylvestris</i>	Nectar, Fruits	I,B,M
6.	<i>Pongamia pinnata</i>	Nectar, Dust & Pollution Control	I,M
7.	<i>Syzigium cumini</i>	Nectar, Fruits	I,B,M
8.	<i>Ziziphus mauritiana</i>	Fruit	B,M

* I – Insects, B – Birds, M – Mammals

- The plantation shall be maintained for 5 years. Dead saplings shall be replaced to maintain the survival percentage of 90%.
- Horticultural trees such as Mango, Custard Apple, Papaya, Pomegranate etc. may be distributed to farmers in affected villages freely as part of Corporate Social Responsibility (CSR) to compensate the loss of horticultural trees in the area.
- 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, Rose 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 Independent Engineer 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

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

339. **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

340. **Impacts:**

- Wildlife can survive if the landscapes they live in remain intact. The clearing of land and felling of trees will directly cause loss of habitat to avifauna and wildlife dwelling in the area.
- There are no National Parks or Wildlife Sanctuaries within 10 km radius of the proposed road. There will be no direct impact on Protected Areas or wildlife habitat due to the project.
- The proposed project does not involve diversion of forest land
- The domestic fauna in the area will also face problem in movement due to construction activity.

341. **Mitigation Measures**

- The Contractor 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 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.
- Noise will be kept under control by regular maintenance of equipment and vehicles. Noisy activity shall be prohibited during night time.
- Trees located outside ROW will not be felled.
- 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

342. **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

343. **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

344. The project road Bengaluru to Kunigal 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 will be no impact on protected area

I. Reserved Forest

345. The proposed project does not involve diversion of reserved forest land. Hence, there will be no impact on reserved forest

J. Induced and Cumulative Impact

346. 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.

347. 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.

348. 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.

349. 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.

350. Information on other development projects in and around the project area was not available. Hence, it is difficult to assess cumulative impacts from other projects which may get implemented in the project area.

K. Climate Change Impacts and Risks

1. Climate Change Mitigation

351. The Transport Emissions Evaluation Model for Projects (TEEMP)⁹ developed by Clean Air Asia¹⁰ was utilized to assess the CO₂ 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.

352. Information that was fed into the model for projecting the CO₂ emissions were:

- i) The project will rehabilitate and widen 35.525 km of the SH-85 from **Bengaluru to Magadi** and 15.164 km of the MDR from **Magadi to Kunigal** which will have three different Homogeneous sections: HS-I, HS-IIA and HS-IIB.
- ii) The road configuration will change from 2 lane to 4-lane divided highway with paved shoulder with carriageway width of 14.0 m and will have an asphalt bituminous surface in **Bengaluru to Magadi** Section and from 2 lane to 2-Lane with Paved Shoulder in Magadi to Kunigal Section
- iii) Existing road roughness varies from 4.7 m/km to 6.0 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 24 months in 2017-19 and road operations will begin in 2020.

⁹ TEEMP is an excel-based, free-of-charge spreadsheet models to evaluate emissions impacts of transport projects.

¹⁰A 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.

- 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.

353. Traffic forecasts were taken from the detailed project report. Maximum PCU for 4.0 lane divided highway with paved shoulder were considered as 80,000 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 93 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

354. It was assumed that in Section-I, all vehicles do use the entire length as average trip distance while in Section-IIA & IIB, 2-wheelers and 3-wheelers have average trip distance of 1/3rd of the total road length and all other vehicles do use the entire length as average trip distance. Furthermore, 2-wheelers and 3-wheelers constitute 100% and 90%, respectively of the total local traffic.

355. 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 94 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%

356. 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

357. The proposed road upgrading resulting to surface roughness and road capacity improvements have implications in CO₂ 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.

358. CO₂ 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 approximately 36.49 km, total CO₂ emissions will be of the order of 3,999.3 tons.

Table 95 Estimated Total CO₂ Emissions during Road Construction

Road Section	Length (km)	Emission Factor (ton CO ₂ /km)	CO ₂ Emission (tons)
HS-I	8.8	109.6	964.48
HS-IIA	27		2959.2
HS-IIB	15.15		1660.44
Total	50.95		5584.12

359. The design life of roads is 20 years. Total CO₂ emission at Business-As-Usual scenario was estimated at **8,556.76** tons/year, without and with-induced traffic are **14,983.41** tons / year and **15,184.58** tons / year respectively. These values are below the 100,000 tons per year threshold¹¹ set in the ADB SPS 2009. Therefore it is not necessary to implement options to reduce or offset CO₂ emissions under the project. The project's section-wise CO₂ emission intensity indicators are provided below:

Table 96 Section-wise Project CO₂ Emissions Intensity Indicators

Road Sections	Particular	CO ₂ emission		
		Business-As-Usual	Project (without Induced Traffic)	Project (with Induced Traffic)
HS-I	tons/km	1,928.30	2,729.50	2,534.85
	tons/year	3,518.18	4,868.75	4,521.54
	tons/km/year	96.41	136.48	126.74
	g/t km	97.32	103.22	117.33
	g/tkm	71.64	80.20	86.87
HS-IIA & IIB	tons/km	2,761.63	5,780.05	6,087.48
	tons/year	5,038.59	10,310.16	10,858.54
	tons/km/year	138.08	289.00	304.37
	g/pkm	79.24	84.92	86.02
	g/tkm	99.11	115.37	117.11

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

Table 97 Project CO₂ Emissions Intensity Indicators

Particular	CO ₂		
	Business-As-Usual	Project (without Induced Traffic)	Project (with Induced Traffic)
tons/km	4,689.92	8,399.95	8,512.73
tons/year	8,556.76	14,983.41	15,184.58
tons/km/year	234.50	420.00	425.64
g/t km	85.79	88.88	92.16
g/tkm	85.61	99.84	104.89

361. The with-project scenarios will be have higher CO₂ emissions. Furthermore, with project scenarios (both without and with induced traffic), there will be increase in the CO₂ emission

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

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 CO₂ emissions of the project road much below the threshold limit of 100,000 tons/year.

3. Climate Risks and Adaptation needs

362. 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. 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.

363. **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 $\geq 0.6^{\circ}\text{C}$ 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. The project road is located in Bangalore Urban and Ramanagara districts. As per the KSAPCC, projected minimum temperature increases are slightly above those of the maximum temperatures (**Table-22**).

Table 98 Projected change in annual temperature for 2021-50 compared to 1961-90

Districts	Projected change tAVG in $^{\circ}\text{C}$	Projected change tMIN in $^{\circ}\text{C}$	Projected change tMAX in $^{\circ}\text{C}$
Bangalore Urban	1.96	2.06	1.88
Ramanagara	1.97	2.05	1.92

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

364. **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.

365. Increased temperature and precipitation will have following impacts:

- **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.

- **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.

366. 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.

367. 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.

368. 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.

369. 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.

370. 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.

371. 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-23**, costs for taking these measures add up to a total of **Rs. 18.9 crores**. This is approximately 4.7% 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-99** 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 99 Details of Climate Adaptation Measures with Cost Implications

Roads/Details	Bengaluru to Magadi and Magadi to Kunigal
Cross Drainage Structures	
Increase in Length in proposed culverts (in meter)	187.9
<i>Cost Impact (Rs. Crore)</i>	3.26
Increase in Length of Bridges (in meter)	38.76
<i>Cost Implication (Rs. Crore)</i>	6.70
Embankment	
Total Length of Embankment (in meter)	18,175
Increase in Height (in meter)	0.6-1 m
<i>Cost Implication for increasi (Rs. Crore)</i>	6.65
Roadside drains	
Lined built-up (m)	44,778
Unlined open (m)	55,760
<i>Cost Implication increasing depth (Rs. Crore)</i>	5.55
Total Cost (Rs. Crore)	18.9

L. Social Impacts

1. Educational, Medical and Religious Properties

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

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

373. 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-100.

Table 100 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	1	9	28	38
Medical Amenities	1	1	4	6
Religious Places	13	3	56	72

- 1 educational institutions will be fully affected, 9 will partially affected and there will be no impact on remaining 28 educational institutions (Table-101)
- Out of 72 religious structures along the project road, 13 will be fully affected and 3 will be partially affected. There will be no impact on remaining 56 religious

places. Details of affected properties are presented in Table-102

- 1 hospital will be partially affected, 1 primary health centre will be partially affected (Table-103)

Table 101 List of Affected Educational Institutions

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance # (m)	Affected Status	Remarks
1.	Embassy Public School	Kachohalli	16+250	16+250	LHS	10.5	Partially Affected	Only Boundary wall affected
2.	Govt. Primary School	Honniganahatti	21+400	21+400	LHS	14.0	Partially Affected	Only Boundary wall affected
3.	Govt. Primary & Middle School	Thavarekere	23+755	23+755	LHS	12.0	Partially Affected	Only Boundary wall affected
4.	Govt. School (Closed)	Devamachohalli	26+455	26+300	LHS	11.4	Partially Affected	Only Boundary wall affected
5.	Govt. Primary School	Cholanayakanahalli	30+400	30+055	LHS	13.0	Partially Affected	Only Boundary wall affected
6.	Angels Nightngale Public School	Bachenahatti	38+275	37+650	LHS	15.0	Partially Affected	Only Boundary wall affected
7.	Govt. Primary School	Bachenahatti	39+735	39+060	RHS	11.5	Partially Affected	Only Boundary wall affected
8.	Govt. High School	Bachenahatti	40+600	39+900	LHS	11.4	Partially Affected	Only Boundary wall affected
9.	Govt. Primary School	Thagachikuppe	41+440	40+700	RHS	8.0	Partially Affected	Boundary wall & one room will be affected
10.	Govt. Primary School	Marlagondla	42+080	41+340	LHS	13.5	Affected	

Distance in meter from existing centerline

Table 102 List of affected Religious Properties

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)	Affected Status	Remarks
1.	Road side Mini Worship Place (Hanuman)	Kachohalli	16+000	16+000	RHS	8.0	Affected	
2.	Sani Temple	Kachohalli	16+200	16+200	RHS	10.2	Partially Affected	
3.	Road side Mini Worship Place (Hanuman)	Machohalli	16+810	16+810	LHS	7.6	Affected	
4.	Road side Mini Worship Place	Thavarekere	23+495	23+495	RHS	10.8	Affected	
5.	Panchmukhi Vinayak Temple	Thavarekere	23+515	23+515	RHS	21.1	Partially Affected	Only Boundary wall affected
6.	Idgah	Baichaguppe	24+960	24+950	LHS	32.9	Affected	Due to realignment
7.	Sani Temple	Bachenahatti	39+645	38+975	RHS	7.7	Affected	
8.	Road side Mini Worship Place	Thagachikuppe	41+460	40+720	RHS	11.4	Affected	Due to realignment
9.	Hanuman Temple	Marlagondla	43+760	43+010	RHS	5.5	Affected	
10.	Road side Mini Worship Place	Karla Mangla	44+560	43+810	RHS	9.3	Affected	
11.	Small Hanuman Temple	Magadi	47+965	47+162	LHS	6.3	Affected	
12.	Road side Mini Worship Place	Magadi	48+900	48+090	LHS	9.2	Affected	
13.	Road side Mini	Magadi	49+100	48+290	RHS	9.3	Affected	

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)	Affected Status	Remarks
	Worship Place (Nag Dev)							
14.	Vinayak Temple	Magadi	49+985	49+185	RHS	10.4	Affected	
15.	Road side Mini Worship Place	Vaddarapaly	51+700	50+885	RHS	7.6	Affected	
16.	Mini Worship Place (Gram Devta)	Voddarapalya	-	51+615	LHS	8.1	Partially Affected	

Distance in meter from existing centerline

Table 103 List of affected Medical Amenities

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)	Affected Status	Remarks
1.	Primary Health Center	Thavarekere	23+800	23+800	LHS	12.0	Partially Affected	Only Boundary wall affected
2.	Amma Hospital	Thavarekere	24+170	24+170	RHS	16.0	Affected	

Distance in meter from existing centerline



Photograph of Fully Affected Govt. Primary School at Ch. Km 42+080, Marlagondla



Photograph of Fully Affected View of Amma Hospital at Ch. Km 24+170, Thavarekere



Road side Mini Worship Place at Ch. Km 16+000



Road side Mini Worship Place at Ch. Km 16+810



Road side Mini Worship Place at Ch. Km 23+495



Idgah at Ch. Km 24+960

Photographs of Fully Affected Religious Structure



Sani Temple at Ch. Km 39+645



Road side Mini Worship Place at Ch. Km 41+460



Hanuman Temple at Ch. Km 43+760



Road side Mini Worship Place at Ch. Km 44+560



Small Hanuman Temple at Ch. Km 47+965



Road side Mini Worship Place at Ch. Km 48+900



Road side Mini Worship Place (Nag Dev)
at Ch. Km 49+100



Vinayak Temple at Ch. Km. 49+985

374. **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

375. According to the Land Acquisition Plan (LAP) **71.86 Ha** of land will be acquired for the project, out of which 60.65 Ha. is private land. The details of affected land are presented in the **Table-104**.

Table 104 Type of Land Affected

Type of land		No. Ha.
Private	Agriculture/Non-irrigated	60.64
	<i>Subtotal</i>	<i>60.64</i>
Public	Government	11.22
	<i>Subtotal</i>	<i>11.22</i>
Total		71.86

Source: Land acquisition Plan, ICT Pvt. Ltd 2015

3. Ownership of Land being acquired for the Project

376. Out of total 71.86 Ha of land, which is going to be affected, 60.64 ha (84.39%) land is privately owned, while remaining 11.22 ha (15.61%) land belongs to Government / Waste land. The details of land acquisition requirement are summarized in the **Table-105**.

Table 105 Details of Land being acquired for the Project

Sl. No.	Land Details	Acquisition of Land Area (Ha.)	Percentage
1	Private Land	60.64	84.39
3	Govt. Land / Waste Land	11.22	15.61
Total		71.86	100

Source: Land acquisition Plan, ICT Pvt. Ltd 2015

4. Impacts on Structure in the Project Area

377. After considering the mitigation measures, 542 assets including government and common property resources (CPRs) are likely to be affected. Out of total 542 affected properties, 336 (61.99%) are private structures owned by 201 titleholders and 135 non-titleholder households. Out of 164 affected government properties, 87 are mini water tanks, 18 are bus shelters, 6 bore well, 23 boundary wall of (college, hostel, high school, primary school, community hall, horticulture office and taluk office), 8 hand pump, 3 balvadi, 3 milk dairy, 3 water tank, 2 municipality buildings, 2 pump house, 2 water tap, 2 open well, 1 power station, 1 fair price shop, 1 gram panchayat building and 1 bore-well with mini water tank. The details of affected properties are presented in the Table-106

Table 106 Details of Affected Structures

Sl. No.	Structure/ properties in the Affected Area	Number of Affected Properties	Fully affected
1	Private Structures	336	111
2	Government Structures	164	135
3	Community Structures	20	19
Total		520	265

Source: Census Survey 2015-16

5. Impacts on Private Structures

378. As per the census survey, 336 private properties are likely to be affected due to the road improvement project. These private properties are residential, commercial and residential-cum-commercial. 111 private structures are fully affected and rest 225 private structures will be partially affected and will remain viable for use. Both partially and fully affected structures are owned by 201 title-holders and 135 non-titled holders. Details on the loss of private assets are given in Table-107.

Table 107 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	125	80	45	46	142	347	631
2	Commercial	137	86	51	66	272	500	907
3	Res-Cum-	54	39	15	22	87	225	366

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)
	Commercial							
4	Boundary wall	20	20	0	0	22	48	74
	Total	336	225	111	134	523	1120	1978

Source: Census Survey 2015-16

*Family here refers to the "Family" as defined in RFCTLARR Act, 2013. "Family" includes a person, his or her spouse, minor children, minor brothers and minor sisters dependent on him; and An adult (18years and above) of either gender with or without spouse or children or dependents shall be considered as a separate family for the purpose of this Act.

6. Legal Ownership of the Properties/ Structures

379. The likely impact on Titleholders and Non-Titleholders were assessed through the census survey undertaken within Col of the project road. The details of ownership of properties are presented in Table-108.

Table 108 Details of Ownership of Properties

Sl. No.	Type of Properties	No. of Households		Total	Percentage
		Titleholder	Non-Titleholder		
1	Residential	79	46	125	37.20
2	Commercial	69	68	137	40.77
3	Res-cum-commercial	42	12	54	16.07
4	Boundary Wall	11	9	20	5.95
	Total	201	135	336	100

Source: Census Survey 2015-16

7. Severity of Impact on Households Losing Structures

380. The analysis of impact on the scale of severity reveals that out of 336 private structures, 225 structures are partially affected (up to 25%), while 111 structures are fully affected, leading to physical displacement. The intensity of impact is further classified in the Table-109.

Table 109 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%)	134	25.62
2	Partially Impacted	(Less than 25%)	389	74.38
	Total		523	100

Source: Census Survey 2015-16

8. Loss of Livelihoods

381. Out of 359 total households losing their livelihood, 88 are fully affected and 271 are partially affected commercial households. Majority of them are owners and conducting commercial activities in these structures (53.20%) but some of them are tenants who have taken the premises on rent for commercial purpose (45.13%). The details of economic impact as per the category of affected households are presented in Table-110.

Table 110 Loss of Livelihoods

Sl. No.	Loss	Partially affected Households	Fully affected Households	Total affected Households	Percentage
1	Owners of Shop	125	66	191	53.20
2	Tenants	141	21	162	45.13
3	Employees	5	1	6	1.67
Total		271	88	359	100.0

Source: Census Survey 2015-16

9. Impacts on Common Property Resources

382. There are 42 CPRs properties affected along the project road which includes 11 aralikatte, 2 flag hosting stages, 1 open well, 1 public toilet, 4 samadhi, 1 boundary wall of graveyard, 20 temples and 2 boundary walls of mosque. There are 164 government properties affected which include 87 mini water tanks, 18 bus shelters, 6 bore wells, 23 boundary walls of college, hostel, high school, primary school, community hall, horticulture office and taluk office; 8 hand pumps, 3 balvadi, 3 milk dairy, 3 water tanks (toti), 2 municipality buildings, 2 pump houses, 2 water taps, 2 open wells, 1 power station, 1 horticulture office, 1 fair price shop, 1 taluk office, 1 gram panchayat building, 1 bore well with mini water tank and 1 community hall. The summary list of CPRs affected along the project are presented in Table-111.

Table 111 Types of CPRs and Government Properties likely to be affected

Sl. No.	Types of Properties	Items	Total	% Age
1	The Other Community Properties (CPRs)	Aralikatte	11	5.34
2		Flag hosting stage	2	0.97
3		Open well	1	0.49
4		Public Toilet	1	0.49
5		Samadhi	4	1.94
6		Boundary wall of Graveyard	1	0.49
7	Government Properties	Balavadi	3	1.46
8		Balavadi Compound wall	1	0.49
9		Bus depot Compound wall	1	0.49
10		Fire station compound wall	1	0.49
11		Hospital compound wall	1	0.49
12		Bore well	6	2.91
13		Bus Shelter	18	8.74
14		College Boundary wall	1	0.49
15		Boundary Wall of Community hall	1	0.49
16		Milk Dairy	3	1.46
17		Hand pump	8	3.88
18		High school Boundary Wall	4	1.94
19		Hostel Boundary wall	1	0.49
20		Mini Water Tank	87	42.23
21		Municipality building	2	0.97
22		Open well	2	0.97

Sl. No.	Types of Properties	Items	Total	% Age
23		Power station	1	0.49
24		Boundary wall Primary and High school	1	0.49
25		Boundary wall Primary School	9	4.37
26		Pump house	2	0.97
27		Tap	2	0.97
28		Water tank(Totti)	3	1.46
29		Bore well with Mini water tank	1	0.49
30		Boundary Wall of Horticulture office	1	0.49
31		Fair price shop	1	0.49
32	Boundary Wall of Taluk office	1	0.49	
33	Gram Panchayat Building	2	0.97	
Total			206	100.00

Source: Census Survey 2015-16

10. Key Effects on Assets and Displaced Persons

383. A summary of the impacts based on the Census survey of likely to be impacted structures and Land owners is provided in Table-112.

Table 112 Summary of Impact on Structures and Displaced Persons

SN	Categories of Impact	Sub-Categories	Area (Ha.)		Total
A	Impact on Land				
	Private land to be acquired (in Ha.)	Irrigated	4.8		60.64
		Non- Irrigated	44.76		
		NA	11.08		
	Government /Forest Land (in Ha.)	Government	11.22		11.22
		Forest	0		
	Total (ha.)				
B	Impacts on Households / Families / Persons		No. of HH	No. of Families	No. of PAPs
	Title-Holders losing Land and Structure	Land	201	555	939
		Structure	560	1175	2745
	Non-Title Holders	Squatters	135	247	418
		Encroachers	0	0	0
		Renters	181	310	605
		Employees	6	8	16
	Total Affected		1083	2295	4723
C	Extent of Impact				
	Physically Displaced / Significantly Affected	Titled	51	143	236
		Non-Titled	83	152	259
	Moderately Affected	Titled Including Land	710	1587	3448
		Non-Titled	239	413	780
	Vulnerable Affected	Titled	603	1493	3175

SN	Categories of Impact	Sub-Categories	Area (Ha.)		Total
		Non-Titled	258	476	849
	Total				
D	Community Structure		19		19
	CPRs Affected		195		195
	Religious Structure Affected		16		16
	Total				

M. Steps for Minimizing Adverse Impacts

384. 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. 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.
- At two places, the alignment has been modified to avoid / minimize impacts on sensitive structures / receptors. Few key examples are:
- At Cholanaikanahalli (km.30+030 to 30+070) in Bangalore district, two temples, one temple gate and a flag hosting stage were saved by shifting the alignment to the left hand side
- At Thirumali village (Km. 47+180 to 47+240) in Ramanagara district one flag hosting stage, one temple and one school boundary were saved by shifting the alignment to the left hand side
- At Cholanaikanahalli two temples, one temple gate and a flag hosting stage and at Thirumali village one flag hosting stage, one temple and one school boundary were saved by shifting the alignment to the left hand side (LHS) eccentric widening

N. Rehabilitation and Resettlement

385. 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 346.43 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

386. 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.

387. 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.

388. 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

389. 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

390. 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

391. 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

392. **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
- Non-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**

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

394. **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**

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

396. **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

397. Impacts:

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

398. Mitigation Measures:

- 54 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 Meeting

399. 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

400. 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.

401. 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.

402. 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

1. Disturbance due to present traffic scenario with respect to environmental pollution and road safety
2. Anticipation of disturbance due to the improvement proposal with respect to environmental pollution and road safety
3. Expectation on road safety measures in the improvement proposal
4. Accidents and conflicts involving wildlife, if any
5. Preference of avenue trees, if any

403. 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

404. The public consultation meeting schedule for the project road in provided in Table-113.

Table 113 Public Consultation Meeting Schedule

SI	Date	Time	Venue	Location Coordinates
PCM-1	11 Jan 2016	13:00	Govt. Higher Primary School, Magadi	12°57'4.52"N 77°14'11.22"E
PCM-2	20 Jan 2016	10:30	Govt. Higher Primary School, Honganahatti	12°58'26.06"N 77°25'14.78"E



Photographs of Public Consultation

D. Analysis of Collected Feedback

1. Stakeholders and women participants

405. A total of 99 stakeholders participated in 2 public consultation meetings. Meeting at Government Primary School, Magadi had the highest number of participants including women

participants. The percentage of women participation varied between 62%-67% in these public meetings. Gender-wise distribution of participants is provided in Table-114.

Table 114 Gender wise Distribution of Participants in PCMs

SL	Location	Female	Male	Total
PCM-1	Govt. Higher Primary School, Magadi	47	23	70
PCM-2	Govt. Higher Primary School, Honganahatti	18	11	29
Total		65	34	99

406. 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-115. Overall, 77% of women and 65% of men responded with written response.

Table 115 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, Magadi	32	15	47	68.1	65.2	67.1
PCM-2	Govt. Higher Primary School, Honganahatti	18	7	25	100.0	63.6	86.2
Total		50	22	72	76.9	64.7	72.7

2. Perception on Noise Pollution Issues

407. About 99% respondents felt that traffic induced noise pollution could be disturbing. This may be attributed to the fact that the road at present has very high traffic. About 69% respondents scaled present traffic noise as highly disturbing while another 14% viewed it as moderately disturbing. It may be interesting to note 51% of the respondents expected the traffic volume to further increase after project implementation but about 43% of them expected reduction in noise level due to smoother vehicular flow due to improved road conditions. However, 54% respondents anticipated increased noise level to be high or moderate after project implementation due to increased traffic flow. The respondents, at large expected honking noise to be less after the project implementation. About 82% respondents opined the honking noise a menace at the present conditions but only 42% of them apprehended high or moderate level of honking noise in post project scenario. The perception of the respondents with respect to noise pollution is detailed in Table-116.

Table 116 Perception of Respondents on Noise Pollution due to Traffic

1 Do you feel disturbed due to traffic noise	Yes	98.6%			No	1.4%
If yes, then Degree of Impact	<i>High</i>	<i>Moderate</i>	<i>Low</i>	<i>Insignificant</i>	<i>Can't Say</i>	<i>Not Applicable</i>
Disturbance from Noise of present traffic	69.4%	13.9%	9.7%	4.2%	1.4%	1.4%
Disturbance from Honking of present traffic	63.9%	18.1%	11.1%	2.8%	-	1.4%
2 Increase in traffic volume after project implementation	51.4%	20.8%	8.3%	5.6%	13.9%	-
3 Do you anticipate change in	Increase	54.2%	Decrease	43.1%	No	2.8%

noise level due to the project?					Change	
If anticipated increase, then Degree of Impact	<i>High</i>	<i>Moderate</i>	<i>Low</i>	<i>Insignificant</i>	<i>Can't Say</i>	<i>Not Applicable</i>
Increase in noise after project implementation	20.8%	20.8%	12.5%	-	-	45.8%
Increase in honking after project implementation	27.8%	13.9%	8.3%	1.4%	2.8%	45.8%
Disturbance due to construction machinery & vehicles	19.4%	20.8%	6.9%	-	6.9%	45.8%

408. PCM wise variation of response on noise pollution is presented in Table-117. It may be observed that about 65% of the respondents in PCM 1 at Magadi Town disturbed by the traffic noise, while only 33% respondents at Honganahatti village expressed dissatisfaction over it. Annoyance over existing traffic and honking noise as well as post project traffic and honking noise also varied considerably in two venues. It may be noteworthy that anticipation on disturbance due to honking noise is much higher in urban location of Magadi, where traffic congestion is frequent in comparison to the relatively congestion free rural locations. Similarly, anticipation of annoyance from future traffic is also much higher in urban location.

Table 117 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	65.3%	54.2%	55.6%	40.3%	18.1%
PCM-2	33.3%	15.3%	8.3%	11.1%	2.8%
Total	98.6%	69.5%	63.9%	51.4%	20.9%

3. Perception on Air Pollution Issues

409. About 97% of the respondents felt that traffic induced air pollution could be disturbing. Further, about 67% respondents scaled present air pollution due to vehicular emission are either highly or moderately disturbing while about 79% respondents viewed menace due to dust pollution is high or moderate.



Roadside Waste Burning contributing to air pollution



Dumping of Municipal Waste on carriageway causing foul smelling air in the surrounding

410. Only 5.6% respondents said air pollution may have contribution from sources other than vehicular pollution and could not name them. Many respondents said the gases from the open drains, dumping of municipal waste on road shoulder and especially burning of wastes on the road edges contribute significantly to the air pollution.

Table 118 Perception of Respondents on Air Pollution due to Traffic

4 Do you feel disturbed due to air pollution	Yes	97.2%			No	2.8%
If yes, then Degree of Impact	<i>High</i>	<i>Moderate</i>	<i>Low</i>	<i>Insignificant</i>	<i>Can't Say</i>	<i>Not Applicable</i>
Disturbance due to air emissions from present traffic	54.2%	12.5%	18.1%	5.6%	6.9%	2.8%
Disturbance due to dust due to present traffic	65.3%	13.9%	8.3%	8.3%	1.4%	2.8%
5 Any other sources of Air Pollution other than traffic	5.6%	-	8.3%	-	86.1%	-
6 Change in air quality due to the project?	Deteriorate	73.6%	Improve	19.4%	No Change	6.9%
If anticipated increase, then Degree of Impact Ø	<i>High</i>	<i>Moderate</i>	<i>Low</i>	<i>Insignificant</i>	<i>Can't Say</i>	<i>Not Applicable</i>
Increase in air pollution due to increased traffic	38.9%	13.9%	12.5%	8.3%	-	26.4%
Increase in dust due to increased traffic	54.2%	9.7%	5.6%	2.8%	1.4%	26.4%
Increase in dust due to construction activity	50.0%	8.3%	4.2%	6.9%	4.2%	26.4%

411. It is noteworthy that only about 19% of the respondents expected improved air quality after project implementation due to better road conditions while about 3% of them could not anticipate any change in air quality in future with respect to the present condition. However, majority (73%) 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 in post project scenario was upbeat by 15% in comparison to the existing conditions due to improved road conditions. The perception of the respondents with respect to air pollution is detailed in Table-118.

412. PCM wise variation of response on air pollution is presented in Table-119. It has been observed that about 50% of the respondents in PCM 1 at Magadi Town expressed disturbance due to present level of vehicular emission, while only 4.2% respondents at Honganahatti village expressed dissatisfaction over it. It may be worth mentioning that road near in PCM venue at Magadi town is comparatively more congested than the other venue, which have swayed the public opinion on pollution to a considerable extent. Annoyance over air borne dust and emission due to present day traffic movement as well as anticipated disturbance on the same in post project scenario also remained very high in PCM 1 than PCM2.

Table 119 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	50.0%	61.1%	30.6%	40.3%	38.9%
PCM-2	4.2%	4.2%	8.3%	13.9%	11.1%
Total	54.2%	65.3%	38.9%	54.2%	50.0%

4. Perception on Road Safety Issues

413. About 63.9% participants opined that the project road at the present condition is accident prone and requested for its improvement. Further, about 39% of the participants feared that construction period may lead to further increase of accidents and adequate safety measures must be enforced.

414. 83% of the respondents wanted pedestrian crossings at important junctions and popular movement locations like schools, hospitals and temples etc. while 90% 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 (86%). Many of the participants viewed that the dumped municipal waste and construction debris on the road shoulders at a few locations are also a threat to the road safety, especially during the night time.



Roadside dumping of construction waste and debris are posing a safety threat to the

415. About 78% respondents viewed regular police patrol can also curb the accident rate while another 83% 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 75% 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-120. Overall, the respondents were unanimous over the requirement of road safety features and demanded for its implementation at the earliest.

Table 120 Perception of Respondents on Road Safety Issues

Perception on Road Accidents	%
Is the road accident prone?	63.9
Anticipation of increased road accidents in construction phase?	38.9
Choice of People on Road Safety Measures	
Speed Breaker	90.3
Pedestrian crossing	83.3
Road signage	86.1
Improved emergency services	77.8
Police Patrol	77.8

Speed Cameras	83.3
Road safety education camps	75.0
Driver Awareness Programs	76.4

5. Perception on Ecology and Biodiversity Issues

416. Only 5.6% participants reported sighting of wild animals in the project area. Out of them 1.4% said prevalence of sighting is low, while remaining 4.2% respondents said the sighting is very rare. Only about 3% respondents reported that they experienced crop damage by some time or other by wild animals.

417. Accidents involving wildlife is reported about 1.5% participants while injuries to human life by wild animals are reported to be unknown. No wildlife accident spots were identified by the participants. Participants reported that major wildlife observed in the project area involves rabbit, , rabbit, wild boar and snakes. Participants opined that shady and fruit bearing trees like mango, neem and pipal should be selected for avenue plantations. The perception of the participants regarding ecology and biodiversity issues is detailed in Table-121.

Table 121 Perception of Respondents on Ecology & Biodiversity Issues

Indicators	%
Are wild animals sighted in your area?	5.6%
Frequency of Sighting wild animals	High – 0% Moderate – 0% Low - 1.4%
Crop damage by wild animals	2.8%
Accident involving wildlife	1.4%
Incident on man wildlife conflict	Nil
Poaching / wildlife trafficking incident in nearby locality	No
Frequently sighted wild animals	Rabbit, Wild boar, Snakes etc.
Frequent Wildlife accident spots, if any	Nil
Preferred tree species in agricultural land boundaries	Mango, Coconut, Eucalyptus
Preferred species for roadside plantation	Neem, Mango, Pipal

E. Outcome of the Public Consultation Meeting

418. 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.
- Majority of the stakeholders are agreed that the road is accident prone and needs immediate improvement.
- Pedestrian crossing, proper road signage and speed control measures are the most sought after road safety measures by the stakeholders.
- Stakeholders considered dumping of waste and debris on the edge of the carriageway as a safety threat and requested the project authorities to take measures against such offenders.
- Stakeholders considered burning of waste at the edge of the road is adding up

- with the vehicular emission only to worsen the air quality.
- Accident involving wildlife and man-animal conflicts are reported to be absent, and incidents of crop damage by wild animals are reported by very few respondents.
- 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 other fruit bearing trees, especially Neem and Tamarind should selected for Avenue plantation.
- Participants at large requested for upgradation 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 upkeepment.

F. Consultation in Religious Places

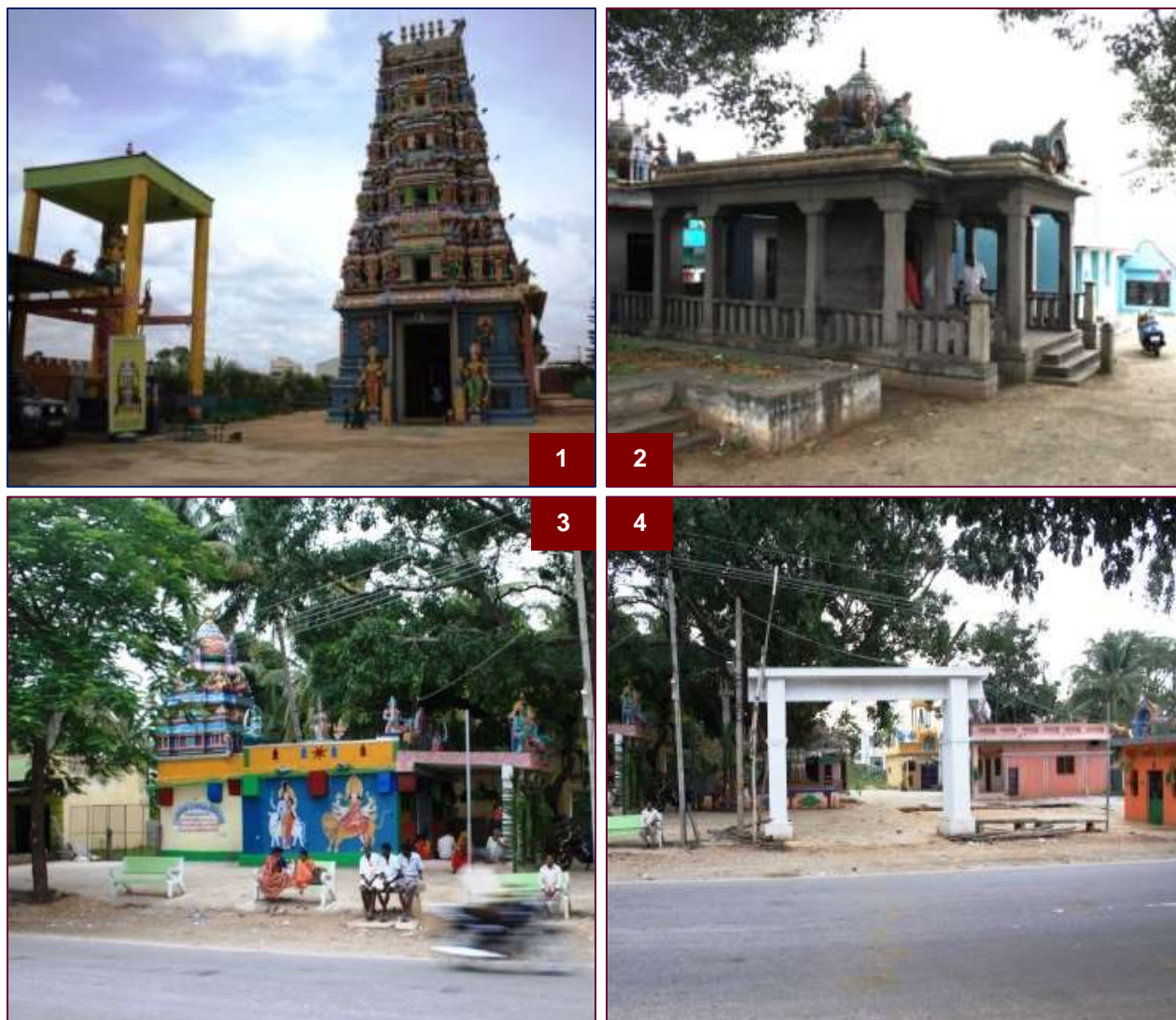
419. To assess the requirement of noise barrier in the religious places along the project road, consultations with stakeholders were carried out. Local devotees, temple owner or trustees and devotees visiting the temples were informed about the impending development.

420. Four temples, as detailed in Table-122 were selected for such consultation based on its local importance and relative proximity with the proposed alignment.

Table 122 List of Temples Identified for Consultation

S.N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1.	Huliyuramma Temple	Machohalli	17+150	17+150	LHS	14.6
2.	Panchmukhi Vinayak Temple	Thavarekere	23+515	23+515	RHS	21.1
3.	Maramma Temple	Cholanayakanahalli	30+455	30+100	RHS	16.6
4.	Nandi Temple		30+425	30+080	RHS	21.5

Distance in meter from existing centerline



Location of Consultations at Religious Places along Bengaluru-Kunigal Road

1. Outcome of Consultation at Religious Places

421. There were no variations in the response of the participants regarding installation of noise barrier, as detailed in Table-123 below. All the participants unanimously ruled out any requirement of boundary wall for mitigating traffic noise. They showed reservation against construction of boundary wall due to temple aesthetics and accessibility.

Table 123 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.	Huliyuramma Temple	16	Devotees, Priest	0	0%	16	100%
2.	Panchmukhi Vinayak Temple	15	Priest, Devotees	0	0%	15	100%
3.	Maramma Temple	11	Priest Devotees,	0	0%	11	100%

S. N.	Description	No. of participants	Type of Participants	Response of Participants regarding Noise Barrier			
4.	Nandi Temple		Trustee				
Overall Response				0	0%	42	100%



Photographs of Consultation at Religious Places

VIII. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

422. 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

423. 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 124 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	<ul style="list-style-type: none"> ▪ Soaked CBR value of sub grade is recommended to be 15 %. ▪ 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 ▪ 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. 	Design requirement IRC:37-2012 IRC: 58-2015	Entire stretch; Embankment raised for a length of 18.175 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 safety reasons.	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
	<p>The Length of lined drain along the project is 44,778 m on either side (i.e. 2 x 22,389 = 44,778m) and the length of unlined drain is 55,760 m on either side (i.e. 2 x 27,880 = 55,760 m).</p> <ul style="list-style-type: none"> ▪ Considering the adequacy and hydrological requirements, some additional culverts and replacement of some culverts have been proposed. ▪ 11 new RCC Box culverts proposed to be constructed ▪ 33 culverts proposed to be widened ▪ 42 culverts proposed for reconstruction ▪ In addition to the above, 16 hume pipe culverts has been proposed in junction area. 		<p>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.</p> <p>For list of bridges, Please refer Table 19 of Chapter-2 of IEE Report</p>				
1.2 Safety along the proposed alignment	<ul style="list-style-type: none"> ▪ The project road is having substandard horizontal geometry in some sections. There are about 136 nos. Horizontal curve having radius less than 200m 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 two 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-reflective warning sign boards near school, hospital and religious places 	<p>Design requirement</p> <p>Vertical geometry will be based on IRC-SP:73-2015</p> <p>IRC:SP:84-2014 IRC SP 87 2013 IRC: 37-2012</p>	<p>Entire stretch</p> <p>At embankment height >3.0 m total length = 7.950 km</p> <p><u>Horizontal Curve:</u> Please refer Annexure-1.2 of Volume-II Design Report</p> <p><u>Vertical Alignment:</u> Please refer Annexure-1.3 of Volume-II Design Report</p>	<p><u>MI:</u> number and location of Semi-rigid type / rigid type / flexible type safety barriers, warning sign boards</p> <p><u>PT:</u> numbers and location are in accordance with site needs</p>	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
	<ul style="list-style-type: none"> ▪ 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 						
2. Natural Hazards							
2.1 Flooding / Water-Logging	<ul style="list-style-type: none"> ▪ Provision of adequate number of CD structures. Additional culverts have been proposed. ▪ All CD structures designed for 50year 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	<p><u>MI</u>: Design and numbers of cross & side drains, slab/box culverts Hume pipes, road embankment height, design and number of bridges</p> <p><u>PT</u>: Design and numbers are in accordance with site needs</p>	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	<ul style="list-style-type: none"> ▪ 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 and ADB' SPS 2009. ▪ Complete all necessary land and 	The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.	Throughout the corridor	<p><u>MI</u>: Payment of compensation and assistance to PAFs as per RAP</p> <p>Number of complaints / grievances related</p>	Check LA records; design drawings vs land plans; Interview with affected persons	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
	<p>property acquisition procedures prior to the commencement of civil work.</p> <ul style="list-style-type: none"> ▪ 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 	<p>and</p> <p>ADB's Involuntary Resettlement Policy.</p> <p>Contract Clause for preference to local people during employment.</p>		<p>to compensation and resettlement</p> <p><u>PT</u>: 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.</p>	<p>Check status of employment given to local people during construction</p>		
4. Felling of Trees							
<p>4.1 Loss of trees</p> <p>4.2 Loss of habitat of avifauna</p>	<ul style="list-style-type: none"> ▪ 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 ▪ 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 relevant norms. Systematic corridor level documentation for the trees to be felled and those saved will be maintained by the PIU. 	<ul style="list-style-type: none"> ▪ Forest Conservation Act, 1980 ▪ The Karnataka Preservation of Trees Act, 1976 ▪ Environmental Policy of KSHIP 	<p>Throughout the corridor</p> <p>Total number of affected trees=1658 LHS: 906 RHS: 752</p>	<p><u>MI</u>: Number and location of geometric adjustments made to avoid tree cutting, budget amount allocated for additional plantation</p> <p><u>PT</u>: Unnecessary tree felling along the project road avoided; Budget allocation is adequate</p>	<p>Review final design. Check budget provision for additional plantation.</p>	<ul style="list-style-type: none"> - Design Consultant (incorporated in DPR), - Contractor (joint inspection, marking of trees, follow up for clearance) - KSHIP & - Forest Department 	<p>KSHIP & Forest Department</p>

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
5. Shifting of Utilities							
5.1 Disruption of utility services to local community	<ul style="list-style-type: none"> ▪ 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	<p><u>MI</u>: Number of complaints from local people, number, timing and type of notifications issued to local people, time taken to shift utilities</p> <p><u>PT</u>: No. of complaints should be 0. Effective and timely notification. Minimal time for utility shifting</p>	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 construction materials	<ul style="list-style-type: none"> ▪ Transport, loading and unloading of loose and fine materials through covered vehicles. ▪ Paved approach roads. ▪ Storage areas to be located downwind of the habitation area. ▪ Water spraying on the unpaved haulage roads and other dust prone areas. ▪ Provision of PPEs to workers. 	<ul style="list-style-type: none"> - MORT&H Specifications for Road and Bridge works - The Air (Prevention and Control of Pollution) Act, 1981 and - Central Motor and Vehicle Act 1988 - Environmental Policy of KSHIP 	Throughout project corridor	<p><u>MI</u>: PM10 level measurements Complaints from locals due to dust</p> <p><u>PT</u>: PM10 level < 100 µg/m³; Number of complaints should be zero.</p>	Standards CPCB methods; Observations; Public consultation; Review of monitoring data maintained by contractor	Contractor	KSHIP / IE
1.2 Emission of air pollutants	<ul style="list-style-type: none"> ▪ Regular maintenance of machinery and equipment. 	The Air (Prevention and	Batching & Asphalt Mixing	<u>MI</u> : Levels of HC, SO ₂ , NO ₂ , and	Standards CPCB	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
(HC, SO ₂ , NO ₂ , CO etc,) from vehicles and use of equipment and machinery	<ul style="list-style-type: none"> ▪ 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/m³. The monitoring is to be conducted as per the monitoring plan. ▪ DG sets with stacks of adequate height and use of low sulphur diesel as fuel. ▪ LPG should be used as fuel source in construction camps instead of wood ▪ Air quality monitoring as per Environmental Monitoring Program ▪ Contractor to prepare traffic management and dust suppression plan duly approved by IE & KSHIP 	<p>Control of Pollution) Act, 1981(Amended 1987) and Rules 1982;</p> <p>Environmental Policy of KSHIP</p>	Plants, Hot Mix Plant, Crushers, DG sets locations	<p>CO. Status of PUC certificates</p> <p><u>PT</u>: To keep SO₂ and NO₂ levels less than 80ug/m³. PUC certificate of equipment and machinery is up to date</p>	<p>methods</p> <p>Review of monitoring data maintained by the Contractor</p>		
2. Noise							
2.1 Disturbance to local residents and sensitive	<ul style="list-style-type: none"> ▪ All equipment to be timely serviced and properly maintained. 	Legal requirement Noise Pollution (Regulation and	Throughout project section especially at	<u>MI</u> : day and night Noise levels. Number of	As per Noise rule, 2000	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
receptors due to excessive noise from construction activities and operation of equipment and machinery	<ul style="list-style-type: none"> ▪ 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 and built up areas to daylight hours. ▪ Construction of noise barrier at sensitive receptors ▪ Initiation of multi-layered plantation, to serve as mitigation option for operation phase ▪ Honking restrictions near sensitive areas ▪ Noise limits for construction equipment such as compactors, rollers, front loaders, concrete mixers, cranes (moveable) etc. shall not exceed 75 dB(A) at a distance of 11 m from its source ▪ PPEs to workers ▪ Noise monitoring as per Environmental Monitoring Program 	<p>Control) Rules, 2000 and amendments Thereof;</p> <p>Environmental Policy of KSHIP</p>	<p>construction sites, residential and identified sensitive locations.</p> <p>Refer Table No. 63, 64 and 65 of Chapter-4 of IEE for information on sensitive receptors.</p>	<p>complaints from local people</p> <p><u>PT</u>: Zero complaints or no repeated complaints by local people. Average day and night time noise levels are within permissible limits for work zone areas</p>	<p>Consultation with local people</p> <p>Review of noise level monitoring data maintained by contractor</p> <p>Observation of construction site</p>		
3. Land & Soil							
3.1 Land use Change and Loss of productive /	<ul style="list-style-type: none"> ▪ Non-agricultural areas to be used as borrow areas to the extent possible. 	Project requirement	Throughout the project section	<u>MI</u> : Location of Construction Camp, Storage	Visit of construction camp, plant	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
topsoil	<ul style="list-style-type: none"> ▪ 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 	<p>Annex-8.1 Guidelines on Top Soil Conservation and Reuse</p> <p>Annex-8.2 Guidelines for Siting and Layout of Construction Camp</p>	Land identified for construction camp, storage areas, hot-mix plant, batching plant etc.	<p>Areas, Hot-mix Plant, Batching Plant</p> <p>Top soil storage area</p> <p><u>PT</u>: Zero complaints or disputes registered against contractor by land owner</p>	sites; review of the reports submitted by the contractor		
3.2 Slope failure and Soil erosion due to Construction activities, earthwork, and	<ul style="list-style-type: none"> ▪ Bio-turfing of embankments to protect slopes. ▪ Slope protection by providing frames, dry stone pitching, masonry retaining walls, planting of grass 	IRC: 56 -1974 recommended practice for treatment of embankment slopes for erosion	Throughout the project road	<p><u>MI</u>: Occurrence of slope failure or erosion issues</p> <p><u>PT</u>: No slope failures. Minimal</p>	Review of design documents and site observation	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
cut and fill, stockpiles etc.	<p>and trees.</p> <ul style="list-style-type: none"> ▪ 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 	<p>control Clause No. 306 and 305.2.2 MORT&H</p> <p>Annex-8.3 Guidelines on Soil Stabilization</p>		erosion issues			
3.3 Borrow Area Management	<ul style="list-style-type: none"> ▪ Obtain EC from SEIAA before opening any new borrow area. ▪ Comply to EC conditions ▪ Non-productive, barren lands, upland shall be used for borrowing earth with the necessary permissions/consents. ▪ Follow IRC recommended practice for borrow area (IRC:SP:108:2015) for identification of location, its operation and rehabilitation ▪ Borrow areas not to be dug continuously. ▪ To the extent borrow areas shall be sited away from habitated areas. ▪ Depths of borrow pits to be regulated and sides not steeper than 25%. ▪ Topsoil to be stockpiled and protected for use at the rehabilitation stage. ▪ At least 10% of the acquired area shall be kept for stockpiling of fertile topsoil. The piles shall 	<p>IRC Guidelines on Borrow Areas; Environmental Protection Act and Rules, 1986; Water Act 1974; Air Act 1981</p> <p>Annex-8.4 Guidelines on Siting, Operation and Re-development of Borrow Area</p> <p>Environmental Policy of KSHIP</p>	Borrow sites location	<p><u>MI</u>: Existence of borrow areas in inappropriate unauthorized locations. Poor borrow area management practices. Number of accidents. Complaints from local people.</p> <p><u>PT</u>: No case of non-compliance to conditions stipulated by SEIAA in clearance letter. Zero accidents. Zero complaints.</p>	<p>Review of design documents and site observations</p> <p>Compare site conditions with EC conditions by SEIAA</p>	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	
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	<p>be covered with gunny bags / tarpaulin.</p> <ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Aggregates will be sourced from existing licensed quarries. ▪ Copies of consent / approval / rehabilitation plan for a new quarry or use of existing source will be submitted to IE & KSHIP. ▪ The contractor will develop a Quarry Redevelopment plan, as per the Mining Rules of the state and submit a copy of the approval to EA. ▪ Obtain environmental clearance from SEIAA in case of opening new quarry 	<p>IRC Guidelines on Quarry Areas; Environmental Protection Act and Rules,1986; Water Act 1974; Air Act 1981</p> <p>Annex-8.5 Guidelines on Siting, Operation and Re-development of Quarry Area</p>	Quarry area locations	<p><u>MI</u>: Existence of licenses for all quarry areas from which materials are being sourced</p> <p>Existence of a Quarry Redevelopment Plan</p> <p><u>PT</u>: Quarry license is valid; No case of non-</p>	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
	<ul style="list-style-type: none"> ▪ 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 Sr. Environmental Specialist of IE for approval in the Format given in Annex-8.18 	Environmental Policy of KSHIP		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	<ul style="list-style-type: none"> ▪ 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.	<u>MI</u> : Location of approach and haulage roads; Presence of destroyed / compacted agricultural land or land which has not be restored to its original condition <u>PT</u> : 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-	<ul style="list-style-type: none"> ▪ Construction vehicles and equipment will be maintained and refueled in such a fashion that oil / diesel spillage does not contaminate the soil. 	Design requirement	Fuelling station, construction sites, and construction camps and	<u>MI</u> : Quality of soil near storage area Presence of spilled oil or bitumen in project	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
bituminous debris generated from demolition and road construction	<ul style="list-style-type: none"> ▪ Fuel storage and refueling sites to be kept away from drainage channels. ▪ Unusable debris shall be dumped in ditches and low lying areas. ▪ 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 an identified dumping site approved by the State Pollution Control Board 		disposal location.	<p>area</p> <p><u>PT</u>: Soil test conforming to no – contamination;</p> <p>No sighting of spilled oil or bitumen in construction site or camp site</p>			
4. Water Resources							
4.1 Sourcing of water during Construction	<ul style="list-style-type: none"> ▪ 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 	CGWA Guidelines	Throughout the Project section	<p><u>MI</u>: Approval from competent authority; Complaints from local people on water availability</p> <p><u>PT</u>: Valid approval from Competent Authority. Zero complaints from local people.</p>	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
	<p>subject to approval of village & local administration.</p> <ul style="list-style-type: none"> ▪ Water intensive activities not to be undertaken during summer season. ▪ Provision of water harvesting structure to augment groundwater condition in the area 						
4.2 Disposal of water during construction	<ul style="list-style-type: none"> ▪ Provisions shall be made to connect roadside drains with existing nearby natural drains. 	Design requirement	Throughout the Project section	<p><u>MI</u>: Condition of drainage system in construction site; Presence / absence of water logging in project area.</p> <p><u>PT</u>: Existence of proper drainage system. No water logging in project area</p>	Standards methods; Site observation and review of documents	Contractor	KSHIP / IE
4.3 Alteration in Surface Water Hydrology	<ul style="list-style-type: none"> ▪ 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 	Design requirement,	Near all drainage channels, River /Nallah crossings etc.	<p><u>MI</u>: Proper flow of water in existing streams and rivers</p> <p><u>PT</u>: No complain of water shortage by downstream communities. No record of overtopping / water logging</p>	<p>Review of design documents</p> <p>Site observation</p>	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
	original course immediately after construction.						
4.4 Siltation in Water Bodies due to construction activities / earthwork	<ul style="list-style-type: none"> ▪ Embankment slopes to be modified suitably to restrict the soil debris entering water bodies. ▪ Silt fencing shall be provided along ponds within the direct impact zone intercepting highway to prevent siltation in water bodies. ▪ Sediment / silt should be collected and stockpiled for possible reuse as surfacing of slopes where they have to be re-vegetated. ▪ 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 	Design requirement; Worldwide Best Practices; Annex-8.6 Guideline for Sediment Control	Near all water bodies/ waterway	<p><u>MI</u>: Presence/absence of siltation in rivers, streams, nala, ponds and other water bodies in project area; water quality monitoring</p> <p><u>PT</u>: No records of siltation due to project activities. Surface water quality tests confirm to turbidity and TSS limit</p>	Field observation	Contractor	KSHIP / IE
4.5 Deterioration in Surface water quality due to leakage from vehicles and equipment and waste from construction camps.	<ul style="list-style-type: none"> ▪ 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 	<p>The Water (Prevention and Control of Pollution) Act, 1974 and amendments thereof;</p> <p>Environmental Policy of KSHIP</p>	Water bodies; refueling stations; construction camps.	<p><u>MI</u>: Water quality of ponds, streams, rivers and other water bodies in project</p> <p>Presence of oil floating in water bodies in project area</p> <p><u>PT</u>: Surface water quality meets freshwater quality standards (IS:2296)</p>	<p>Conduction of water quality tests as per the Environmental Monitoring Plan</p> <p>Field observation</p>	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
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	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 <ul style="list-style-type: none"> ▪ Construction camp to be sited away from water bodies. ▪ Wastes must be collected, stored and taken to approved disposal site only. ▪ Water quality shall be monitored 						
5. Flora and Fauna							
5.1 Vegetation loss due to site preparation and construction activities	<ul style="list-style-type: none"> ▪ Restrict tree cutting up to toe line considering safety to road users. ▪ Roadside trees to be removed with prior approval of competent authority. ▪ 6,626 trees shall be planted on both sides of the project road ▪ 3,587 trees are proposed to be planted in local community area, local schools, partnership with participatory forestry schemes or in degraded revenue land. ▪ 100 trees will be planted in oxbow land ▪ Trees will be planted as per the Tree Plantation Strategy given in Annex-8.12 ▪ Total Compensatory Plantation will be 1:6 ▪ Local villagers to be employed for plantation activities. Employment preference to be given to women ▪ Regular maintenance of all trees 	Forest Conservation Act 1980; IRCSP:21 and IRCSP:66 Environmental Policy of KSHIP	Throughout project corridor Additional Plantation near Sensitive receptors, river banks, borrow areas, quarry area etc.	<u>MI</u> : ROW width; Number of trees for felling; Compensatory plantation plan and Number of trees replanted. <u>PT</u> : 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

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	<p>planted.</p> <ul style="list-style-type: none"> ▪ 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 						
6. Construction Camp							
6.1 Impact associated with location	All camps should be established with prior permission from SPCB. Camps to maintain minimum distance from following: # 500 m from habitation # 1000 m from forest areas where possible # 500 m from water bodies where possible # 500 m from through traffic route	Design Requirement The Water (Prevention and Control of Pollution) Act, 1974 and its amendments thereof Annex-8.2 Guidelines for Siting and Layout of Construction Camp	All construction camps	<p><u>MI</u>: Location of camp sites and distance from habitation, forest areas, water bodies and through traffic</p> <p><u>PT</u>: Distance of camp site is less than 500m from listed locations</p>	<p>On site observation</p> <p>Interaction with workers and local community</p>	Contractor and EO	KSHIP / IE
6.2 Worker's Health in construction camp	<ul style="list-style-type: none"> ▪ 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 	<p>The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 and</p> <p>The Contract</p>	All construction camps	<p><u>MI</u>: Camp health records. Existence of proper first aid kit in camp site. Complaints from workers.</p> <p><u>PT</u>: No record of</p>	<p>Camp records</p> <p>Site observation</p> <p>Consultation with contractor workers and local people living nearby</p>	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
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	<p>latrines with septic tanks with soak pits shall be provided.</p> <ul style="list-style-type: none"> ▪ 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 practitioner ▪ Waste disposal facilities such as dust bins must be provided in the camps and regular disposal of waste must be carried out. ▪ The Contractor will take all precautions to protect the workers from insect and pest to reduce the risk to health. This includes the use of insecticides which should comply with local regulations. 	<p>Labour (Regulation & Abolition) Act, 1970</p> <p>The Water (Prevention and Control of Pollution) Act, 1974 and amendments thereof</p> <p>Environmental Policy of KSHIP and provision of ISO:14001:2004</p>		<p>illness due to unhygienic conditions or vectors.</p> <p>Zero cases of STD.</p> <p>Clean and tidy camp site conditions.</p>			
7. Management of Construction Waste / Debris							
7.1 Selection of Debris Disposal Sites	<ul style="list-style-type: none"> ▪ 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- 	<p>Design Requirement;</p> <p>Annex-8.7: Guideline for Siting and Management of Debris Disposal Site,</p> <p>Environmental Policy of KSHIP</p>	At all Dumping Sites	<p><u>MI</u>: Location of dumping sites Number of public complaints. <u>PT</u>: No public complaints. Consent letters for all dumping sites available with contractor</p>	<p>Field survey and interaction with local people.</p> <p>Review of consent letter</p>	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
	<p>8.7</p> <ul style="list-style-type: none"> Details of identified debris disposal site should be reported to the IE for approval in the Format given in Annex-8.19 						
7.2 Reuse and disposal of construction and dismantled waste	<ul style="list-style-type: none"> The existing bitumen surface shall be utilized for paving of cross roads, access roads, and paving works in construction sites and camps, temporary traffic diversions and haulage routes. All excavated materials from roadway, shoulders, verges, drains, cross drainage will be used for backfilling embankments, filling pits, and landscaping. Unusable and non-bituminous debris materials should be suitably disposed-off at pre-designated disposal locations, with approval of the concerned authority. The bituminous wastes 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 	<p>Design Requirement;</p> <p>Annex-8.8: Guideline for Preparing Comprehensive Waste Management Plan</p>	Throughout the project corridor	<p><u>MI</u>: Percentage of reuse of existing surface material</p> <p>Method and location of disposal site of construction debris</p> <p><u>PT</u>: No public complaint and consent letters for all dumping sites available with contractor or IE</p>	<p>Contractor records</p> <p>Field observation</p> <p>Interaction with local people</p>	Contractor	KSHIP / IE
8. Traffic Management and Safety							
8.1 Management of existing traffic and safety	<ul style="list-style-type: none"> Temporary traffic diversion shall be planned by the contractor and approved by the 'Engineer'. The traffic control plans shall 	<p>Design requirement and</p> <p>IRC: SP: 27 -1984;</p>	Throughout the project corridor especially at intersections.	<p><u>MI</u>: Traffic Management Plan. Presence/ absence of safety signs,</p>	Review Traffic Management Plan;	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
	<p>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'.</p> <ul style="list-style-type: none"> ▪ The Contractor will ensure that the diversion / detour are always maintained in running condition, particularly during the monsoon to avoid disruption to traffic flow. ▪ On stretches where it is not possible to pass the traffic on the part width of existing carriageway, temporary paved diversions will be constructed. ▪ Restriction of construction activity to only one side of the existing road. ▪ 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 	<p>IRC:SP: 32 -1988 Road Safety for Children (5-12 Years Old);</p> <p>IRC:SP: 44 -1994 Highway Safety Code</p> <p>IRC: SP: 55 -2001; Guidelines for Safety in Construction Zones;</p> <p>IRC:53:2012 Road Accident recording</p> <p>The Building and other Construction workers Act 1996 and Factories Act 1948</p> <p>Annex-8.9 Guideline for Preparing of Traffic Management Plan</p>		<p>clear traffic demarcations, flag men etc. on site. Complaints from road users. Number of traffic accidents</p> <p><u>PT</u>: No complaints. No accidents due to poor traffic management. Traffic signs, demarcation lines etc. present in appropriate locations on site</p>	<p>Field observation of traffic management and safety system</p> <p>Interaction with people in vehicles using the road</p>		
8.2 Pedestrians, animal movement	<ul style="list-style-type: none"> ▪ 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 	Same as above	Near habitation on both sides of schools, temples, hospitals, graveyards, Construction Sites,	<u>MI</u> : Presence/ absence of access routes for pedestrians. Road signage. Number of complaints from	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
	clearance above 3m and not catering to perennial flow of water may serve as underpass for animals		Haulage roads and diversion sites.	local people PT: Easy access to schools, temples and public places. Zero complaints			
8.3 Safety of Workers and accident risk from construction activities	<ul style="list-style-type: none"> ▪ Contractors to adopt and maintain safe working practices. ▪ Usage of fluorescent and retro refractory 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 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, 	<p>Same as above</p> <p>Annex-8.10 Guideline to Ensure Worker's Safety during Construction</p> <p>Environmental Policy of KSHIP and provision of ISO:14001:2004</p>	Construction sites	<p>MI: Availability of Safety gears to workers</p> <p>Safety signage Training records on safety</p> <p>Number of safety related accidents</p> <p>PT: Zero fatal accidents. Zero or minor non-fatal accidents.</p>	<p>Site observation</p> <p>Review records on safety training and accidents</p> <p>Interact with construction workers</p>	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
	<p>Handling, Use and Emergency Response for Hazardous Substances is given in Annex-8.11.</p> <ul style="list-style-type: none"> ▪ 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" 						
8.4 Accident risk to local community	<ul style="list-style-type: none"> ▪ Restrict access to construction sites only to authorized personnel. ▪ Physical separation must be provided for movement of vehicular and human traffic. ▪ Adequate signage must be provided for safe traffic movement ▪ Provision of temporary diversions and awareness to locals before opening new construction fronts. 	Same as above	Construction sites	<p><u>MI</u>: Safety signs and their location; Incidents of accidents; Complaints from local people</p> <p><u>PT</u>: Zero incident of accidents. Zero complaints.</p>	<p>Site inspection</p> <p>Consultation with local people</p>	Contractor	KSHIP / IE
9. Site Restoration and Rehabilitation							
9.1 Clean-up Operations, Restoration and Rehabilitation	<ul style="list-style-type: none"> • 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 	<p>Project requirement</p> <p>Annex-8.2 Annex-8.4 Annex-8.5 Annex-8.7</p> <p>Environmental Policy of KSHIP and</p>	Throughout the project corridor, construction camp sites and borrow areas	<p><u>MI</u>: Condition of camp sites, construction sites and borrow areas.</p> <p>Presence / absence of construction material / debris</p>	<p>Site observation</p> <p>Interaction with locals; Issue completion certificate after restoration of all sites are found</p>	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
	<p>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.</p> <ul style="list-style-type: none"> All the opened borrow areas will be rehabilitated and 'Engineer' will certify 	provision of ISO:14001:2004		<p>after completion of construction works on construction site.</p> <p><u>PT</u>: Clean and tidy sites. No trash or debris left on site. Site restored and leveled.</p>	satisfactory		
C. OPERATION AND MAINTENANCE STAGE							
1. Air Quality							
2.1 Air pollution due to due to vehicular movement	<ul style="list-style-type: none"> 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. 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 	<p>Environmental Protection Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981</p> <p>Environmental Policy of KSHIP</p>	Throughout the Corridor	<p><u>MI</u>: Air quality monitoring as per post project Environmental Monitoring Program</p> <p><u>PT</u>: Levels are equal to or below baseline levels given in the IEE report</p>	<p>As per CPCB requirements</p> <p>Site inspection</p>	PIU / Pollution Monitoring Agency	KSHIP
2. Noise							
2.1 Noise due to movement of traffic	<ul style="list-style-type: none"> 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 	<p>Noise Pollution (Regulation and Control) Rules, 2000 and amendments thereof</p> <p>Environmental Policy of KSHIP</p>	Sensitive receptors as identified in the IEE Report	<p><u>MI</u>: Noise monitoring as per post project Environmental Monitoring Program</p> <p><u>PT</u>: Levels are equal to or below</p>	<p>Noise monitoring as per noise rules , 2000</p> <p>Discussion with people at sensitive</p>	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
	<ul style="list-style-type: none"> 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 			baseline levels given in the IEE report	receptor sites		
3. Land & Soil							
3.1 Soil erosion at embankment during heavy rainfall.	<ul style="list-style-type: none"> Periodic checking to be carried to assess the effectiveness of the stabilization measures viz. turfing, stone pitching etc. Soil quality monitoring. If monitored parameters exceeds prescribed limit, suitable control measures must be taken. Necessary measures to be followed wherever there are failures 	Project requirement	<p>At bridge locations and embankment slopes and other probable soil erosion areas.</p> <p>Soil quality monitoring from different land use area along the project road such as agricultural area, residential area and low lying areas</p>	<p><u>MI</u>: Existence of soil erosion sites; Number of soil erosion sites</p> <p>soil quality monitoring as per post project Environmental Monitoring Program</p> <p><u>PT</u>: Zero or minimal occurrences of soil erosion</p>	<p>On site observation</p> <p>As per CPCB requirements</p>	PIU	KSHIP
4. Water Resources / Flooding and Inundation							
4.1 Siltation	<ul style="list-style-type: none"> Regular checks shall be made for soil erosion and turfing conditions for its effective maintenance. 	Project requirement	Near surface Water bodies	<p><u>MI</u>: Water quality monitoring as per post project Environmental Monitoring Program</p>	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
				PT: No turbidity of surface water bodies due to the road			
4.2 Water logging due to blockage of drains, culverts or streams	<ul style="list-style-type: none"> ▪ 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	<p>MI: Presence/ absence of water logging along the road</p> <p>PT: No record of overtopping/ Water logging</p>	Site observation	PIU	KSHIP
5. Flora							
5.1 Vegetation	<ul style="list-style-type: none"> ▪ 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 	<p>Forest Conservation Act 1980</p> <p>Environmental Policy of KSHIP</p>	Project tree plantation sites	<p>MI: Tree/plants survival rate</p> <p>PT: Minimum rate of 70% tree survival</p>	<p>Records and field observations.</p> <p>Information from Forestry Department</p>	Forest Department / PIU	KSHIP
6. Maintenance of Right of Way and Safety							
6.1 Accident Risk due to uncontrolled growth of vegetation	<ul style="list-style-type: none"> ▪ Efforts shall be made to make shoulder completely clear of vegetation. ▪ Regular maintenance of plantation along the roadside ▪ No invasive plantation near the road. 	Project requirement	Throughout the Project route	<p>MI: Presence and extent of vegetation growth on either side of road. Number of accidents.</p> <p>PT: No accidents due to vegetation growth</p>	<p>Visual inspection</p> <p>Check accident records</p>	PIU	KSHIP
6.2 Accident risks associated with traffic movement.	<ul style="list-style-type: none"> ▪ Traffic control measures, including speed limits, will be forced strictly. ▪ Further encroachment of squatters within the ROW will be 	IRC:SP:55	Throughout the Project route	MI: Number of accidents Conditions and existence of safety signs, rumble strips	<p>Review accident records</p> <p>Site observations</p>	PIU	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	<p>prevented.</p> <ul style="list-style-type: none"> ▪ 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 			<p>etc. on the road</p> <p>Presence/absence of sensitive receptor structures inside the stipulated planning line as per relevant local law</p> <p><u>PT</u>: Fatal and non-fatal accident rate is reduced after improvement</p>			
6.3.Transport of Dangerous Goods	<ul style="list-style-type: none"> ▪ Existence of spill prevention and control and emergency responsive system ▪ Emergency plan for vehicles carrying hazardous material 	-	Throughout the project stretch	<p><u>MI</u>: Status of emergency system – whether operational or not</p> <p><u>PT</u>: Fully functional emergency system</p>	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,

424. 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

425. 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.

426. 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

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

D. Emergency Response Plan

428. 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

429. 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.

430. 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.

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

432. 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>)

433. 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 complainant about redress and the action taken.

434. 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.

435. 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.

436. 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.

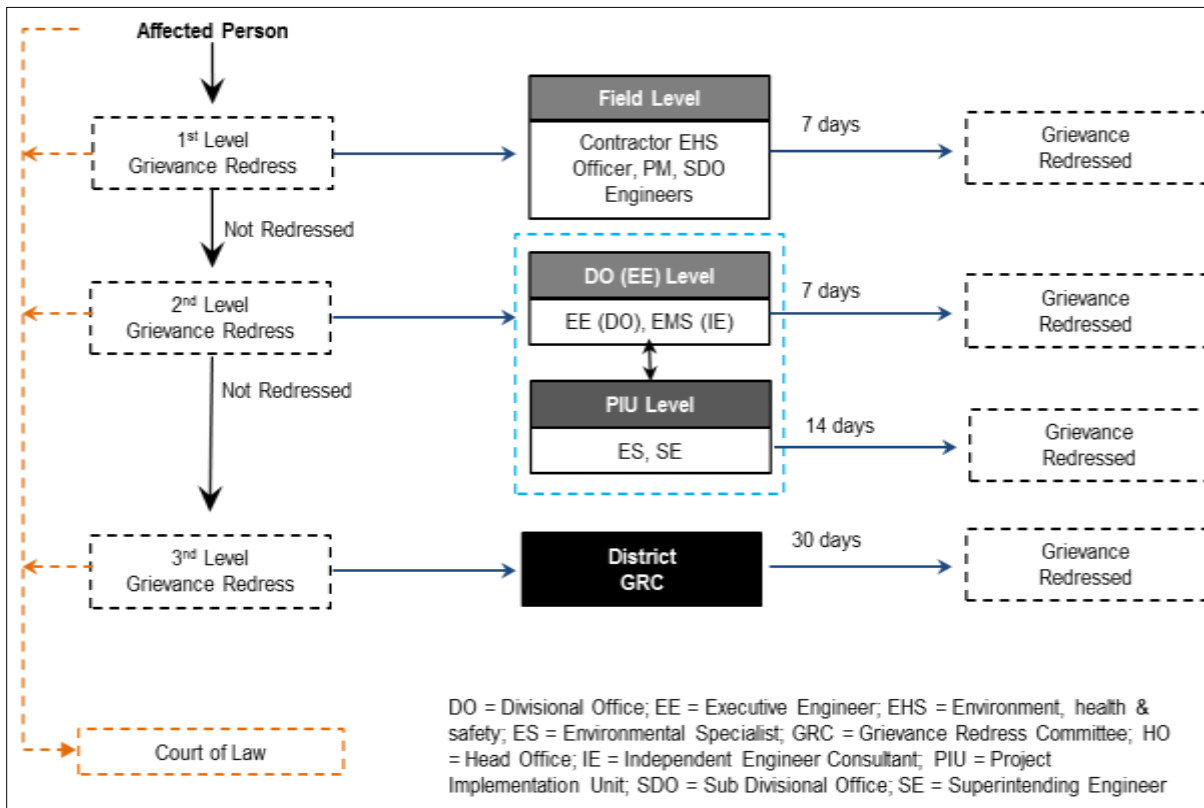


Figure 63 Grievance Redress Process

437. 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.

438. 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.

439. 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.

440. 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

441. 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
-
- The environmental monitoring plan contains:
 - Performance Indicators
 - Environmental Monitoring Program
 - Reporting Formats
 - Necessary Budgetary Provisions

1. Performance Indicators

442. 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

443. The Performance Indicators and monitoring plans prepared are presented in Table-125.

Table 125 Performance Indicators

S.N.	Details	Indicators	Stage	Responsibility
A.	Pre-Construction Stage: Environmental Management Indicators and Monitoring Plan			
1.	Location of construction camps have to be identified and parameters indicative of environment in the area has to be reported. Reporting format is given in Annex-8.13	Construction camp	Pre-construction	Contractor
2.	Location of borrow areas have to be finalized and parameters indicative of environment in the area has to be reported. Reporting format is given in Annex-8.16	Borrow areas	Pre-construction	Contractor
3.	Location of Quarry and Stone Crusher sites have to be finalized and parameters indicative of environment in the area has to be reported. Reporting format is given in Annex-8.18	Quarry and Stone Crusher sites	Pre-construction	Contractor
4.	Locations for Debris Disposal Site have to be identified and parameters indicative of environment in the area has to be reported. Reporting format is given in Annex-8.19	Debris Disposal Site	Pre-construction	Contractor
5.	Progress of tree removal marked for cutting is to be reported	Site clearing	Pre-construction	Contractor
B.	Construction Stage: Environmental Condition Indicators and Monitoring Plan			
1.	The parameters to be monitored as per frequency, duration & locations of monitoring specified in the Environmental Monitoring Program prepared (Refer Table-136)	Air quality	Construction	Contractor through NABL approved monitoring agency
		Noise level	Construction	Contractor through NABL approved monitoring agency
		Ground Water quality	Construction	Contractor through NABL approved monitoring agency
		Surface Water quality	Construction	Contractor through NABL approved monitoring agency
		Soil quality	Construction	Contractor through NABL approved monitoring agency
2.	Progress of measures suggested as part of the strategy is to be reported	Tree plantation	Construction	Contractor
3.	Contractor shall report implementation of the measures suggested for topsoil conservation to Sr. Environmental Specialist of IE	Top Soil Conservation	Construction	Contractor
4.	Contractor shall report implementation of the measures suggested for slope stabilization and sediment control to Sr. Environmental Specialist of IE	Slope Stabilization and Sediment Control	Construction	Contractor

S.N.	Details	Indicators	Stage	Responsibility
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

444. The detail monitoring schedule during construction and operation stages are presented in Table-126. 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 126 Environmental Monitoring Program

Environment Component	Project	Environmental Monitoring Program			Institutional Responsibility	
	Stage	Parameters	Location	Frequency	Implementation	Supervision
Air Quality	Construction ¹²	PM ₁₀ , PM _{2.5} , SO ₂ , NO _x , 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 24 months

Environment Component	Project Stage	Environmental Monitoring Program			Institutional Responsibility	
		Parameters	Location	Frequency	Implementation	Supervision
				Construction work should be in full swing during monitoring <u>Duration:</u> 24 hours		
		PM ₁₀ , PM _{2.5} , SO ₂ , NO ₂ , CO,	At 5 locations: - Bengaluru near start point, - Tavarekere - Magadi - Chandurayanahalli - Talekere	Twice in a season at one day interval for 3 seasons (except monsoon) Construction work should be in full swing during monitoring <u>Duration:</u> 24 hours	Contractor through NABL approved monitoring agency	IE / PIU
	Operation ¹³	PM ₁₀ , PM _{2.5} , SO ₂ , NO ₂ , CO,	At 4 locations: Bengaluru near start point, Tavarekere, Chandurayanahalli and Talekere	Once in a season for 3 seasons (except monsoon) <u>Duration:</u> 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) <u>Duration:</u> 24 hours	Contractor through NABL approved monitoring agency	IE / PIU
		Noise level in dB(A)	At 6 locations: - Bengaluru , - Tavarekere, - Chollanayakanahalli - Magadi - Chandurayanahalli - Kenchanahalli	4 times a year (in each season) <u>Duration:</u> 24 hours	Contractor through NABL approved monitoring agency	IE / PIU
	Operation	Noise level in dB(A)	At 6 locations: - Bengaluru , - Tavarekere, - Chollanayakanahalli - Magadi - Chandurayanahalli - Kenchanahalli	Once in every three years <u>Duration:</u> 24 hours	PIU through NABL approved monitoring agency	PIU / KSHIP
Ground Water Quality	Construction	Physical, Chemical & Biological parameters as per	At 6 locations: - Bengaluru , - Tavarekere, - Chollanayakanahalli - Magadi	4 times a year	Contractor through NABL approved monitoring agency	IE / PIU

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

Environment Component	Project Stage	Environmental Monitoring Program			Institutional Responsibility															
		Parameters	Location	Frequency	Implementation	Supervision														
		IS 10500:2012 However, IE may include additional parameters	- Chandurayanahalli - Kenchanahalli																	
	Operation	Physical, Chemical & Biological parameters as per IS 10500:2012	At 6 locations: - Bengaluru , - Tavarekere, - Chollanayakanahalli - Magadi - Chandurayanahalli - Kenchanahalli	Twice in every three years (Pre-monsoon & post-monsoon)	PIU through NABL approved monitoring agency	PIU / KSHIP														
Surface Water Quality	Construction	Physical, Chemical & Biological parameters as per IS:2296	At 6 locations: <table border="1"> <thead> <tr> <th>Design Ch. Km</th> <th>Village</th> </tr> </thead> <tbody> <tr> <td>25+750</td> <td>Devamachohalli</td> </tr> <tr> <td>46+270</td> <td>Thirumali</td> </tr> <tr> <td>47+240</td> <td>Thirumali</td> </tr> <tr> <td>49+110</td> <td>Magadi</td> </tr> <tr> <td>56+200</td> <td>Kalarikaval</td> </tr> <tr> <td>64+460</td> <td>Talekere</td> </tr> </tbody> </table>	Design Ch. Km	Village	25+750	Devamachohalli	46+270	Thirumali	47+240	Thirumali	49+110	Magadi	56+200	Kalarikaval	64+460	Talekere	4 times a year	Contractor through NABL approved monitoring agency	IE / PIU
Design Ch. Km	Village																			
25+750	Devamachohalli																			
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Design Ch. Km	Village																			
25+750	Devamachohalli																			
46+270	Thirumali																			
47+240	Thirumali																			
49+110	Magadi																			
56+200	Kalarikaval																			
64+460	Talekere																			
Soil	Construction	pH, Conductivity, Organic matter, N, P, Na, K, Pb	At 4 locations: Wherever the contractor decides to locate the Hot Mix Plant; construction camp; remaining 2 will be from different land use area along the project road such as agricultural area and residential area	Once in a year	Contractor through NABL approved monitoring agency	IE / PIU														
	Operation	pH, Conductivity, Organic matter, N, P, Na, K, Pb	2 will be from different land use area along the project road such as agricultural area and residential area	Once in every three years	PIU through NABL approved monitoring agency	PIU / KSHIP														
Soil Erosion	Construction	Visual observation & turbidity test	Visual observation at high embankments sites such as bridge location, culvert locations, embankment area etc.	Pre-monsoon and post-monsoon season	Environmental Specialist, Hydrologist, and Material Specialist of	IE / PIU														

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 roadside plantation	Side of the carriageway	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

445. 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

446. 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.

447. 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-127.

- 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.

448. 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 127 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

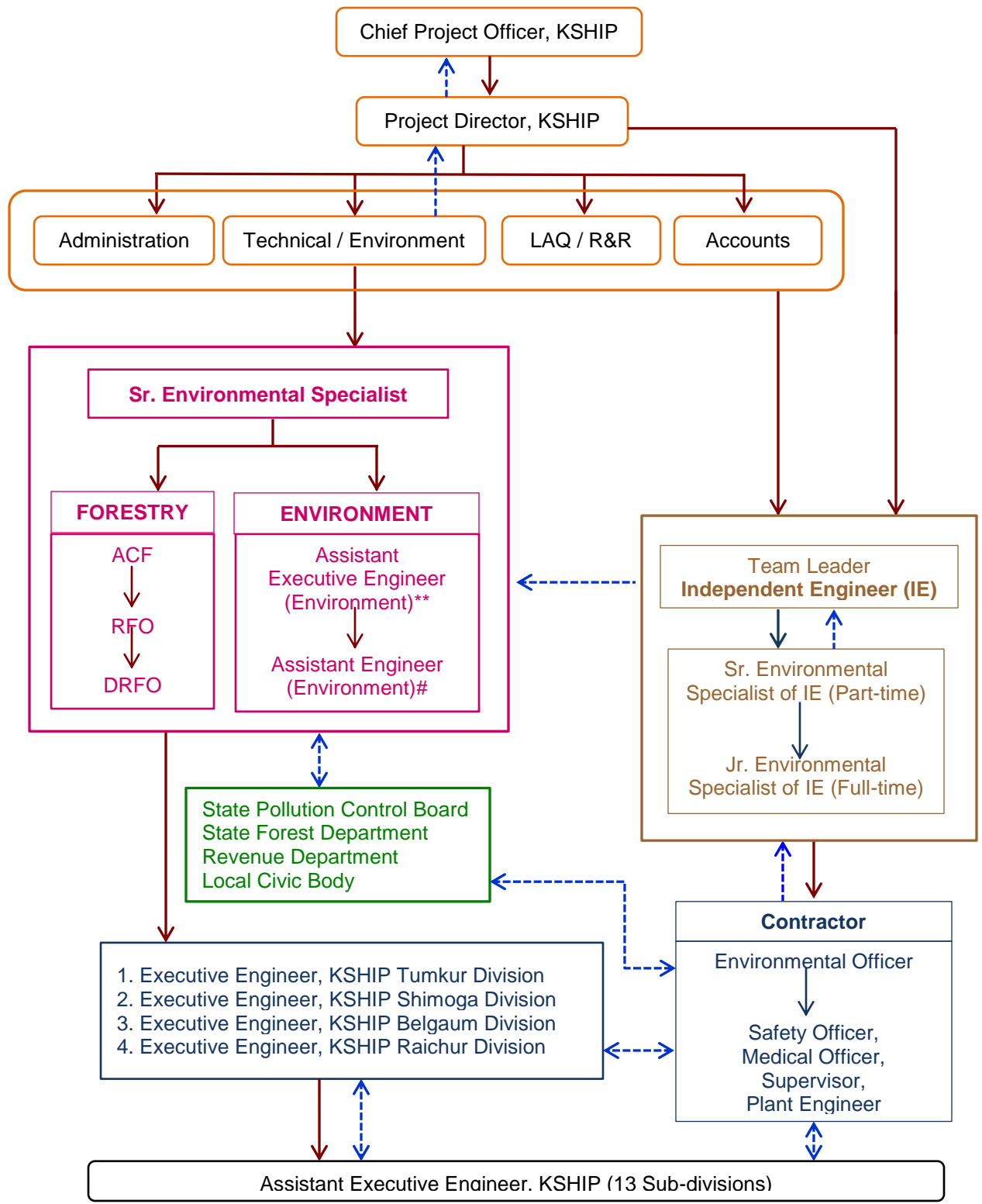
449. Project Implementation Unit (PIU) is responsible for implementation of all the mitigation and management measures suggested in EMP and also make sure that the statutory requirements are not violated during the pre-construction, construction and operation stages of the project.

450. 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.

451. 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.

452. 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.



Note: **Assistant Executive Engineer (2 positions): 1 position already sanctioned, 1 position to be sanctioned
Assistant Engineer (2 positions): 1 position already sanctioned, 1 position to be sanctioned

Figure 64 Implementation Arrangement

2. Implementation Arrangements

453. 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.

454. 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.

455. 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.

456. 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

457. 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

458. 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

459. 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 contractor (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:

460. 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

461. **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.

462. 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.

463. 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.

464. 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

465. 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.

466. 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

467. 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.

468. 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

469. 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

470. 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.

471. Given below is a list of Training Institutes (Table-128) which can be contacted for providing training in various issues related to environmental management as identified in Training Components.

Table 128 List of Training Institutes

Sl. No.	Name of Training Institute
1.	Indian Academy of Highway Engineers (IAHE) (Ministry of Road Transport & Highways, Govt. of India) A-5, Institutional Area, Sector-62, NH-24 Bypass, NOIDA-201301 (UP) Telephone: 0120-2400085 - 86, 2405006 - 09, Course Coordinator: Shri. M. Riten Kumar Singh(JointDirector) Email: iahe.training@gmail.com
2.	Wildlife Institute of India Post Box # 18, Chandrabani, Dehadun 248 001 Uttarakhand Email: dwii@wii.gov.in

Sl. No.	Name of Training Institute
	Phone: 0135-2640910, 0135-2640114, 0135 2646102 Fax: 0135-2640117
3.	Central Road Research Institute (CRRI) P.O. CRRI, Delhi-Mathura Institute, New Delhi – 110 025 Shri. T. K. Amla, Chief Scientist, Head & Course Organizer Phone: 011 26921939 Email: tkamla.crrri@nic.in
4.	Centre for Innovations in Public Systems (CIPS) Administrative Staff College of India, College Park Campus Road No. 3, Banjara Hills, Hyderabad – 500 034 Phone: 040 667 20720 Fax: 040 667 20721 E-mail: chakrapani@cips.org.in
5.	Kerala Forest Research Institute An Institute of Kerala State Council for Science, Technology and Environment Peechi P.O, Thrissur District - 680653 Kerala Phone: 0487 2690100; Fax: 0487-2690111
6.	National Environmental Engineering Research Institute (NEERI) Nehru Marg, Nagpur – 440020, Maharashtra Phone: 0712 2249885-88; 2249970-72 URL: http://www.neeri.res.in
7.	Envirotech Instruments Pvt. Ltd. Manufacturers of Air Pollution Monitoring Instruments A-271, Okhla Industrial Area, Phase-1, New Delhi-110020 Phones: 011 26813887, 26814139 Fax: 011 26811833 Email: envirotech@vsnl.com
8.	Centre for Science and Environment 41, Tughlakabad Institutional Area, New Delhi-110062 Phone: 011 29955124, 29956110, 29956394, 29956399 Fax: 011 29955879 Email: cse@cseindia.org
9.	TUV India PVT Ltd 801, Raheja Plaza 1, L.B.S. Marg, Ghatkopar (West) Mumbai – 400086 Phone: +91 22 66477096/ 98, +91 22 66477009 Email: infoindia@tuv-nord.com
10.	SGS India - South 28B/1, 28B/2, 2nd Main Road, Ambattur Industrial Estate Chennai, Tamil Nadu, 600 058 Phone: +91 (0) 44 6608 1600 /1700 / 1800, +91 (0) 87 54 44 6594 (Regional Branch Manager)

I. Environmental Budget

472. 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

473. A capital cost provision of about Rs. 4.44 Crore has been kept towards implementation of environmental management plan. Summary of environmental budget is presented in Table-129.

**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 & Geology	Construction	Establishment of Construction Camp	Sq. ft	Area required 100 Sq.ft/ labour; No. of labours: 100 Total area required = (100 x 100) = 10,000 sq.ft	300	3,000,000
Soil	Construction	Bitumen disposal pit for disposal of Bituminous waste generated (23,500 Cum) as per specification given in Figure-6.1 of Chapter-6	No.	27	58,800	1,587,600
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 years = 2,400 trips	500	1,200,000
Water	Construction	Provision of water supply facilities for the construction camps	Month	24	10,000	240,000
Water	Construction	Provision of sewage and sanitation facilities for the construction camps, including maintenance for 2 years	Month	24	10,000	240,000
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 2 locations = 2	10,000	20,000
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 2 locations = 2	50,000	100,000
Water	Construction	Silt fencing near water	Meter	1,100	850	935,000

Component	Stage	Item	Unit	Quantity	Cost# (Rs.)	Total Cost (Rs.)	
		bodies, low lying areas and areas identified by the IE					
Water	Construction	Ground Water Recharge Pit / Rainwater Harvesting Structures	No.	10	62,800	628,000	
Water	Construction	Enhancement of water body at 1 location as per specification given in the Pond Enhancement Plan (Annex-8.27) and described in Section-6.3.5.1 of Chapter-6	No.	1	63,07,000	6,307,000	
Water	Construction	Phyco-Remediation of water body using NUALGI as per details provided in Annex-8.26	Liter	67.5	9,000	607,500	
Noise	Construction	Construction of noise barrier at sensitive receptors along the project road (for details please refer Section 6.5.2 of Chapter-6)	Meter	686	7,500	5,145,000	
Vegetation loss	Construction	Provision of fuel in the construction camp	No.	4 commercial LPG Cylinder per month x 24 months = 96 cylinders	1,500	144,000	
Solid Waste Management	Construction	Clearing garbage from construction camp and construction site	Month	24	4,000	96,000	
Safety of Workers	Construction	Providing PPE to the labours during the construction	Cost/ person	100	1,200	120,000	
Health Checkup	Construction	Provision for biannual health checkups	No.	100 persons x 4 checkups = 400	2,000	800,000	
Resettlement & Rehabilitation	Construction	Compensation for structure including affected religious structures, livelihood loss, resettlement assistances & RP implementation	Covered under Engineering Cost				
					Total	21,170,100	

Note: 1) Construction period is 24 months/ 2 years
basis of unit cost is the Consultant's past experience in similar projects

B. Environmental Monitoring Budget

Parameters	Stage	Frequency	No. of Locations	No. of Samples	Unit Cost/ Sample# (Rs.)	Total Cost (Rs.)
Ambient Air Quality	Construction	Twice in a season for 3 seasons	7	84	4,000	336,000

Parameters	Stage	Frequency	No. of Locations	No. of Samples	Unit Cost/ Sample# (Rs.)	Total Cost (Rs.)
		(except monsoon)				
	Operation	Once in a season for 3 seasons (except monsoon)	4	24	4,000	96,000
Noise Level	Construction	4 times a year (in each season)	7	56	2,000	112,000
	Operation	Once in every three years	6	18	2,000	36,000
Ground Water Quality	Construction	4 times a year (in each season)	6	48	7,000	336,000
	Operation	Twice in every three years (Pre-monsoon & post-monsoon)	6	36	7,000	252,000
Surface Water Quality	Construction	4 times a year (in each season)	6	48	7,000	336,000
	Operation	Twice in every three years (Pre-monsoon & post-monsoon)	6	36	7,000	252,000
Soil Quality	Construction	Once in a year	4	8	5,000	40,000
	Operation	once in every three years	2	6	5,000	30,000
Transportation of samples to the laboratory	Construction	Immediately after sampling	-	-	Lump sum	250,000
	Operation	Immediately after sampling	-	-	Lump sum	400,000
Grand Total						2,476,000

Note: 1) Construction period is 24 months/ 2 years

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.)
Plantation in Oxbow land	Construction	Plantation (100 trees) in realignment section in non-forest stretches as per standard tree plantation program approved by the Forest Department, GoK (location of oxbow plantation is given in Table 6-11 in Section-6.6.1 of Chapter-6)	Ha	0.5	2,34,000	117,000
		Fencing	m	340	168	57,120
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) <ul style="list-style-type: none"> ▪ Road side plantation 6,626 trees ▪ Plantation in community area, schools etc.: 3,587 trees 	Nos.	10,213	1,911	19,517,043
Total						19,691,163

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 construction supervision consultant, 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 129 Summary of Environmental Budget

Component	Description	To be implemented by	Amount (Rs.)
A.	Mitigation / Enhancement	Contractor	21,170,100
B.	Environmental Monitoring		2,476,000
Subtotal			23,646,100
C.	Forestry	KSHIP	19,691,163
D.	Training & Mobilization		1,040,000
Subtotal			20,731,163
Grand Total			44,377,263

X. CONCLUSION & RECOMMENDATIONS

A. Conclusion

474. The Project road is a part of SH 85 (Bengaluru to Jalsoor) and part of MDR (from Magadi to Kunigal). The proposed improvement starts in Bengaluru district from the junction of Loop of NICE Road near Bengaluru (Km 15+325) up to Km 51+680 (Existing), then along MDR from Km 0+000 and ends at junction with NH 75 near Kunigal via Chikkamudigere & Iyandahalli in Ramanagara district. Length of the existing road is 51.660 km. After the proposed improvement (realignment, curve improvement), length of the project road will be 50.689 km. **No new bypass is proposed, and instead realignments at three locations (total 2.637 km) for improving the road geometrics, safety and meet the project objectives.**

475. Bengaluru to Tavarekere section and Tavarekere to Magadi section would be required to be widened to four lane with paved shoulder configuration from the year 2015 and 2020 onwards respectively. Bengaluru to Tavarekere which is on the outskirts of Bengaluru, would require to be widened to six lane configuration from the year 2028. On the other hand, Kunigal-Magadi section of the project road would require to be improved to two-lane with granular shoulder configuration from the year 2016. It would require to be improved to four-lane configuration from the year 2028.

476. 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.

477. 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.

478. As per the Government of India regulation, Environmental Clearance is not required for the proposed project. However, Tree Felling Permission from State Forest Department will be required before start of construction.

B. Recommendations

479. 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.

480. 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.

481. 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.

482. 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.

483. As discussed above, the Environmental Management Plan has been prepared incorporating various modern technologies and guidelines to reduce the environmental impacts of highway construction to make it a Green Highway. Therefore, it is recommended to strictly follow the EMP and associated Guidelines during construction phase and operation phase of the project.

Green Highway considerations at Construction Stage

- Use of Waste Plastic in Road Construction
- Use of Recycled Asphalt Cold Mix Technology
- Slope stabilization using Coir Geotextile and Vetiver Grass
- Phyco-Remediation of water using NUALGI
- Native indigenous trees species with large canopy cover shall be planted. One sq. m. of green canopy absorb 0.2 kg of CO₂ and other waste gases.
- Preservation of fertile top soil
- Adequate number to cross drainage structures proposed to maintain natural flows of streams without changing the gorge of flow at highway site
- Rainwater Harvesting Structures to improve ground water level
- Provision of LPG in construction camp as fuel source
- Utilization of low electrical equipment viz. CFL, LED etc. in construction camp
- Utilization of solar panels in camps, offices and execution sites
- Disposal of hazardous and non-hazardous waste from construction site and reporting its environmental compliances to concerned authorities
- Use of CNG vehicles
- Reduction in fuel consumption & lower down fuel demand in machinery & vehicles