



BANGALORE DEVELOPMENT AUTHORITY

Kumara Park West, T. Chowdaiah Road, Bengaluru-560020

DEVELOPMENT OF EIGHT LANE PERIPHERAL RING ROAD CONNECTING TUMKUR ROAD TO HOSUR ROAD (CROSSING BALLARI ROAD AND OLD MADRAS ROAD)

FINAL ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR OBTAINING ENVIRONMENTAL CLEARANCE VOLUME I



Schedule 7(f) of EIA Notification, 2006, Category-A, Length- 73.50 Km, Project Cost:14,934 Crores
Study period: December, 2019 to February, 2020

Project by

**Engineer Member
Bangalore Development Authority
Kumara Park West,
T. Chowdaiah Road,
Bengaluru - 560020**



Consultants

**Environmental Health & Safety
Consultants Pvt. Ltd
Bengaluru - 560044
080 - 23012100**

OCTOBER 2022

Document No. EHSC/BDA/INFRA-DIV/BLR/2019-20/PRR

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FINAL ENVIRONMENTAL IMPACT ASSESSMENT REPORT

OF

DEVELOPMENT OF EIGHT LANE PERIPHERAL RING ROAD CONNECTING TUMAKURU ROAD TO HOSUR ROAD (CROSSING BALLARI ROAD AND OLD MADRAS ROAD)

IN

BENGALURU URBAN DISTRICT, KARNATAKA



EXECUTIVE ENGINEER
INFRASTRUCTURE DIVISION
BANGALORE DEVELOPMENT AUTHORITY
KUMARA PARK WEST, T. CHOWDIAH ROAD,
BENGALURU-560020

CONSULTANTS



ENVIRONMENTAL HEALTH & SAFETY
CONSULTANTS PVT LTD
#174/New No.13/2, 14th E Cross, Industrial Town,
Agrahara Dasarahalli, Bangalore - 560 010,
Karnataka



NABET/EIA/2124/RA 0241 Dated: 07.06.2022

DOCUMENT NO. EHSC/BDA/INFRA-DIV/BLR/2019-2020/PRR

OCTOBER 2022

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REVISION RECORD

Rev. No.	Date	Purpose
EHSC/01	09.05.2020	Issued as Draft EIA/EMP Report for comments and suggestions and strictly not for submission to any authorities
EHSC/02	18.05.2020	Issued as Second Draft EIA/EMP Report for comments and suggestions
EHSC/03	18.06.2020	Issued as Third Draft EIA/EMP for submission to KSPCB for conducting Environmental Public Hearing
EHSC/04	25.03.2022	Issued as Revised Draft EIA/EMP Report for for comments and suggestions
EHSC/05	15.04.2022	Issued as Revised Draft EIA/EMP Report for submission to KSPCB for conducting fresh Environmental Public Hearing
EHSC/06	06.09.2022	Issued as Final EIA/EMP Report for comments and suggestions
EHSC/07	16.09.2022	Issued as Final EIA/EMP Report to KSEIAA with a request to transfer of file to MoEF&CC
EHSC/08	22.10.2022	Issued as Final EIA/EMP Report for obtaining Environmental Clearance from MoEF&CC

DOCUMENT CONTROL

Prepared by	Verified by	Approved by
Dr. T M Santhosh Kumar EIA Coordinator	S.J. Prabha Manager (Technical)	Shivanand M. Dambal Chairman & Managing Director

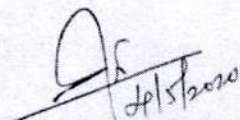
Declaration by Experts contributing to the EIA/EMP studies of Development of Eight Lane Peripheral Ring Road - Phase -I. Connecting Tumkur Road to Hosur Road (Crossing Bellary Road and Old Madras Road) by Bangalore Development Authority, Govt. of Karnataka.

I, hereby certify that I was a part of the EIA team in the following capacity that developed the above EIA.

1. EIA coordinator:

Name: Mr. Santhosh Kumar T.M

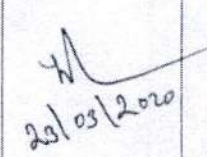
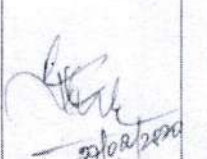
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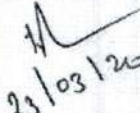





Period of involvement: November, 2019 to July, 2020


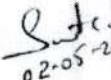
Contact information: +91-80 23016200

2. Functional area experts:

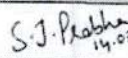
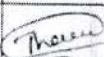

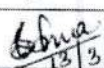
Sl. No.	Functional areas	Name of the expert/s	Involvement (period and task)	Signature and date
1	AP	Shri. Shivanand M. Dambal	Involved in collection of baseline data, developing air quality monitoring network as per NAAQ standards, monitoring baseline air quality in the study area, identification of sources of air pollution, identification of anticipated impacts and providing mitigation measures to control air pollution, preparation of EMP with cost and time for implementation, preparation of report.	
2	WP	Mr. Madhu Kumar C.	Involved in developing water quality sampling network, collection of water samples, identification of sources of water pollution, identification of anticipated impacts and providing mitigation measures to control water pollution, developing water conservation measures, preparation of EMP with cost and time for implementation, preparation of report.	

Sl. No.	Functional areas	Name of the expert/s	Involvement (period and task)	Signature and date
3	SHW	Shri. Shivanand M. Dambal	Involved in identification of solid and hazardous waste during construction and operation phase of the project, quantification, segregation and disposal of SHW, quantification of excavated soil, reuse of excavated soil, recycle and reuse of solid waste, identification of impacts and providing mitigation measures, preparation of EMP with cost and time for implementation, preparation of report.	 23/03/20
4	SE	Mr. Naresh G.	Involved in collection of baseline socio-economic (SE) data, developing methodologies for collection of SE data, analysis of SE data, developing RAP, identification of anticipated impacts and providing mitigation measures, identification of social changes arising due to the project, preparation of EMP along with cost & time for implementation of EMP, preparation of report.	 13/03/20
5	EB	Mr. Santhosh Kumar T.M	Involved in collection of baseline flora and fauna data, developing methodologies for collection of flora and fauna data, identification of flora and fauna of the region, conducting surveys, analysis of data, identification of anticipated impacts and providing mitigation measures, landscape & greenbelt development plan, preparation of EMP along with cost & time for implementation of EMP, preparation of report.	 14/03/20
6	EB (Aqua)	Shri. M. F. Rahman	Involved in collection of aquatic ecology data of tanks viz., Phytoplanktons, Zooplanktons, fisheries, etc. identification of anticipated impacts and providing mitigation measures, preparation of EMP along with cost & time for implementation of EMP, preparation of report.	 30.4.20

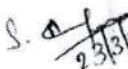
Sl. No.	Functional areas	Name of the expert/s	Involvement (period and task)	Signature and date
7	HG	Shri. Venkata Naresh Kumar	Involved in analysis of surface hydrological data, ground water table measurement, ground water recharge, estimation of ground water potential, etc, identification of anticipated impacts and providing mitigation measures, preparation of EMP, preparation of report.	E.V. Naresh Kumar 13/3/20
8	GEO	Shri. Venkata Naresh Kumar	Involved in collection of data pertaining to geology, geomorphological analysis, etc, identification of anticipated impacts and providing mitigation measures, preparation of EMP, preparation of report.	E.V. Naresh Kumar 13/3/20
9	SC	Mrs. Shrinidhi R.	Involved in collection of baseline soil profile of the study area, designing of soil sampling network, identification of anticipated impacts and providing mitigation measures, preparation of EMP, preparation of report.	P. Shrinidhi 16/3/20
10	AQ	Mrs. Praveena Kumari H.N	Involved in collection of baseline weather monitoring data, developing air quality monitoring network as per NAAQ standards, review and evaluation of field monitoring, quantification of pollutants using relevant software, identification of impacts, providing mitigation measures, preparation of report.	Praveena 23/03/2020
11	AQ (TM)	Ms. Manisha A. Appannavar	Assisting FAE-AQ in developing air quality monitoring network as per NAAQ standards, review and evaluation of field monitoring.	Manisha 13/3/2020
12	NV	Mr. Khaja Bande Nawaz Attar	Involved in designing of noise level monitoring network, collection of baseline noise levels of the study area, assessment of noise levels in respect of sensitive receptors, identification of anticipated impacts and providing mitigation measures, preparation of EMP along with cost & time for implementation of EMP, preparation of report.	Khaja Bande 13/03/2020

Sl. No.	Functional areas	Name of the expert/s	Involvement (period and task)	Signature and date
13	LU	Mr. Khaja Bande Nawaz Attar	Involved in developing Land use land cover and analysis, preparation of thematic maps using satellite data, and interpretation of data, identification of anticipated impacts and providing mitigation measures, preparation of report.	 13/3/20.
14	RH	Dr. Sunil C.	Involved in preparation of risk and hazard management, assessment of flood, fire protection system, emergency preparedness, security, blasting operations, foundation, etc, identification of anticipated impacts and providing mitigation measures, preparation of report.	 02-05-2020

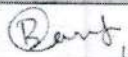
3. Functional area Associates:

Sl. No.	Functional areas	Name of the FAA	Signature and date
1	EB & SC	Prabha S.J	 14.03.2020
2	EB & SC	Tharkesh A.B	 13.03.2020
3	AP & WP	Naveen Kumar S.	 13.03.2020
4	NV & SHW	Sushma B. Noganihal	 13/3/20

4. Laboratory:

Sl. No.	Name of the Laboratory	Signature and date
1	Environmental Health and Safety Research and Development Centre, No. 13/2, 1 st Main Road, Near Fire Station, Industrial Town, Rajajinagar, Bangalore - 560010.	 23/3/2020

5. Supporting Staff:

Sl. No.	Functional areas	Supporting staff	Signature and date
1	HG & LU	Basavaraj D.B	 14/3/2020


Sl. No.	Functional areas	Supporting staff	Signature and date
2	SHW & HG	Murghesh Bukitgar	Mug 04/03/2020
3	WP & EB	Brunda S	B 14/03/2020
4	EB & SC	Charan P.C	Ch 23/03/2020
5	LU	Ayeesha A. Hunagund	Ay 12/03/2020
6	LU	Pooja R. H.	Pooja 12/03/2020

Declaration by the Head of the accredited consultant organization/ authorized person

I, Shivanand M. Dambal hereby confirm that the above mentioned experts prepared the EIA of Development of Eight Lane Peripheral Ring Road. Connecting Tumkur Road to Hosur Road (Crossing Bellary Road and Old Madras Road) by Bangalore Development Authority, Govt. of Karnataka. I also confirm that EIA Coordinator (EC) has gone through the report, and the consultant organization shall be fully accountable for any misleading information.

It is certified that no unethical practices, plagiarism involved in carrying out the work and external data / text has not been used without proper acknowledgement while preparing this EIA report.

Signature:


11/4/2022

Name: Shivanand M. Dambal

Designation: Chairman & Managing Director

Name of the EIA consultant organization: Environmental Health and Safety Consultants Pvt. Ltd, #174, New No. 13/2, 14th 'E' Cross, Agrahara Dasarahalli, Bangalore - 560044.

NABET Certificate No. & Issue Date: NABET/EIA/2124/RA 0241 Dated: 07.06.2022 valid up to 22.08.2024

Project team: Bangalore Development Authority

Sl. No.	Name	Designation
1	Shri. Kumar Naik G. I.A.S.	Commissioner
2	Dr. H. R Shantharajanna, K.E.S.	Engineer Member
3	Dr. Sowjanya A, K.A.S.	Dy. Commissioner (Land Acquisition)
4	Shri. B.A. Shivanand, K.E.S.	Engineer Officer-3
5	Shri. R.K Mohan	Executive Engineer, Infrastructure Division
6	Shri. R. Suresh	Assistant Executive Engineer, Infrastructure Sub-division
7	Shri. T. R. Rajeev	Principal Consultant, M/s STUP Consultants Pvt. Ltd., Bengaluru

**Tree Enumeration Survey Team - M/S Environmental Health & Safety
Consultants Pvt. Ltd., Bengaluru**

Sl. No.	Name	Roles & Responsibilities
1	Dr. T M Santhosh Kumar	EIA Coordinator
2	Mrs. Shrinidhi R.	Team Leader, EHSCPL
3	Ms. Prabha S. J.	Team Leader, EHSCPL
4	Mr. Tharakesh A. B.	Team Leader, EHSCPL
5	Mr. Naveen Kumar S.	Team Leader, EHSCPL
6	Mr. Charan P.C.	Team Leader, EHSCPL
7	Ms. Brunda S.	Team Member, EHSCPL
8	Mr. Govindaraju A.Y.	Driver, EHSCPL
9	Mr. Mahesha P.	Driver, EHSCPL
10	Mr. Mahesh S.	Driver, EHSCPL
11	Mr. Shivappa S.	Driver, EHSCPL
12	Mr. Shreedhar	Driver, EHSCPL
13	Mr. Basarakodu Basavaraja	Team Member
14	Mr. Raj	Team Member
15	Mr. Basavaraja	Team Member
16	Mr. Shivaraj	Team Member
17	Mr. Rudresha C. K.	Team Member
18	Mr. Uday Kumar	Team Member
19	Mr. Dayananda Rummagola	Team Member
20	Ms. Bineet Kaur Raina	Team Member
21	Ms. Divyashree H.V.	Team Member
22	Ms. Ashwini K.B.	Team Member
23	Mr. Yogesh S.	Team Member
24	Mr. Santhosha	Team Member
25	Mr. Prakash S. Madluru	Team Member
26	Mr. Sharath	Team Member
27	Mr. Vishnu H. V.	Team Member
28	Ms. Gagana P.	Team Member
29	Ms. Madhushree V.	Team Member

**Socio-economic Survey Team – M/S Environmental Health & Safety Consultants
Pvt. Ltd., Bengaluru**

Sl. No.	Name	Roles & Responsibilities
1	Dr. T M. Santhosh Kumar	EIA Coordinator
2	Mr. Rajasekhar K.	Functional Area Expert
3	Mr. Naresh G.	Functional Area Expert
4	Mrs. Shrinidhi R.	Team Member
5	Ms. Prabha S. J.	Team Member
6	Mr. Tharakesh A. B.	Team Member
7	Mr. Naveen Kumar S.	Team Member
8	Mr. Charan P.C.	Team Member
9	Ms. Brunda S.	Team Member
10	Mr. Shashi Kumar	Team Member
11	Mr. Mahesha P.	Driver, EHSCPL
12	Mr. Mahesh S.	Driver, EHSCPL
13	Mr. Shivappa S.	Driver, EHSCPL
14	Mr. Shreedhar	Driver, EHSCPL



Quality Council of India
National Accreditation Board for
Education & Training



Certificate of Accreditation

Environmental Health and Safety Consultants Pvt. Ltd

#174/New No.13/2, 14th E Cross, Industrial Town, Agrahara Dasarahalli, Bangalore

The organization is accredited as **Category-A** under the QCI-NABET Scheme for Accreditation of EIA Consultant Organization, Version 3: for preparing EIA-EMP reports in the following Sectors –

S. No	Sector Description	Sector (as per)		Cat.
		NABET	MoEFCC	
1	Mining of minerals- opencast only	1	1 (a) (i)	B
2	River Valley projects	3	1 (c)	A
3	Thermal power plants	4	1 (d)	A
4	Metallurgical industries (ferrous & non-ferrous)	8	3 (a)	A
5	Synthetic organic chemicals industry (dyes & dye intermediates; bulk drugs and intermediates excluding drug formulations; synthetic rubbers; basic organic chemicals, other synthetic organic chemicals and chemical intermediates)	21	5(f)	A
6	Distilleries	22	5 (g)	A
7	Sugar Industry	25	5 (j)	B
8	Highways,	34	7 (f)	A
9	Building and construction projects	38	8 (a)	B
10	Townships and Area development projects	39	8 (b)	B

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RAAC minutes dated Dec 29, 2021 and Supplementary Assessment minutes dated May 13, 2022 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no. QCI/NABET/ENV/ACO/22/2376 dated June 07, 2022. The accreditation needs to be renewed before the expiry date by Environmental Health and Safety Consultants Pvt. Ltd, Bangalore following due process of assessment.

Sr. Director, NABET
Dated: June 07, 2022

Certificate No.
NABET/EIA/2124/RA 0241

Valid up to
August 22, 2024

For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.



ಬೆಂಗಳೂರು ಅಭಿವೃದ್ಧಿ ಪ್ರಾಧಿಕಾರ

Bangalore Development Authority

ಸಂಖ್ಯೆ :
No. BDA/EE/PRR/ 321 /2020-21

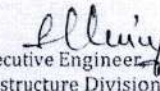
ದಿನಾಂಕ : 16/06/2020
Date :

DECLARATION BY PROPONENT

Sub: Development of Eight Lane Peripheral Ring Road – Phase –I. Connecting Tumkur Road to Hosur Road (Crossing Bellary Road and Old Madras Road) - Undertaking letter-reg,
Ref: State Level Expert Appraisal Committee (SEIAA), Karnataka Terms of References (ToRs) letter No.: SEIAA 40 IND 2019; dt: 21.01.2020

The EIA/EMP report of the aforementioned project has been prepared in line with the Terms of References (ToRs) issued by KSEIAA and the contents (details/information) submitted in the report is factually correct to the best of our knowledge.

Your's truly,


Executive Engineer
Infrastructure Division
Bangalore Development Authority
Bangalore

ಟಿ. ಚೌಡಯ್ಯ ರಸ್ತೆ, ಕುಮಾರಪಾರ್ಕ್ ಪಶ್ಚಿಮ, ಬೆಂಗಳೂರು 560 020
T. Chowdaiah Road, Kumarapark West, Bangalore 560 020, Facsimile : 2334 5799, E-mail : bda@vsnl.com



**ENVIRONMENTAL HEALTH AND
SAFETY CONSULTANTS PVT. LTD**



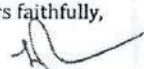
Corporate Office : # 174/New No. 13/2, 14th 'E' Cross, Industrial Town, Agrahara Dasarahalli, Bengaluru - 560 010.
Tel. : 080-23016200 Fax : 080-23012111 ehscltr@yahoo.com, ehscbir1974@gmail.com, info@ehsc.in www.ehsc.in

DECLARATION BY CONSULTANT

In accordance with Ministry of Environment, Forests and Climate Change, Government of India OM No. J-11013/41/2006-IA-II (I) dt: 04.08.2009, M/s Environmental Health and Safety Consultants Pvt Ltd, Bangalore is hereby certify that the EIA and EMP report of Development of Eight lane Peripheral Ring Road connecting Tumkur Road to Hosur Road (crossing Ballari Road and Old Madras Road) is prepared based on the generic structure given in EIA Notification dated 14th September, 2006.

The contents of the EIA/EMP report is prepared based on the technical information provided the Project Proponent. The data submitted in this report is factually correct to the best of our knowledge. The secondary information used while preparing this report was properly referenced. The ToRs have been complied subject its applicability to project site. Any typographical errors in this document shall be brought to the notice of this office for further rectification.

Yours faithfully,


(Shivanand M. Dambal)
Chairman & Managing Director

08/05/2020

Branch Office : #13/2, 1st Main Road, Near Fire Station, Industrial Town, Rajajinagar, Bengaluru - 560 010.
Tel : 080 - 23012100 Fax : 080 - 23012111



**ENVIRONMENTAL HEALTH AND
SAFETY CONSULTANTS PVT. LTD**



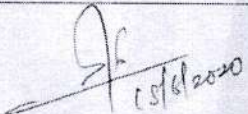
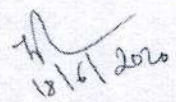
Corporate Office : # 174/New No. 13/2, 14th 'E' Cross, Industrial Town, Agrahara Damorahalli, Bengaluru - 560 010.
Tel : 080-23016200 Fax : 080-23012111 ehscblr@yahoo.com, ehscblr1974@gmail.com, info@ehsc.in www.ehsc.in

Certificate of Plagiarism Check

Title of EIA report	Development of Eight lane Peripheral Ring Road connecting Tumkur Road to Hosur Road (crossing Ballary Road and Old Madras Road)
Name of Accredited Organization	M/s Environmental Health and Safety Consultants Pvt Ltd
NABET Certificate No. Issue Date	NABET/EIA/1821/RA0107 dated: Nov.19.2018, Valid till 22.04.2021
Unique Identification Number	EHSC/BDA/INFRA-DIV/BLR/2019-20/PRR
Name of EIA Co-ordinator (EC)	Mr. Santhosh Kumar T. M
Name of the software	Copyleaks plagiarism checker
Date of check	17.06.2020 & 18.06.2020
Time of Check	4.30 PM & 5.15 PM

Declaration by the Head of the accredited consultant organization

We hereby certify that this EIA Report has been evaluated using online software using Copyleaks plagiarism checker. The report produced has been analyzed by the system and based on it; we certify that the EIA report produced in accordance with good scientific practice.

 (Santhosh Kumar T.M) EIA Coordinator	 (Shivanand M. Dambal) Chairman and Managing Director
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Branch Office : #13/2, 1st Main Road, Near Fire Station, Industrial Town, Rajajinagar, Bengaluru - 560 010.
Tel : 080 - 23012100 Fax : 080 - 23012111

This Document is issued Under
Right to Information Act-2005

ABBREVIATIONS

AADT	Annual Average Daily Traffic
AAQM	Ambient Air Quality Monitoring
AAS	Atomic Absorption Spectroscopy
ACM	Aluminium Composite Material
ACO	Accredited Consultant Organisation
ADB	Asian Development Bank
ADT	Average Daily Traffic
AERMOD	Air Quality Dispersion Modeling
AISS	All India Soil Survey
AMSL	Above Mean Sea Level
AP	Air Pollution Monitoring, Prevention and Control
APHA	American Public Health Association
AQ	Meteorology, Air Quality Modelling and Prediction
AQI	Air Quality Index
Aqua	Aquatic
ASTM	American Society for Testing and Material
ATCC	Automatic Traffic Counter and Classifier
BaP	Benzo(a)pyrene
BDA	Bangalore Development Authority
BDL	Below Detectable Limit
BIAL	Bangalore International Airport Limited
BIS	Bureau of Indian Standards
BLR	Bangalore
BMA	Bangalore Metropolitan Area
BMR	Bangalore Metropolitan Region
BMRDA	Bangalore Metropolitan Region Development Authority
BMTCL	Bangalore Metropolitan Transport Corporation
BOD	Biochemical Oxygen Demand
BSI	Botanical Survey of India
B-TIC	Bangalore Traffic Information Centre
BWSSB	Bangalore Water Supply and Sewerage Board
°C	Celsius
C&D	Construction & Demolition
C ₆ H ₆	Benzene
CPA	Critically Polluted Area
CAT	Catchment Area Treatment
CAT	Category
CBOs	Community-Based Organization
cc	Cubic Centimetre
CEPI	Comprehensive Environmental Pollution Index
CER	Corporate Environmental Responsibility
CFE	Consent for Establishment
CFO	Consent for Operation
CGWB	Central Ground Water Board
CH	Chainage
CIFRI	Central Inland Fisheries Research Institute

Cl	Chlorine
cm	Centimetre
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
CO ₃	Carbon Trioxide
COD	Chemical Oxygen Demand
COPD	Chronic Obstructive Pulmonary Disease
CPCB	Central Pollution Control Board
Cr	Chromium
CRRRI	Central Road Research Institute
Cu	Copper
dB	Decibel
DC	District Commissioner
DCF	Deputy Conservator of Forest
DEM	Digital Elevation Model
Dept.	Department
DFO	District/Divisional Forest Officer
DG	Diesel Generator
DIV	Division
DPR	Detailed Project Report
E	East
EB	Ecology and Biodiversity
EC	Environmental Clearance
EC	Electrical Conductivity
EE	Executive Engineer
EHSC	Environmental Health & safety Consultants Pvt Ltd
EHSRDC	Environmental Health and Safety Research and Development Centre
EIA	Environmental Impact Assessment
EM	Engineering Member
EMP	Environmental Management Plan
ENE	East North East
ENV	Environment
EPC	Engineering Procurement and Construction
EPH	Environmental Public Hearing
ESE	East South East
ESZ	Eco - Sensitive Zone
ET	Evapotranspiration
FAE	Functional Area Expert
FC	Forest Clearance
Fe	Iron
Fig	Figure
FRLHT	Foundation for Revitalisation of Local Health and Tradition
ft	Feet
g	Gram
GC	Gas Chromatography
GEM	Groundwater Estimation Methodology
GEO	Geology
GHG	Green House Gases

Document is issued Under
Project Information No. 2008/7

GI	Galvanised Iron
GIS	Geographical Information System
GoI	Government of India
GoK	Government of Karnataka
Govt	Government
GPS	Global Positioning System
GSI	Geological Survey of India
Ha	Hectare
HABs	Harmful Algal Blooms
HCO ₃	Hydrogen Carbonate
HG	Hydrology, Ground Water and Water Conservation
HIRA	Hazard Identification and Risk Assessment
HNO ₃	Nitric Acid
Hr	Hour
HSD	High Speed Diesel
HTMS	Highway Traffic management System
ICAR	Indian Council of Agricultural Research
IMD	Indian Meteorological Department
IND	India
Indo-HCM	Indian Highway Capacity Manual
INFRA	Infrastructure
IQ	Intelligence Quotient
IRC	Indian Roads Congress
IRR	Inner Ring Road
IRS	Indian Remote Sensing
ISO	International Standards Organisation
IT	Information Technology
ITS	Intelligent Transport System
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
K	Potassium
KES	Karnataka Engineering Service
KFD	Karnataka Forest Department
KIADB	Karnataka Industrial Area Development Board
KLD	Kilo Litre Per Day
Km	Kilo Meter
Kmph	Kilometre per hour
KPCL	Karnataka Power Corporation Ltd
KSEIAA	Karnataka State Environment Impact Assessment Authority
KSPCB	Karnataka State Pollution Control Board
Kw	Kilowatt
Kwh	Kilowatt – Hours
L	Litre
LAQ	Land Acquisition
LCVs	Light Commercial Vehicles
LED	Light Emitting Diode
LHS	Left Hand Side
LPCD	Litre Per Capita Per Day

LPG	Liquified Petroleum Gas
LTD	Limited
LU	Land Use
m	Meter
m ³	Meter cube
MAV	Multi Axle Vehicle
Mcft	Million Cubic Feet
mg	Milligram
MIN	Minimum
ml	Millilitre
MLD	Million litres Per Day
MM	Millimetre
Mn	Manganese
MnSO ₄	Manganese Sulphate
MoEF&CC	Ministry of Environment, Forest & Climate Change
MORTH	Ministry of Road Transport and Highways
MoU	Memorandum of Understanding
MPA	Mega Pascal
MPN	Most Probable Number
MS	Motor Spirit
MSDS	Material Safety Data Sheet
MT	Metric Tonnes
MW	Mega Watt
N	North
N	Nitrogen
N ₂ O	Nitrous Oxide
NA	Not Available
NAAQ	National Ambient Air Quality
NAAQM	National Ambient Air Quality Monitoring
NABET	National Accreditation Board for Education and Training
NABL	National Accreditation Board for Testing and Calibration Laboratories
NGOs	Non-Governmental Organization
NGT	National Green Tribunal
NH	National Highway
NH ₃	Ammonia
NHAI	National Highway Authority of India
Ni	Nickel
NICE	Nandi Infrastructure Corridor Enterprises
NNE	North-North East
NNW	North-North West
No	Number
NO	Nitric Oxide
NO ₂	Nitrogen Dioxide
NO ₃	Nitrate
NO ₅	Nitrogen Pentoxide
NOC	No Objection Certificate
NPV	Net Present value
NRSC	National Remote Sensing Centre

NTFPs	Non-timber forest products
NV	Noise and Vibration
O ₃	Ozone
OM	Office Memorandum
OMR	Old madras Road
ORR	Outer Ring Road
P	Phosphorous
PAH	Polycyclic Aromatic Hydrocarbons
PAN	Panchromatic
PAP	Project Affected People
Pb	Lead
PCB	Pollution Control Board
pH	Potential of Hydrogen
PM	Particulate Matter
PNLIT	Puttenahalli Neighbourhood Lake Improvement Trust
PO ₄	Phosphate
PPE	Personal Protective Equipment
ppm	Parts Per Million
PRA	Participatory Rural Appraisal
PRR	Peripheral Ring Road
PUPs	Pedestrian Underpasses
PVT	Private
QCI	Quality Council of India
Qty.	Quantity
R&R	Resettlement and Rehabilitation
RA	Re – Accreditation
RAP	Rehabilitation Action Plan
RCC	Reinforced Cement Concrete
REC	Regional Empowered Committee
RET	Rare, Endangered and Threatened
RF	Reserve Forest
RFCTLARR	Right to Fair Compensation and Transparency in Land Acquisition Rehabilitation and Resettlement Act, 2013
RFID	Radio – frequency Identification
RH	Risk Assessment and Hazard Management
RHS	Right Hand Side
RO	Regional Officer
ROB	Road Over Bridge
RoW	Right of Way
Rs	Rupees
RUB	Road Under Bridge
SC	Soil Conservation
SCBA	Self-Contained Breathing Apparatus
SCNBWL	Standing Committee of National Board for Wildlife
SE	Socio – Economic
SEAC	State Expert Appraisal Committee
Sec	Second
SEZ	Special Economic Zone

SH	State Highway
SHW	Solid and Hazardous Waste
SIA	Social impact assessment
SIMP	Social Impact Management Plan
SO ₂	Sulphur Dioxide
SO ₄	Sulphate
Sq.Km.	Square Kilometre
Sqm	Square metre
SSE	South-South East
SSW	South-South West
STP	Sewage Treatment Plant
Sy	Survey
TAC	Technical Advisory Committee
TDR	Transferable Development Rights
TDS	Total Dissolved Solids
TG	Tippagondanahalli
TH	Total Hardness
TM	Team Member
ToRs	Terms of Reference
TPA	Tonnes Per Annum
TSS	Total Suspended Solids
UAS	University of Agricultural Sciences
USEPA	United State Environmental Protection Agency
VMS	Variable Message Sign
Vol.	Volume
VOPs	Vehicles Overpasses
VUPs	Vehicle Underpasses
W	West
WNW	West North West
WP	Water Pollution Monitoring, Prevention and Control
Ws	Wind Speed
WSW	West South West
Zn	Zinc

TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
ES1. Introduction	1
ES2. Project description	2
ES2.1 Typical cross section	5
ES3. Description of baseline environment	6
ES3.1 Physical Environment	6
ES3.1.1 Ambient Air Quality	6
ES3.1.2 Ambient noise levels	6
ES3.1.3 Surface water	6
ES3.1.4 Ground water	6
ES3.1.5 Soil	7
ES3.1.6 Land use	7
ES3.2 Biological environment	7
ES3.3 Socio-economic studies	8
ES4. Anticipated environmental impacts and mitigation measures	9
ES4.1 Impact evaluation	15
ES5. Environmental Monitoring Programme	16
ES6. Risk and hazard studies	16
ES6.1 Risks and hazards during construction phase	16
ES6.2 Mitigation measures to be adopted during construction phase	16
ES6.3 Measures to guard the pipeline from accidental damage at intersecting area	17
ES6.4 Anticipated impacts during operation phase	18
ES6.5 Mitigation measures to be adopted during operation phase	18
ES7. Project benefits	19
ES8. Environmental Management Plan	20
INTRODUCTION	21
1.1 EIA & Purpose of the project	21
1.2 Project proponent	21
1.3 Brief description of the project and its importance to the region	23
1.4 Applicability of various legislations	24
1.5 Scope of EIA	33
1.6 Components of EIA	33
1.7 Approach and methodology	33
1.8 Environmental Screening	38
1.8.1 Project Influence area	38
1.8.2 Weightage / Ranking system:	38
PROJECT DESCRIPTION	42
2.1 Introduction	42
2.2 Existing Scenario and Need for the project	42
2.3 Traffic Analysis and Forecasts	45
2.4 Classified Traffic Volume Counts	45
2.5 Origin Destination Survey	48
2.6 Speed and delay Survey	49
2.7 Capacity Analysis	49
2.8 Traffic growth Projections	50
2.9 Proposed Project	51
2.10 Design Speed	51
2.11 Pavement Design	51

2.12 Typical Cross Section	52
2.13 Vehicle Underpasses (VUPs).....	52
2.14 Pedestrian Underpasses (PUPs) and animal underpasses.....	53
2.15 Vehicle Overpasses (VOPs).....	53
2.16 Road Over Bridges (ROB) and Road Under Bridges (RUB).....	62
2.17 Major junctions.....	62
2.18 Flyovers	64
2.19 Minor Bridges and Culverts.....	65
2.20 Wayside Amenities	66
2.20.1 Bus Shelters.....	66
2.20.2 Rest Areas.....	67
2.20.3 Toll Plaza.....	67
2.21 Road Furniture and Safety Measures.....	68
2.21.1 Road Signs.....	68
2.21.2 Road Markings.....	69
2.21.3 Road Delineators.....	69
2.21.3.1 Metal Crash Barriers	69
2.21.3.2 Concrete Crash Barriers	69
2.21.3.3 Kilometer Stones.....	70
2.21.4 Lighting.....	70
2.21.5 Footpath.....	70
2.21.6 Utility Ducts.....	70
2.21.7 Cycle Track.....	70
2.21.8 Rain Water Harvesting.....	70
2.21.9 Requirement of Construction Materials	71
2.21.9.1 Sourcing of Construction Materials	71
2.21.9.2 Cutting and Filling of earth work	71
2.21.10 Use of fly ash.....	71
2.21.11 Calculation of Carbon Footprint from the project.....	74
2.21.12 Land Acquisition, Rehabilitation and Resettlement.....	74
2.21.13 Landscaping and Green Belt Development.....	74
2.21.14 Provision of Intelligent Transport System (ITS)	75
2.21.15 Project Cost.....	75
2.21.16 Summary of project details	76
2.21.17 Project implementation schedule.....	77
BASELINE ENVIRONMENT SCENARIO.....	78
3.1 Environmental settings.....	78
3.2 Physical Environment	85
3.2.1 Topography	85
3.2.2 Climate & Meteorology	85
3.2.2.1 Meteorological data monitored at site for the study period.....	85
3.2.3 Ambient Air Quality	87
3.2.3.1 Methodology for AAQM	87
3.2.3.2 Criteria for setting of AAQM Stations	90
3.2.3.3 Results of Ambient Air Quality.....	90
3.2.4 Ambient Noise levels.....	96
3.2.4.1 Results of Ambient Noise levels.....	99
3.2.5 Hydrology, Geology & Minerals.....	100
3.2.5.1 Methodology.....	100

3.2.5.2 Field studies	100
3.2.5.3 Secondary data utilized.....	101
3.2.5.4 Regional geology & structure.....	101
3.2.5.5 Geomorphology	102
3.2.5.6 Mineral resources	102
3.2.5.7 Drainage	102
3.2.5.8 Hydrogeology	102
3.2.5.8.1 Hydrogeological Survey	105
3.2.5.8.2 Depth to water level	105
3.2.5.8.3 Carrying capacity of nalas	105
3.2.5.8.4 Ground water resources	107
3.2.5.8.5 Water required for construction activities	107
3.2.6 Surface & Ground water quality	108
3.2.6.1 Criteria for selection of water quality sampling locations	110
3.2.6.2 Methodology for collection of water samples.....	110
3.2.6.3 Results & Discussions.....	113
3.2.6.3.1 Surface water quality	113
3.2.6.3.2 Ground water quality.....	116
3.2.7 Soil characteristics	119
3.2.7.1 Objectives.....	119
3.2.7.2 Soil types and cropping pattern	119
3.2.7.3 Scope and methodology	119
3.2.7.4 Analysis and interpretation of soil quality results	122
3.2.7.5 Developing nutrient index	125
3.2.7.6 Summary	125
3.3 Land use assessment	126
3.3.1 Introduction	126
3.3.2 Approach and methodology	127
3.3.3 Results and observations.....	127
3.4 Biological Environment.....	132
3.4.1 Description of the project site and Study area.....	132
3.4.1.1 Jarakabandekaval Reserve Forest.....	133
3.4.1.2 Bannerghatta National Park.....	134
3.4.1.3 Puttenahalli Bird Conservation Reserve	135
3.4.1.4 Wildlife habitats	135
3.4.1.5 Status of lakes in the study area	136
3.4.2 Methodology	139
3.4.2.1 Primary data.....	139
3.4.2.2 Secondary data	139
3.4.3 Results and Discussions.....	140
3.4.3.1 Project alignment: Flora.....	140
3.4.3.1.1 Composition of trees, shrubs and herbs.....	140
3.4.3.1.2 Species of Economic and Social Values.....	152
3.4.3.1.3 Species of Ethano-Botanical / Ethano – Medicinal Value	152
3.4.3.1.4 Species of cultural values.....	153
3.4.3.1.5 Keystone species.....	153
3.4.3.2 Project alignment: Fauna	153
3.4.3.2.1 Avifaunal composition	153

3.4.3.2.2 Butterfly composition	154
3.4.3.3 Study area: Fauna	154
3.4.3.3.1 Avifaunal composition	154
3.4.3.3.2 Butterfly composition	155
3.4.3.3.3 Mammals and Insects recorded at the study area	155
3.4.3.3.4 Species recorded during other seasons	155
3.4.3.4 Conclusion	155
3.5 Aquatic Environment	156
3.5.1 Scope of work	157
3.5.2 Methodology	157
3.5.3 Results and discussion	158
3.5.3.1 Water Chemistry	158
3.6 Social Environment	162
ANTICIPATED IMPACTS & MITIGATION MEASURES	163
4.1 Impacts during construction phase	163
4.1.1 Air Environment	163
4.1.1.1 During pre-construction and construction phase	163
4.1.1.2 Anticipated impacts estimated using AERMOD	164
4.1.1.3 Mitigation measures	165
4.1.2 Noise Environment	166
4.1.2.1 Anticipated impacts	166
4.1.2.2 Noise level predictions using dhvani PRO noise model	167
4.1.2.3 Mitigation measures	169
4.1.3 Water Environment	170
4.1.3.1 Thippagondanahalli Reservoir Catchment Area	170
4.1.3.2 Anticipated impacts	171
4.1.3.3 Mitigation measures	173
4.1.4 Soil Environment	176
4.1.4.1 Anticipated impacts	176
4.1.4.2 Mitigation measures	177
4.1.5 Land use assessment	179
4.1.5.1 Anticipated impacts	179
4.1.5.2 Mitigation measures	179
4.1.6 Solid & Hazardous waste storage, handling and disposal	179
4.1.6.1 Anticipated impacts	179
4.1.6.2 Mitigation measures	180
4.1.7 Hydrology and geology	181
4.1.7.1 Anticipated impacts	181
4.1.7.2 Mitigation measures	182
4.1.8 Biological Environment	183
4.1.8.1 Anticipated impacts	183
4.1.8.2 Mitigation measures	184
4.1.9 Aquatic biota	185
4.1.9.1 Anticipated impacts	185
4.1.9.2 Mitigation measures	187
4.1.10 Social Environment	187
4.2 Impacts during operation phase	187
4.2.1 Air Environment	187
4.2.1.1 Anticipated impacts	187

4.2.1.2 Mitigation measures	188
4.2.2 Noise Environment	188
4.2.1.1 Anticipated impacts	188
4.2.1.2 Mitigation measures	188
4.2.3 Water Environment	189
4.2.3.1 Anticipated impacts	189
4.2.3.2 Mitigation measures	189
4.2.4 Soil Environment	189
4.2.4.1 Anticipated impacts	189
4.2.4.2 Mitigation measures	190
4.2.5 Land use assessment	190
4.2.5.1 Anticipated impacts	190
4.2.5.2 Mitigation measures	190
4.2.6 Solid & Hazardous waste storage, handling and disposal	190
4.2.6.1 Anticipated impacts	190
4.2.6.2 Mitigation measures	190
4.2.7 Biological Environment	191
4.2.7.1 Anticipated impacts	191
4.2.7.2 Mitigation measures	191
4.2.8 Social Environment	191
4.3 Evaluation of Impacts	191
ANALYSIS OF ALTERNATIVES	194
5.1 Project Alignment	194
5.2 Petronet MHB pipeline alignment	194
5.3 Construction of project alignment near Lakes	194
5.3.1 Structural designs	196
5.3.1.1 Superstructure	196
5.3.1.2 POT cum PTFE bearings	196
5.3.1.3 Foundation	196
5.3.1.4 Substructure	197
5.3.1.5 Miscellaneous	197
5.4 Technology	199
ENVIRONMENTAL MONITORING PROGRAM	200
6.1 Monitoring of Environmental Parameters	200
6.2 Monitoring of Greenbelt / Tree Plantation	206
6.3 Monitoring of Labor camps	206
6.4 Monitoring of Risk and Hazards	206
6.5 Monitoring of Land Acquisition, R&R	206
6.6 Monitoring during sourcing of construction materials	206
6.7 Preparation of Compliance Reports	206
6.8 Guidelines for pollution control	207
ADDITIONAL STUDIES – SOCIO-ECONOMICS, RISK & HAZARDS	209
7.1 Socio-economic studies	209
7.2 Geographical Coverage	209
7.3 Approach and Methodology	209
7.3.1 Objectives	209
7.3.2 Methodology	209
7.3.2.1 Desk research	209
7.3.2.2 Population projection in project affected villages	212

7.3.2.3 Field Survey	215
7.3.2.4 Limitations faced during field survey	215
7.3.2.5 Data analysis	215
7.4 Socio Economic Characteristics of the PIZ.....	215
7.4.1 Demographic Profile.....	215
7.4.2 Occupational Distribution	216
7.5 Profile of the Likely Project Affected Households (Survey Results)	216
7.5.1 Demographics.....	216
7.5.2 Lifestyle.....	216
7.5.3 Sources of livelihood	216
7.5.4 Agriculture and plantation practices	216
7.5.5 Cultural activities	217
7.5.6 Status of women	217
7.6 Archaeological monuments/ socially sensitive receptors	217
7.7 Aspirations and Apprehensions.....	219
7.8 Land Acquisition & Resettlement impacts.....	219
7.8.1 Likely impacts on the project.....	221
7.8.2 Potential impacts	221
7.8.3 Negative impacts	221
7.8.4 Positive impacts	221
7.8.5 Mitigation measures	222
7.9 Environmental Public Hearing	223
7.10 Natural Resource Conservation and Optimization.....	227
7.11 Risks and Hazards associated with the project.....	227
7.11.1 Risks and hazards during construction phase	228
7.11.1.1 Accidents.....	228
7.11.1.2 Blasting activities	228
7.11.1.3 Petroleum pipeline alignment	228
7.11.2 Mitigation measures to be adopted during construction phase	229
7.11.2.1 Tool box meeting	229
7.11.2.2 Prevention of accidents	229
7.11.2.3 Prevention of fall hazards	230
7.11.2.4 Prevention of accidents from hazardous chemicals spill during construction phase.....	230
7.11.2.5 Blasting activities	231
7.11.2.6 Measures to guard the pipeline from accidental damage at intersecting area	233
7.11.2.7 Risk assessment and Hazard management for petroleum pipeline	233
7.11.3 Safety measures during construction phase.....	238
7.11.4 Emergency preparedness during construction phase.....	238
7.11.5 Anticipated impacts during operation phase	239
7.11.5.1 Accident prone Zone	239
7.11.5.2 Hazardous chemical spillage during the operation phase	239
7.11.6 Mitigation measures to be adopted during operation phase.....	239
7.11.6.1 Accident prone zone	239
7.11.6.2 Post-accident emergency assistance and medical care to accident victims.....	240
7.11.7 Hazardous chemical spillage during the operation phase	243
7.11.8 Pedestrian safety	246
7.11.8.1 Along intersections, subways and flyovers.....	246
7.11.8.2 Pedestrian safety at intersections	247
7.11.8.3 Pedestrian safety at flyovers and subways.....	247

7.11.9 Training on Management System.....	248
7.11.10 Hazard identification and risk assessment.....	248
PROJECT BENEFITS.....	256
ENVIRONMENTAL COST BENEFIT ANALYSIS	257
ENVIRONMENTAL MANAGEMENT PLAN.....	258
10.1 Pre-construction activities management.....	258
10.2 Construction phase management.....	263
10.2.1 Top soil management.....	263
10.2.2 Borrow area management.....	263
10.2.3 Land Acquisition, Resettlement and Rehabilitation Action plan.....	264
10.2.3.1 Preparation of SIA.....	264
10.2.3.2 Process of Obtaining Consent	265
10.2.3.3 Preliminary Notification for Acquisition	265
10.2.3.4 Preparation of R&R scheme.....	265
10.2.3.5 Present status	266
10.2.4 Catchment area treatment plan	266
10.2.5 Ecological restoration plan	268
10.2.5.1 Green belt development.....	268
10.2.5.2 Compensatory afforestation.....	271
10.2.5.3 Schedule – I birds' conservation	271
10.2.5.4 Aquatic life conservation	271
10.3 Operation phase management.....	274
10.3.1 Noise reduction management plan.....	274
10.3.2 Road safety, traffic management and risk management plan.....	275
10.3.3 Transmission of diseases and its prevention	276
10.4 Institutional arrangements.....	276
10.4.1 Roles and Responsibilities of EMC during emergencies	277
10.4.1.1 Engineering Member (EM).....	277
10.4.1.2 Engineering Officer-3	277
10.4.1.3 Executive Engineer (EE).....	278
10.4.1.4 Environmental Officer.....	278
10.4.1.5 Risk Expert and his patrolling team	278
10.4 EMP Cost.....	279
CORPORATE ENVIRONMENTAL RESPONSIBILITY	283
SUMMARY AND CONCLUSION	285
12.1 Project description & Justification for implementation of the project.....	285
12.2 Preamble	286
12.3 Significant features of the proposed PRR alignment	286
12.4 Baseline Environmental Scenario.....	287
12.5 Anticipated impacts & Mitigation measures	289
12.6 Alternative analysis.....	296
12.7 Environmental Monitoring Programme	296
12.8 Environmental Public Consultation.....	296
12.9 Environmental Management Plan	297
DISCLOSURE OF CONSULTANTS.....	298
COMPLIANCE TO OBSERVATIONS OF HON'BLE SUPREME COURT JUDGEMENT AND NGT.....	299
14.1 Compliance to deficiencies noted in the Hon'ble Supreme Court judgment dt: 17.03.2020	299
14.2 Compliance to directions of the Hon'ble Supreme Court judgment dt: 17.03.2020	301

14.3 Compliance to observations of Hon'ble National Green Tribunal, principal bench in its order dt: 08.02.2019	302
COMPLIANCE TO TERMS OF REFERENCES	304
PHOTOGRAPHS	311

LIST OF TABLES

Table ES1: Salient features of the project.....	2
Table ES2: RoW utilization for various elements.....	5
Table ES3: Land use and land cover data of project alignment and study area.....	7
Table ES4: Identification of types of hazards near petroleum pipeline area from the PRR.....	18
Table 1.1: Methodology adopted for preparation of EIA studies	34
Table 1.2: Natural Environment.....	38
Table 1.3: Biological Environment.....	39
Table 1.4: Socio- Economic Environment.....	40
Table 1.5: Categorization of Environmental Impacts.....	41
Table 2.1: Annual Average Daily Traffic at various count locations.....	45
Table 2.2: Comparison of ADT and AADT	46
Table 2.3: Traffic Composition at Count Locations.....	47
Table 2.4: Distribution of vehicle trips (purpose).....	48
Table 2.5: Distribution of vehicle trips (Loading pattern)	48
Table 2.6: Distribution of vehicle trips (Commodity movement)	48
Table 2.7: Speed Profile at various sections.....	49
Table 2.8: Capacity Analysis.....	49
Table 2.9: Traffic growth rates (Generated traffic).....	51
Table 2.10: RoW utilization for various elements	52
Table 2.11: List of proposed Vehicular Underpasses	52
Table 2.12: List of proposed VoPs	53
Table 2.13: List of ROB/RUB proposed	62
Table 2.14: List of Minor Bridges.....	65
Table 2.15: List of proposed Box culverts	65
Table 2.16: List of proposed Bus Shelters.....	66
Table 2.17: List of proposed Toll Plazas along PRR.....	67
Table 2.18: Quantity required for construction activities	71
Table 2.19: Details of Thermal Power Plants.....	71
Table 2.20: Estimated carbon footprint for PRR project.....	74
Table 3.1: Meteorological data collected at site.....	86
Table 3.2: Details of AAQM parameters with analysis methodology.....	88
Table 3.3: Air Quality Index for PM ₁₀	96
Table 3.4: Air Quality Index for PM _{2.5}	96
Table 3.5: Summary of Ambient Air Quality Monitoring Results (98 Percentile)	97
Table 3.6: Details of Noise Level Monitoring	99
Table 3.7: Carrying capacity of nalas along PRR.....	105
Table 3.8: Details of water required for construction activities	107
Table 3.9: List of water bodies along the project alignment.....	109
Table 3.10: Details of Lakes present within 500 m from the proposed alignment.....	109
Table 3.11: Interpretation of soil quality analysis data.....	122
Table 3.12: Rating Chart for Soil Test values and their Nutrient Indices.....	125
Table 3.13: Land use and land cover data of project alignment and study area.....	127
Table 3.14: Chainage wise list of trees recorded within the RoW.....	143
Table 3.15: Checklist of tree species recorded within the RoW.....	144
Table 3.16: Checklist of Aquatic macrophytes recorded from the tanks studied in Bengaluru North and South Districts.....	162
Table 4.1: Air quality modelling results.....	165
Table 4.2: Permissible Exposure in cases of continuous Noise	167

Table 4.3: Noise level modelling results during Day time	167
Table 4.4: Noise level modelling results during Night time.....	168
Table 4.5: Predicted noise levels during operation phase.....	189
Table 4.6: Severity criteria.....	192
Table 4.7: Score ranges	192
Table 4.8: Evaluation of impacts	193
Table 6.1: Environmental Monitoring Program for Construction phase (3 years).....	200
Table 6.2: Environmental Monitoring Program for Operation phase (3 years):.....	203
Table 6.3: Summary of Environment and Social Monitoring	207
Table 6.4: List of guideline manuals for pollution control	207
Table 7.1 Geographical coverage and demographic details of Affected Villages	210
Table 7.2: Villages which are fall under BBMP Wards.....	212
Table 7.3: Population projection for the project affected/land acquisition villages for 4 decades..	213
Table 7.4: Salient features of Demography in Study Area	215
Table 7.5: List of social sensitive receptors along the PRR.....	218
Table 7.6: Village wise extent proposed for Land acquisition	220
Table 7.8: Identification of types of hazards near petroleum pipeline area from the PRR	234
Table 7.9: Emergency contact details in case of accidental damage to petroleum pipeline	237
Table 7.10: List of hospital identified along the PRR for post-accident emergency care	242
Table 7.11: Hazard Identification and Risk Analysis during construction stage	249
Table 10.1: T. G Halli Catchment Area Treatment Plan	267
Table 10.2: Tree plantation plan.....	269
Table 10.3: Cost estimate for forest diversion	271
Table 10.4: Cost estimate for conservation of schedule I species	271
Table 10.5: Cost estimate for introduction of herbivorous fishes and rehabilitation of fish species	274
Table 10.6: Details of sensitive receptors and locations proposed for installation of noise barriers	275
Table 10.7: STI and HIV prevention plan.....	276
Table 10.8: Roles and responsibilities of members of Environmental Cell.....	277
Table 10.9: Summary of EMP Cost	282

LIST OF FIGURES

Fig ES1: Map showing existing NICE Road and proposed PRR alignment on SOI Toposheet.....	4
Fig ES2: Typical cross section (at grade) of the proposed PRR showing various elements.....	5
Fig 2.1: Map showing existing NICE Road and proposed PRR alignment on SOI Toposheet.....	43
Fig 2.2: Google view showing PRR alignment & existing NICE road.....	44
Fig 2.3: Typical cross section (at grade) of the proposed PRR showing various elements.....	54
Fig 2.4: Typical cross section (at VUP & PUP approaches) of the proposed PRR showing various elements.....	54
Fig 2.5: Typical cross section (at ROB approaches) of the proposed PRR showing various elements.....	55
Fig 2.6: Typical cross section (at ROB crossing portion) of the proposed PRR showing various elements.....	55
Fig 2.7: Typical cross section (at flyover portion) of the proposed PRR showing various elements.....	56
Fig 2.8: Typical cross section of PRR Main Road below major Road crossings.....	56
Fig 2.9: Typical cross section of PRR at RUB Approach location.....	57
Fig 2.10: Typical cross section of PRR at RUB.....	57
Fig 2.11: Typical cross section of PRR with LSR lower than Main road.....	58
Fig 2.12: Typical cross section of PRR with RSR lower than Main road.....	58
Fig 2.13: Typical cross section of PRR with Service Road lower than Main road.....	59
Fig 2.14: Typical cross section of PRR at underpass location.....	59
Fig 2.15: Typical cross section at Hosur Road Flyover Approach Location.....	60
Fig 2.16: Typical cross section at Tumakuru Road & Hosur Road Flyover Portion.....	60
Fig 2.17: Typical cross section at Tumakuru Road Flyover Approach Location.....	61
Fig 2.18: Typical Cross section of RUB @ 16+061.....	62
Fig 2.19: Clover leaf inter change at Tukmur Road.....	63
Fig 2.20: Clover leaf inter change at Bellary Road.....	63
Fig 2.21: Clover leaf inter change at Old Madras Road.....	64
Fig 2.22: Clover leaf inter change at Hosur Road.....	64
Fig 2.23: Typical cross section of flyover @ 4+343 Hesaraghatta Road.....	65
Fig 2.24: Typical layout of Toll Plaza.....	68
Fig 2.25: Strip plan showing quarries and crushers along the PRR alignment.....	73
Fig 3.1: Administrative boundaries of the study area.....	80
Fig 3.2: Project alignment on BDA masterplan map (Draft 2031) showing various features.....	81
Fig 3.3: Environmental Sensitive Areas in the study area.....	82
Fig 3.4: Digital Elevation Map (DEM) showing the project alignment and study area.....	83
Fig 3.5: Slope map of the project alignment and study area.....	84
Fig 3.6: Wind direction details obtained from IMD, Pune for Bengaluru city from 1995-2016.....	85
Fig 3.7: Wind rose diagram for the period.....	87
Fig 3.8: Flowchart showing the methodology for AAQM.....	88
Fig 3.9: Map showing AAQM locations.....	89
Fig 3.10: Graph showing the results of PM ₁₀	91
Fig 3.11: Graph showing the results of PM _{2.5}	91
Fig 3.12: Graph showing the results of NO ₂	93
Fig 3.13: Graph showing the results of CO.....	94
Fig 3.14: Graph showing the results of Ni.....	95
Fig 3.15: Map showing Ambient Noise Level Monitoring locations.....	98
Fig 3.16: Noise Levels in commercial area locations.....	99
Fig 3.17: Noise Levels in residential area locations.....	100
Fig 3.18: Geology map of the study area.....	103

Fig 3.19: Drainage map of the study area.....	104
Fig 3.20: Map showing surface water quality sampling locations	111
Fig 3.21: Map showing ground water quality sampling locations	112
Fig 3.22: Nitrate (mg/L) at different locations.....	114
Fig 3.23: DO (mg/L) at different locations.....	115
Fig 3.24: BOD (mg/L) at different locations.....	115
Fig 3.25: TDS (mg/L) at different locations.....	117
Fig 3.26: TH (mg/L) at different locations	117
Fig 3.27: Fluoride (mg/L) at different locations.....	118
Fig 3.28: Map showing soil sampling locations.....	120
Fig 3.29: Map indicating types of soil in the study area	121
Fig 3.30: Map showing land use and land cover in the study area (15 km radius).....	129
Fig 3.31: Map showing crop lands	130
Fig 3.32: Map showing the habitations.....	131
Fig 3.33: Map showing the RF in the study area.....	137
Fig 3.34: Map showing the distance of protected areas from the proposed PRR alignment.....	138
Fig 3.35: Graph showing girth class distribution and number of trees.....	141
Fig 3.36: Graph showing volume of 20 dominant tree species recorded.....	142
Fig 3.37: Graph showing GBH of 5 dominant tree species with cultural values recorded.....	153
Fig 5.1: Flyovers proposed along 6 lakes falling within the proposed PRR alignment.....	195
Fig 5.2: Flyover proposed along Jarakabande Lake	197
Fig 5.3: Flyover proposed along Gunjur Lake	198
Fig 5.4: Flyover proposed along Chikkabanahalli Lake	198
Fig 5.5: Flyover proposed along Chinnaganahalli Lake	198
Fig 5.6: Flyover proposed along Thirumenahalli Lake	199
Fig 5.7: Flyover proposed along Chikkatogur Lake.....	199
Fig 7.1: Archaeological monuments.....	219
Fig 7.2: Structures along the alignment.....	223
Fig 7.3: Emergency Response Activities flow chart.....	244
Fig 10.1: Typical catchment area treatment.....	268
Fig 10.2: Organization Structure of Environment Cell.....	276

LIST OF ANNEXURES

Annexure-1	Environmental Clearance dt: 20.11.2014
Annexure-2	NGT Order dt: 08.02.2019
Annexure-3	ToRs accorded by SEIAA, Karnataka dt: 21.01.2020
Annexure-4	Supreme Court judgement dt: 17.03.2020
Annexure-5	BDA request letter dt: 07.09.2020 seeking clarification from MoEF&CC on Categorization of the project
Annexure-6	Hon'ble High Court Order dt: 23.02.2021
Annexure-7	MoEF&CC Clarification letter dt:04.12.2020
Annexure-8	Hon'ble High Court Order dt: 22.09.2021
Annexure-9	Hon'ble Supreme Court Judgement dt: 20.01.2022
Annexure-10	Corrigendum to ToRs issued by KSEIAA dt: 25.02.2022
Annexure-11	BDA letter dt: 28.07.2022 requesting SEIAA, Karnataka to transfer the file to MoEF&CC
Annexure-12	Administrative approval for the proposed project
Annexure-13	Online application of Forest Clearance
Annexure-14	Earthworks, cut and fill details
Annexure-15	Ambient Air Quality Monitoring stations, results & isopleths
Annexure-16	Ambient Noise Level Monitoring stations & results
Annexure-17	Hydrology sampling stations & results
Annexure-18	Surface Water Quality stations & results
Annexure-19	Ground Water Quality stations & results
Annexure-20	Soil quality analysis locations & results
Annexure-21	Land use maps (Scale 1:25,000)
Annexure-22	Ecology and Biodiversity details
Annexure-23	Aquatic Ecology
Annexure-24	Socio-economic – Land Acquisition Notification and questionnaire used for the study
Annexure-25	Project Alignment and Petronet MHB alignment
Annexure-26	MoU format as per Green Highways (Plantation & Maintenance) Policy-2015

VOLUME II

1	Proceedings of the Environmental Public Hearing held on 18.08.2020
2	Compliance to Proceedings of Environmental Public Hearing held on 18.08.2020
3	Proceedings of Virtual Environmental Public Hearing held on 23.09.2020
4	Compliance to Proceedings of Virtual Environmental Public Hearing held on 23.09.2020
5	Compliance to comments / objections received in written / e-mail to KSPCB and BDA with respect to the Environmental Public Hearing held on 18.08.2020 and Virtual Environmental Public Hearing held on 23.09.2020
	a. Environment related issues
	b. Environmental & Land Acquisition related issues
	c. Land Acquisition related issues
	d. Environmental Public Hearing related issues
6	Proceedings of the Environmental Public Hearing held on 13.07.2022
7	Compliance to Proceedings of Environmental Public Hearing held on 13.07.2022
8	Compliance to comments / objections received in written / e-mail to KSPCB and BDA with respect to the Environmental Public Hearing held on 13.07.2022

EXECUTIVE SUMMARY

ES1. Introduction

Bangalore Development Authority (BDA) had proposed to take up the development of "Eight lane peripheral Ring Road" connecting Tumakuru Road to Hosur Road forming a closed ring with the existing NICE Road. The proposed project involves development of 73.5 km long Peripheral Ring Road (PRR) between Tumakuru Road on West and Hosur Road on East via Ballari Road and Old Madras Road. It integrates with the existing NICE Road. The proposed alignment of PRR will be located at an approximate radial distance of 17 km - 25 km from city centre and acts as a bypass to the city for the long-distance personalized vehicles (cars and cabs) and commercial vehicles (trucks and LCVs). The proposed "Peripheral Ring Road" connects major Highways namely Tumakuru Road (NH-4), Hesaraghatta Road (SH-39), Doddaballapura Road (SH-09), Ballari Road (NH-7), Hennur- Baglur Road (SH-104), OMR (NH-4), Hoskote-Anekal Road (SH-35), Sarjapur Road and Hosur Road (NH-7).

The Environmental Clearance for the project was earlier accorded by the Karnataka State Environmental Impact Assessment Authority (KSEIAA) vide letter No.: SEIAA 32 IND 2009 dt: 20.11.2014. Further, the Environmental Clearance was challenged at the Hon'ble NGT and after detailed deliberation, Hon'ble NGT in its order dt: 08.02.2019 directed BDA to prepare fresh EIA report. Further, BDA approached Hon'ble Supreme Court challenging the orders of Hon'ble NGT. Meanwhile, as per the directions of Hon'ble NGT and without prejudice to the orders of the Hon'ble Supreme Court, fresh application was submitted to SEIAA for issue of ToRs for the project. The project was considered in the 235th SEAC meeting held on 02.12.2019 and ToRs has been issued by SEIAA vide letter No. SEIAA 40 IND 2019 dt: 21.01.2020. However, the Supreme Court in its judgment dt: 17.03.2020 upheld the orders of the Hon'ble NGT and directed to prepare fresh EIA studies for the project. Further, it has also issued directions to SEIAA to re-verify the earlier deficiencies found in the EIA report based on which EC was stayed.

In view of the above, a clarification letter seeking the applicability of General Conditions to the project and whether the Final EIA Report can be submitted to MOEF&CC as per General Conditions or to SEIAA as per Hon'ble Supreme Court directions for appraisal and onward reconsideration for issue of EC was submitted to MoEF&CC, GoI on 07.09.2020.

Meanwhile, BDA has conducted a physical Public Hearing on 18.08.2020 and a Virtual Public Hearing on 23.09.2020 for the project.

Further, MoEF&CC, GoI vide letter Dt: 04.12.2020 informed that further action may be taken by the Project Proponent as per the directions of the Hon'ble Supreme Court of India and in case SEAC/SEIAA are satisfied with the applicability of General Conditions, they may transfer the proposal to Ministry for its appraisal at Central Level in accordance with the provisions of EIA Notification, 2006.

Meanwhile, the Hon'ble High Court Order dt: 22.09.2021 (WP No. 10342/2008) also states that the directions issued by the Hon'ble Supreme Court are to be complied with and directed the respondents to comply all the directions issued by the Hon'ble Supreme Court.

Further, there is a change in total land requirement for the project from 733 Ha to 1036.51 Ha due to change in length of the project from 65.5 km to 73.5 km due to realignment and inclusion of cloverleaf structures at chainages CH 0+000 km to CH 3+400 km (NICE integration at Tumkur Road), 28+843.36 km to CH 31+896.76 km (Near Bilishivale), CH 37+996.76 km to CH 44+400 km (Near Sigehalli) and CH 60+619.92 km to CH 64+700 km (NICE integration at Hosur Road). Hence, an application seeking amendment to the ToRs was submitted to KSEIAA on 03.02.2022.

Subsequently, the Corrigendum to the Terms of References (ToRs) was issued by KSEIAA vide letter No. SEIAA 40 IND 2019 dt: 25.02.2022.

Further, as per the directions of the MoEF&CC, GoI vide its letter Dt: 04.12.2020, BDA submitted a request to the SEIAA, Karnataka on 28.07.2022 to transfer the file to MoEF&CC due to applicability of General Conditions for the project.

ES2. Project description

PRR is proposed with 100 m Right of Way. The cross section comprises of divided eight lane main road separated with central median of 13m. Service roads, 10.50 m in width in each direction are provided on either side of main road for local traffic. Main road is access controlled for trucks, buses, LCV and passenger cars. Service road and Main road are separated by built up drain. An exclusive utility corridor is proposed on both side of ROW for accommodating various service utilities. The primary objectives of the PRR are to relieve the traffic congestion in the metropolitan region and to provide linkage to the radial and arterial roads within the city. This project also aims at connecting new urban nodes outside the city and also provides quick access to BIAL from various parts of the city.

The total land required for the construction of the proposed project is 1036.51 Ha with removal of 1,395 structures. The land will be acquired as per BDA Act, 1976 (as per the provisions of the Land Acquisition Act, 1894). The project involves diversion of 7.73 Ha of forest land in Sy. No. 59 belonging to Jarakabandekaval RF. Boundary of Bannerghatta National Park and Puttenahalli Bird Conservation Reserve are located at a distance of 7.75 Km and 1.49 Km respectively. The interstate boundary of Tamil Nadu is at a distance of 8.27 Km from the proposed alignment of PRR. Peenya Industrial Area and Jigani-Bommasandra Industrial Area are notified as severely polluted area and critically polluted areas by CPCB and are located at a distance of 3.4 Km and 4 km respectively from the proposed PRR alignment. The total cost of the project is Rs 14,934 Crores and the administrative approval for the project has been issued vide letter dt: 21.02.2022. The project is very significant to Bangalore city to relieve the already overcrowded traffic within the city. The economic activities like commercial ventures, infrastructure development, IT, etc will certainly improve consequent to development of PRR.

Table ES1: Salient features of the project

Location of the project	Starting point: Tumakuru Road (13°3'20.98"N, 77°28'37.39"E) Ending point: Hosur Road (12°51'29.46" N, 77°39'45.69" E) Bangalore Urban District, Bangalore Administrative map showing the taluks and villages along the PRR is given in Fig 3.1.
Length of PRR	73.5 km
Width of the alignment (m)	100
No. of VUPs	14
No. of VOPs	7
No. of ROB/RUB	5
No. of bridges a. Major b. Minor	a. Nil, b. 12
No. of Culverts	51
No. of intersections	10
No. of bus shelters	54
No. of toll plazas	15
No. of villages through which alignment is passes	77
Population of the villages through which alignment passes	6,06,975
No of structures to be removed	1,395

Lakes along the alignment	<ul style="list-style-type: none"> • Tank near Jarakabandekaval Forest from Chainage 11+334 Km to 11+564 Km • Chinnaganahalli Lake from Chainage 37+332 Km to 37+416 Km • Chikkabanahalli Lake from Chainage 39+003 Km to 39+227 Km • Gunjur Lake from Chainage 51+931 Km to 52+468 Km • Thirumenahalli lake from Chainage 64+300 km to 64+690 km • Chikkatogur lake from Chainage 22+130 km to 22+250 km
Protected Area/Wildlife Sanctuaries/ Eco-sensitive areas/ Reserve Forest	<ul style="list-style-type: none"> • Bannerghatta National Park – 7.75 Km • Puttenahalli Bird Conservation Reserve – 1.49 Km
Forest land required (ha)	7.73 Ha of forest land in Sy. No. 59 belonging to Jarakabandekaval RF
Length of the alignment proposed in forest area (m)	773
Width of the alignment proposed in forest area (m)	100
Interstate Boundary	Tamil Nadu- 8.27 Km
Earthquake Zone	Seismic Zone II (Least Active zone)
Influencing Catchment area	Thippagondanahalli Catchment Area
Nearest Critically Polluted Areas (CPAs) identified by CPCB	Peenya Industrial Area -3.4 km (Severely Polluted Area) Jigani-Bommasandra Industrial Area-4 Km (Critically Polluted Area)
Gas pipeline	About 3.9 km of gas pipeline alignment (CH 28+350 km to CH 31+615 km) passes adjacent to the proposed alignment and intersects the alignment at two points namely at chainages CH 38+824 km and CH 6+875 km.

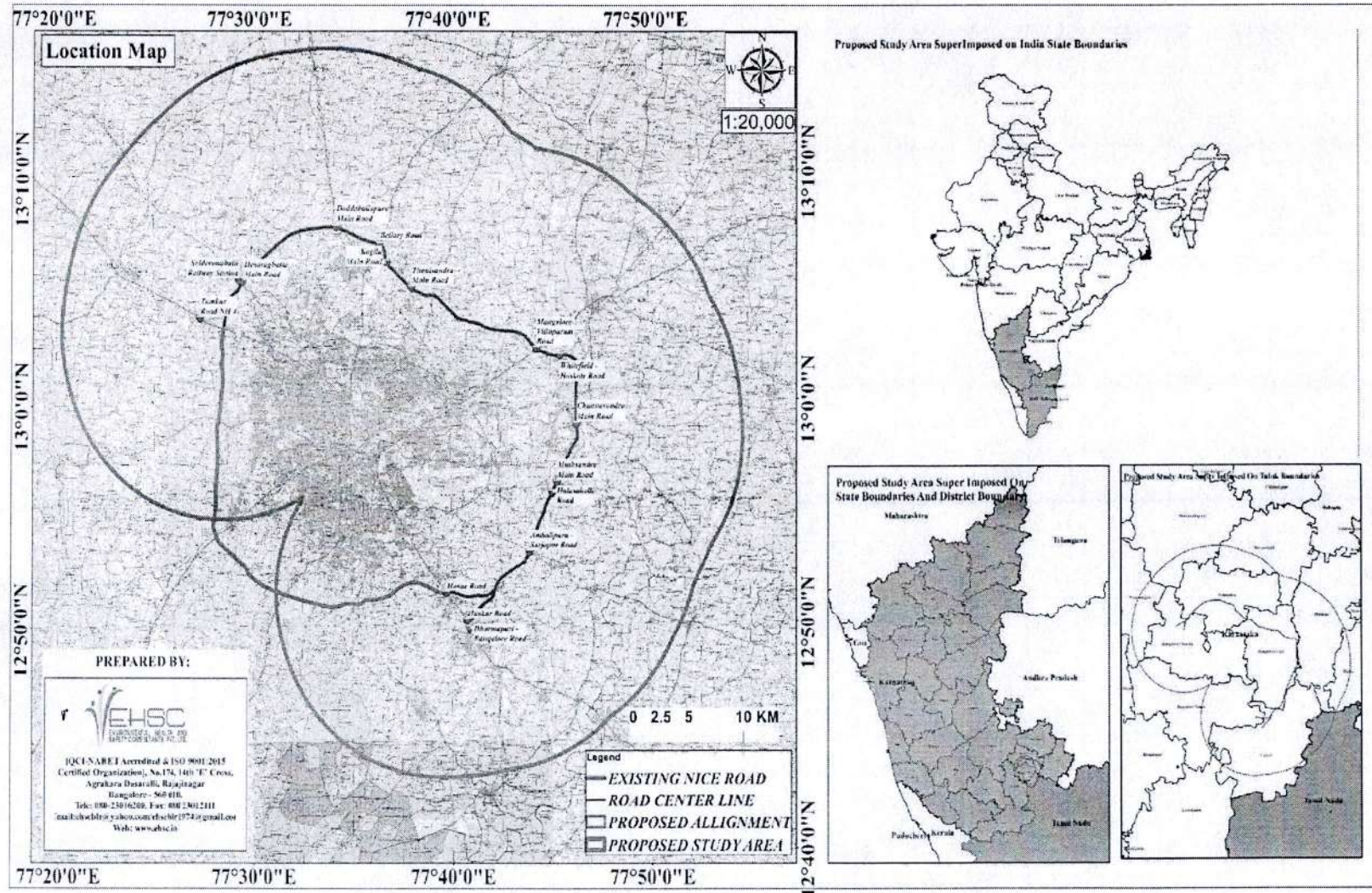


Fig ES1: Map showing existing NICE Road and proposed PRR alignment on SOI Toposheet

ES2.1 Typical cross section

Typical cross section for the project for 100 m ROW comprises of following cross section elements. Typical cross section details of the proposed PRR is given below;

Table ES2: RoW utilization for various elements

Sl.No	Particulars	RoW utilization	Sl.No	Particulars	RoW utilization
1	Median	13 m	9	Shyness-1	0.25 x 2 (0.5 m)
A	Open drain	5 m	10	Service road	10.5 x 2 (21 m)
B	Granular shoulder	4.0 x 2 (8.0 m)	11	Shyness -2	0.25 x 2 (0.5 m)
2	Gantry -1	0.75 x 2 (1.5 m)	12	Drain	1.0 x 2 (2.0 m)
3	Edge strip	0.50 x 2 (1.0 m)	13	Cycle track	2.0 x 2 (4.0 m)
4	Left Carriageway	14 m	14	Foot path	2.0 x 2 (4.0 m)
5	Right Carriageway	14 m	15	Space for U/G Cable	1.0 x 2 (2.0 m)
6	Paved shoulder	1.5 x 2 (3 m)	16	Space for other utilities	2.0 x 2 (4.0 m)
7	Gantry-2	0.75 x 2 (1.5 m)	17	Green space	5.0 x 2 (10.0 m)
8	Covered drain	2.0 x 2 (4 m)			

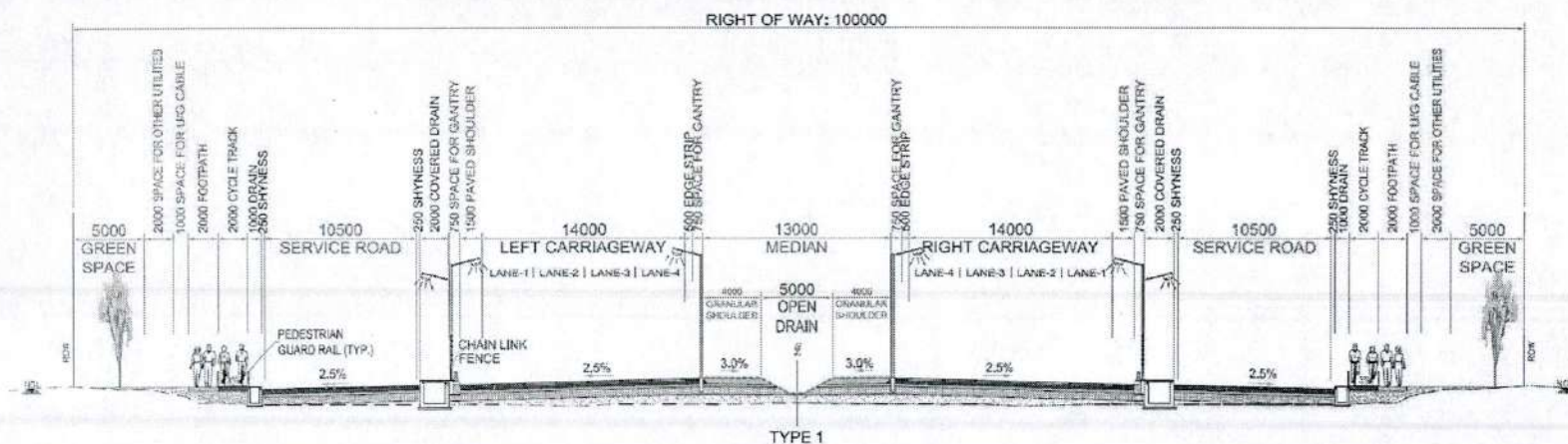


Fig ES2: Typical cross section (at grade) of the proposed PRR showing various elements

ES3. Description of baseline environment

In order to assess the baseline environmental status, primary baseline data was collected in the right of way as well as the area falling within 500 meters on the either side of the Right of Way (RoW) and secondary data was collected within 15 kms aerial distance. The data was collected for one season (December 2019-February 2020) and during February, 2022 to March, 2022 for realignment by M/s EHSCPL, Bengaluru accredited as 'A' category organization from NABET in nine sectors including Highways projects. In addition to the baseline environmental monitoring, field inspection in the study area, collection of primary and secondary information for all the environmental components and discussions with the officials and local public were conducted by the experts.

ES3.1 Physical Environment

ES3.1.1 Ambient Air Quality

A network of 12 Ambient Air Quality Monitoring Stations has been selected for assessment of the existing status of air environment within the study zone. The average minimum and average maximum concentrations of PM₁₀: 63.6 µg/m³ and 84.78 µg/m³; PM_{2.5}: 16.35 µg/m³ and 28.40 µg/m³; SO₂: 6.77 µg/m³ and 7.80 µg/m³; NO_x: 17.91 µg/m³ and 26.72 µg/m³; CO: 0.66 mg/m³ and 1.42 mg/m³; Pb: 0.01 µg/m³ to 0.40 µg/m³; Ni: 5.27 ng/m³ and 7.90 ng/m³; O₃: 1.25 µg/m³ to 5.73 µg/m³ and NH₃: 1.07 µg/m³ to 6.06 µg/m³ were recorded. As per Air Quality Index (AQI), Good and satisfactory ambient air quality was observed in the study area. The air quality w.r.t SO₂, PM_{2.5} and NO₂ is good.

ES3.1.2 Ambient noise levels

Ambient noise levels were measured at 20 locations (13 commercial, 4 residential, 2 sensitive and 1 industrial area). As per the monitoring results, out of 13 commercial area locations, noise levels are exceeded the standards in 11 locations except at 2 locations (N12 and N18) during day time. The noise levels are in the range between 62.15 to 79.77 db(A). Similarly, during night time 6 locations are exceeded and remaining 7 locations are within the standards. The noise levels are in the range between 36.82 to 63.58 dB(A). Vehicular movement is the major contributor of noise in the commercial area.

ES3.1.3 Surface water

Surface water sampling was carried out at 9 lakes and the results shows that the pH of the 9 lakes ranges from 7.32 to 8.31, EC- 477 µs/cm to 2080 µs/cm, Total Hardness - 92 mg/L to 452 mg/L, Chloride - 52.6 mg/L to 283.82 mg/L, DO - 4.6 mg/L to 5.2 mg/L and total coliform - 2100 MPN/100 ml to 540 x 10⁴ MPN/100 ml. Water quality criteria as per CPCB guidelines shows that, out of 9 samples, 1 sample belongs to criteria 'D' (11.11%) and 8 samples belongs to criteria 'E' (88.89%). Therefore, all the water from the above locations is suitable for irrigation purposes only. Similarly, the Water Quality Index of all 9 surface found to be "unsatisfactory" as per KSPCB Guidelines.

ES3.1.4 Ground water

Ground water sampling was carried out at 10 locations and the results shows that the pH ranges from 6.66 to 7.68, Alkalinity - 94 mg/L to 420 mg/L, Electrical conductivity - 658 µs/cm to 2900 µs/cm, TDS 480 mg/L to 1918 mg/L, Calcium - 34.4 mg/L to 192 mg/L and Bicarbonate values ranges from 94 mg/L to 420 mg/L. All the values are well within the standards except for TH at Kadugodi (668 mg/L), Varthur (660 mg/L) and Jigani Bommasandra Industrial Area (888 mg/L); Total Chromium at Jigani Bommasandra Industrial area (0.127 mg/L) and Iron at Yelahanka New Town (0.38 mg/L), Rampura Village (0.721 mg/L) & Jigani Bommasandra Industrial area (0.575 mg/L).

ES3.1.5 Soil

The soil samples were collected from 15 locations and the texture of soil in the study area varied all along the alignment. The soil analysis results indicate that, soil texture varied from sandy loam to loam. Sandy loam soils are capable of quickly draining excess water. Loamy soils have good water retention, porosity and permeability this will helps in the drainage of water during construction phase. Organic carbon falls in medium category indicating the setting of cement by adsorbing calcium ions liberated during hydration will be more and thereby favouring road construction activities. Overall results of soil quality analysis were found to be supportive to road construction activities.

ES3.1.6 Land use

Land use land cover of the study area of 2,572.32 Sq. Km indicate that, area predominantly covered with Fallow land (27%) followed by agricultural land (22%) and built up area (20%). Plantation activities in the study area mainly includes banana, coconut, areca nut, teak, eucalyptus, etc and floriculture is also observed in the study area. Waterbodies comprising of 3 % of the study area.

Table ES3: Land use and land cover data of project alignment and study area

Sl. No.	Land use	Area (Sq. Km.)	Percentage (%)
1	Built up area	519.07	20
2	Agricultural land	569.49	22
3	Barren land	206.38	8
4	Fallow land	695.53	27
5	Plantation	450.90	18
6	Water bodies	64.95	3
7	Forest	66	2
Total		2572.32	100

ES3.2 Biological environment

The project alignment covers most of the agriculture and plantation land; a portion of alignment also passes through Jarakabandekaval Reserve Forest. The project involves diversion of 7.73 Ha of forest land belonging to Jarakabandekaval Reserve Forest and attracts the provisions of Forest (Conservation) Act, 1980. In view of this, an online application to MoEF&CC for forest land diversion has been submitted. Where, indirect evidence confirmed that the presence of Indian Peafowl (Schedule-I), construction of road may cause loss of habitat. Apart from this, the project alignment is 7.75 Km away from the Bannerghatta National Park and 1.49 km from the Puttenahalli lake bird's conservation reserve.

Total tree enumeration all along the alignment was carried out and a total of 122 trees species (n=36,824) belonging to 41 families were found within the alignment. The project requires removal of 32,175 trees. The predominant tree species recorded were *Eucalyptus globulus* Labill (n=11053), *Cocos nucifera* L. (n=5976), *Mangifera indica* L. (n=4254), *Eucalyptus tereticornis* L. (n=2488), *Tectona grandis* L.f. (n=3038), *Grevillea robusta* A. Cunn. ex R. Br. (n=1712), *Pongamia pinnata* (L.) Pierre (n=1615), *Azadirachta indica* A. Juss. (n=1065) and *Manilkara zapota* (L.) Van Royen (n=945). All the recorded species are common to region and no RET species were recorded. Out of 36,824 trees, 13,355 trees were falling in TG Halli Catchment area and 631 trees falling in Jarakabandekaval RF where forest diversion of 7.73 Ha is proposed. All the recorded tree species are commonly found, some of them were medicinal, edible and timber yielding; they have economic and social values in the region. *Ficus spp.* is the keystone species found within the project alignment. Tree of 30 cm GBH were dominant throughout the alignment, totaling to 22,341 individuals. Analysis of carbon sequestration potential of tree species reveals that the trees species (n=36,824) of >30 cm GBH have sequestered 3728.69 tonnes of carbon.

ES3.3 Socio-economic studies

Socio-economic survey (100%) was carried out by visiting all the villages, areas falling within the proposed PRR alignment. However, due to the conversion of several villages to towns over a period of time, identifying the land losers in the towns was an obstacle. A team was constituted to conduct the social impact survey studies with considerable exposure and experience in the past, who are familiar with the socio-economic settings of the area and understood the local dialect. Field survey planned from January, 2020 for the primary data collection which constituted the most important element of the methodology. Field survey was carried out along the corridor stretch containing a total of about 145 households using standard questionnaire. The potential respondents in the sample households were contacted personally by the field investigators who explain the purpose of the visit and seek their participation by sharing relevant information impartially. The field investigators also clarified the doubts and apprehensions expressed by the respondents. Some of the limitations faced during field survey are as follows;

- Firstly, most of the land owners wanted to meet the BDA authorities in presence of Chief Minister regarding finalization of the Compensation price before sharing the information
- Objection from localities' who does not want to cooperate as the project was delayed for very long period of time
- Actual Land owners have settled in other places
- Non availability of actual land owner's information at certain places
- In some places, survey team has been threatened and sent away from the villages

As revealed during field survey, all the respondents are aware of the infrastructural project in the area and is of the opinion that it is essential to ease the traffic movements. The perceptions of the respondents as regards to construction to eight lane road in the area could be summarized as follows;

- The land losers demand the compensation to be paid as per present market value by following RFCT LARR Act 2013.
- Delay's for about nearly 15 years for construction of the project has left people in misery and no hope for future development/activities.
- Project affected peoples were unable to either transact or build on their own land for over a period of 15 years, which has led in delaying marriages of their children.
- The land losers also demanded additional compensation for delays in the proposed project.
- People request for the NOC (No Objection Certificate) from BDA as they are not able to sell their lands due to PRR land acquisition notification.
- Psychological stress has developed among the PAPs due to delay in providing compensation led to animosity against the project and hence non involvement during surveys / studies.
- Many PAPs loose full land to PRR and becomes landless.
- Most of the titleholders have said that they have already sold their lands and asked us why their names are still mentioned in the Land acquisition notification.
- Many of the landowners have developed their lands to sites and layouts and also which some are already sold Hence, they are demanding compensation for the developed sites, layouts, and other immovable structures in the land.

Land acquisition is proposed for a width of 100 mts ROW, except at locations of toll plaza and interchanges. The total land required for the construction of the proposed project is 1036.51 Ha (2567 A 22.25 G) and involves removal of 1,395 structures. The total numbers of structures likely to be affected fully/partially are 1,395 under the proposed impact zone within the corridor. It can be seen from the following table that the project will likely to be impacted upon 1,377 on residential/commercial structures and 18 agricultural lands and assets. Public hearing will be conducted as per the guidelines of EIA Notification, 2006 and its subsequent amendments in consultation with KSPCB and DC respectively.

ES4. Anticipated environmental impacts and mitigation measures

Sl.No.	Environmental Attribute	Activity	Impact	Mitigation Measures
1	Air Pollution	Site preparation, construction activities, transportation of raw materials, earthwork, quarrying, labour camps, etc	<ul style="list-style-type: none"> Emission of dust due to site clearance and excavation activities. Operation of hot mix plants, concrete batching plants and asphalt mixing plants. Dust emissions may cause reduction in growth rate, deposition of dust on leaves, photosynthetic activity, necrosis, leaf curling, abscission, etc in the plants. Continuous exposure to dust emissions may cause respiratory disorders, eye irritation, cough, chest pain, infections, etc in human. The typical day model output reveals that maximum GLC observed in the core construction area up to 109.45 $\mu\text{g}/\text{m}^3$ and impact observed till 2 kms from the core construction zone. 	<ul style="list-style-type: none"> Barricading the project site on either side of the of the RoW to reduce dispersion of dust As per KSPCB Guidelines, the hot-mix plants with dust extraction unit will be installed in downwind direction from nearby settlement and located at least 500 m from the nearest habitation. Use of Personal Protective Equipment's (PPE) for all the labor. Water will be sprinkled 3 times a day in the line and earth mixing sites, asphalt mixing site and service roads. In filling subgrade, water spraying is needed to solidity the material. After the impacting, water will be sprayed regularly to prevent dust. With the implementation of EMP, the dust load will be reduced to 76.814 $\mu\text{g}/\text{m}^3$ will fall in the satisfactory range of AQI.
2	Noise Pollution	Site preparation, construction activities & transportation of raw materials	<ul style="list-style-type: none"> Movement of vehicles and heavy machineries Construction activities including blasting, hot mix plants, batching plants, operation of machineries devices for breaking concrete), earth-moving machines, pile drivers, 	<ul style="list-style-type: none"> Machinery and vehicles will be maintained regularly Noise barriers in the form of barricade and proper signages (no horn zones) will be used to minimize the noise pollution. Controlled blasting method will be

Sl.No.	Environmental Attribute	Activity	Impact	Mitigation Measures
			<p>pneumatically driven devices and combustion engines.</p> <ul style="list-style-type: none"> Construction activities are expected to produce noise levels in the range of 80 - 95 dB (A). The increasing noise levels due to drilling, blasting and allied construction activities will disturb the avi-fauna and faunal burrow animal habitats like reptiles. 	<p>deployed which reduces increased noise levels and also reduces vibrations effect, including erection of tall barricades (40ft height) around construction spots.</p>
3	Water Pollution	Improper management of sewage and waste, earthworks, construction activities, labor camps, tree removal, runoff, etc	<ul style="list-style-type: none"> Removal of 4925 trees affects the hydrological regime and water quality in the TG Halli catchment area. Improper handling and disposal of muck will change the natural flow pattern of the surface runoff in the natural drains/nalacriss-crossing the alignment neighborhood flooding and moderate loss of crops/plantation. Deposition of dust on nearby lakes may be anticipated due to construction activities which affects the penetration of sunlight thereby increasing BOD and phytoplankton productivity threatening the survival of aquatic biota. Improper collection, handling & disposal of solid wastes (organic solid waste:45Kgs/day) from labor camps will result in formation of leachate under precipitation/rainy days and thereby indirectly affects the ground 	<ul style="list-style-type: none"> Plantation of trees to the number of trees removed in the catchment area in the ratio 1:10 will be carried out in the catchment area. Muck will not be stored / filed near nala / streams to ensure natural flow of water in the drain / nala across the proposed alignment. Erection of barricades and water sprinkling shall minimize the deposition of dust on the waterbodies thereby reducing the impact on avifauna and aquatic biota. Solid wastes (75Kgs/day) from the labor camps will be segregated into organic (45Kgs/day) & inorganic wastes (30Kgs/day) through different colored bins located at different places within the camps. Organic solid wastes will be handed over to nearby piggeries and Inorganic wastes will be disposed to

Sl.No.	Environmental Attribute	Activity	Impact	Mitigation Measures
			water quality of the region through infiltration factors.	BBMP authorized scrap dealers/waste recyclers.
4	Hydrology & geology	Construction activities, water extraction, etc	<ul style="list-style-type: none"> The foundations require excavation of pits and blasting of rock which has a negligible impact as the pits shall be filled back with stony waste & gravel that shall be stabilized. However, likely impact on the geological resources will occur from the extraction of materials (borrow of earth, granular sub base and aggregates for base courses and bridges) which is insignificant. As such there is no threat to Geologic environment. The litho unit is massive and hard which is stable. The proposed project corridor length crosses about 63 minor & major drainages and also few tanks. Construction activities such as excavation, storage of debris, muck, etc may affect the streams which are seasonal that carry huge volume of storm water and contribute to recharge of groundwater as such these needs to be protected. This may also cause flooding during monsoon season. 	<ul style="list-style-type: none"> The collapse can be avoided by formation of benches of 1.5 m to 3.0 m height for working conveniently and making access to sub surface levels for pit formation. The safety buffer zone of 30.0 m to be left to protect the natural stream course and maintained periodically with desilting and cleaning. The safety buffer zones specifically pronounced in the orders of the Hon'ble National Green Tribunal, Principal Bench, New Delhi shall be strictly adhered to. Maintenance of streams by removing debris periodically may minimize the impact on drainage pattern.

Sl.No.	Environmental Attribute	Activity	Impact	Mitigation Measures
5	Soil Quality	Land acquisition, agriculture and removal of vegetation, Storage and use of top soil, construction activities, labor camps, etc	<ul style="list-style-type: none"> Removal of structures leads to generation of construction debris. About 20.93 MT of construction debris will create confined augmented absorptions of toxic heavy metals in the soil, which may reach toxic levels through the food chain. Removal of trees and vegetation & earth works including quarrying leads to erosion and loss of top soil. About 32,175 number of trees will be removed thereby erosion of soil is anticipated. Top soil from the borrow area will lose its fertility if not handled properly. Also the borrow area become potential breeding ground for mosquitoes and other bacterial infection disease. The transportation of borrow and quarry materials also cause dust nuisance. 	<ul style="list-style-type: none"> Reuse of the construction debris for scientific disposal of construction debris to avoid contamination. Selection of the disposal sites will be carried out in consultation with the State Pollution Control Board, Revenue Department and Forest Department in order to ensure that no natural drainage, productive lands or natural habitat is adversely impacted due to disposal. Turfing of road embankment slopes and compensatory afforestation activities. Borrow areas situated less than 0.8 km (if unavoidable) from villages and settlements should not be dug for more than 30 cm after removing 15cm of topsoil and should be drained.
6	Solid & Hazardous Waste	Earth works, labour camps, utilization of hazardous materials for construction.	<ul style="list-style-type: none"> The project requires demolition of 1,395 Nos. of structures which generates demolition waste and debris (20.93 MT) due to dismantling of existing cross drainage structures and roadside residential and commercial structures may lead to entry of toxic heavy metals into the soil and nearby waterbodies. Improper disposal of sewage 	<ul style="list-style-type: none"> Demolition wastes and debris shall be stored separately in dumping yards located 1000 m away from the sensitive locations such as settlements, forest areas, schools, etc and lined with impermeable membrane/concrete. These wastes shall be reused for construction and filling purposes as per the C&D Waste Management Rules, 2016.

Sl.No.	Environmental Attribute	Activity	Impact	Mitigation Measures
			<p>(18KLD) and solid wastes (45Kgs/day) from labor camps area leads to the formation of leachate thereby causing soil pollution, surface and ground water pollution.</p> <ul style="list-style-type: none"> Improper handling of hazardous materials such as bituminous material-asphalt waste and tar during transportation and construction activities may enter into waterbodies thereby increasing the turbidity. 	<ul style="list-style-type: none"> Mobile STPs are used to treat the sewage generated from labor camps and solid waste generated shall be segregated, stored in separate bins and disposed off to KSPCB authorized disposal sites. Hazardous and other wastes (Bituminous material-asphalt waste, tar) will be stored in stockyards with paved bases and handled as per Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016
7	Land use	Construction of PRR, excavation activities, vehicular movements, residential and commercial development, demand for infrastructure, etc	<ul style="list-style-type: none"> Utilization of local land resources for the project is one of the major impact on land use. Land acquisition of 1036.51 Ha along 73.5 Km with RoW of 100 m leads to loss of productive agricultural land, forest land and water bodies. The project also envisages removal of trees (32,175 trees) and roadside structures (1,395 structures) which also leads to permanent changes in the existing land use pattern. Road construction activities involve alterations in the local physiography and drainage patterns. The impacts on physiography may include destabilization of slopes due to cut and fill operations. 	<ul style="list-style-type: none"> Compensatory afforestation will be carried out in the ratio 1:10 to balance the number of trees removed. Parallel cross drainage structures will be added to improve local physiography and drainage.
8	Ecology & Biodiversity	Removal of trees, construction	<ul style="list-style-type: none"> Removal of 32,175 trees and clearance of vegetation cause 	<ul style="list-style-type: none"> Green belt development plan and avenue plantation along with

ES5. Environmental Monitoring Programme

Environmental Monitoring Programme will be carried out during both construction and operation phase for 3 years each which involves Ambient Air Quality Monitoring, ambient noise level monitoring, soil quality analysis, surface water quality analysis, ground water quality analysis, aquatic life studies and periodic health check-ups for labors as per the CPCB guidelines through MoEF&CC recognized laboratories under the supervision of BDA. Environmental Monitoring is proposed during the construction and operation phase of the project. Rs. 8,68,55,280/- was estimated for environmental monitoring during construction phase (36 months) and Rs. 1,13,02,560/- is estimated for operation phase (36 months) of the project. Other activities includes, monitoring of green belt/tree plantation, labor camps, risks and hazards associated with gas pipelines, land acquisition, sourcing of construction materials, borrow areas, etc.

The Environmental Cell of BDA will convene a meeting quarterly once in a year and review the progress of environmental and social mitigation measures including management plans. The cell will also review the compliance conditions of various statutory clearances and public grievances. Accordingly, six monthly compliance reports to EC conditions and also to other clearance conditions will be prepared and submitted to Integrated Regional Office, MOEF&CC, Bangalore and also to Regional Office, KSPCB on 01 June and 01 December of every calendar year without fail for monitoring of EC conditions.

ES6. Risk and hazard studies

This section involves studying the risk and hazards associated with the various aspects of the proposed project such as excavations, accidental falls, occupational hazards, vehicular transportation of chemicals and hazardous materials, blasting, presence of petroleum pipeline along the proposed alignment, emergency preparedness, road safety, accident prone zones, etc. during its construction and operation phases.

ES6.1 Risks and hazards during construction phase

- **Accidents:** Accidents during construction phase includes in the activities of handling heavy equipments, fall from heights, hazardous chemical spills, fire hazards, electric shocks etc which may occur due to the practice of unsafe procedures.
- **Blasting activities:** Since the area of the PRR alignment is flat terrain, the project doesn't require the activity of blasting. If any hard-rocky exposure encounter during the construction phase, the requirement of blasting activity is needed. The PRR alignment is passing along the boundary of urban landscapes, where the intervention of wildlife habitat is negligible and no eco sensitive areas are present in the alignment. However, two eco sensitive areas namely, Bannerghatta National Park, located at distance of 7.75 Km and Puttenahalli Bird Conservation Reserve, located at the distance of 1.49 Km is present around the boundary of proposed PRR alignment.
- **Petroleum pipeline alignment:** In the proposed PRR alignment, part of the area at chainage from 28+000 km to 31+700 km to near Bilishivale, Vaderaahalli, Rampura and Adhuru villages has an underground petroleum pipeline running parallelly along the proposed PRR corridor. The pipeline intersects the proposed PRR alignment in two areas near Chikkabanahalli village belonging to Bangalore East Taluk and at Kasaghattapura village belonging to Bangalore North Taluk. Flyover is proposed at intersecting areas to avoid impact on MHB Petronet pipelines.

ES6.2 Mitigation measures to be adopted during construction phase

- Toolbox meetings and trainings will be conducted on site on a weekly basis by safety managers and supervisors about safety, do's and don't during construction.
- Measures for prevention of accidents includes; handling of heavy equipments by using certified lifting equipments like cranes with specific training. Workers shall be

communicated with the information of hazards and safety precautions to be followed during the lifting activity, Use of personal protective equipment, barricading for unauthorized workers, use of ladders, etc.

- Prevention of fall hazards by ensuring that Scaffoldings are assembled, dismantled or significantly altered only under the supervision of a competent person. Provision of guide rails and toe boards to ensure safety for workmen. Provision of safety nets or other screens will be provided to catch any falling materials.
- Prevention of accidents from hazardous chemicals spill during construction phase through use of epoxy strippers, solvents can cause skin irritation and harm the respiratory organs of the person handling these chemicals frequently. Hence, PPE's such as nitrile gloves, rubber gloves, with a cloth liner, and protective clothing will be used during the chemical handling. Splash proof goggles shall be used to prevent the chemical splash hazard to eyes during its usage.
- Controlled blasting will be employed to avoid noise and vibration by temporarily stopping other activities in the immediate vicinity. Blasting activity will not be carried out during high wind speed and unfavorable atmospheric conditions. Blasting will be carried out only in daytime. Use of NONEL (Nonelectric Detonating System) will be preferred to use for blasting to reduce the vibration of the ground and disturbance to human and surrounding wildlife.

ES6.3 Measures to guard the pipeline from accidental damage at intersecting area

In the proposed PRR alignment, part of the area at chainage from 28+000 km to 31+700 km to near Bilishivale, Vaderahalli, Rampura and Adhuru villages has an underground petroleum pipeline running parallelly along the proposed PRR corridor. The pipeline intersects the proposed PRR alignment in two areas near Chikkabanahalli village belonging to Bangalore East Taluk and at Kasaghattapura village belonging to Bangalore North Taluk.

For pipelines crossing under the proposed PRR alignment, the concurrence from the pipeline operating organization will be obtained to ensure the proper protection is provided to the pipeline to avoid accidental damage. Flyover is proposed at intersecting areas to avoid impact on MHB Petronet pipelines. In addition to this, special precautions are necessary at such locations to safeguard the carrier pipe by passing it through an additional oversize pipe termed a "Casing Pipe". This casing pipe will avoid any mechanical damage to pipeline present in the proposed PRR alignment, casing installation is carried out with the support from pipeline operating organization Petronet MHB. For the case of pipelines crossing in a busy road or highway, metallic casing is preferred as per API RP 1102 protocol.

The basic purpose of providing a casing is to relieve the carrier pipe from external load due traffic movement, to provide a path for leaky products to escape from road crossings and also to enable the leaky pipe to be replaced beneath the road surface. The casing pipe shall be designed to capable of withstanding the pressure equal to that of carrier pipe. The casing pipe shall be of steel, cast iron or reinforced cement concrete and have adequate strength and be large enough to permit ready withdrawal of the carrier pipe. Ends of the casing shall be sealed from the outside, so that it does not act as a drainage path.

Also, the concrete culvert of suitable size designed to accommodate the suitable load at both construction and operation phase of the PRR project shall be used to protect existing pipeline from the vulnerable to damage.

Table ES4: Identification of types of hazards near petroleum pipeline area from the PRR

Activity	Risk	Impact	Control measures
Soil excavation activity near to pipeline area, Burrowing of earth, Movement of Heavy machineries, Blasting activity.	Accidental damage to petroleum pipeline causing, spillage of petroleum products namely High Speed Diesel, fire hazard due to presence of ignition sources nearby, flow of petroleum products into nearby drainage system, Contamination of nearby surface water bodies lakes,	Expose flammable petroleum products to Fatal accidents due to the explosion. Burn injuries to the inhabitants of surrounding area. Fire hazard due to vapor cloud explosion Contamination of lake	Consultation with Petronet MHB authorities shall be done strictly before initiating the excavating activity near to the pipeline area. Mechanical excavation will not be carried out. Blasting shall be strictly prohibited surrounding the pipeline area. Emergency preparedness plan shall be implemented and followed. Onsite emergency mock drill shall be done periodically with all workers and sub-contractors considering the events of Emergency spill response and containment actions.

ES6.4 Anticipated impacts during operation phase

- Accident prone Zone: The various causes of road accidents includes; excessive speed and rash driving, violation of traffic rules, failure to perceive traffic situation or sign or signal in adequate time, carelessness, fatigue, alcohol, sleep, vehicle defects, improper road conditions & designs, unfavorable weather conditions etc.
- Hazardous chemical spillage during the operation phase: Releases of hazardous materials and other emergencies such as fires that pose a significant threat to health, safety and environment by their nature require an emergency response or the mitigating factors to fight with the situations.

ES6.5 Mitigation measures to be adopted during operation phase

- Pedestrian safety: pedestrian facilities (footpaths, guard rails, zebra crossings, traffic signals, pedestrian signals, signages, illumination, street lights, refuges, etc) will be planned, designed, operated and maintained so it is usable by everyone, including those disabilities or using mobility aids. IRC: 103-2012 guideline will be followed to design the pedestrian facility. Care will be taken to provide the facilities to pedestrian to not only along the roads and intersections, but also at the areas like workplaces, access to transit areas, markets, schools etc.
- Accident mitigation measures includes; design improvement at curves and to road geometry, street lighting, improvement in skid resistance, road markings and signs, guide posts with reflector, guard rail, constructing flyovers and bypass, better education and awareness to drivers on the dangers of speeding, cameras for speed enforcement and surveillance, provision of safe underpass/overpass for villagers for crossing, etc.
- Post-accident emergency assistance and medical care to accident victims.

- In the event of an incident including hazardous chemical spillage the crew shall ensure all preventive measures to curb product spillage/leakage, inform local police, fire Brigade, alert passers-by and cordon off the area, communicate to the concerned oil/chemical company & the transporter.

ES7. Project benefits

Improvements in the physical infrastructure:

- Project will boost economic development activities viz., industries, educational institutions, hospitals, information technology development, housing and other infrastructure projects, etc.

Improvements in the social infrastructure:

- Enhanced connectivity between rural and urban area of north and east parts of Bangalore. Many villages where PRR alignment is passing through doesn't have proper road network and access to city. The project will bring substantial socio-economic development in the region.
- Better access to various places reduces travel time of commuters and thus quality of life will be improved.
- Improved access to higher education facilities & modern health facilities.
- The project provides linkage to internal arterial roads and new urban roads will be developed due to the project.

Employment potential:

- Direct and Indirect employment opportunities during construction and operation phase will be increasing.
- The project will generate 300 employment (50 Skilled, 100 semiskilled and 150 unskilled) during construction phase and 300 employment (120 Skilled, 100 semiskilled and 80 unskilled) during operation phase. Further, due to the road development many indirect jobs will be created.

Other tangible benefits:

- Construction of PRR will provide better connectivity for the commuters accessing various national and state highways including BIAL.
- The project is planned as a requirement for the future of Bangalore city traffic beyond ORR.
- Traffic congestion inside the Bangalore city will be reduced and thus helps in reduced heat island effects.
- The project acts have a bypass for long distance traffic moving interstate.
- Decrease in travel time reduces pollution levels.
- Accidents will be considerably reduced due to proper road safety aspects.
- Vehicle operation and maintenance cost will be considerably reduced.

ES8. Environmental Management Plan

PRE CONSTRUCTION ACTIVITIES MANAGEMENT PLAN		
Finalization of RoW/alignment: Joint inspection will be convened by engineering and land acquisition team & at unavoidable situations, possibility of slight re-alignment may be verified.	Storage of construction materials: necessary guidelines will be followed w.r.t storage and stacking of construction materials.	Demarcation / Numbering of Trees: In consultation with DFO, Bangalore Urban District, KFD, joint tree marking within the RoW will be undertaken.
Finalization of locations for erecting hot mix plants, crushers and batching plants: While selecting the locations for erection of hot mix plants, crushers and batching plants KSPCB siting guidelines shall be ensured	Identification of borrow areas and quarries: Sourcing of construction materials is from the Government approved quarries. Borrow areas will be identified as per MoEF&CC guidelines.	Land Acquisition, R&R including CPR: Land acquisition will be planned in consultation with PAFs. R&R activities will be initiated by giving sufficient time to PAFs to relocate and to make alternate arrangements.
Labor camps: provision such as drinking water, LPG, sanitation facilities, first aid, canteen creches, etc will be ensured	Traffic management: necessary guidelines w.r.t traffic control, management, signages, markings, flags, etc will be ensured	Sourcing of fly ash: necessary guidelines will be followed w.r.t transportation and utilization of fly ash during construction.
Water for construction activities: 30KLD/km of water required for construction activities will be sourced from BWSSB	-	-
CONSTRUCTION PHASE MANAGEMENT PLAN		
Borrow area management: Borrow areas will be identified by the contractors and BDA by following the due procedure as per the guidelines of IRC 10: 1961 Rev 1989 & MoRTH	CAT plan: involves extensive plantation activities, construction of water recharge structures for improvement of ground water level and soil moisture content	Land Acquisition, R&R Action plan: LA and R&R will be carried upon Preparation of SIA, Process of obtaining Consent, Preliminary Notification for Acquisition, & Preparation of R&R scheme
Aquatic life conservation: Rehabilitation of fish species & introduction of herbivorous fish and fingerlings into lakes	Ecological restoration plan: involves Green belt development, Compensatory afforestation & conservation of schedule-I species	Topsoil management: identification of designated place for top soil storage, stabilization of stockpiles to avoid erosion, temporary drainage facility around stockpiles, embankment & turfing, plantation activities, etc.
OPERATION PHASE MANAGEMENT PLAN		
Noise reduction Management Plan: installation of poly carbonate noise barriers	Road safety, traffic management and risk management plan: Implementation of ITS, Accident emergency medical care, crane services, crash rescue vehicles, patrol vehicles and an emergency response team	Transmission of diseases and its prevention: Creating awareness, Counselling of truck drivers and cleaners and Medical facility upgradation

The total amount estimated for implementation of Environmental Management Plan (EMP) for construction phase is 51.47 Crores (Capital Cost) and operation phase is 4.28 Crores (Capital Cost) along with a recurring cost of 4.77 Crores during Operation Phase. This EMP cost is exclusive of the land acquisition and R&R cost amounting to Rs. 9,318 Cr.

Chapter
1

INTRODUCTION

1.1 EIA & Purpose of the project

Environmental Impact Assessment (EIA) is an effective tool for a planner to integrate the environmental consequences while designing the project. EIA helps to visualize the potential impacts and provide mitigation measures during project life cycle¹.

Bangalore city has 2 existing circular ring roads viz., Inner Ring Road (IRR) of 29 Km length, Outer Ring Road (ORR) of 65 Km length (executed by BDA) with crowded development on either side of the RoW. Hence, further augmentations of these roads are techno-economically not feasible for the growing traffic. In view of this, it is essential to develop an alternative road facility away from ORR for movement of commercial and personalized vehicles entering the city. The city should have a circular ring road beyond ORR to connect all Primary and Secondary roads to reduce traffic congestion on all radial roads. By using the existing access controlled NICE road and to complete the circle of road to fulfill the demands of existing and growing traffic, it is proposed to implement Peripheral Ring Road (PRR) of 73.50 Km with 8 lane configurations to Bangalore city. The purpose of the PRR is to relive the traffic congestion in the metropolitan region and to provide linkage to the radial and arterial roads within the city. This project also aims at connecting new urban nodes outside the city and also provides quick access to BIAL from various parts of the city.

1.2 Project proponent

The Bangalore Development Authority (BDA) came into existence on 16.01.1976 under the BDA Act 1976, a separate act of the State Legislature. The main objectives of the BDA is planning residential projects in the city, roads, providing infrastructure services in the city. The Bangalore Development Authority has also been instrumental in the widening of the city's roads. It has its Registered Office at T. Chowdiah Road, Kumara Park West, Bangalore- 560 020.

M/s Environmental Health & Safety Consultants Private Limited, Bengaluru (Accredited by NABET) is entrusted by BDA, GoK, to carry out the EIA/EMP studies for the proposed project. BDA is the employer and executing agency for the project. The Environmental Clearance for the project was earlier accorded by the Karnataka State Environmental Impact Assessment Authority (KSEIAA) vide letter No.: SEIAA 32 IND 2009 dt: 20.11.2014 (Annexure-1). Further, the Environmental Clearance was challenged at the Hon'ble NGT and after detailed deliberation, Hon'ble NGT in its order dt: 08.02.2019 (Annexure-2) directed BDA to prepare fresh EIA report. Further, BDA approached Hon'ble Supreme Court challenging the orders of Hon'ble NGT. Meanwhile, as per the directions of Hon'ble NGT and without prejudice to the orders of the Hon'ble Supreme Court, fresh application was submitted to SEIAA for issue of ToRs for the project. The project was considered in the 235th SEAC meeting held on 02.12.2019 and ToRs has been issued by SEIAA vide letter No. SEIAA 40 IND 2019 dt: 21.01.2020 (Annexure-3). However, the Supreme Court in its judgment dt: 17.03.2020 (Annexure-4) upheld the orders of the Hon'ble NGT and clarified that the project qualify under 7(f) in the schedule of EIA Notification.

In view of the above, a clarification letter seeking the applicability of General Conditions to the project and whether the Final EIA Report can be submitted to MOEF&CC as per General Conditions

¹<http://envfor.nic.in/divisions/iass/eia/Chapter1.htm>

or to SEIAA as per Hon'ble Supreme Court directions for appraisal and onward reconsideration for issue of EC was submitted to MoEF&CC, GoI on 07.09.2020 (Annexure -5).

Meanwhile, BDA has conducted a physical Public Hearing on 18.08.2020 and a Virtual Public Hearing on 23.09.2020 for the project. Subsequently, the process of conducting public hearing was challenged in the Hon'ble High court of Karnataka vide WP no. 10178/2020. Hon'ble High Court in its order 23.02.2021 directed the KSPCB to conduct the Environmental Public Hearing once again. Copy of the order is enclosed as Annexure-6.

Further, MoEF&CC, GoI vide letter Dt: 04.12.2020 (Annexure -7) informed that further action may be taken by the Project Proponent as per the directions of the Hon'ble Supreme Court of India and in case SEAC/SEIAA are satisfied with the applicability of General Conditions, they may transfer the proposal to Ministry for its appraisal at Central Level in accordance with the provisions of EIA Notification, 2006.

Meanwhile, the Hon'ble High Court in its Order dt: 22.09.2021 (WP No. 10342/2008) also states that the directions issued by the Hon'ble Supreme Court are to be complied with and directed the respondents to comply all the directions issued by the Hon'ble Supreme Court (Annexure-8).

Further, the Hon'ble Supreme Court vide its Judgement dt:20.01.2022 (Annexure-9) clarified that since LA Act has been incorporated into the BDA Act so far as they are applicable, the provisions of 2013 Act are not applicable for the acquisitions made under the BDA Act. Therefore, the Land acquisition will be carried out as per the BDA Act, 1976 (as per the provisions of Land Acquisition Act, 1894). BDA vide Government Order no. UDD 214 MNJ 2018 Bangalore dt: 21.02.2022, the land acquisition activities and compensation process will be carried out as per the Judgement of the Hon'ble Supreme Court or as decided by the Cabinet Ministry during Land Acquisition process.

Further, there is a change in total land requirement for the project from 733 Ha to 1036.51 Ha due to change in length of the project from 65.5 km to 73.5 km due to realignment and inclusion of cloverleaf structures at chainages CH 0+000 km to CH 3+400 km (NICE integration at Tumkur Road), 28+843.36 km to CH 31+896.76 km (Near Bilishivale), CH 37+996.76 km to CH 44+400 km (Near Sigehalli) and CH 60+619.92 km to CH 64+700 km (NICE integration at Hosur Road). Hence, an application seeking amendment to the ToRs was submitted to KSEIAA on 03.02.2022. Subsequently, the Corrigendum to the Terms of References (ToRs) was issued by KSEIAA vide letter No. SEIAA 40 IND 2019 dt: 25.02.2022 (Annexure-10).

Further, as per the directions of the MoEF&CC, GoI vide its letter Dt: 04.12.2020, BDA submitted a request to the SEIAA, Karnataka on 28.07.2022 (Annexure- 11) to transfer the file to MoEF&CC due to applicability of General Conditions for the project.

This EIA report has been prepared as per the guidance manual issued by Ministry of Environment, Forests & Climate Change (MoEF&CC) and Terms of References (ToRs) issued by SEIAA, Karnataka along with IRC/NHA guidelines available. The baseline data collection was carried out from December 2019 to February 2020 (one season) and the EIA report comprises physical, biological and socio-economic components of the existing environment, project specific impact studies (identification, prediction and evaluation) along with the preparation of Environmental Monitoring Programme, Environmental Management Plan (EMP) and budgetary aspects for mitigation of adverse impacts due to the proposed project. Further, additional data collection for ecology and biodiversity and socio-economic studies were carried out for the realignment section of the road in February and March, 2022.

1.3 Brief description of the project and its importance to the region

BDA since 2005-2006 had proposed to take up the development of "Eight lane peripheral Ring Road" connecting Tumakuru Road to Hosur Road forming a closed ring with the existing NICE Road. The Government of Karnataka issued final notification on 29.06.2007 for land acquisition in 67 villages along the alignment. Further, issue of final notification for land acquisition in remaining 5 villages is under progress.

The proposed project involves development of 73.5 km long Peripheral Ring Road (PRR) between Tumakuru Road on West and Hosur Road on East via Ballari Road and Old Madras Road. It integrates with the existing NICE Road. The proposed alignment of PRR will be located at an approximate radial distance of 17 km - 25 km from city centre and acts as a bypass to the city for the long-distance personalized vehicles (cars and cabs) and commercial vehicles (trucks and LCVs). The proposed "Peripheral Ring Road" connects major Highways namely Tumakuru Road (NH-4), Hesaraghatta Road (SH-39), Doddaballapura Road (SH-09), Ballari Road (NH-7), Hennur- Baglur Road (SH-104), OMR (NH-4), Hoskote-Anekal Road (SH-35), Sarjapur Road and Hosur Road (NH-7). The project implementation is planned in three sections namely; from Tumkur road to Bellary road (18.367 km), Bellary Road to OMR (17.956 km) and OMR to Hosur road (28.790 km).

PRR is proposed with 100 m Right of Way. The cross section comprises of divided eight lane main road separated with central median of 13m. Service roads, 10.50 m in width in each direction are provided on either side of main road for local traffic. Main road is access controlled for trucks, buses, LCV and passenger cars. Service road and Main road are separated by built up drain. An exclusive utility corridor is proposed on both side of ROW for accommodating various service utilities. The total land required for the construction of the proposed project is 1036.51 Ha with removal of 1,395 structures. The land acquisition will be carried out as per BDA Act, 1976 (as per the provisions of Land Acquisition Act, 1894).

The project involves diversion of 7.73 Ha of forest land in Sy. No. 59 belonging to Jarakabandekaval RF. Boundary of Bannerghatta National Park and Puttenahalli Bird Conservation Reserve are located at a distance of 7.75 Km and 1.49 Km respectively. The interstate boundary of Tamil Nadu is at a distance of 8.27 Km from the proposed alignment of PRR. Peenya Industrial Area and Jigani-Bommasandra Industrial Area are notified as severely polluted area and critically polluted areas by CPCB and are located at a distance of 3.4 Km and 4 km respectively from the proposed PRR alignment. The total cost of the project is Rs 14,934 Crores and the administrative approval for the project has been issued vide letter dt: 21.02.2022 (Annexure-12). The project is very significant to Bangalore city to relieve the already overcrowded traffic within the city. The economic activities like commercial ventures, infrastructure development, IT, etc will certainly improve consequent to development of PRR.

1.4 Applicability of various legislations

Sl.No	Name of the Act/Rule	Applicability
A. ENVIRONMENT		
1	Environment (Protection) Act, 1986 – EIA Notification, 2006 and its amendments	<p>a) According to EIA Notification, 2006 and its subsequent amendments, all New National Highways and Expansion of National Highways greater than 100 Km involving additional RoW / Land Acquisition greater than 40 m on existing alignment and 60 m on realignment / bypasses are considered as category 'A' project. Similarly, all new State Highway projects and state highway projects in hilly terrain above 1000 m AMSL and or ecologically sensitive areas are considered as category 'B' projects. Further, expressways are considered as highways and General conditions of the notification shall also be applicable.</p> <p>b) Due to lack of clarity regarding the definition of 'ring road' in the schedule of EIA Notification, 2006 and its amendments and the project was previously appraised by the SEAC and SEIAA, fresh application was submitted to SEIAA towards updating the deficiencies found on EIA/EMP report.</p> <p>c) As per the orders of Hon'ble Supreme Court dt:17.03.2020, PRR is an "expressway" which falls under Schedule 7(f) of the EIA Notification, 2006 and its subsequent amendments.</p> <p>d) General conditions are applicable to this project in view of presence of critically polluted areas notified by CPCB within 5 Km from the proposed PRR.</p> <p>e) Keeping in view of the facts and after detailed deliberation on sl.no (b) mentioned above by the Hon'ble Supreme Court, the directions has been issued for preparation of fresh EIA report and submit to SEAC for appraisal and SEIAA for issue of EC again since the earlier EC was issued by the SEIAA. Further, it has also issued directions to SEIAA to re-verify the earlier deficiencies found in the EIA report based on which EC was stayed (J, Para 83 (i&v) Page-68 of the order).</p> <p>f) In view of the above, a clarification letter seeking the applicability of General Conditions to the project and whether the</p>

Sl.No	Name of the Act/Rule	Applicability
		<p>Final EIA Report can be submitted to MOEF&CC as per General Conditions or to SEIAA as per Hon'ble Supreme Court directions for appraisal and onward reconsideration for issue of EC was submitted to MoEF&CC, Gol on 07.09.2020.</p> <p>g) Further, MoEF&CC, Gol vide letter Dt: 04.12.2020 (Annexure -7) informed that further action may be taken by the Project Proponent as per the directions of the Hon'ble Supreme Court of India and in case SEAC/SEIAA are satisfied with the applicability of General Conditions, they may transfer the proposal to Ministry for its appraisal at Central Level in accordance with the provisions of EIA Notification, 2006. Thus, the project is categorised under 7(f) of the schedule of the EIA Notification, 2006 and falls under 'A' category due to applicability of General Conditions.</p> <p>h) Further, as per the directions of the MoEF&CC, Gol vide its letter Dt: 04.12.2020, BDA submitted a request to the SEIAA, Karnataka on 28.07.2022 (Annexure- 11) to transfer the file to MoEF&CC due to applicability of General Conditions for the project.</p> <p>Hence, Final EIA Report to be submitted to MOEF&CC for appraisal and issue of EC.</p>
B. POLLUTION		
2	The Air (Prevention and Control of Pollution) Act, 1981 & KSPCB Categorization	New highway construction project is re-categorized as 'Orange under Non-industrial operations' by KSPCB vide addendum-6 dt: 29.06.2020.
3	The Water (Prevention and Control of Pollution) Act, 1974	
4	The Noise Pollution (Regulation and Control) Rules, 2000 & its amendments	<ul style="list-style-type: none"> As per Clause 3(3), the State Government shall take measures for abatement of noise including noise emanating from vehicular movements, (blowing of horns, bursting of sound emitting fire crackers, use of loud speakers or public address system and sound producing instruments) and ensure that the existing noise levels do not exceed the standards specified under these rules. Similarly, as per Clause 5A, sound emitting construction equipment's shall not be used or operated during night time in residential

Sl.No	Name of the Act/Rule	Applicability
		areas and silence zones. While entrusting the Contractors for the project construction activities, provisions of this act shall be made mandatory in the bid document to control noise pollution.
5	Hazardous and Other Wastes (Management, Handling and Transboundary Movement) Rules, 2016	<ul style="list-style-type: none"> As per Clauses 12(4), 12(6) and 12(7), the import and export of hazardous and other wastes (Bituminous material-asphalt waste, tar) may be allowed to users with the permission from KSPCB. Hazardous waste Authorization has to be obtained from KSPCB. Temporary DG sets will be used during construction phase. Used Oil needs to be handled scientifically and disposed to KSPCB Authorized reproprocessors. For this, Hazardous waste Authorization to be obtained from KSPCB.
6	Central Motor Vehicles Act, 1988	As per Clause 190(2), any person who drives or causes or allows to be driven, in any public place a motor vehicle shall not violates the standards prescribed in relation to road safety, control of noise and air pollution. While entrusting the Contractors for the project construction activities, provisions of this act shall be made mandatory in the bid document control vehicular air & noise pollution.
7	Critically Polluted Areas notified by Central Pollution Control Board (CPCB)	As per the CEPI (Comprehensive Environmental Pollution Index) scores monitored by CPCB, Peenya Industrial area (CEPI Score-65.11) and Jigani Bommasandra Industrial area (CEPI Score 70.99) are declared as 'severely polluted' and 'critically polluted' areas respectively. These industrial areas are located at a distance of 3.4 Km and 4 Km respectively from the nearest proposed alignment.
C. FOREST & WILDLIFE		
8	The Forest (Conservation) Act, 1980 & MOEF&CC OM dt: 20.03.2013	The proposed PRR project involves diversion of 7.73 Ha of forest land in Sy. No. 59 belonging to Jarakabandekaval RF and attracts the provisions of the Forest (Conservation) Act, 1980. Hence, application for diversion of forest land was submitted on 08.06.2020 in MOEF&CC online portal vide online proposal no. FP/KA/ROAD/45790/2020 (Annexure-13) for issue of Forest Clearance. Upon receiving the application, Nodal officer of F(C)A, 1980 at KFD shall verify the correctness of application and upon acceptance the same shall be forwarded to

Sl.No	Name of the Act/Rule	Applicability
		<p>concerned DCF for site verification and recommendation. Through proper channel, the application will be forwarded to Regional Office, MoEF&CC, Bangalore for placing before REC for Stage-I FC recommendation.</p> <p>As per provisions of the OM dt: 20.03.2013, environmental clearance to the linear projects can be granted subject to declaration that the project can be implemented even if they deny forest clearance with the other alternatives while submitting the forest clearance application. Details of such alternatives shall also be provided at the time of submission of application for FC. However, as per the Hon'ble Supreme Court judgement dt: 17.03.2020, forest clearance shall be submitted to EAC while granting the EC.</p>
9	The Wildlife (Protection) Act, 1972	<p>The PRR alignment is located at a distance of 7.75 km from the boundary of Bannerghatta National Park for which the final ESZ Notification has been issued by MoEF&CC on 11.03.2020. Therefore, as per the item No.4(ii) of MoEF&CC OM dt: 08.08.2019 proposals involving developmental activity/project located outside the stipulated boundary limit of notified ESZ and located within 10 km of National Park/ Wildlife Sanctuary, prior clearance from Standing Committee of the National Board for Wildlife (SCNBWL) is not applicable.</p> <p>Similarly, Puttenahalli Bird Conservation Reserve is located at a distance of 1.49 km from the proposed PRR alignment. However, ESZ guidelines are not applicable for the Conservation Reserves.</p>
10	The Karnataka Preservation of Trees Act, 1976	<p>36,824 no. of trees are falling within the 100 m RoW of the alignment. Out of which, there is a possibility of retaining 4,649 trees within the green space (5 m x 2) within RoW. As per the Clause 8 (3)-(vii) of the rules, if the number of tree felling is more than 50 that are necessitated for any public purpose like road widening, construction of road, canal, tanks, buildings etc., permission is issued after issue of public notice to invite objections from the public and the same is considered by the Tree Officer and Tree Expert Committee of Karnataka Forest Department.</p>
11	Biological Diversity Act, 2002	<p>Biological Diversity Act, 2002 in general aims at conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the use of biological</p>

Sl.No	Name of the Act/Rule	Applicability
		resources and Intellectual Property Rights (IPR) related matters. However, since the act specifies about 'equitable benefit sharing' the trees proposed on either side of the road may be useful under People's Biodiversity Register (PBR). Hence, plantation of 3,21,750 trees all along the green space of the alignment will be carried out.
D. WETLANDS/LAKES		
12	Wetlands (Conservation and Management) Rules, 2017	As per this Rules, conversion of wetlands for non-wetland uses including any kind of encroachments are prohibited. Hence, to avoid the construction in lake bed areas, flyovers are proposed along 6 lakes (Tank at Jarakabande Forest, Chinnaganahalli lake, Chikkabanahalli lake, Gunjur lake, Chikkatogur Lake and Thirumenahalli lake) to minimize the impact on wetlands. Necessary permission for the same will be obtained from the authority.
13	Supreme Court order dt: 05.03.2019 w.r.t lakes/wetlands in CA No. 5016 of 2016	As per the Hon'ble Supreme Court order dt:05.03.2019, it was directed to maintain a distance of 30 m from the periphery of the water body for development of green belt. Accordingly, buffer of minimum 30 m maintained from the boundary of alignment to lake boundary. Further, flyovers are proposed along 6 lakes to minimize the impact on lakes. Necessary permission for the same will be obtained from the authority.
14	The Karnataka Lake Conservation and Development Authority Act, 2014	As per Clause 14(6) of the Act, 2014, construction of roads, bridges and likewise other structures within the lake area including the tank bund are prohibited. Hence, flyovers are proposed along 6 lakes to minimize the impact on lakes. Necessary permission for the same will be obtained from the authority.
15	Govt. of Karnataka notification regarding protection and conservation of Thippagondanahalli (TG Halli) Reservoir catchment area dt: 18.11.2003, 12.01.2004 and on 20.07.2019.	<ul style="list-style-type: none"> This notification regulates the restriction of activities within the catchment area especially on continuous water pollution causing quarrying and industries. About 20.9 km of the proposed alignment passes through the Thippagondanahalli Reservoir catchment area notification where Kumudavathy and Arkavathy river sub catchment exists. There are no restrictions regarding the construction of roads or linear alignments in the said notification. The project involves removal of 13,355 trees (6242 other trees and 7113 <i>Eucalyptus</i> sp.) in the catchment area and hence CAT plan will be proposed

Sl.No	Name of the Act/Rule	Applicability
		to mitigate the impacts, conservation and protection of TG Halli Catchment.
E. SOCIO-ECONOMICS		
16	The Ancient Monuments and Archaeological Sites and Remains Act, 1958	As per Clause 19(1), no construction activities such as any building within the protected area or carry on any mining, quarrying, excavating, blasting or any operation of a like nature in such area, or utilize such area or any part thereof in any other manner shall be carried out without the permission of the Central Government. In such cases, prior permission shall be sought from the Central Government. Tipu Sultan's Palace and old dungeon Fort & Gates are located at a distance of 14.7 km from the proposed PRR alignment and no construction activities are proposed in or around the monuments/archaeological sites. Therefore, the provisions of this Act are not applicable to the project.
F. LEGISLATIVE		
17	National Green Tribunal (NGT) Act, 2010	<p>The Environmental Clearance for the project was accorded earlier from KSEIAA on 20.11.2014 vide letter No. SEIAA 32 IND 2009. However, the clearance was challenged under the provisions of the act. The Principal Bench of Hon'ble NGT made the following observations in its order dt:08.02.2019;</p> <ul style="list-style-type: none"> • Primary data was more than three years prior to the EIA report. • There are omissions in the EIA report with regard to data of forest land as well as the provisions of revised Master Plan, 2015. • Thippagondanahalli (T.G. Halli) Reservoir Catchment area has been suppressed in the EIA report. • Green Cover particulars have been overlooked. • Proximity of area to the Petroleum pipelines and land earmarked for Petroleum pipelines overlaps the project. • Stage -I forest clearance to be obtained. • The EIA consultant was not accredited. • Public Hearing was not proper which vitiated the decision by the SEAC. <p>"4. ... It will, thus, be in the interest of justice that a fresh rapid EIA is conducted. If the project is found viable, after incorporating due abatement measures, including the suggestions of the appellant, the same can be taken up without further</p>

Sl.No	Name of the Act/Rule	Applicability
		delay. It is made clear that the project proponent will not proceed on the basis of the impugned Environmental Clearance”.
18	Supreme Court Order dt: 17.03.2020 in Civil Appeal No(s).2566/2019	<p>The order of the Hon’ble NGT dt: 08.02.2019 was challenged by the BDA in the Hon’ble Supreme Court. After detailed deliberations, Hon’ble Supreme Court vide its Judgement dt:17.03.2020 provided the following directions;</p> <ul style="list-style-type: none"> • The appellant is directed to conduct a fresh rapid EIA for the proposed PRR project; • The appellant shall, for the purpose of conducting the rapid EIA, hire a sector-specific accredited EIA consultant; • The appellant shall have due regard to the various deficiencies noted in the present judgment as well as ensure that additional precautions are taken to account for the prevailing state of the environment; • The appellant shall ensure that the requisite clearances under various enactments have been obtained and submitted to the SEAC prior to the consideration by it of the information submitted by the appellant in accordance with the OMs issued by the MoEF-CC from time to time; • The SEAC shall thereafter assess the rapid EIA report and other information submitted to it by the appellant in accordance with the role assigned to it under the 2006 Notification. If it is of the opinion that the appellant has complied with the 2006 Notification as well as the directions issued by this Court, only then shall it recommend to the SEIAA the grant of EC for the proposed project. The SEAC and the SEIAA would lay down appropriate conditions concerning air, water, noise, land, biological and socioeconomic environment and other conditions it deems fit; and • The appellant will consult the requisite authority to ensure that no potential damage is caused by the project to the petroleum pipelines over which the proposed road may be constructed. <p>All the above directions will be complied and implemented by BDA.</p>
19	Hon’ble High Court Order dt:	Lt. Col. P R Rai & others Vs State of Karnataka

Sl.No	Name of the Act/Rule	Applicability
	22.09.2021 in WP No. 10342/2008	questioned the implementation of the project. However, the Hon'ble High Court Order states as follows; "3....The directions issued by the Hon'ble Supreme Court are to be complied with and therefore, the present petition stands disposed of with a direction to the respondents to comply all the directions issued by the Hon'ble Supreme Court."
20	High Court Order dt: 23.02.2021 in Writ Petition No(s).10178/2020	<p>The Draft EIAEMP Report was prepared and submitted to KSPCB on 22.06.2020. Further, all the requisite project documents were circulated to all the stakeholders on 24.07.2020.</p> <p>Subsequently, the Environmental Public Consultation was conducted at "Nityotsava Wedding and Convention Hall, Singanayakahalli Village, Yalahanka Taluk, Bangalore Urban District" on 18.08.2020 as per the provisions of the EIA Notifications, 2006 and its subsequent amendments. Keeping in view of the present pandemic COVID-19 situation, the Environmental Public Hearing was conducted as per the guidelines issued by the BBMP with necessary precautionary measures such as thermal screening, distribution of masks, face shields, gloves, utilization of hand sanitizers, seating arrangements with not more than 50 seats at two separate platforms with social distancing.</p> <p>Considering the pandemic situation, a Virtual Public Hearing was also conducted on 23.09.2020 through Zoom platform, so that the public can participate in the meeting and give their submissions from their homes. The virtual Environmental Public Hearing was also successfully conducted with more than 300 participants.</p> <p>The validity of the Virtual Public Hearing conducted through ZOOM platform on 23.09.2020 was challenged by the public at the Hon'ble High Court of Karnataka. After detailed deliberations, the Hon'ble High Court of Karnataka vide its Judgement dt:23.02.2021 disposed off the case with a direction to conduct a fresh public hearing in the physical form.</p>
21	Hon'ble Supreme Court Judgement dt: 20.01.2022 in Miscellaneous Application	The Hon'ble Supreme Court vide its Judgement dt:20.01.2022 clarified that since LA Act has been incorporated into the BDA Act so far as they are

Sl.No	Name of the Act/Rule	Applicability
	No(s).1614-1616 of 2019 in Miscellaneous Application No(s).1346-1348 of 2019 in Civil Appeal No(s).7661-7663 of 2018	applicable, the provisions of 2013 Act are not applicable for the acquisitions made under the BDA Act. Thus, BDA vide Government Order no. UDD 214 MNJ 2018 Bangalore dt: 21.02.2022, the land acquisition activities and compensation process will be carried out as per the Judgement of the Hon'ble Supreme Court or as decided by the Cabinet Ministry during Land Acquisition process.
G. CONSTRUCTION		
22	The Mining Act, 1952	The mining act notifies safe mining activities. Sand, minerals and construction materials required for construction activities shall be procured from Government authorized approved quarry sites.
23	The Building And Other Construction Workers (Regulation of Employment And Conditions of Service) Act, 1996	Chapter VI of this act aims at benefitting the labourers/workers w.r.t. wages, working hours, drinking water facilities, toilet facilities, accommodation, crèches, first aid/medical facilities, etc. While entrusting the Contractors for the project construction activities, provisions of this act shall be made mandatory in the bid document.
24	The Explosives Act, 1884 and the Explosives Rules, 2008	As per Clause 6 & 7, no person shall manufacture, import, export, transport, possess for sale or use an explosive without prior permission. Blasting activities during the construction phase may require use of explosives. Necessary permissions from the Competent Authority under the act will be obtained.
25	Construction and Demolition Waste Management Rules, 2016	As per Clause 4(1), every waste generator shall be responsible for collection, segregation of concrete, soil and others and storage of construction and demolition waste generated, as directed or notified by the concerned local authority in accordance with these rules. All the C&D wastes shall be segregated, stored and disposed off as per the rules. The project requires demolition of 1,395 Nos. of structures. Hence, provisions of this notification are applicable.
26	Fly ash Notification, 2009 and its subsequent amendments	There are 9 Thermal Power Plants located within an aerial distance of 300 km from the proposed alignment. Therefore, as per the directions of MOEF&CC, fly ash will be procured from these Thermal Power Plants for construction purposes by engaging MoU with Energy Dept., GoK. Details provided in Chapter-2.
27	The Karnataka Regulation of Stone crushers Act, 2011	As per Clause 6 and 7, the stone crushers shall not be established outside the safer zone and the license for Govt. projects may be granted on fulfilling the provisions of Air (Prevention and

Sl.No	Name of the Act/Rule	Applicability
		Control of pollution) Act, 1981 and Environmental Protection Act, 1986 and subsequent rules. Necessary permissions shall be obtained from the competent authority for establishing stone crushers and stone crushing activities.

1.5 Scope of EIA

The EIA, the objective of the present study is as follows:

- Understanding the status of Physical, biological and socio-economic aspects of the environment.
- Identification, prediction and evaluation of impacts due to project activities on various environmental components during the Construction and Operational phases of the project.
- Providing Mitigation measures and accordingly formulating Environmental Management Plan (EMP).
- Providing post-project environmental monitoring programme to be implemented by BDA.

1.6 Components of EIA

The generic structure of the EIA/EMP report has been followed as per the EIA Notification, 2006. However, the Environmental cost benefit analysis was not recommended by the SEAC, Karnataka during scoping stage and was not included in the EIA/EMP report. The structure of the EIA/EMP report is as given below;

1. Introduction
2. Project Description
3. Baseline Environmental Scenario
4. Anticipated Environmental Impacts and Mitigation Measures
5. Analysis of Alternatives (Technology and Site)
6. Environmental Monitoring Program
7. Additional Studies - Public Consultation, Risk Assessment, Social Impact Assessment, R&R Action Plans
8. Project Benefits
9. Environmental Cost Benefit Analysis
10. Environmental Management Plan
11. Summary & Conclusion
12. Disclosure of Consultants engaged
13. Corporate Environmental Responsibility (CER)
14. Compliance to Hon'ble NGT and Supreme Court orders
15. Compliance to Terms of References (ToRs)
16. Photographs

1.7 Approach and methodology

The EIA/EMP report has been prepared as per requirements of the EIA Notification, 2006 and its subsequent amendments of MoEF&CC under the Environment (Protection) Act, 1986 and the ToRs issued for the project. Further, various IRC guidelines and other secondary literature were referred while preparing the report. Brief methodology adopted for preparation of EIA/EMP report and obtaining Environmental Clearance for the proposed project is as follows;

Table 1.1: Methodology adopted for preparation of EIA studies

Sl. No.	Components	Source
1	Secondary data collection	<ul style="list-style-type: none"> MoEF&CC guidelines on preparing EIA report for Highways Central Ground Water Board reports Karnataka State Natural Disaster Monitoring Centre Reports Survey of India Toposheets National Institute of Disaster Management, GoI Published Papers Geological Survey of India data Indian Space Research Organization data National Remote Sensing Centre data Forest Dept., working plans Indian Meteorological data (IMD) Water Resources Information System Mines and Geology Dept., GoK KSPCB data on Air, Water, Noise and Soil CPCB Guidelines PMGSY Environmental Code of Practice IRC Guidelines
2	Primary data collection	Methodology
2.1	Ambient Air Quality	<ul style="list-style-type: none"> Collection of weather monitoring data Selection of AAQM locations as per CPCB guidelines AAQM monitoring as per NAAQ standards - 2009, CPCB Interpretation of results as per AQI Index, CPCB Impacts and Mitigation Measures
2.2	Ambient Noise Level	<ul style="list-style-type: none"> Selection of Ambient Noise level monitoring locations as per Protocol for Ambient Noise Level Monitoring, CPCB Ambient Noise level monitoring Interpretation of results as per Noise (Regulation and Control) rules - 2000, CPCB Identification of impacts and mitigation measures
2.3	Hydrology and Geology	<ul style="list-style-type: none"> Collection of the relevant data from the reports and maps of Central Ground Water Board (CGWB) Geological Survey of India (GSI), other Institutions and Departments. Identification of Inter- related and Inter - dependent key factors that play vital role in the occurrence of ground water its quality and potential. Identification of surface water resources in

Sl. No.	Components	Source
		<p>the project area.</p> <ul style="list-style-type: none"> Assess the ground water resource potential in the project area. Identification of site-specific environmental issues and mitigation measures and Report preparation.
2.4	Surface and Groundwater Quality	<ul style="list-style-type: none"> Identification of sampling locations Collection, preservation and Transportation of samples as per CPCB guidelines Analysis of water samples as per BIS and APHA guidelines Interpretation of results as per CPCB and BIS Identification of impacts and mitigation measures
2.5	Soil characteristics	<ul style="list-style-type: none"> Identification of Soil types, status, crops and cropping pattern in the study area Identification of soil sampling locations based on geology and soil maps Collection and analysis of soil samples as per manual of Food and Agricultural Organization and Soil manual of Department of Agriculture and co-operation, Ministry of Agriculture & Farmers Welfare, Gol. Interpretation of results Identification of impacts and mitigation measures
2.6	Land use assessment	<ul style="list-style-type: none"> Procurement of satellite imageries from NRSC Processing of satellite imageries by using ERDAS and Arc GIS and other analytical tools for generation of land use and land cover analysis of the study area Preparation of thematic maps Practical Manual for hands on training/experiential learning released from UAS, Bengaluru, AISS & LU and GSI. Identification of impacts and mitigation measures
2.7	Ecology and Biodiversity (Terrestrial)	<ul style="list-style-type: none"> Discussion with forest officials and local people Tree enumeration all along the proposed alignment. Identification of sampling locations Quadrant and line transect method for collection of flora Transect method for collection of fauna and point count method for collection of avi - fauna data Identification of Conservation status of flora

Sl. No.	Components	Source
		<p>and fauna by using IUCN, BSI and wildlife schedules</p> <ul style="list-style-type: none"> Assessment of Phyto - sociological parameters - frequency, density, species richness, species diversity Interpretation of results Identification of impacts and mitigation measures
2.8	Ecology and Biodiversity (Aquatic)	<ul style="list-style-type: none"> Collection of water samples for Physico - chemical analysis Collection of samples by using plankton net. The collected samples were fixed in 5% Formaldehyde solution and subjected to qualitative and quantitative analysis by using Microscope and Sedge wick - Rafter plankton counting cell. Collection of samples for littoral fauna by operating 'D' frame net and sieved through No.40 sieve and fixed in 5% Formaldehyde solution followed by qualitative and quantitative analysis Fishing operation with the help of local fishermen and visiting fish markets Discussion with fishermen Identification of conservation status of fishes by using IUCN Interpretation of results Identification of impacts and mitigation measures
2.9	Socio-economic studies	<ul style="list-style-type: none"> Delineation of Demographic profile, Literacy, Occupation status, infrastructure facilities available, health status, religion and caste, cultural properties of the study area Use of PRA Technique i.e Questionnaire survey and focal group discussions of PAPs Identification of structures all along the proposed alignment Prediction of impacts on land acquisition Conducting Environmental Public Hearing at site Compliance to observations raised during EPH
2.10	Risk Assessment	<ul style="list-style-type: none"> Identification of risk and hazards associated with the project activities during Construction and Operation phase. Risk analysis associated with accidents & the presence of gas pipelines near the proposed alignment Identification of impacts and mitigation

Sl. No.	Components	Source
		measures
3	Impact identification and prediction	<ul style="list-style-type: none"> ▪ Prediction of Impacts on Air quality by using computer programmed CALINE1.1. ▪ Prediction of Noise level by using dhvani pro model. ▪ Evaluation of impacts by using Leopold matrix method
4	Project benefits	Better connectivity for the commuters accessing various national and state highways, decongestion of traffic inside the Bangalore city, provide linkage to internal arterial roads, development of new urban roads, reduction in accidents, boost economic development, direct and indirect employment opportunities, provides better access to various places, improvement in quality of life, socio-economic development, etc.
5	Environmental Management Plan	Pre-construction activities management, Construction phase management viz., Top soil management, borrow area management, Land Acquisition and Rehabilitation Action Plan, Catchment Area Treatment Plan, Ecological Restoration Plan, Operation Phase Management viz., Noise reduction plan, Road safety and Traffic Management, Transmission of diseases management, Institutional Mechanism for implementation of EIA and EMP, EMP Cost
6	Environmental Public Hearing	Submission of Draft EIA report along with Executive Summary in English and Kannada to Karnataka State Pollution Control Board (KSPCB), Finalization of date of EPH by RO, KSPCB with DC, Bangalore (Urban) District. Paper Advertisements in National and regional daily newspapers, Local Paper advertisements, preparation of presentation of draft EIA report in Kannada, Presentation to public regarding the project in Kannada, Issue of video recording and proceedings by KSPCB.
7	Issue of Environmental Clearance	Preparation of compliance to proceedings of Environmental Public Hearing, finalizing the draft EIA report, uploading Final EIA Report to MoEF&CC website, circulation of project documents to EAC members, preparation of Final EIA presentation, presentation to EAC, recommendation by EAC & issue of EC by MOEF&CC, Govt. of India.

1.8 Environmental Screening

1.8.1 Project Influence area

Assessment of the baseline environmental status was made based on the primary baseline data collection in the RoW and the area falling within 500 meters on the either side of the RoW along with secondary data collection within an aerial distance of 15 km.

1.8.2 Weightage / Ranking system:

Relevant environmental parameters with regard to physical, biological and socio-cultural components of the environment was collected and analyzed. The identified sub-parameters have been assigned weightages and each project corridor has been assessed based on these evaluation criteria as per World Bank screening methodology². The weightage and ranking system considered is as given below;

Table 1.2: Natural Environment

Environmental Attribute	Total Weight	Scoring Criteria		Score	Screening result w.r.t PRR
Topography	4	Plains	-	1	1
		Rolling terrain	-	2	
		Flood plains/coastal belt	-	3	
		Hilly/mountainous terrain	-	4	
Vulnerability to natural hazards (such as floods, cyclones, cloud burst, landslide, subsidence, earthquake etc.)	4	Not prone at all	-	1	2
		Rare occurrence	-	2	
		Prone to natural disasters/risks	-	3	
		Highly prone to natural disasters (regular occurrence)	-	4	
Surface water resources	5	Number (average) of water bodies per km (rivers, canals, reservoirs, lakes and ponds) – Crossings as well as water bodies within 500 mts on either side of the road	5 or less	1	5
			6 to 10	2	
			11 to 15	3	
			16 to 20	4	
			21 or more	5	
Drainage Conditions	5	Over-topping and/or water logging within 250 mts. on either side of the sub-project road (average number of such instances per km)	2 or less	1	1
			3 to 4	2	
			5 to 6	3	
			6 to 7	4	
			7 or more	5	
Ground water resources	4	Is ground water availability/extraction an issue in the sub-project blocks?	Yes*	4	0
			No	0	
Materials	4	Availability of stone quarries	Within 50 km	1	1

² <https://web.worldbank.org/archive/website00528/WEB/PDF/GUIDELIN.PDF>

Environmental Attribute	Total Weight	Scoring Criteria	Score	Screening result w.r.t PRR
Availability		50 to 100 km	2	
		100 to 200 km	3	
		More than 200 km	4	
Soil Erosion	4	Is soil erosion an issue in/along the sub-project road?	Not at all	1
			To some extent	
			Critical	
			Very critical	
Total	30	Screening result Score		11

Table 1.3: Biological Environment

Environmental Attribute	Total Weight	Scoring Criteria	Score	Screening result w.r.t PRR
Designated protected area	10	Presence of designated protected areas within 15 km from the proposed sub project location boundary	Yes	10
			No	
Wildlife habitats (including birds, aquatic species)	6	Occurrence outside the designated protected areas from the proposed sub project location boundary	Within 5 km	6
			5 to 10 km	
			10 km or more	
Migratory route / crossing of wild animals and birds (outside designated protected areas)	6	Within 5 km from the proposed sub project location boundary	Yes	0
			No	
Reserve Forests (RFs)	5	Presence within 500 m from the proposed sub project	Yes	5
			No	
Protected or other Forests	5	Length of forest along the road with in 250 mts	< 5km	2
			5 to 10km	
			10 to 15 km	
			15 to 20 km	
			20 km more	
Green Tunnel	4	Length of green Tunnel within 30 mts (on either side) along the road	2 km or less	0
			2 to 5 km	
			5 to 10 km	
			10 km or more	
Tree in the ROW	4	Number of trees likely to be affected	Up to 1000	4
			1000 to 2000	
			2000 to 4000	

Environmental Attribute	Total Weight	Scoring Criteria	Score	Screening result w.r.t PRR
		> 4000	4	
Total	40	Screening result Score		27

Table 1.4: Socio- Economic Environment

Environmental Attribute	Total Weight	Scoring Criteria		Score	Screening result w.r.t PRR
Settlement	5	Total length of settlement (both town and villages abutting the road corridors)	10 km or less	1	5
			10 to 20 km	2	
			20 to 30 km	3	
			30 to 40 km	4	
			> 40 km	5	
Drinking water sources	4	Total number of drinking water sources (wells, hand pumps, community water ponds, /taps etc.) within the ROW	10 or less	1	4
			11 to 20	2	
			21 to 30	3	
			31 or more	4	
Sensitive Receptors	5	Number of sensitive receptors within 50 mts on either of the alignment such as (educational and health facilities)	10 or less	1	2
			11 to 20	2	
			21 to 30	3	
			31 to 40	4	
			> 41	5	
Religious Structures	4	Number (total) of religious structures (Temple, shrine, mosques, church, gurudwara) with in ROW	10 or less	1	1
			11 to 20	2	
			21 to 30	3	
			>31	4	
Cultural Properties	4	Number (total) of cultural properties (protected / un protected archaeological monuments) with in 500 mts from the alignment	5 or less	1	1
			6 to 10	2	
			11 to 15	3	
			16 to 20	4	
			21 or more	5	
Market place	4	Number (total) of weekly market places / hats, grain fruits/ vegetable/ fish/ cattle market	5 or less	1	4
			6 to 10	2	
			11 to 15	3	
			> 15	4	

Environmental Attribute	Total Weight	Scoring Criteria	Score	Screening result w.r.t PRR
Common Property resources (CPR)	4	Number (total) of CPRs (pastures/ gauchar land, seating area of the community, cremation / burial ground,) within / along ROW	5 or less	4
			6 to 10	
			11 to 15	
			> 15	
Total	30	Screening result Score		21

Based on score obtained by various environmental attributes the impacts will be categorized in to the following categories. The criteria of categorization considered is as follows;

Table 1.5: Categorization of Environmental Impacts

Sl. No.	Impact Category	Score Limit
1	Low	< 30%
2	Medium	30 - 50 %
3	High	50 - 80 %
4	Very High	> 80 %

Total weightage wise scoring of the project is 59. Based on score obtained by various environmental attributes the impacts will be categorized as **High Category**.

Chapter
2

PROJECT DESCRIPTION

2.1 Introduction

Bangalore Metropolitan Region comprising of 3 districts namely Bangalore Urban, Bangalore Rural and Ramanagara with an area of 8005 Sq.Km. (Revised Structure Plan for BMR 2031, BMRDA). The project covering the length of 73.5 Km is a new / green field project proposed in Bangalore Urban District to cater the ever growing demands of Traffic in the metropolitan region and connecting all major National/State highways for ease of traffic flow. The project will connect the existing NICE road from Tumakuru Road to Hosur Road and thereby completes the full circle of road network to Bangalore City. The proposed road is designed based on the guidelines and specifications of Indian Road Congress (IRC) and Indian Highway Capacity Manual.

2.2 Existing Scenario and Need for the project

Bangalore city has 2 existing circular ring roads viz., Inner Ring Road of 29 Km length, Outer Ring Road of 65 Km length (executed by BDA) with crowded development on either side of the RoW. Hence, further augmentations of these roads are techno-economically not feasible for the growing traffic. Further, NHAI has implemented elevated roads in Bangalore city viz., From Silk Board Junction on ORR towards Hosur (NH-7), from Gorguntepalya junction on ORR towards Tumakuru (NH-4) and on Ballari Road towards BIAL. The elevated roads were helpful in increasing the roadway capacity on existing roads beyond ORR. However, the traffic on elevated roads shall pass through existing ORR and its interconnecting roads within the city, which are already overcrowded. Map showing the existing roads and PRR is given below (Fig-2.1& 2.2).

According to BDA Master Plan, 2015, PRR was part of the Plan to decongest the city roads. However, due to various reasons, the project was not grounded. Further, according to Master Plan, 2031 (draft), Bangalore is home for more than 11 Million people with more than 100 Lakh trips/day. Presently, the city operates 6000 BMTC buses which are expected to increase to 15000 by 2031. The journey speed has reduced to 11 Kmph in 2015 from 18 Kmph in 2008 and this may further reduce due to increase in traffic. As per the report, the vehicular traffic may increase three times and the road network may severely congest in the city. It was also mentioned in section 11.6.1 of the Vol. (3) of the Master Plan, 2031, PRR is critical to Bangalore Metropolitan Area (BMA).

In view of this, it is essential to develop an alternative road facility away from ORR for movement of commercial and personalized vehicles entering the city. The city should have a circular ring road beyond ORR to connect all Primary and Secondary roads to reduce traffic congestion on all radial roads. Government through NICE has implemented 45 Km 4 lane divided road between Hosur Road (NH-7) and Tumakuru Road (NH-4). This is a toll road with 100 m RoW. The commercial vehicles which are not allowed in ORR and many personalized vehicles are using this road.

By using the existing access controlled NICE road and to complete the circle of road to fulfill the demands of existing and growing traffic, it is proposed to implement Peripheral Ring Road (PRR) of 73.5 Km with 8 lane configurations to Bangalore city. The primary objectives of the PRR are to relieve the traffic congestion in the metropolitan region and to provide linkage to the radial and arterial roads within the city. This project also aims at connecting new urban nodes outside the city and also provides quick access to BIAL from various parts of the city.

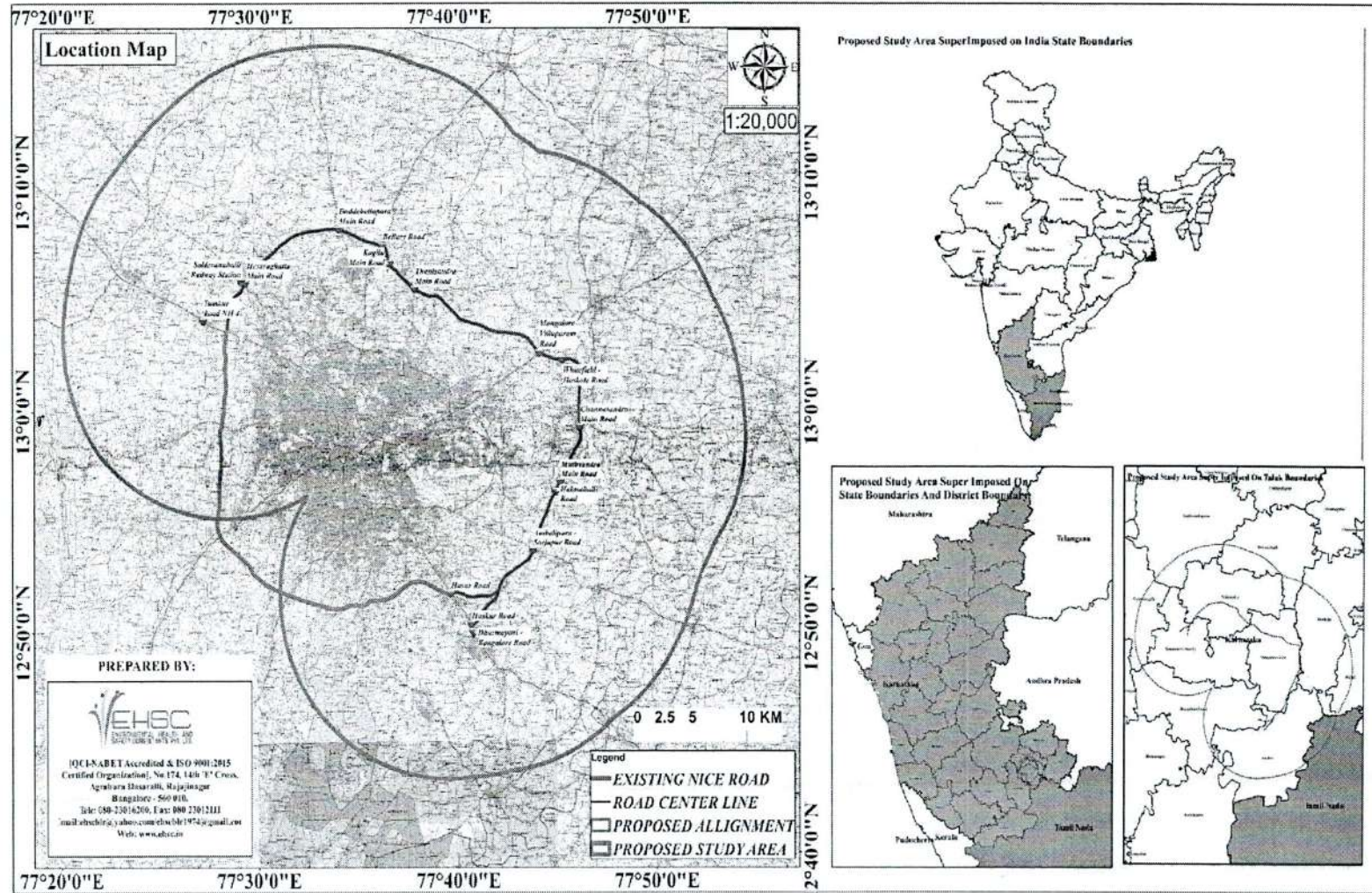


Fig 2.1: Map showing existing NICE Road and proposed PRR alignment on SOI Toposheet

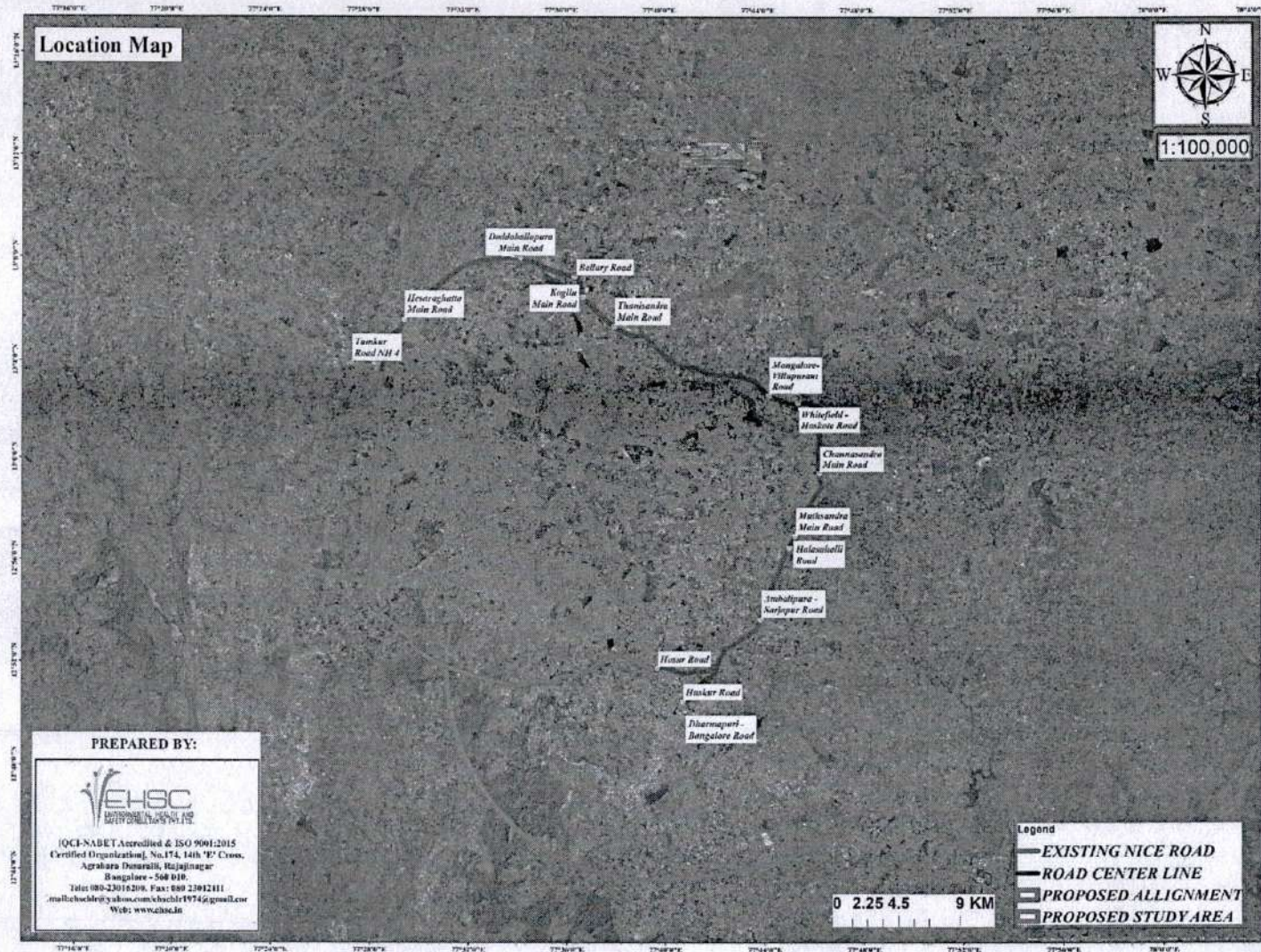


Fig 2.2: Google view showing PRR alignment& existing NICE road

2.3 Traffic Analysis and Forecasts

While preparing the DPR, detailed traffic surveys were conducted by the DPR Consultants between 15-12-2018 and 14-01-2019. The studies include classified traffic volume counts, Origin Destination survey, Vehicle Registration Survey, Speed and Delay survey, traffic growth projections.

2.4 Classified Traffic Volume Counts

Classified traffic volume counts were taken at locations and for the given time period (7 days count continuous). The survey was carried out by Automatic Traffic Counter & Classifier (ATCC). For effective vehicle counts, vehicle classification used in the study were grouped under motorized and non-motorized categories. The vehicles passing through the survey stations were enumerated in each direction separately in accordance with the vehicle classification system given in IRC as minimum. The results of the study are given below.

Table 2.1: Annual Average Daily Traffic at various count locations

Location	Tumakuru Road	Hesaraghatta Road	IHR	Doddaballapura Road	Airport (Ballari) Road	Hennur Road	Addur Cross	Old Madras Road	Whitefield Road	Channasandra Road	Sarjapura Road	Hosur Road	Anekal Road
Car / Jeep (white board)	16347	1763	930	5996	39048	2287	2896	11425	7837	1722	4326	9757	2771
Car / Jeep (yellow board)	27545	2037	1458	5134	58324	3834	1596	12907	9100	2546	7680	16885	3331
LCV / Tempo Traveller	4880	963	397	1728	3774	767	1161	4693	2055	1247	1418	3700	899
LCV - Goods	4430	381	82	767	1561	668	177	1858	368	504	284	803	99
Mini Buses	549	21	7	242	726	20	1	147	61	79	24	605	25
Buses	4921	674	164	1308	3660	547	167	3905	854	589	1087	3582	737
2 Axle Trucks	3311	419	121	593	2679	510	381	3603	1209	690	706	6677	469
3 Axle Trucks	2723	193	37	364	2108	372	196	1719	690	788	1016	5033	230
4 to 6 Axle Trucks	5268	30	5	362	1622	43	42	1114	380	238	278	4089	73
7 or more Axle Trucks	2	0	0	0	14	1	0	1	0	0	1	7	0
HCE / EME	2	0	0	0	14	1	0	1	0	0	1	7	0
Total Tollable Vehicles, No	69976	6481	3201	16494	98008	9049	6617	41372	22554	8403	16820	51138	8634
Total Tollable Vehicles, PCU	93390	8606	3788	20741	108775	11399	8096	56462	27307	11901	21216	76447	10854
T/w	28200	10676	8140	18949	30884	8948	7853	34229	13019	12427	18064	30655	14890
Auto	2074	714	267	936	831	743	756	2714	801	484	606	271	528
Exempted Vehicles	81	4	2	28	68	6	2	40	14	6	7	14	12
Tractor	9	1	3	11	20	12	2	18	5	13	5	4	13
Tractor Trailer	19	23	3	85	62	203	15	114	58	66	49	19	85

Location	Tumakuru Road	Hesaraghatta Road	IIHR	Doddaballapura Road	Airport (Ballari) Road	Hennur Road	Addur Cross	Old Madras Road	Whitefield Road	Channasandra Road	Sarjapura Road	Hosur Road	Anekal Road
Cycles	12	91	58	66	109	32	17	93	149	119	43	57	17
Animal Drawn	9	7	0	14	26	12	2	15	24	13	6	11	7
Total Non Tollable Vehicles, No	30404	11516	8473	20089	24334	9956	8647	37223	14070	13128	18780	31031	15552
Total Non Tollable Vehicles, PCU	23886	9015	6475	15812	18732	8507	6879	29578	11103	10297	14529	23470	12230
Total, No	100380	17997	11674	36583	122342	19005	15264	78595	36624	21531	35600	82169	24186
Total, PCU	117276	17621	10263	36553	127507	19906	14975	86040	38410	22198	35745	99917	23084

Table 2.2: Comparison of ADT and AADT

Sl.No	Location	ADT		AADT	
		Nos	PCUs	Nos	PCUs
1.	Tumakuru Road	98490	115346	100380	117276
2.	Hesaraghatta Road	17567	17244	17997	17621
3.	IIHR Road	11380	10021	11674	10263
4.	Doddaballapur Road	35723	35779	36583	36553
5.	Ballari Road	120004	125231	122342	127507
6.	Hennur Road	18587	19520	19005	19906
7.	Addur Cross	14892	14640	15264	14975
8.	Old Madras Road	76888	84414	78595	86040
9.	Whitefield Road	35846	37671	36624	38410
10.	Channasandra Road	21038	21755	21531	22198
11.	Hoskote Sarjapur Road	34806	35036	35600	35745
12.	Hosur Road	80574	98294	82169	99917
13.	Anekal Road	23597	22575	24186	23084

Note: ADT: Average Daily Traffic, AADT: Annual Average Daily Traffic

Table 2.3: Traffic Composition at Count Locations

Location	Tumakuru Road	Hesaraghatta Road	IHR	Doddaballapura Road	Airport (Ballari) Road	Hennur Road	Addur Cross	Old Madras Road	Whitefield Road	Channasandra Road	Sarjapura Road	Hosur Road	Anekal Road
Car / Jeep (white board)	16.1%	9.7%	7.9%	16.3%	28.0%	11.9%	18.9%	14.4%	21.2%	7.9%	12.1%	11.8%	11.4%
Car / Jeep (yellow board)	27.7%	11.5%	12.7%	14.2%	42.4%	20.4%	10.6%	16.6%	25.1%	12.0%	21.8%	20.7%	14.0%
LCV / Temp Traveller	5.6%	6.9%	3.9%	5.6%	2.8%	6.4%	8.1%	6.8%	6.4%	6.9%	4.4%	5.0%	4.1%
LCV - Goods	3.8%	0.7%	0.2%	1.4%	0.5%	1.2%	0.8%	1.6%	0.3%	1.4%	0.4%	0.5%	0.1%
Mini Buses	0.6%	0.1%	0.1%	0.7%	0.5%	0.1%	0.0%	0.2%	0.2%	0.4%	0.1%	0.7%	0.1%
Buses	4.9%	3.8%	1.4%	3.6%	2.3%	2.9%	1.1%	5.0%	2.4%	2.8%	3.1%	4.4%	3.1%
2 Axle Trucks	3.3%	2.4%	1.1%	1.6%	1.6%	2.7%	2.5%	4.6%	3.3%	3.2%	2.0%	8.2%	2.0%
3 Axle Trucks	2.7%	1.1%	0.3%	1.0%	1.2%	2.0%	1.3%	2.2%	1.9%	3.7%	2.9%	6.2%	1.0%
4 to 6 Axle Trucks	5.3%	0.2%	0.0%	1.0%	1.0%	0.2%	0.3%	1.4%	1.0%	1.1%	0.8%	5.0%	0.3%
7 or more Axle Trucks	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
HCE / EME	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
T/w	27.8%	59.0%	69.4%	51.5%	19.0%	46.7%	51.2%	43.2%	35.3%	57.3%	50.4%	36.9%	61.3%
Auto	2.0%	3.9%	2.3%	2.5%	0.5%	3.9%	4.9%	3.4%	2.2%	2.2%	1.7%	0.3%	2.2%
Exempted Vehicles	0.1%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
Tractor	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%
Tractor Trailer	0.0%	0.1%	0.0%	0.2%	0.0%	1.1%	0.1%	0.1%	0.2%	0.3%	0.1%	0.0%	0.4%
Cycles	0.0%	0.5%	0.5%	0.2%	0.1%	0.2%	0.1%	0.1%	0.4%	0.6%	0.1%	0.1%	0.1%
Animal Drawn	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

- Proportion of tollable vehicles varies between 64% and 80% at all NHs.
- Passenger car proportion is between 21% and 74% at all locations with 72% at Ballari road.
- Truck proportion varies between 12% and 21%.

2.5 Origin Destination Survey

Origin and Destination survey was organized for both passenger and freight carriers over a period of 24 hours on a normal working day on specified locations. This survey is conducted mainly to understand the behavior and traffic pattern in the study locations. The outcomes of the study are as follows;

Table 2.4: Distribution of vehicle trips (purpose)

Sl. No.	Trip Purpose	Tumakuru Road	Doddaballapur Road	Ballari Road	Hennur Road	Old Madras Road	Whitefield Road	Channasandra Road	Sarjapura Road	Anekal Road	Hosur Road
1	Commercial / Business	26.10%	3.92%	24.20%	6.36%	11.35%	18.84%	25.61%	11.03%	20.55%	6.23%
2	Work / Official	37.07%	19.86%	35.41%	44.83%	35.40%	36.24%	45.91%	54.73%	36.33%	47.37%
3	Personal	18.55%	52.61%	18.73%	45.13%	37.08%	40.38%	24.68%	30.66%	29.22%	39.80%
4	Recreation	3.70%	1.31%	8.20%	0.60%	2.83%	1.98%	1.27%	1.58%	4.13%	0.53%
5	Tourist	11.93%	17.68%	9.91%	2.68%	11.65%	2.38%	2.19%	1.93%	8.09%	5.70%
6	Educational	0.73%	3.83%	0.96%	0.40%	0.90%	0.09%	0.35%	0.07%	0.86%	0.18%
7	Others	1.92%	0.78%	2.59%	0.00%	0.80%	0.09%	0.00%	0.00%	0.82%	0.18%

Table 2.5: Distribution of vehicle trips (Loading pattern)

Sl. No.	No of Trips	Tumakuru Road	Doddaballapur Road	Ballari Road	Hennur Road	Old Madras Road	Whitefield Road	Channasandra Road	Sarjapura Road	Anekal Road	Hosur Road
1	Once in a day	49.70%	28.29%	38.37%	45.30%	41.48%	41.32%	40.95%	26.71%	41.26%	52.06%
2	2 or more times in a day	28.50%	30.01%	27.40%	36.91%	39.03%	30.04%	40.96%	33.93%	26.13%	43.30%
3	Once in 15 days	4.84%	9.28%	5.96%	10.28%	13.58%	1.50%	3.02%	8.52%	1.98%	1.55%
4	Once in month	16.96%	32.42%	28.27%	7.51%	5.91%	27.14%	14.82%	30.84%	30.63%	3.09%
5	Occasional	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.25%	0.00%	0.00%	0.00%

Table 2.6: Distribution of vehicle trips (Commodity movement)

Sl. No.	No of Trips	Tumakuru Road	Doddaballapur Road	Ballari Road	Hennur Road	Old Madras Road	Whitefield Road	Channasandra Road	Sarjapura Road	Anekal Road	Hosur Road
1	Empty	27.84%	41.81%	25.66%	43.65%	31.30%	33.60%	38.56%	30.05%	44.95%	28.73%
2	Vegetables / Fruit / Milk / Fish	12.88%	24.74%	16.82%	19.79%	19.21%	6.88%	9.80%	9.94%	10.08%	7.89%
3	Food Grains	5.11%	9.05%	10.19%	9.83%	5.41%	11.73%	5.53%	20.13%	14.99%	7.84%
4	Salt	3.77%	6.07%	6.44%	2.54%	9.54%	3.44%	3.52%	1.03%	1.03%	3.72%
5	Building Materials	8.90%	12.71%	13.70%	22.32%	13.27%	18.78%	21.98%	18.45%	11.11%	19.30%
6	Wood	6.72%	1.95%	3.41%	0.88%	3.12%	7.41%	7.66%	4.52%	3.62%	4.25%
7	Textile Materials	3.24%	1.49%	2.31%	0.22%	1.88%	2.65%	1.38%	3.61%	3.36%	2.00%
8	Leather	1.36%	0.00%	0.67%	0.00%	0.84%	0.26%	0.88%	1.68%	1.29%	1.29%
9	Plastic Products	2.37%	0.69%	1.49%	0.11%	0.37%	0.71%	0.88%	5.42%	2.33%	3.82%
10	Iron coils/pipes/cables/wire	4.95%	1.26%	2.98%	0.66%	0.81%	3.26%	2.01%	2.06%	5.94%	3.92%
11	Minerals	1.42%	0.00%	2.88%	0.00%	1.11%	0.35%	0.25%	0.90%	0.00%	2.73%
12	Petrol / diesel /	2.43%	0.00%	3.51%	0.00%	6.48%	0.71%	0.63%	0.52%	0.00%	2.58%

Sl. No.	No of Trips	Tumakuru Road	Doddaballapur Road	Ballari Road	Hennur Road	Old Madras Road	Whitefield Road	Channasandra Road	Sarjapura Road	Anekal Road	Hosur Road
	Gas / LPG										
13	Fertilizer	1.16%	0.00%	0.00%	0.00%	0.13%	0.00%	0.00%	0.26%	0.00%	0.46%
14	Finished Consumer Goods	1.08%	0.00%	0.24%	0.00%	0.77%	0.26%	0.13%	0.13%	0.00%	0.15%
15	Paint / Dyes	0.91%	0.00%	2.11%	0.00%	1.44%	0.00%	0.25%	0.26%	0.00%	1.67%
16	Machine	1.74%	0.00%	2.50%	0.00%	0.81%	0.26%	1.76%	0.13%	0.52%	1.85%
17	Container	6.87%	0.00%	1.11%	0.00%	1.55%	3.44%	1.63%	0.13%	0.00%	2.43%
18	Aluminium	0.45%	0.00%	1.01%	0.00%	0.00%	0.44%	0.25%	0.00%	0.26%	0.66%
19	Chemicals	1.01%	0.00%	0.19%	0.00%	0.24%	0.18%	0.13%	0.13%	0.00%	0.38%
20	Liquid Oxygen	1.22%	0.00%	1.92%	0.00%	0.07%	2.91%	2.14%	0.26%	0.00%	2.18%
21	Others	4.57%	0.23%	0.86%	0.00%	1.65%	2.73%	0.63%	0.39%	0.52%	2.15%

2.6 Speed and delay Survey

Speed and delay survey were carried out by the consultant by moving car method at various sections of existing ORR and radial road networks, where commercial and passenger traffic ply. Summary of journey speed at various sections are given below;

Table 2.7: Speed Profile at various sections

From	To	Route	Journey Speed, Kmph
Mekhri Circle	Trumpet Interchange	Via Hebbal flyover	42.16
Tumakuru road (via Gorguntepalya)	Hebbal	Outer Ring Road	18.89
Whitefield	Hebbal	Outer Ring Road	16.71
Electronic City	Hebbal	NICE road	47.92
Electronic City	Hebbal	Central Silk Board, Mekhri circle	16.58
Electronic City	Hebbal	Central Silk Board, KR Puram	15.56

2.7 Capacity Analysis

Capacities of road project road sections are estimated in accordance with Indian Highway Capacity Manual (Indo-HCM), December 2017. The projected traffic levels are computed for three homogeneous sections are presented below.

Table 2.8: Capacity Analysis

Year	Section-1 (Tumakuru Road to Ballari Road)		Section-2 (Ballari Road to Old Madras Road)		Section-3 (Old Madras Road to Hosur Road)	
	Peak PCU / Hr	No of Lanes	Peak PCU / Hr	No of Lanes	Peak PCU / Hr	No of Lanes
2019	3713	2	4238	2	2595	2
2020	4017	2	4550	2	2819	2
2021	4343	2	4882	3	3066	2
2022	4700	3	5244	3	3332	2
2023	5085	3	5628	3	3622	2
2024	4439	2	5386	3	3169	2
2025	4762	3	5739	3	3410	2
2026	5106	3	6112	3	3672	2

Year	Section-1 (Tumakuru Road to Ballari Road)		Section-2 (Ballari Road to Old Madras Road)		Section-3 (Old Madras Road to Hosur Road)	
	Peak PCU / Hr	No of Lanes	Peak PCU / Hr	No of Lanes	Peak PCU / Hr	No of Lanes
2027	5473	3	6521	3	3956	2
2028	5866	3	6950	4	4261	2
2029	6251	3	7370	4	4562	2
2030	6661	3	7818	4	4885	3
2031	7097	4	8294	4	5231	3
2032	7565	4	8797	4	5606	3
2033	8067	4	9334	5	6005	3
2034	8560	4	9863	5	6401	3
2035	9085	4	10431	5	6822	3
2036	9639	5	11023	5	7272	4
2037	10230	5	11650	6	7753	4
2038	10853	5	12311	6	8269	4
2039	11469	5	12967	6	8776	4
2040	12131	6	13664	6	9314	5
2041	12820	6	14399	7	9883	5
2042	13558	6	15166	7	10491	5
2043	14344	7	15983	7	11135	5
2044	15128	7	16801	8	11765	6
2045	15953	7	17653	8	12435	6
2046	16820	8	18559	9	13139	6
2047	17730	8	19507	9	13886	7
2048	18696	9	20502	9	14676	7
2049	19656	9	21509	10	15450	7
2050	20659	9	22568	10	16263	8
2051	21710	10	23677	11	17118	8
2052	22824	10	24845	11	18022	8

The main road sections Tumakuru Road to Ballari Road (1), Ballari road to OMR (2) and OMR to Hosur Road (3) of PRR will reach its capacity in year 2045, 2043 and 2049 respectively. This is based on the assumptions and considerations made in traffic growth estimate as on date.

2.8 Traffic growth Projections

The traffic pattern on the proposed road is influenced by the diverted and generated traffic. Based on these factors, traffic has been estimated on each section of the PRR in 2019. The traffic likely to be generated on account of layouts is slow moving and car traffic. Of the traffic generated from the layout, small proportion of passenger cars and commercial vehicles will use main road of PRR. In a report submitted to BDA, it was found that based on the study carried out by Central Road Research Institute (CRRI) that annual traffic growth varies in the range of 2%-4% in central zone, 5%-7% in the intermediate zone and 8%-9% in Bangalore. The project road falls in intermediate zone with traffic growth varying between 5% and 7%, which is constituted by two wheelers, autos, cars and small proportion of commercial vehicles. Since, only passenger car movement is expected on main road of PRR from these layouts, traffic growths will be much lesser than the one applicable for intermediate zone. This has been considered in traffic growth estimates. Considering this, following growth factors are adopted as given below;

Table 2.9: Traffic growth rates (Generated traffic)

Generated	Car	LCV	Mini Bus	Bus	2AT	3AT	MAV
2019-2023	4.50%	4.00%	3.00%	4.00%	2.00%	2.00%	2.00%
2024-2028	4.95%	4.20%	3.15%	4.20%	2.00%	2.00%	2.00%
2029-2033	4.70%	3.78%	2.84%	3.78%	2.00%	2.00%	2.00%
2033-2038	4.23%	3.40%	2.55%	3.40%	2.00%	2.00%	2.00%
2039-2043	3.81%	3.06%	2.30%	3.06%	2.00%	2.00%	2.00%
2044-2048	3.43%	2.76%	2.07%	2.76%	2.00%	2.00%	2.00%
2049-2053	3.09%	2.48%	1.86%	2.48%	2.00%	2.00%	2.00%

2.9 Proposed Project

Peripheral Ring road is proposed to access controlled facility for main road traffic which comprises of trucks, light commercial vehicles, buses, passenger cars and taxis. Since the project road passes through urban / semi urban area around Bangalore city, considerable local traffic is also expected in addition to generated traffic. For the design of PRR, IRC: 86: 1986 is considered. However, wherever possible technical parameters more than those specified in IRC 86 are also adopted.

2.10 Design Speed

Proposed PRR is designed for 60 Kmph for main road design and 30 Kmph for service road considering local traffic which also includes slow moving traffic and non-motorised traffic and pedestrians.

2.11 Pavement Design

Rigid Pavement (IRC 58: 2015) for main carriageway and flexible pavement (IRC 37:2018) for service road will be adopted with design life of 20 years considered for flexible pavement and 30 years for Rigid pavement. Following road pavement types are used in the project:

- Flexible pavement for main road
- Flexible pavement for service road
- Rigid Pavement for Toll Plaza & its approaches.

The pavement type is finalized based on detailed discussion with Technical Advisory Committee meetings. TAC suggested to adopted flexible pavement instead of rigid pavement earlier proposed. Summary of the flexible pavement design for main road and Toll Plaza approach are as follows:

Main Road:

Stone Matrix Asphalt with modified binder	50 mm
Dense Bituminous Macadam	115 mm, 130 mm, 130 mm
Wet Mix Macadam	250 mm
Granular Sub Base	200 mm
CBR of the 500mm of subgrade	8% (Minimum)
CBR of soil below the 500mm of subgrade	5% (Minimum)

Toll plaza:

M40 Concrete Pavement Thickness (PQC)	300mm
DLC Thickness	150mm (de-bonding layer 200micron polythene sheet in between)
GSB Thickness	150mm
Dowel Bar Dia	38mm

Length of Dowel bar(plain)	500mm
Spacing of Dowel bar(plain)	300mm
Tie Bar Dia (deformed)	12mm
Length of Tie bar (deformed)	580mm
Spacing of Tie bar (deformed)	370mm
Size of Panel	3500mmX4500mm

Service road is designed for loading of 20MSA and effective subgrade CBR is taken as 8%.The summary of the pavement composition is as follows

Stone Matrix Asphalt (SMA)	40mm
Dense Bituminous Macadam (DBM)	75 mm
Wet Mix Macadam (WMM)	250 mm
Granular Subbase (GSB)	200 mm
CBR of the 500mm of the subgrade from borrow pits	8%CBR (Minimum)
CBR of soil below the 500mm of the subgrade	5% CBR (Minimum)

2.12 Typical Cross Section

Typical cross section for the project for 100 m ROW comprises of following cross section elements. Typical cross section of the proposed PRR is given below (Fig-2.3 to 2.17);

Table 2.10: RoW utilization for various elements

Sl.No	Particulars	RoW utilization	Sl.No	Particulars	RoW utilization
1	Median	13 m	9	Shyness-1	0.25 x 2 (0.5 m)
a.	Open drain	5 m	10	Service road	10.5 x 2 (21 m)
b.	Granular shoulder	4.0 x 2 (8.0 m)	11	Shyness -2	0.25 x 2 (0.5 m)
2	Gantry -1	0.75 x 2 (1.5 m)	12	Drain	1.0 x 2 (2.0 m)
3	Edge strip	0.50 x 2 (1.0 m)	13	Cycle track	2.0 x 2 (4.0 m)
4	Left Carriageway	14 m	14	Foot path	2.0 x 2 (4.0 m)
5	Right Carriageway	14 m	15	Space for U/G Cable	1.0 x 2 (2.0 m)
6	Paved shoulder	1.5 x 2 (3 m)	16	Space for other utilities	2.0 x 2 (4.0 m)
7	Gantry-2	0.75 x 2 (1.5 m)	17	Green space	5.0 x 2 (10.0 m)
8	Covered drain	2.0 x 2 (4 m)			

2.13 Vehicle Underpasses (VUPs)

Underpass is a structure allowing movement of traffic beneath a roadway. An underpass is sub classified as cattle underpass, pedestrian underpass and vehicular underpass depending on the principal user. Particulars of VUP are as follows.

Table 2.11: List of proposed Vehicular Underpasses

SL No	Design Chainage		Length (m)	Type of Cross Section	Remarks		
	From	To			Structure Type	Chainage (m)	Radius of curvature (m)
1	2+225	2+315	90	5	VUP	2+270	Straight
2	6+712	6+802	90	5	VUP	6+757	Straight
3	8+814	8+904	90	5	VUP	8+859	Straight
4	10+668	10+758	90	5	VUP	10+713	1750
5	11+670	11+760	90	5	VUP	11+715	Straight
6	12+520	12+610	90	5	VUP	12+565	Straight
7	21+160	21+250	90	5	VUP	21+205	800
8	31+460	31+550	90	5	VUP	31+505	Straight
9	33+576	33+666	90	5	VUP	33+621	Straight
10	46+225	46+315	90	5	VUP	46+270	Straight

SL No	Design Chainage		Length (m)	Type of Cross Section	Remarks		
	From	To			Structure Type	Chainage (m)	Radius of curvature (m)
11	47+505	47+595	90	5	VUP	47+550	Straight
12	49+764	49+854	90	5	VUP	49+809	1000
13	50+835	50+925	90	5	VUP	50+880	2600
14	52+628	52+718	90	5	VUP	52+673	Straight

2.14 Pedestrian Underpasses (PUPs) and animal underpasses

Pedestrian underpasses along with VUP's are proposed at locations where pedestrian and animal movement is expected to cross PRR. Animal underpasses are proposed for the movement of livestock from one side to the other side of the PRR for grazing activities. The locations animal passes will be decided in consultation with villagers at the time of execution. Particulars of VUPs/PUPs/animal underpasses are as follows:

- 7.5m wide underpass with 1.5m wide footpath cum concealed drain.
- Vertical clearance of 4.5m to allow movement of slow-moving vehicles (T/w and cars).

2.15 Vehicle Overpasses (VOPs)

Vehicular Overpasses will be provided at 8 locations and the details are given below.

Table 2.12: List of proposed VoPs

Sl No	Design Chainage, Km	Location
1	3+560	Chikkabanavara to Soladevanahalli
2	23+413	Nagavara to Byalahalli
3	28+091	Bileshivale to Doddagubbi
4	29+763	Rampura to Anagalapura
5	37+766	Doddabanahalli to Kannamangala
6	48+875	Chikka Tirupathi to Mutsandra
7	60+823	Silicon Town to Rayasandra

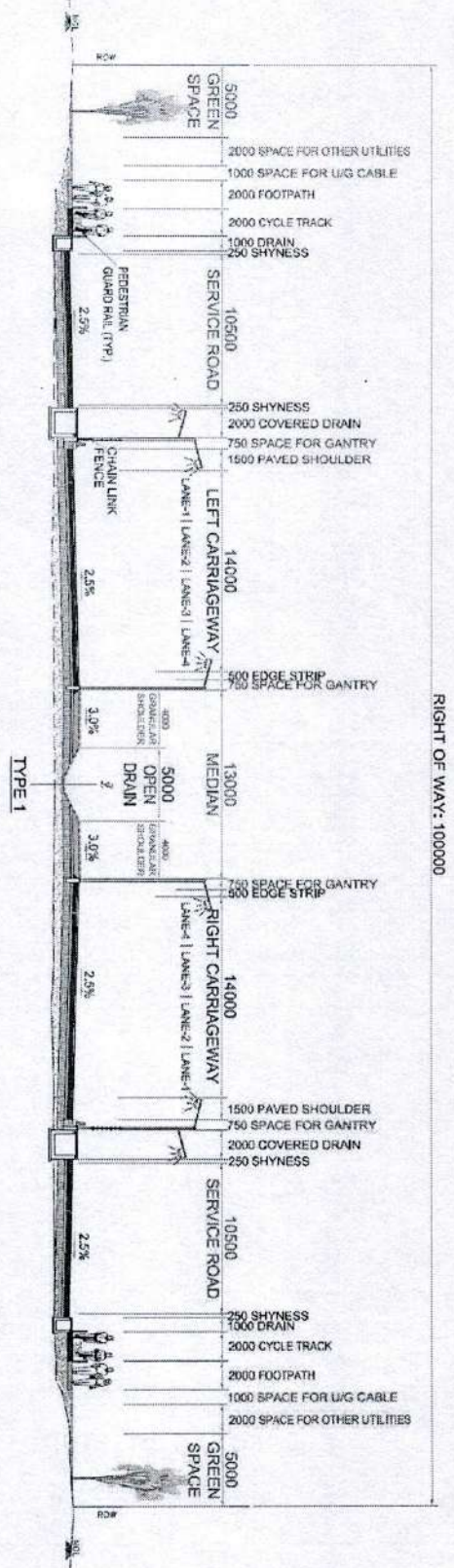


Fig 2.3: Typical cross section (at grade) of the proposed PRR showing various elements

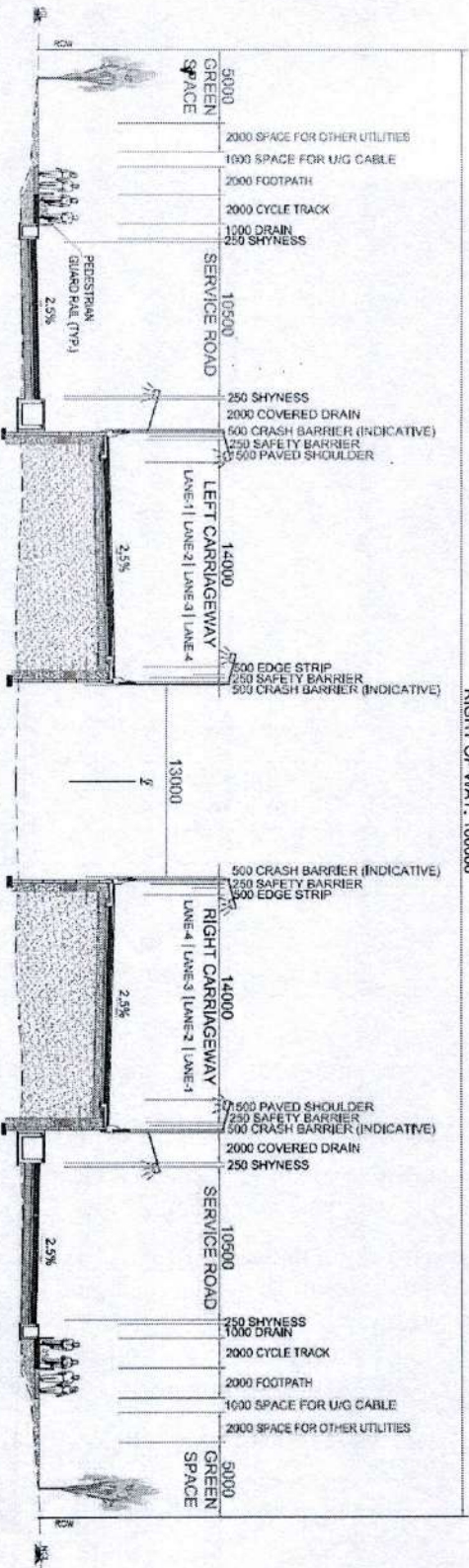


Fig 2.4: Typical cross section (at VUP & PUP approaches) of the proposed PRR showing various elements

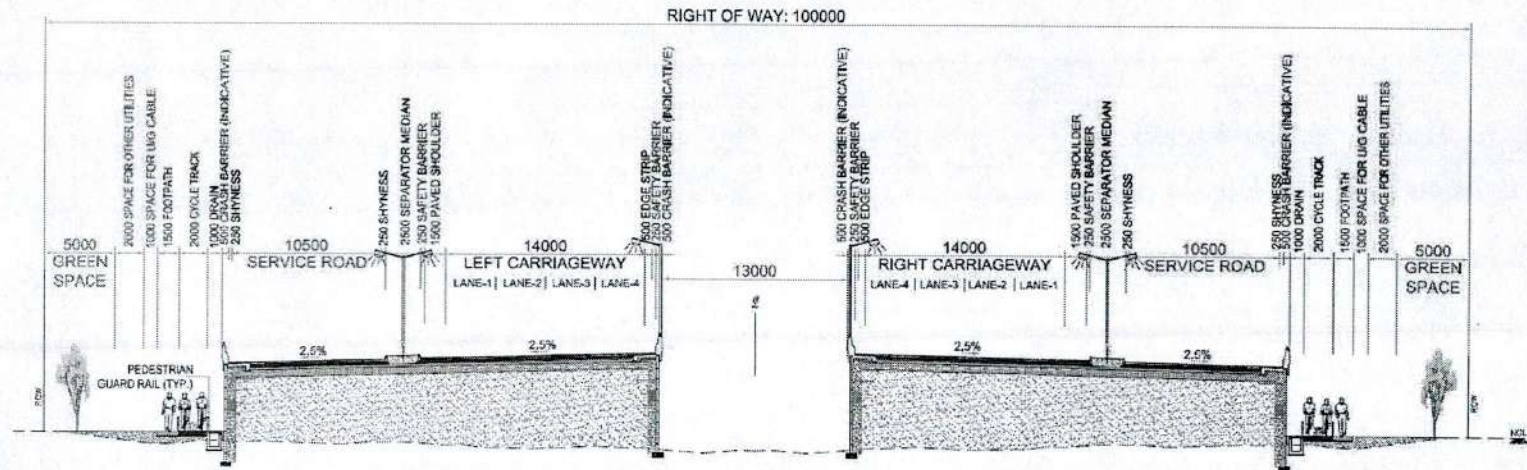


Fig 2.5: Typical cross section (at ROB approaches) of the proposed PRR showing various elements

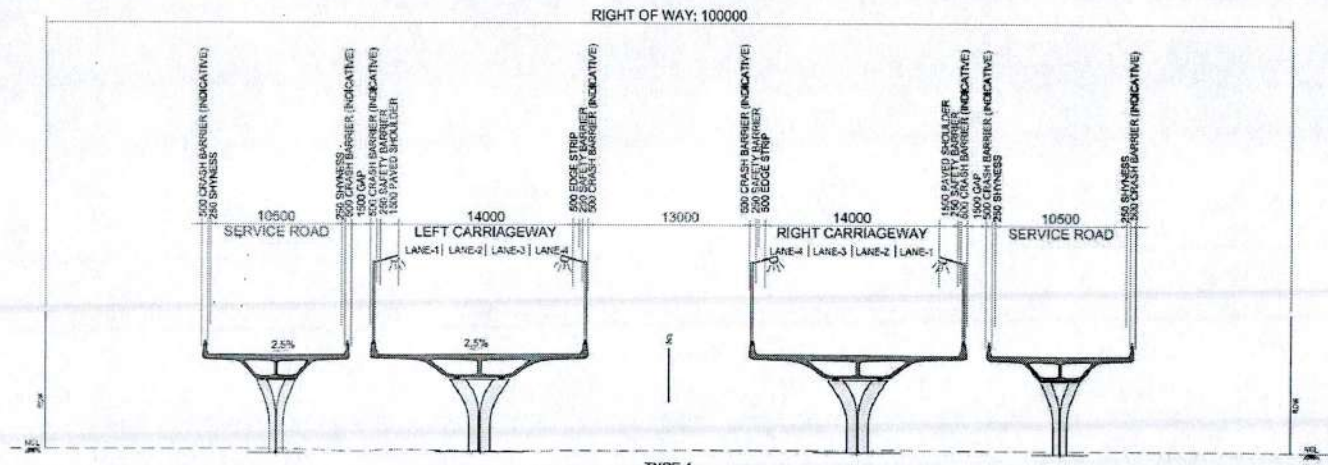
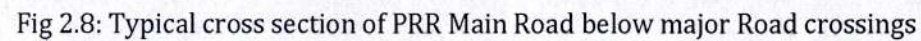
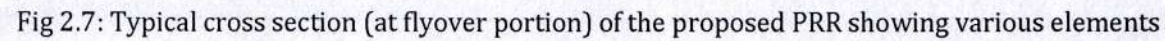


Fig 2.6: Typical cross section (at ROB crossing portion) of the proposed PRR showing various elements



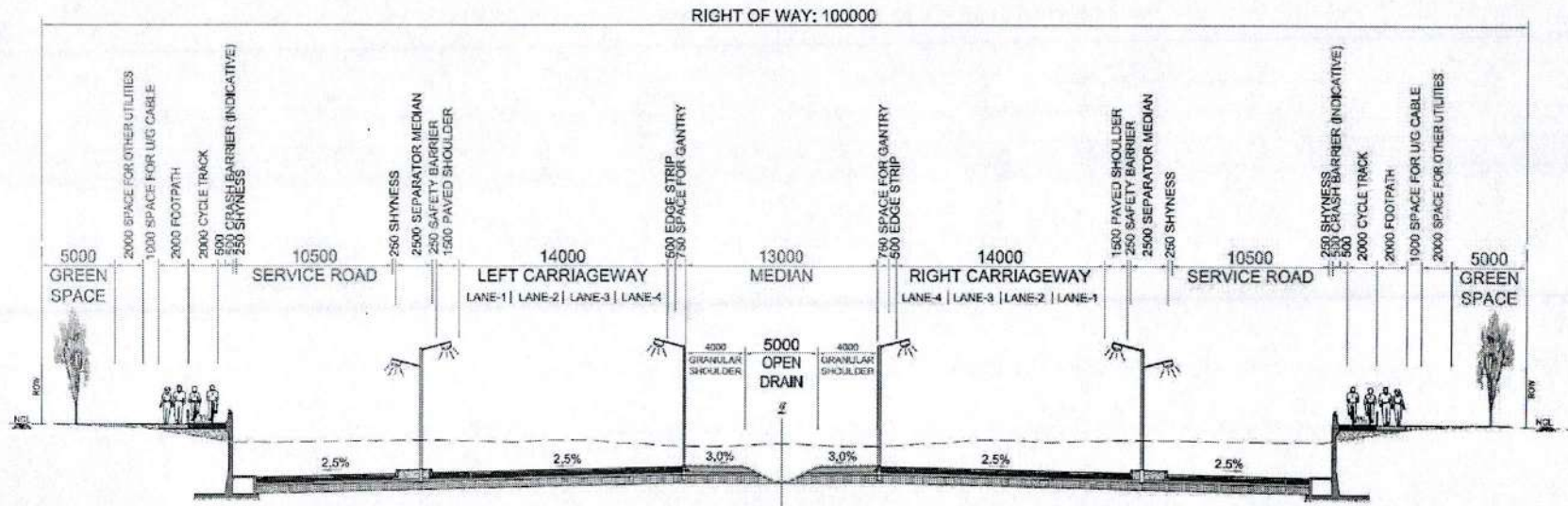


Fig 2.9: Typical cross section of PRR at RUB Approach location

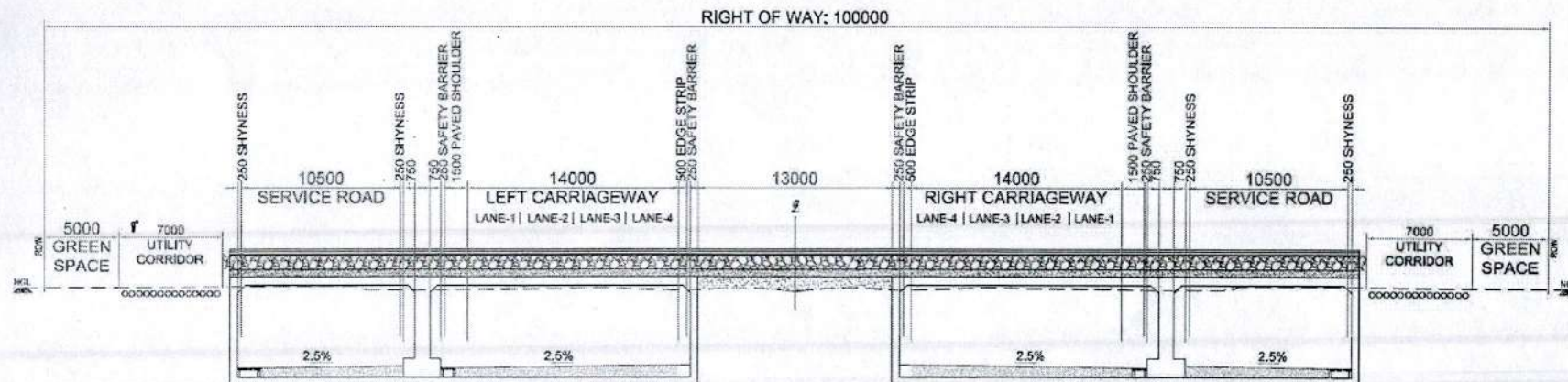


Fig 2.10: Typical cross section of PRR at RUB

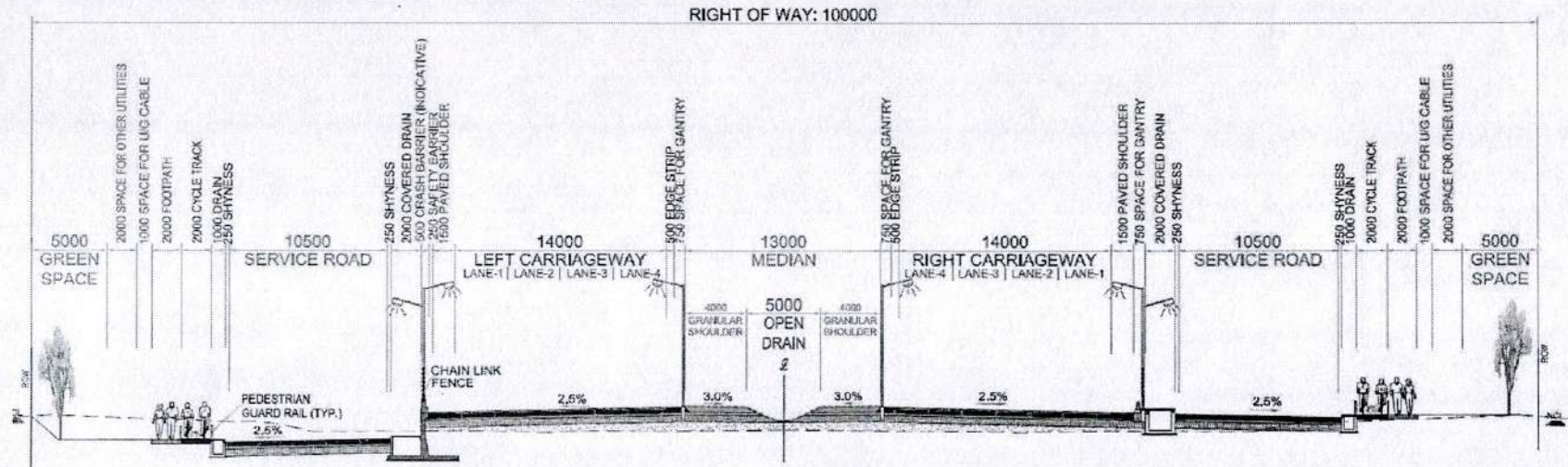


Fig 2.11: Typical cross section of PRR with LSR lower than Main road

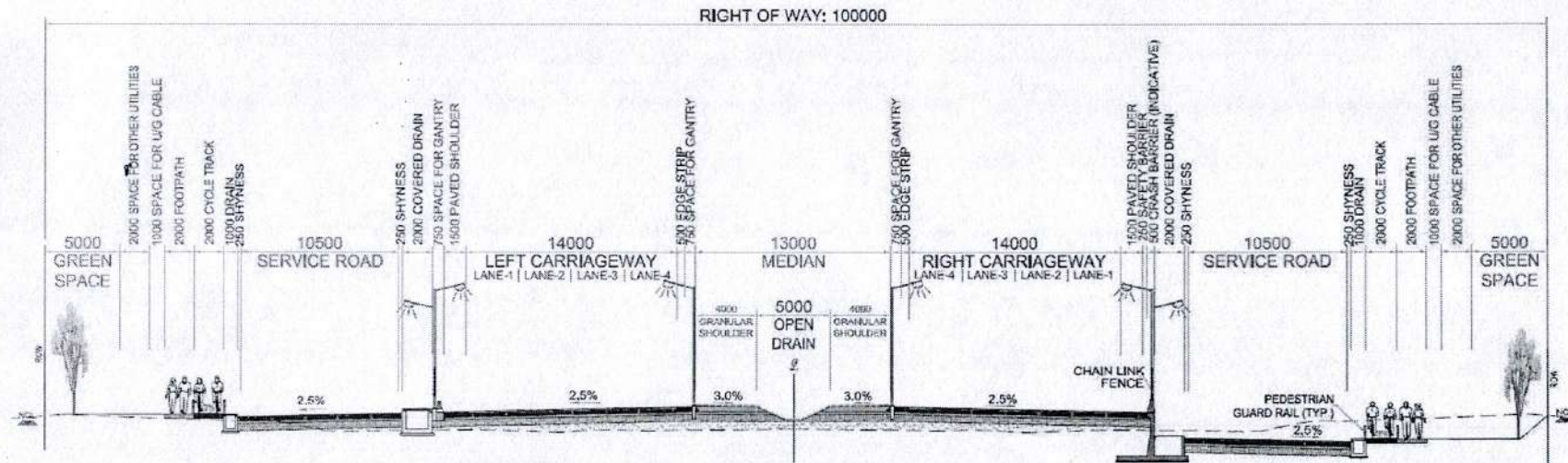


Fig 2.12: Typical cross section of PRR with RSR lower than Main road

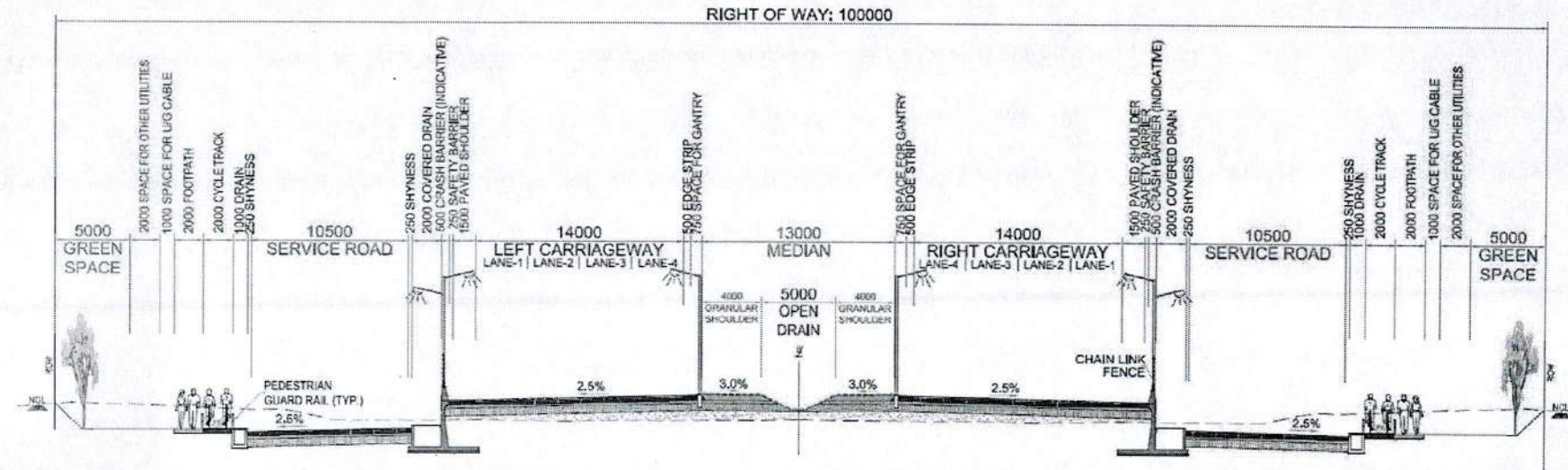


Fig 2.13: Typical cross section of PRR with Service Road lower than Main road

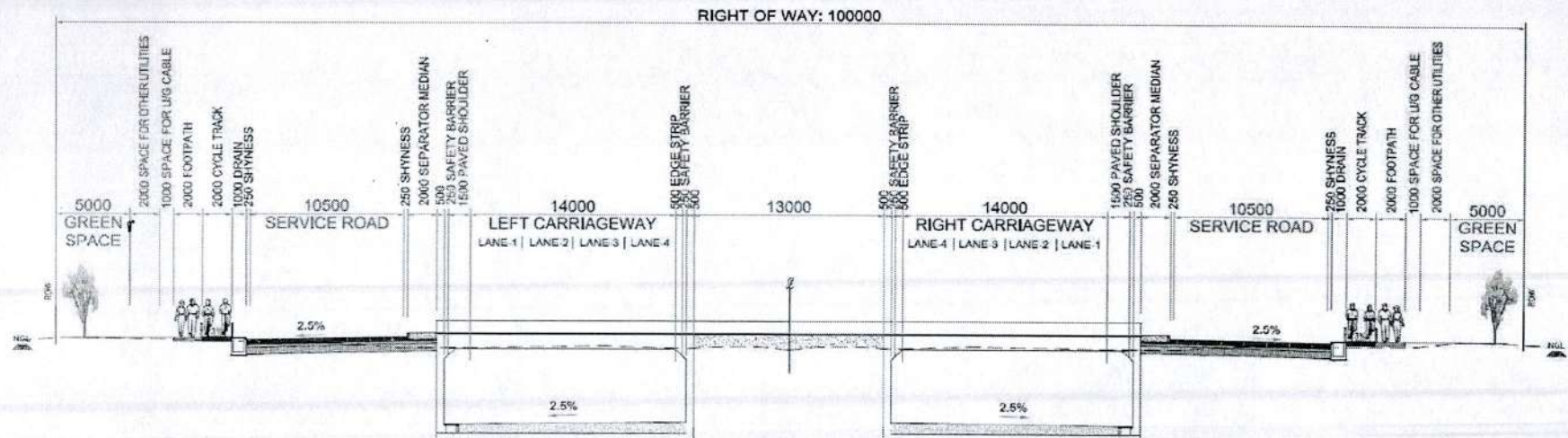


Fig 2.14: Typical cross section of PRR at underpass location

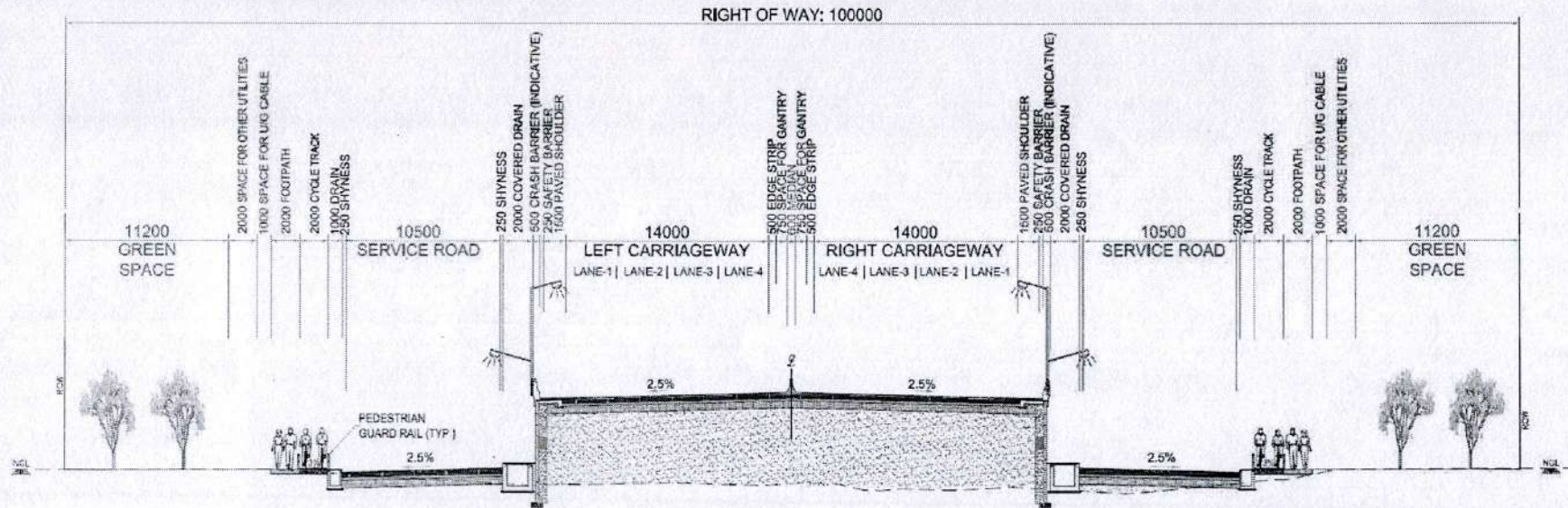


Fig 2.15: Typical cross section at Hosur Road Flyover Approach Location

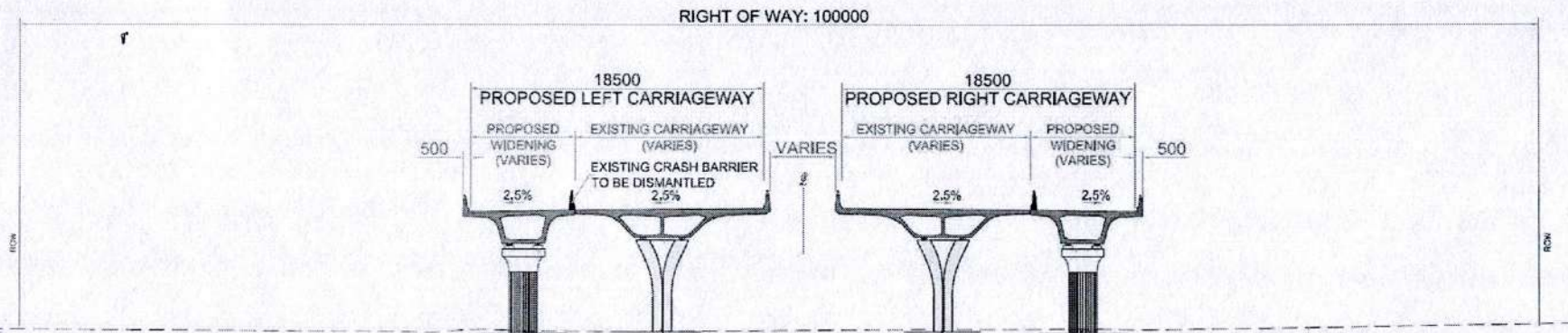


Fig 2.16: Typical cross section at Tumakuru Road & Hosur Road Flyover Portion

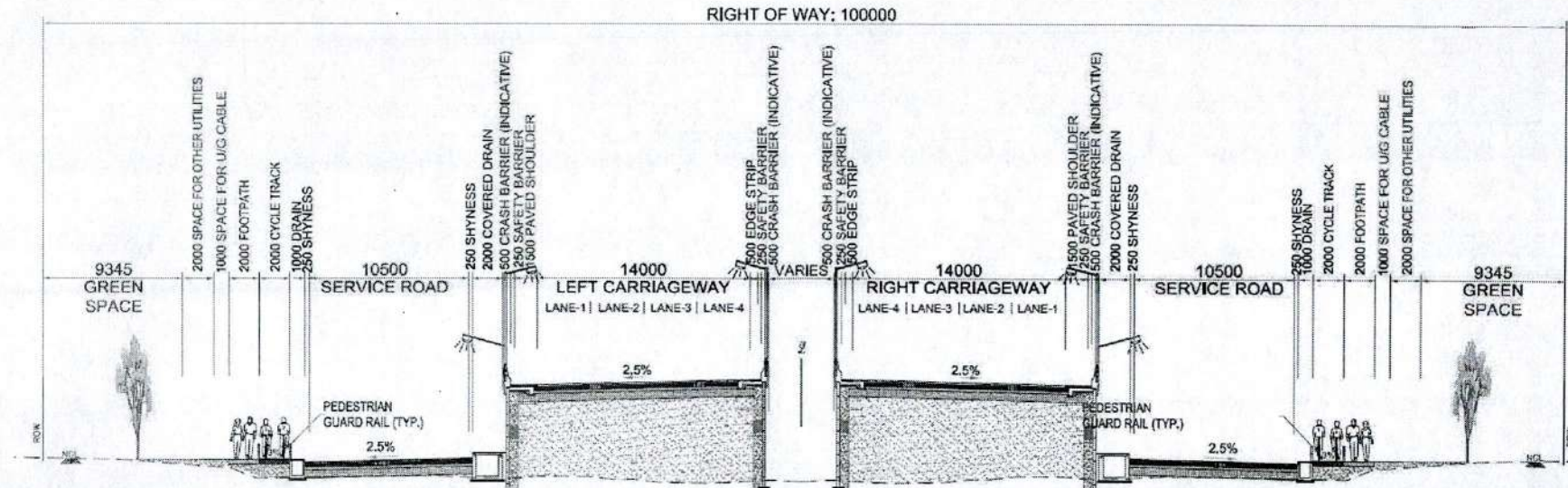


Fig 2.17: Typical cross section at Tumakuru Road Flyover Approach Location

2.16 Road Over Bridges (ROB) and Road Under Bridges (RUB)

PRR alignment crosses 5 railway lines. Out of 5 railway crossings, 3 Road over bridges (ROBs) and 2 RUBs are proposed. And for all the railway crossings through service road on both the sides are facilitated by providing 2 lane flyovers in one direction. At Hesaraghatta junction PRR alignment crosses Tumakuru railway line and Hesaraghatta SH crossing, which are adjacent to each other. Hence combinations of ROB for Tumakuru railway line and Flyover for Hesaraghatta SH crossings are proposed.

Table 2.13: List of ROB/RUB proposed

Sl. No.	Chainage (Km)	Intersecting Railway crossing	Type of Proposal
1.	4+212	Tumakuru railway line	ROB
2.	15+158	Doddaballapur railway line	RUB
3.	16+061	Chikkaballapura railway line	RUB
4.	42+570	Chennai railway line	ROB
5.	58+640	Salem railway line	ROB

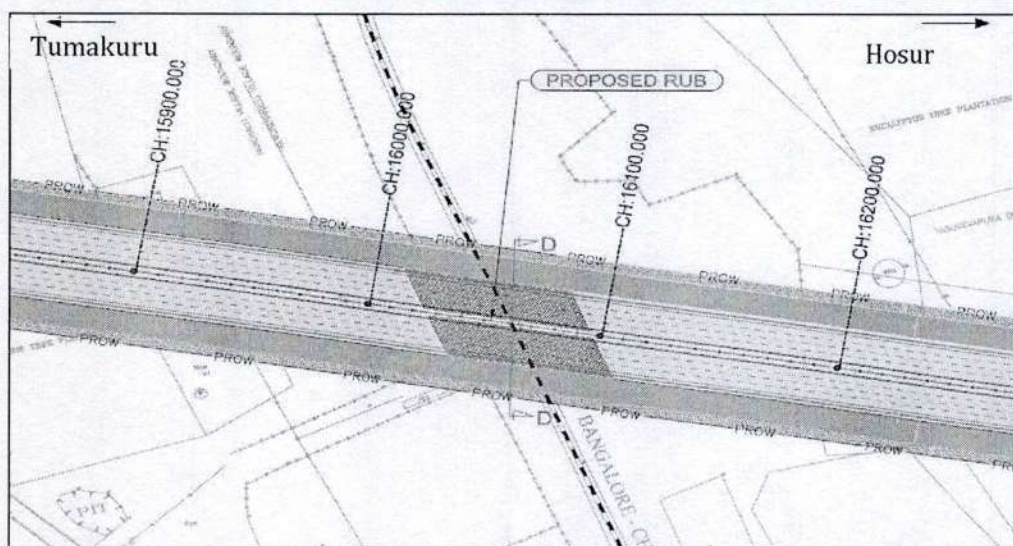


Fig 2.18: Typical Cross section of RUB @ 16+061

2.17 Major junctions

Sl. No.	Chainage (Km)	Intersecting Road Name	Suggested Proposal
1.	0.000	Tumakuru Road (NH-4)	Cloverleaf interchange integrated with NICE road
2.	4+350.528	Hesaraghatta Road	Flyover along PRR
3.	14+434.581	Doddaballapur	Vehicular underpass along PRR
4.	18+651.059	Ballari Road (NH-7)	Cloverleaf
5.	25+605.266	Hennur Road	Vehicular underpass along PRR
6.	36+325.603	Old Madras Road (NH-4)	Cloverleaf
7.	40+255.883	Whitefield-Hoskote Road	Flyover along PRR
8.	43+832.085	Channasandra Road	Flyover along PRR
9.	55+462.192	Sarjapur Road	Vehicular underpass along PRR
10.	64+201.852	Hosur Road (NH-7)	Cloverleaf interchange integrated with NICE road

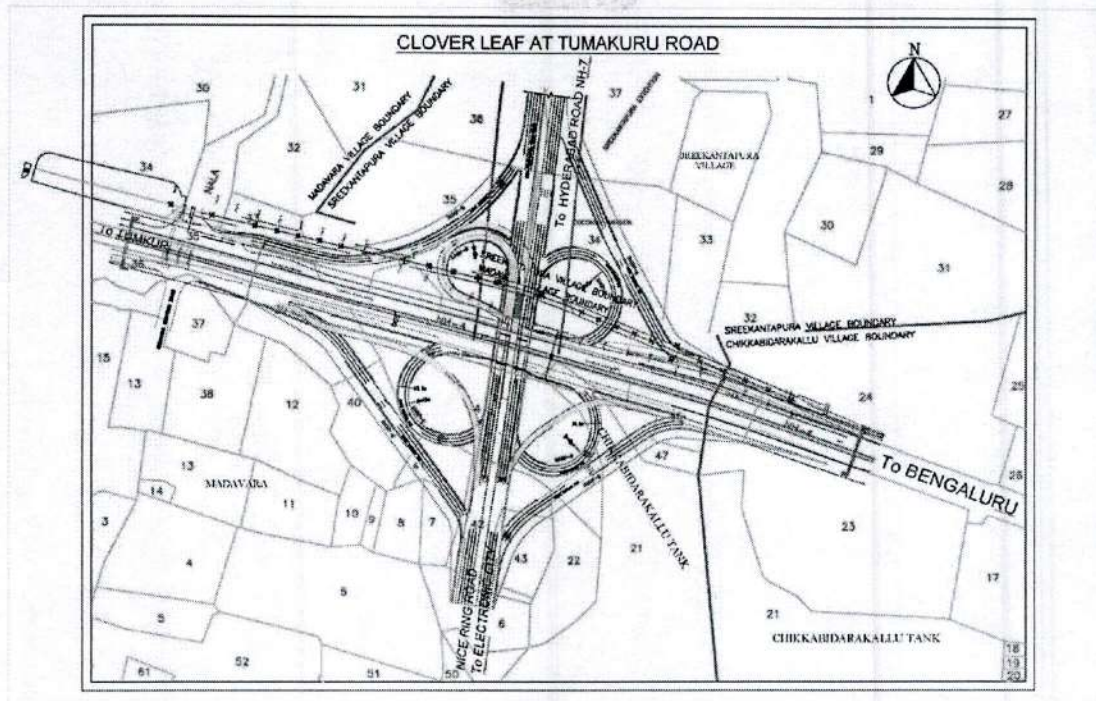


Fig 2.19: Clover leaf inter change at Tukmur Road

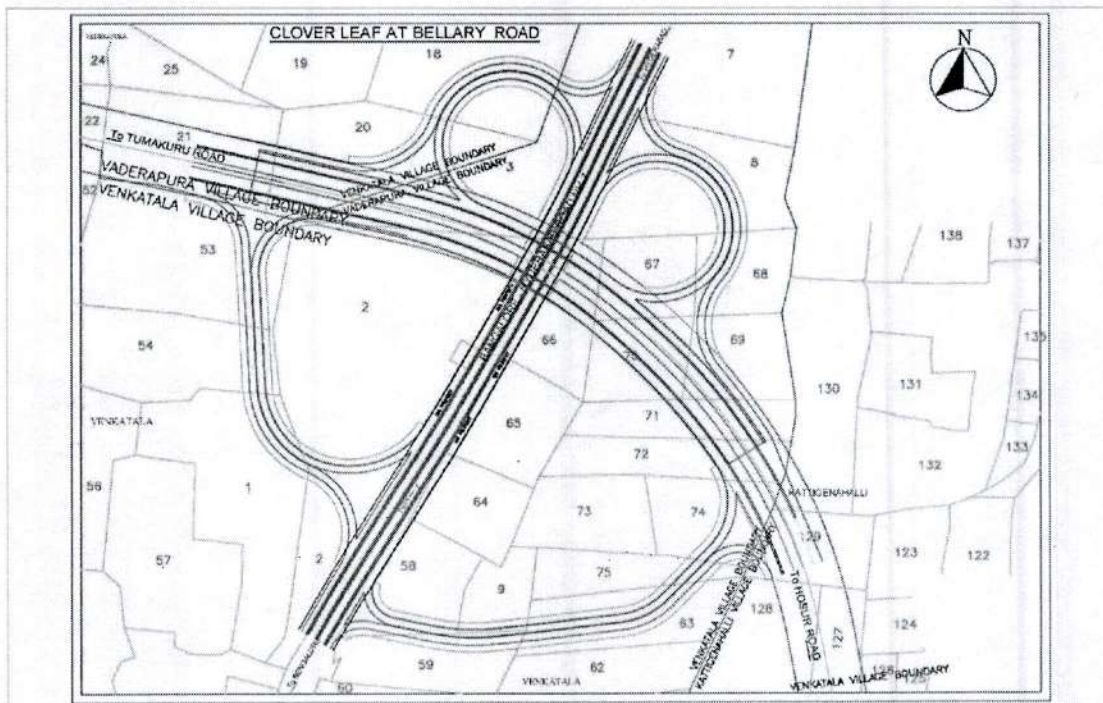


Fig 2.20: Clover leaf inter change at Bellary Road

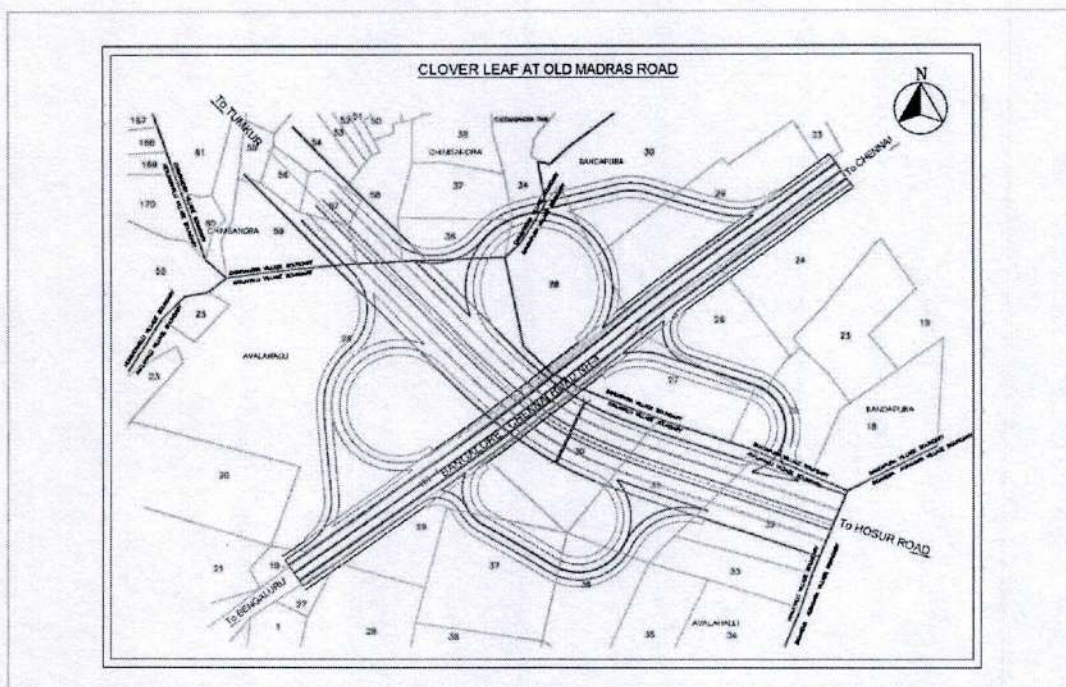


Fig 2.21: Clover leaf inter change at Old Madras Road

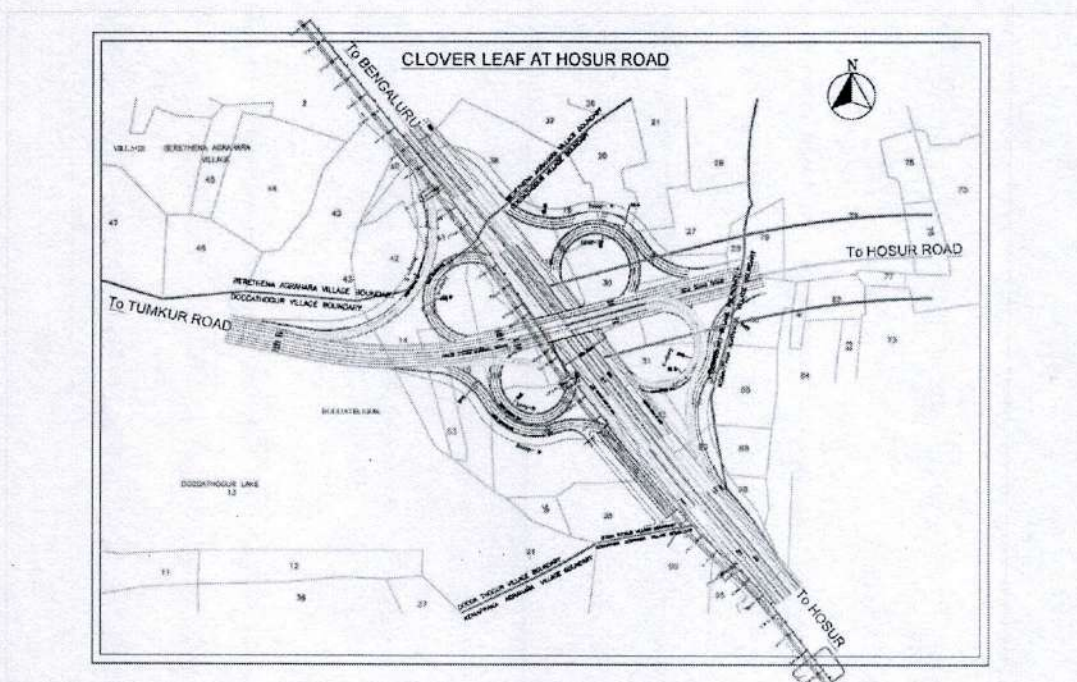


Fig 2.22: Clover leaf inter change at Hosur Road

2.18 Flyovers

A bridge over another road for allowing cross traffic without interruption with its approaches on both sides is commonly called as flyover. At 3 major road crossings, flyover along PRR is proposed. They are Hesaraghatta road, Whitefield -Hoskote road and Hoskote -Anekal road. At Hesaraghatta junction, PRR alignment crosses Tumakuru railway line and Hesaraghatta road SH crossing, hence through service road along PRR is proposed. Further, flyovers along 6 lakes

passing along the proposed PRR alignment and at intersecting areas of petroleum pipelines (Near Bilishivale) are proposed to minimize the magnitude of the impact.

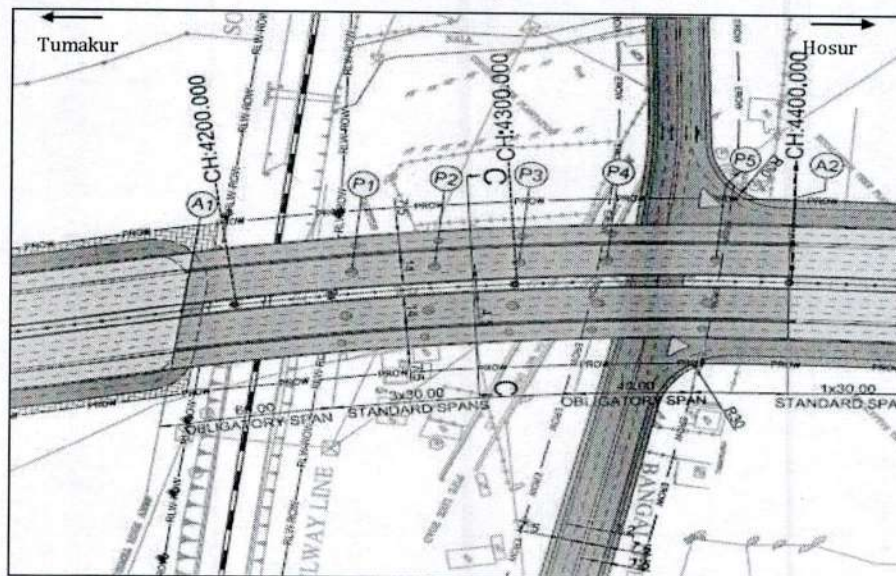


Fig 2.23: Typical cross section of flyover @4+343 Hesaraghatta Road

2.19 Minor Bridges and Culverts

Wherever the project alignment passes through the nala/stream, minor bridges at 12 locations and 51 box culverts are proposed for free flow of water.

Table 2.14: List of Minor Bridges

Sl.No	Chainage (km)	Sl.No	Chainage (km)
1	0+525	7	43+798
2	4+587	8	46+155
3	22+212	9	52+862
4	29+069	10	56+052
5	33+696	11	58+936
6	42+043	12	63+593

Table 2.15: List of proposed Box culverts

Sl.No	Chainage	Sl.No	Chainage	Sl.No	Chainage	Sl.No	Chainage
1	0+525	18	20+024	35	41+484	52	50+849
2	2+229	19	22+202	36	42+049	53	50+919
3	4+582	20	23+889	37	42+220	54	51+429
4	4+813	21	24+307	38	42+537	55	52+862
5	5+790	22	26+209	39	42+967	56	54+902
6	6+429	23	27+237	40	43+800	57	55+222
7	7+413	24	28+857	41	45+491	58	56+052
8	8+673	25	29+063	42	45+747	59	57+967
9	9+146	26	31+702	43	46+159	60	58+937
10	9+389	27	32+815	44	46+334	61	59+833
11	10+238	28	33+237	45	46+689	62	60+060
12	10+642	29	33+697	46	46+899	63	60+245
13	11+339	30	34+717	47	47+136	64	61+057
14	11+600	31	35+724	48	47+273	65	61+592
15	12+777	32	36+292	49	48+329	66	62+177

Sl.No	Chainage	Sl.No	Chainage	Sl.No	Chainage	Sl.No	Chainage
16	15+123	33	36+397	50	49+503	67	64+017
17	16+179	34	37+557	51	49+979		

2.20 Wayside Amenities

2.20.1 Bus Shelters

Exclusive bus bays are not provided on the project road. BMTC buses are expected to move on service road. Since the project road has to be confined within 100 m ROW, exclusive bus bays as per IRC cannot be provided. Hence, only bus shelters are proposed. Bus shelters are proposed without taper. A raised footpath of 2.0 m wide is proposed along with shelter for the safety of waiting passengers. The locations of proposed Bus shelter are presented below.

Table 2.16: List of proposed Bus Shelters

Sl No	Design Chainage (Km)	Side	Location
1	1+450	LHS & RHS	Totadaguddahalli
2	2+450	LHS & RHS	Tammenahalli
3	3+700	LHS & RHS	Soladevanahalli
4	4+800	LHS & RHS	Chikkabanavara
5	6+900	LHS & RHS	Kalathammanahalli
6	7+750	LHS & RHS	Byalakere
7	8+700	LHS	Byalakere
8	9+050	RHS	Byalakere
9	10+500	LHS	Mavallipura
10	10+900	RHS	Mavallipura
11	11+550	LHS & RHS	JarakabandeKavalu
12	12+400	LHS	JarakabandeKavalu
13	12+750	RHS	Ramagondanahalli
14	14+600	LHS & RHS	Nagareswara Nagenahalli
15	16+300	LHS & RHS	Vasudevapura
16	17+300	LHS & RHS	Manchenahalli
17	18+500	LHS	Venkatala
19	18+850	RHS	Venkatala
20	20+000	LHS & RHS	Kogilu
21	21+050	LHS	Kogilu
22	21+350	RHS	Agrahara
23	23+250	LHS	Chokkanahalli
24	23+550	RHS	Chokkanahalli
25	25+450	LHS	Byrathi
26	25+800	RHS	Byrathi
27	27+100	LHS & RHS	Doddagubbi
28	28+250	LHS & RHS	Bileshivale
29	29+920	LHS & RHS	Vaderahalli
30	31+350	LHS	Aduru
31	31+650	RHS	Aduru
32	33+470	LHS	Herandahalli
33	33+770	RHS	Herandahalli
34	36+100	LHS & RHS	Chimsandra
35	37+900	LHS & RHS	Doddabanahalli
36	38+500	LHS & RHS	Kannamanagala
37	40+000	LHS & RHS	Sigehalli
38	41+500	LHS & RHS	Sigehalli

39	44+000	LHS & RHS	Channasandra
40	45+300	LHS & RHS	Nagagondanahalli
41	46+450	LHS & RHS	Hagadur
42	47+400	LHS	Sorahunse
43	47+750	RHS	Sorahunse
44	48+800	LHS & RHS	Sorahunse
45	50+000	LHS & RHS	Varthur
46	51+100	LHS & RHS	Gunjur
47	52+500	LHS & RHS	Kachamaranahalli
48	53+500	LHS & RHS	Kachamaranahalli
49	55+550	LHS & RHS	Sulakunte
50	57+200	LHS & RHS	Kodathi / Chokkasandra
51	59+000	LHS & RHS	Gattihalli
52	60+700	LHS & RHS	Chikkanagamangala
53	61+800	LHS & RHS	Doddanagamangala
54	62+750	LHS & RHS	Doddanagamangala

2.20.2 Rest Areas

Rest areas are proposed at 3 locations, one each in each section (Tumkur Road to Ballari Road, Ballari road to Old Madras Road and Old Madras Road to Hour Road). The rest areas are proposed near the interchanges and the precise locations are dependent on the extent of land acquisition proposed by BDA. The facilities included in the rest areas are toilets, rest rooms, dormitory, ATMs, medical shops, dispensary, repair shops, service centres, vulcanizing shops, spare parts shops, telephone booth, canteens and refreshments. Rest areas will be well landscaped along with high mast lighting facilities to ensure an appealing environment.

2.20.3 Toll Plaza

The main road of PRR will be a tollable road. BDA is desirous of collecting toll for main road users. Details of proposed Toll Plazas are given below.

Table 2.17: List of proposed Toll Plazas along PRR

Sl. No.	Location	Design chainage (m)	Remarks
1	Tumakuru road interchange	1+030.000	Main road toll plaza
2	Hesaraghatta ROB / Grade Separator	5+500.000	Entry and Exit plaza - right side of interchange
3	Doddaballapur road grade separator	13+365.000	Entry and Exit plaza - left side of interchange
4		15+616.000	Entry and Exit plaza - right side of interchange
5	Ballari road grade separator	17+840.000	Entry and Exit plaza - left side of interchange
6		19+540.000	Entry and Exit plaza - right side of interchange
7	Hennur road grade separator	24+600.000	Entry and Exit plaza - left side of interchange
8		26+434.000	Entry and Exit plaza - right side of interchange
9	Old Madras road grade separator	35+085.000	Entry and Exit plaza - left side of interchange
10		36+934.000	Entry and Exit plaza - right side of interchange
11	Whitefield road	38+200.000	Entry and Exit plaza - left

Sl. No.	Location	Design chainage (m)	Remarks
	grade separator		side of interchange
12		39+800.000	Entry and Exit plaza – right side of interchange
13	Channasandra road grade separator	44+650.000	Entry and Exit plaza – left side of interchange
14		45+780.000	Entry and Exit plaza – right side of interchange
15	Bangalore Sarjapura road grade separator	56+000.000	Entry and Exit plaza – left side of interchange
16		57+724.000	Entry and Exit plaza – right side of interchange
17	Hosur road interchange	65+200.000	Main road toll plaza

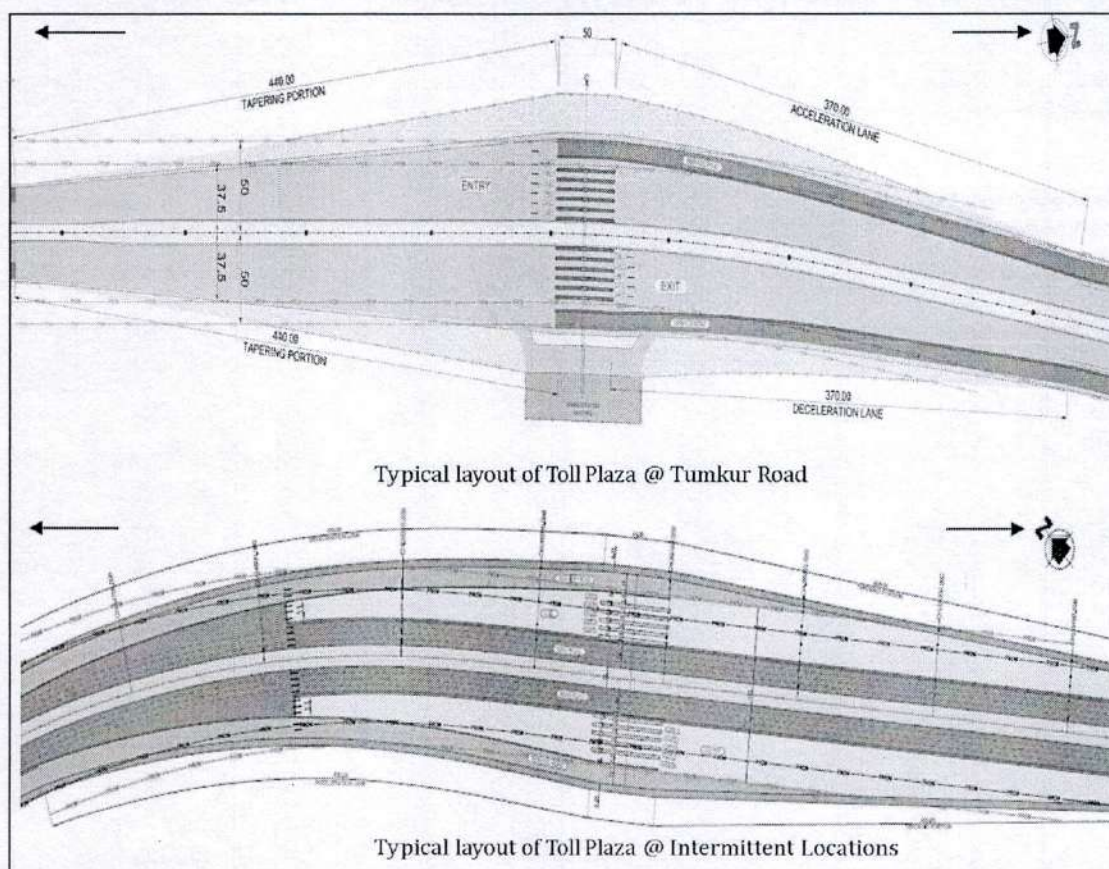


Fig 2.24: Typical layout of Toll Plaza

2.21 Road Furniture and Safety Measures

2.21.1 Road Signs

As per the IRC guidelines (IRC 67-2012) and MoRTH guidelines (Section 802), provisions of Cautionary, Mandatory and Informatory road signs have been made based on the situation and function. The details of types of road signs are as given below;

- Mandatory/Regulatory Signs:** Regulatory signs are mostly circular and include all signs which give notice of special obligations and restrictions. Violation of these signs is considered an offense since these signs impose legal restriction on traffic.
- Cautionary/Warning Signs:** Cautionary signs are usually triangular in shape with red border and black symbol or a message on white background. These signs warn the road

users regarding the existence of certain hazardous conditions either on or adjacent to the road.

- c) **Informatory Signs:** Informatory signs guide the road users about the destination, distance, and provide other information making the road travel easier and safe. All Informatory signs and Guiding signs for facilities are rectangular in shape. Informatory Signs for facilities indicate location and direction to facilities like "fuel station" or "eating place" or "parking" and shall be a symbol within a rectangular board with blue background. Information signs in rectangular shape are also used with destination names and distances with arrows indicating the direction.

The road construction and maintenance signs will be implemented as per IRC IRC:67-2012; Code of Practice for Road Signs. Each sign will be made of High Intensity Grade Retro-Reflective sheeting or Prismatic grade and will be placed at locations where the message can be seen clearly. However, as specified in the IRC guidelines (IRC:67- 2012), sign plates will be made up of theft-proof Aluminum Composite Material (ACM) which is considered cheaper when compared to Aluminum.

Further, Kerb mounted signs and overhead signs shall be supported on GI pipe and gantry or cantilever respectively. Road sign on main road will be with inserts from drain top / at side of central median, while road sign installation on service road will be on footpath edge. All road signs shall be of prismatic grade sheeting corresponding to Class C sheeting and any types of IX or X as per ASTM standards.

2.21.2 Road Markings

Road markings promote road safety by ensuring smooth and orderly flow of traffic. Road markings play a significant role in guiding and controlling traffic on a highway. These serve as barriers signifying the delineation of traffic paths and lateral clearance from traffic hazards for safe movement of traffic. The location and type of marking lines, material and color is planned as per the Code of Practice for Road Markings (IRC: 35- 1997).

As per MOSRTH specification, centre, edge line, give way line, stop line, diagonal/chevron markings, parking, etc shall be painted using hot applied thermoplastic paints with reflect rising glass beads. At toll plaza, transverse bar lines with width of 300 mm and spacing 15-20 m @ c/c shall be provided across the flare approach to toll plaza to reduce speed of vehicles.

2.21.3 Road Delineators

Roadway indicators are used to guide the drivers on the alignment ahead by marking the edges of the roadway. Hazard markers used to define obstructions like guardrails and abutment adjacent to carriageway and bridges which are narrower than the normal width. Object markers are used to indicate hazards and obstructions within the vehicle flow path, for example, channeling islands close to the intersections. Delineators and object markers are provided in as per the guidelines of IRC: 79 1981.

2.21.3.1 Metal Crash Barriers

Metal Beam Crash Barrier is proposed all along the stretch at super elevated sections, sides of drain separating main road and service road. Thire Metal beam rail shall be of W-profile corrugated sheet steel beams comply with the mechanical properties of Tensile strength, Min = 483 MPA, Elongation in 2 inches, Min = 12% and Yield, Min = 345 MPA. Crash barrier system absorbs impact of vehicle and laterally restrains a vehicle from veering off. This ensures minimum damage to the vehicle and passengers.

2.21.3.2 Concrete Crash Barriers

New Jersey concrete barriers are rigid barriers having specifically designed to minimize damage and reduce the likelihood of a car crossing into oncoming lanes in the event of a collision. The barrier will be of pre-cast in M 30 concrete grade preferably having height of 800mm. They are proposed at approaches to bridge structures and median of toll plaza islands.

2.21.3.3 Kilometer Stones

Kilometer stones will be provided as per IRC: 8-1980 guidelines. Kilometer stones will be provided on left-hand side of the road. Further, as per IRC: 26-1967 and IRC: 25-1967, 200 m stones will be provided in between kilometer stones.

2.21.4 Lighting

Illumination for the project road comprises provision of lighting facilities at service roads, Toll Plaza approaches, Roof of vehicular underpass, Toll Plaza canopy, High mast lighting proposed at toll plazas, Rest areas, flyovers and ROB. Illumination level proposed by 40 Lux at all locations and 100 lux for toll roof.

The utilization of solar photovoltaic panels will effectively bring down the cost of electricity by installing solar panels over toll plazas and service road lightings. By using solar street lighting with LED bulbs, 275 kwh and by using solar panels on top of toll plazas 1836 kw of power can be generated and reused.

2.21.5 Footpath

Raised footpath is proposed at edge of service road for pedestrian movement. Footpath is a part of utility corridor with utilities laid below the footpath. Footpath is proposed with interlocking cement concrete paving block of M40 concrete laid over 50mm sand bed. The top surface of footpath will be flush with kerb edge.

2.21.6 Utility Ducts

Utility ducts are proposed across ROW at every 1 Km interval for taking out utility lines. Ducts with 600mm diameter NP4 pipes are proposed. These ducts will be provided with chamber on both sides of utility corridor. In addition, BWSSB has sought provision of box type of structure connecting utility corridor for taking water supply lines. These are provided at every 1 Km intervals. Size of 2m x 2m is proposed.

2.21.7 Cycle Track

Cycle track 2 m is proposed on either side along the PRR to encourage people to use bicycles and this would be helpful in reducing the carbon emissions.

2.21.8 Rain Water Harvesting

The total quantity of rain water harvesting structure is 6,80,616 KLD. As per the guidelines Rain water structures of 0.5 m width and 15 m depth will be provided at every 500 m on either sides of the road (294 Nos) and along the toll plazas (15 Nos) in order to capture the rainwater and utilize it for recharging of ground aquifers. Provisions shall be made for oil and grease removal from surface runoff. Rain water structures will be proposed as per the IRC Guidelines and MoRTH Notification No.: RW/NH-33044/14/2003-S&R(R)Pt.II dt: 03.09.2019. The details are as follows:

Quantum of Rainwater Available (Q) cum/day	
Q=	Catchment Area (m ²) * Runoff Coefficient* Annual Rainfall (m)*Coefficient of evaporation.
Total project area =	10365100 sq.m
Roof area =	24000 sq.m
Avg. rainfall of the study area =	900.3 mm (Source: World weather)
Run off coefficient =	0.8 (Source: ASCE and WPCF)
Avg. Intensity Rainfall recorded =	52.4 days (Source: World weather)
Annual Rainwater Harvesting Potential =	13824 m³/Annum
Run off from Hard Surface (Q) cum/day	
Rainwater harvesting Hard Surface =	2058000 sq.m
Avg. rainfall of the study area =	900.3 mm (Source: Weather-atlas)

Run off coefficient =	0.6 (Source: ASCE and WPCF)
Avg. Intensity Rainfall recorded =	52.4 days (Source: Weather-atlas)
Annual Rainwater Harvesting Potential (Hard Surface) =	666792 m³/Annum
TOTAL RAINWATER POTENTIAL=	680616 m³/Annum

2.21.9 Requirement of Construction Materials

Table 2.18: Quantity required for construction activities

Project Phase	Coarse Aggregate in MT	Fine Aggregate in MT	Cement in MT	Bitumen in MT	Steel Reinforcement in MT	Emulsion in MT
Construction	54,66,120	8,82,280	4,70,850	56,990	97,260	1,160
Operation (for one year)	3,27,970	1,05,880	47,090	5,700	3,890	120
Maintenance period (once in 5 years)	16,39,840	3,97,030	1,41,260	2,84,500	29,180	580

2.21.9.1 Sourcing of Construction Materials

Construction materials will be borrowed from nearby approved quarries and crushers in Bangalore (Rural) and Bangalore (Urban) Districts. The list of approved quarries and crushers were obtained from Mines and Geology Dept., GoK. Based on these details, strip plan is prepared and given below. Borrow areas will be identified as per MOEF&CC guidelines at the time of execution.

2.21.9.2 Cutting and Filling of earth work

Excavated earthwork is estimated to be 95 Lakh cum. However, 138 Lakh cum of earthwork will be utilized in filling for embankment, subgrade and shoulders. Therefore, remaining 43 Lakh cum of earthwork will be obtained from the nearby borrow areas. Cutting and filling details of the project are given in Annexure-14. Borrow areas will be identified as per the specification and details provided in Chapter-9.

2.21.10 Use of fly ash

As per MOEF&CC Notification, 30% fly ash will be utilized for embankment by following the guidelines of IRC SP: 58 2001. The details of Thermal Power Plants available within 300 Km from the project site given below where fly ash is available. MoU will be made with these plants for sourcing by following the detailed procedures as given in Chapter-9.

Table 2.19: Details of Thermal Power Plants

Sl.No	State	Name	Capacity in MW	Qty. of fly ash generated MTA	Aerial Distance in KM
1	Karnataka ³	Himatsingka Linens, Plot No. 1, SEZ, KIADB Industrial Area, Hanumanthapura Post, Hassan.	12.5 MW (captive)	4591	155
2		Grasim Industries Ltd, Kumarapatnam, Ranebennur Taluk, Haveri district.	20 MW (Captive)	60,392	243
3		Ballari Thermal Power Station, KPC Ltd. Kudithini village, Ballari Taluk and district	2 x 500 MW 1 x 700 MW	59,43,461	250
4		JSW Energy Limited,	2 x 130 MW	86,092	252

³<https://kspcb.gov.in/ash.html>

Sl.No	State	Name	Capacity in MW	Qty. of fly ash generated MTA	Aerial Distance in KM
		Thoranagallu, Ballari district	2 x 300 MW	2,35,871	
5		BMM Ispat Ltd, Ballari	25MW 3X70 MW	15000 TPA 150,000 TPA	263
6		The Sandur Manganese & Iron Ores Ltd.) Vyasankere, M.M.Halli-583222. Hospet, Ballari (Dt.),	32 MW (Captive)	12001 TPA	265
7		Udupi Power Corporation Ltd., Yellur, Padubidri, Udupi.	2 x 600 MW	1,25,304	290
8	Tamil Nadu	Mettur Thermal Power Station, Mettur Dam, Salem District.	2 x 410 MW 1 x 600 MW	Data NA	122
9	Andhra Pradesh	Fountain, V V Reddy Colony - RTPP Staff Quarters, RTPP Colony, Kadapa District.	1 x 600 MW	Data NA	200

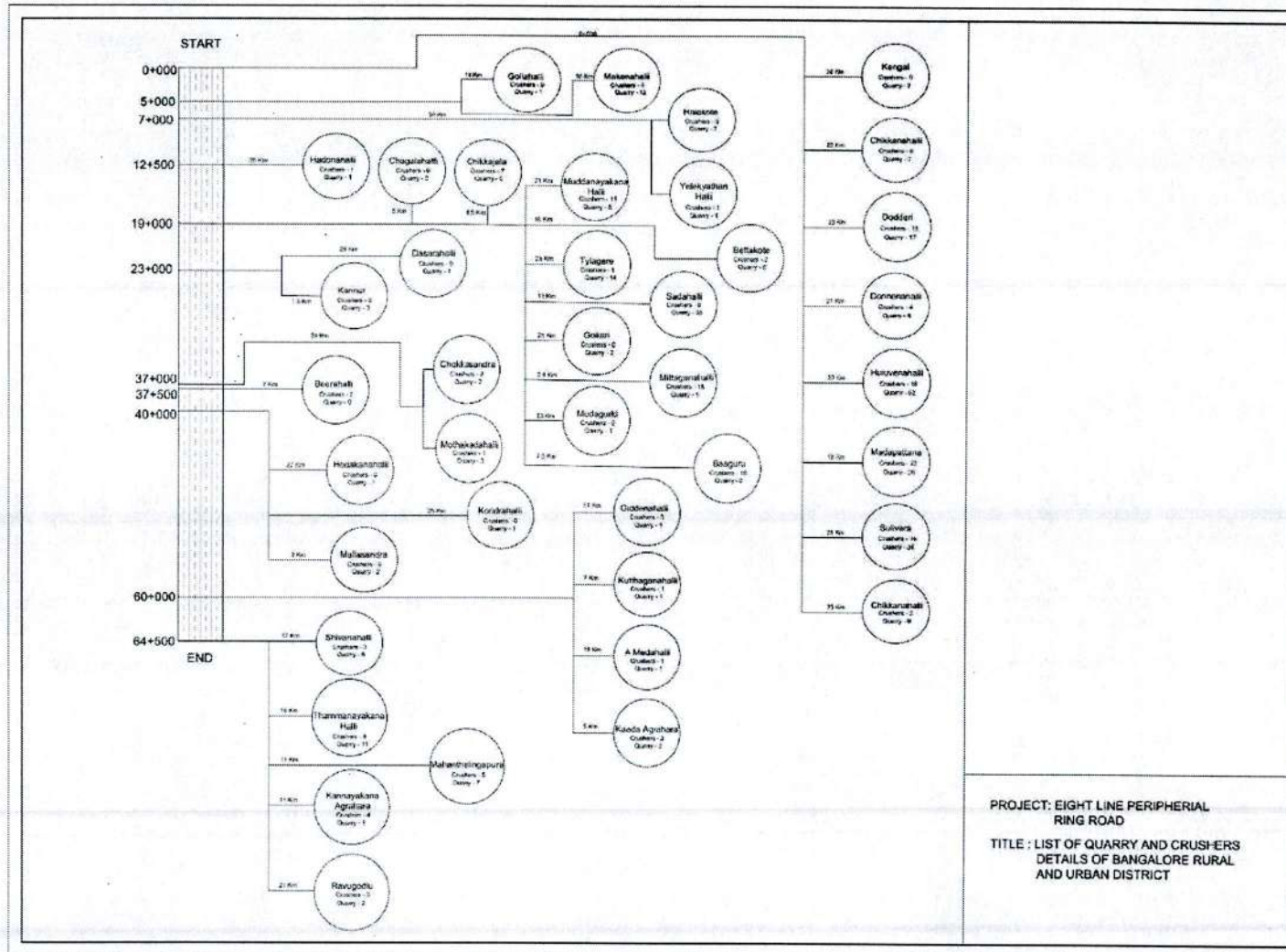


Fig 2.25: Strip plan showing quarries and crushers along the PRR alignment

2.21.11 Calculation of Carbon Footprint from the project

A carbon footprint is a commonly used terms to describe the total amount of carbon dioxide and other greenhouse gas emissions for which an individual or organization is responsible. The carbon footprint of a road can be defined as the total amount of CO₂ and other GHGs (direct and indirect) emitted over the full life cycle of a road, i.e., Construction, operation and maintenance phases. The International Road Federation states that improving traffic fluidity reducing congestion, and hence lowering fuel consumption is an effective way of reducing GHG emissions⁴.

As suggested by ADB for calculation of carbon foot print for the road projects, during construction phase, parameters such as embodied carbon in construction materials, use of fossil fuels, removal of vegetation and use of construction machinery and vehicles were considered. Similarly, during operation phase, embodied carbon in fossil fuels, vehicles were taken into account. Further, during maintenance phase, embodied carbon in construction materials and fossil fuels were considered. By using emission factors for the various parameters, CO₂ estimation was calculated.

Table 2.20: Estimated carbon footprint for PRR project

Project Phase	Construction Phase*	Operation Phase	Maintenance Phase	Total
Particulars	Materials	Traffic	Materials & Fuels	
CO ₂ (tons/km)	7,767.00	23.39	373.23	8,163.62
CO ₂ (tons/73.5 km)	5,70,874.5	1,719.17	27,432.41	6,00,026.08

*Note- CO₂ sequestration of trees not included

A total of 6 Lakh tonnes of carbon dioxide is estimated to be released into the atmosphere during construction, operation and maintenance phases of the proposed PRR project. Further, a total of 36,824 trees with the carbon sequestration capacity of 3,728.09 tonnes of CO₂ are proposed to be removed from the project.

2.21.12 Land Acquisition, Rehabilitation and Resettlement

Project requires 1036.51 ha of land and rehabilitation of 1,395 structures. Project also requires 7.73 Ha of forest land in Jarakabande Kaval RF. The private land will be acquired as per the BDA Act, 1976 (as per the provisions of Land Acquisition Act, 1894) and forest land will be diverted as per the provisions of the Forest (Conservation) Act, 1980. Details of land acquisition, R&R, etc is provided in Chapter-7 of this report.

2.21.13 Landscaping and Green Belt Development

Aesthetic of areas surrounding the roadways are a prime consideration in the design of roads. This must be in the line with road safety considerations. Landscaping of the environment in the vicinity of roads contributes in a number of ways like Control of soil erosion, Noise abatement, Safety barrier, Glare reduction at night from oncoming traffic, Visual barrier where ever required, Indicative guide for direction of traffic movement, Scenic beauty – psychological comfort. Space available within 100 m ROW for landscaping and arboriculture for the project road are 5 m on either side of the main carriageway, central median, edge space between utility corridor and ROW, central space at interchange loops. Arboriculture for the project includes turfing with sods central median to provide aesthetic look and to prevent soil erosion, Shrubs all along the central median at ends of median to sufficient height to prevent night glares and Turfing with sods between ROW and utility corridor. The details of green belt development are provided in Chapter-9 of this report.

⁴ADB Transport and carbon dioxide emission: forecast, options analysis, and evaluation. ADB sustainable development working paper series. Asian Development Bank. 2009; <http://www.indiaenvironmentportal.org.in/files/TRANSPORT-CO2-Emission.pdf>.

2.21.14 Provision of Intelligent Transport System (ITS)

Intelligent Transport Systems (ITS): have been used in advanced countries to improve performance of the existing infrastructure and transport system for better safety, efficiency, comfort and reducing adverse environmental effects. ITS comprises a wide range of information and communication technologies and is applied in the field of transport to improve road/traffic management and enhance convenience of users, thereby maximizing the existing road capacity. Proposed ITS for PRR comprising of following aspects.

- **Establishment of BITC:** Bengaluru Traffic Information Centre (B-TIC) will be established as a central control centre to collect traffic data, analyze the collected data, generate congestion information and analytic result, disseminate to road users and share with relevant authorities.
- **Probe System:** Probe system collects vehicle tracking information dynamically. A probe device installed in a vehicle consists of Global Positioning System (GPS) unit, processor unit, communication unit and power supply unit. The probe device periodically sends real time traffic data such as vehicle position and recorded time to the central system. The probe data collected periodically at the centre is analysed to dynamically generate travel time and travel speed on the road network of digital road map. The analysed data is converted into traffic congestion information and provided to road users. Historical probe data is also used for traffic management and urban development planning.
- **Que Line Measurement System:** A queue length measurement system using vehicle detector will be installed for supplemental purpose for the probe car system.
- **Automatic Traffic Counter cum classifier System:** ATCC system will be installed to measure traffic volume classified into large and small sizes. This is for the purpose of utilizing the measured data for road and traffic management such as planning/evaluation of new road construction, road widening, etc.
- **CCTV Camera System:** CCTV cameras will be installed to monitor the present traffic, road and weather conditions at accident-prone spots.
- **Variable Message Sign (VMS) System:** VMS will be installed to provide information on road, traffic and weather conditions to drivers on the road.
- **Advanced Traffic Signal System:** Area traffic signal control system will be upgraded and signal timing will be automatically adjusted based on the prevailing traffic condition gathered by the vehicle detector and in coordination with other signals in the area.
- **Compulsory Fast Tag for all Vehicles:** FASTag is a simple to use, reloadable tag which enables automatic deduction of toll charges and lets you pass through the toll plaza without stopping for the cash transaction. FASTag is linked to a prepaid account from which the applicable toll amount is deducted. The tag employs Radio-frequency Identification (RFID) technology and is affixed on the vehicle's windscreen after the tag account is active.
- **Highway Traffic Management System:** The Highway Traffic Management System (HTMS) is a system that helps the operator of the Peripheral Ring Road (PRR) to safely and efficiently manage the traffic on the PRR. System consists of three parts of information collection, information processing and surveillance, and information dissemination. In addition, information will be exchanged with other relevant organizations and road users.

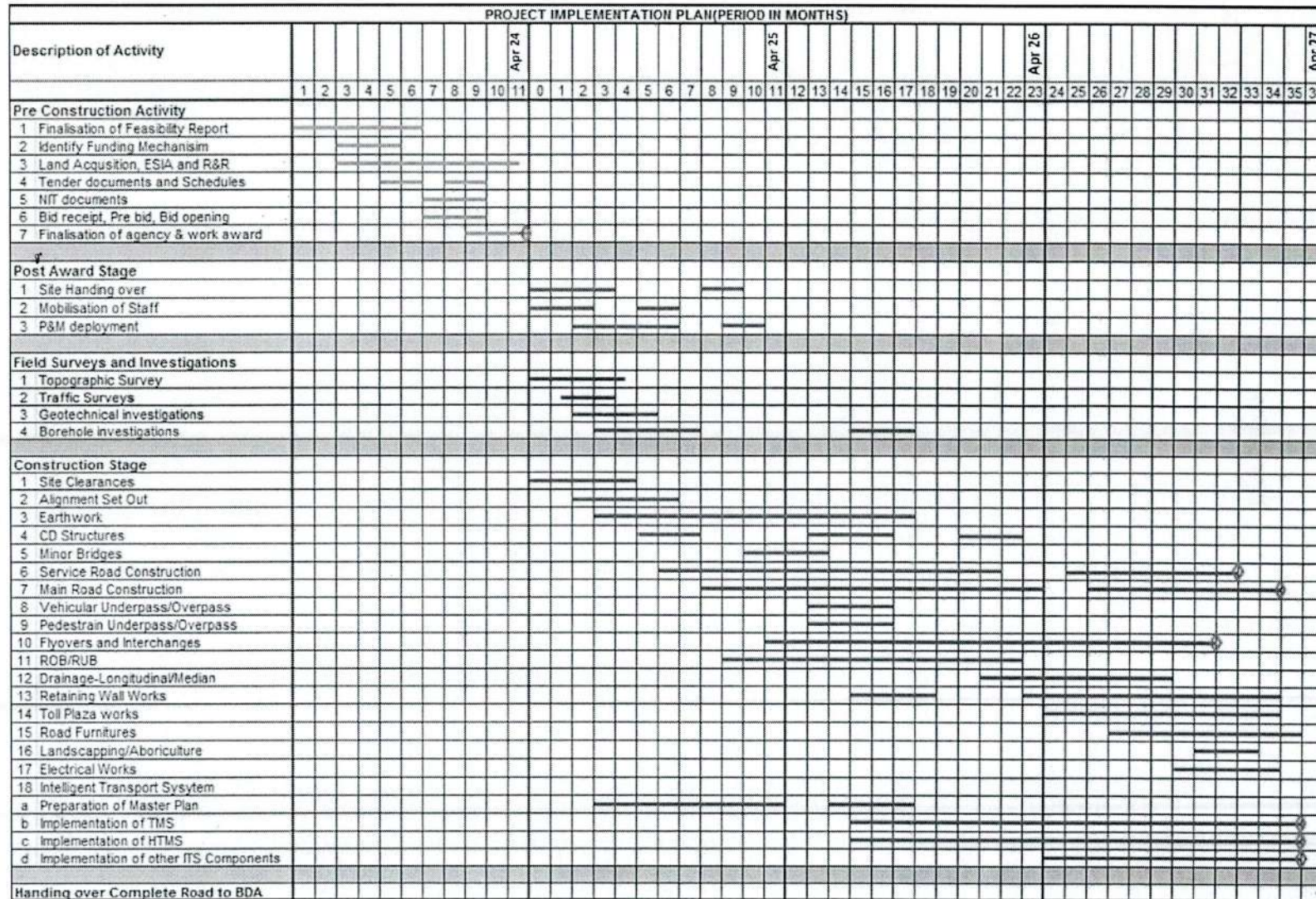
2.21.15 Project Cost

The project cost is estimated to be Rs. 14,934 crores. Out of which, Rs. 9,318 Crores will be earmarked for land acquisition and R&R aspects. Technical construction cost of Rs. 4340 Crores will be availed from Japan International Cooperation Agency (JICA) in the form of loan. State Government will bear the remaining cost of the project. As per the recommendation of TAC, BDA, the project will be taken up in EPC mode and the project implementation schedule is given in 2.21.16.

2.21.16 Summary of project details

Sl.No	Description	Quantity
1	Length of the alignment (Km)	73.50
2	Width of the alignment (m)	100
3	No. of bridges a. Major b. Minor	a. Nil, b. 12
4	No. of Culverts	51
5	No. of intersections	10
6	No. of Railway crossings	5
7	No. of villages through which alignment is passes	77
8	Population of the villages through which alignment passes	6,06,975
9	Length of the alignment proposed in forest area (m)	773
10	Width of the alignment proposed in forest area (m)	100

2.21.17 Project implementation schedule



Chapter
3

BASELINE ENVIRONMENT SCENARIO

3.1 Environmental settings

Baseline environmental data collection in the project area helps to identification and prediction of impacts occur due to the proposed project on different environmental components. It acts as preliminary first hand information on environmental attributes to be monitored during and after the proposed project. The environmental settings w.r.t the proposed PRR is given below;

I. Project alignment	
Location of the project	Starting point: Tumakuru Road (13°3'20.98"N, 77°28'37.39"E) Ending point: Hosur Road (12°51'29.46" N, 77°39'45.69" E) Bangalore Urban District, Bangalore Administrative map showing the taluks and villages along the PRR is given in Fig 3.1.
Lakes along the alignment	<ul style="list-style-type: none"> • Tank near Jarakabandekaval Forest from Chainage 11+334 Km to 11+564 Km • Chinnaganahalli Lake from Chainage 37+332 Km to 37+416 Km • Chikkabanahalli Lake from Chainage 39+003 Km to 39+227 Km • Gunjur Lake from Chainage 51+931 Km to 52+468 Km • Thirumenahalli lake from Chainage 64+300 km to 64+690 km • Chikkatogur lake from Chainage 22+130 km to 22+250 km
Length of PRR	73.5 km
Climate and meteorology	Maximum temperature:31.05°C Minimum temperature:11.25 °C
Agro-climatic zone	Eastern Dry Zone
Type of land use and vegetation pattern at the project site	Mixed Land use: Agricultural area, Residential, Commercial and Industrial areas Vegetation: Dry deciduous type with thorny undergrowth
Topography	Deccan plateau at an elevation of over 900 m
Soil type	Loamy to sandy loam as per texture and classification
Biological resources at the project site	<i>Cocos nucifera</i> , <i>Grevillea robusta</i> , <i>Eucalyptus globules</i> , <i>Acacia nilotica</i> , <i>Mangifera indica</i> , <i>Tectona grandis</i> , <i>Azadirachta indica</i> , etc.
Cultural Resources near the project site	Byraveshwara temple at Kuduregere & other sensitive receptors as provided in Chapter-7
Protected Area/Wildlife Sancturaries/ Eco-sensitive areas/ Reserve Forest	Nil
Forest land required (ha)	7.73 Ha of forest land in Sy. No. 59 belonging to Jarakabandekaval RF
Interstate Boundary	Tamil Nadu- 8.27 Km

Nearest IMD	Bangalore
Nearest CWC station	T. Bekuppe at Ramanagara across River Arkavathy (45.85 km from Hosur -NICE road Junction)
Nearest Railway Station	Yelahanka Railway Station: 2.29 Km and Yeshwanthpur Railway Station: 8.72 Km
Nearest Airport	Bengaluru International Airport (Kempegowda International Airport): 13 Km
Earthquake Zone	Seismic Zone II (Least Active zone)
Toposheet Nos.	57 G/8, 57G/12, 57G/16, 57H/13 & 57H/9
Influencing Catchment area	Thippagondanahalli Catchment Area
Nearest Critically Polluted Areas (CPAs) identified by CPCB	Peenya Industrial Area -3.4 km (Severely Polluted Area) Jigani-Bommasandra Industrial Area-4 Km (Critically Polluted Area) Map showing the industrial areas and various land uses along the PRR is given in Fig 3.2.
Gas pipeline	About 3.9 km of gas pipeline alignment (CH 28+350 km to CH 31+615 km) passes adjacent to the proposed alignment and intersects the alignment at two points namely at chainages CH38+824 km and CH6+875 km.
II. Study area	
Climate & Rainfall	Average temperature: 23.1 °C Annualrainfall:890 - 1157 mm (Stations- Bangalore North, South, East and Anekal; Period-2001-2010)
Soil type	Red Loamy Soil, Red Sandy Soil, Laterite Soil & Clay Soil
Geology	Supracrustal rocks, Peninsular Gneissic Complex, Younger Granites, Granulites, Migmatite, Grey Granite, Granitoid Gneiss, Biotite Gneiss and Biotite Hornblende Gneiss etc.
Rivers & Streams	<ul style="list-style-type: none"> Arkavathy River-2.38Km Vrishabhavathi River-8.67Km
Biological resources in the study area	<i>Acacia auriculiformis, Dalbergia sissoo, Phanera purpurea, Azadirachta indica, Peltophorum pterocarpum, Artocarpus heterophyllus, Pongamia pinnata, Swietenia mahagoni, Tecoma stans, Terminalia catappa, Tamarindus indica, Tectona grandis, Terminalia elliptica, Ficus religiosa, etc</i>
Protected Area/Wildlife Sancturaries/ Eco-sensitive areas/ Reserve Forest	<ul style="list-style-type: none"> Bannerghatta National Park - 7.75 Km (Fig 3.3) Puttenahalli Bird Conservation Reserve - 1.49 Km (Fig 3.3.)

Assessment of the baseline environmental status was made based on the primary baseline data collection in the RoW and the area falling within 500 meters on the either side of the RoW along with secondary data collection within an aerial distance of 15 km. The data was collected for one season (December 2019-February 2020) and due to change in alignment of PRR, tree enumeration and socio-economic studies were conducted in the realignment area during February, 2022 and March, 2022. Further, field inspection in the study area, primary and secondary data collection, discussions of experts with Government officials and general public. The presented status of baseline environment comprises of Physical environment, Land use assessment of study area, Biological (Terrestrial) Environment, Aquatic Environment and Socio - economic Environment.

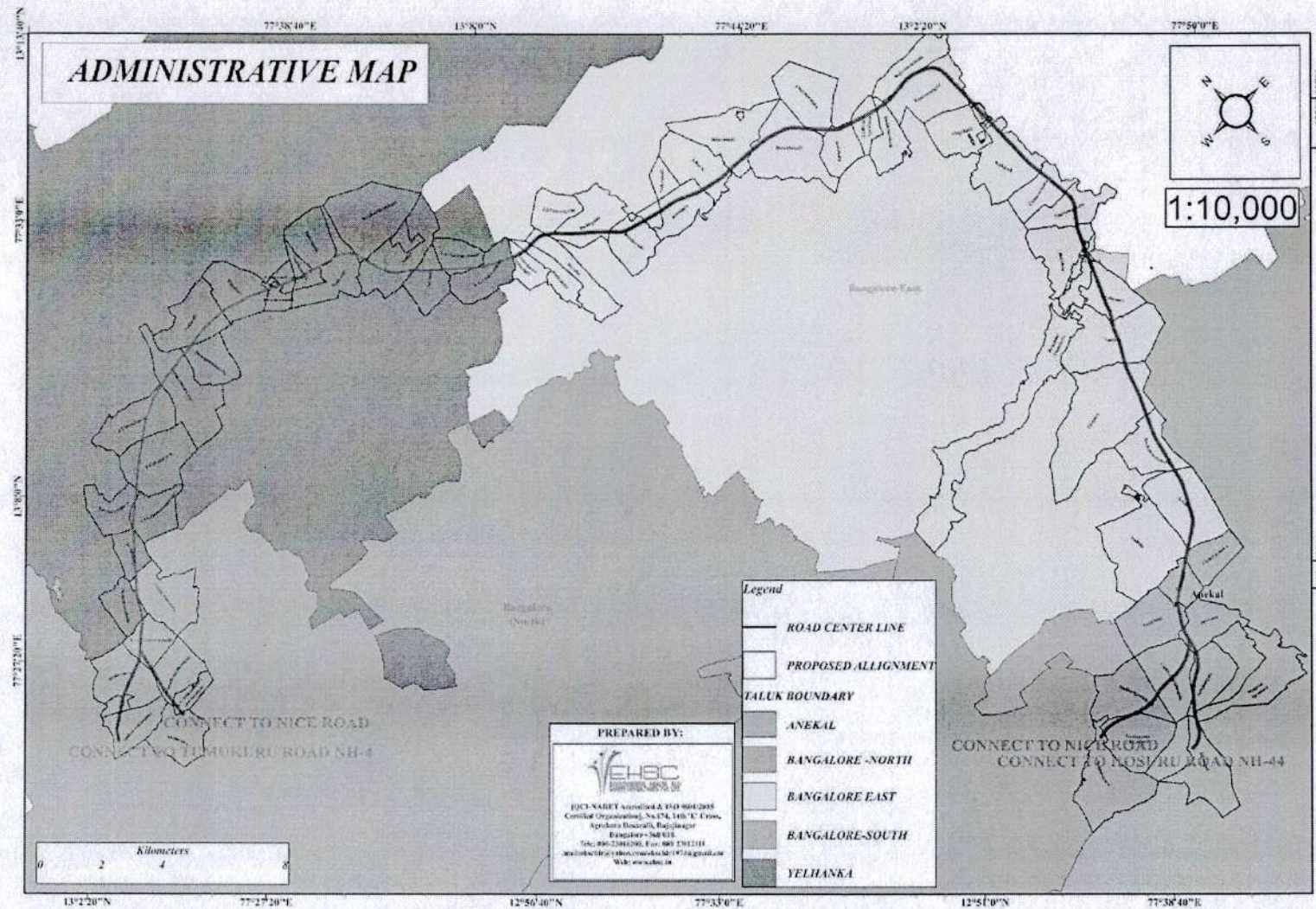
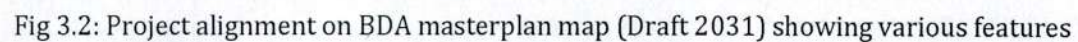


Fig 3.1: Administrative boundaries of the study area



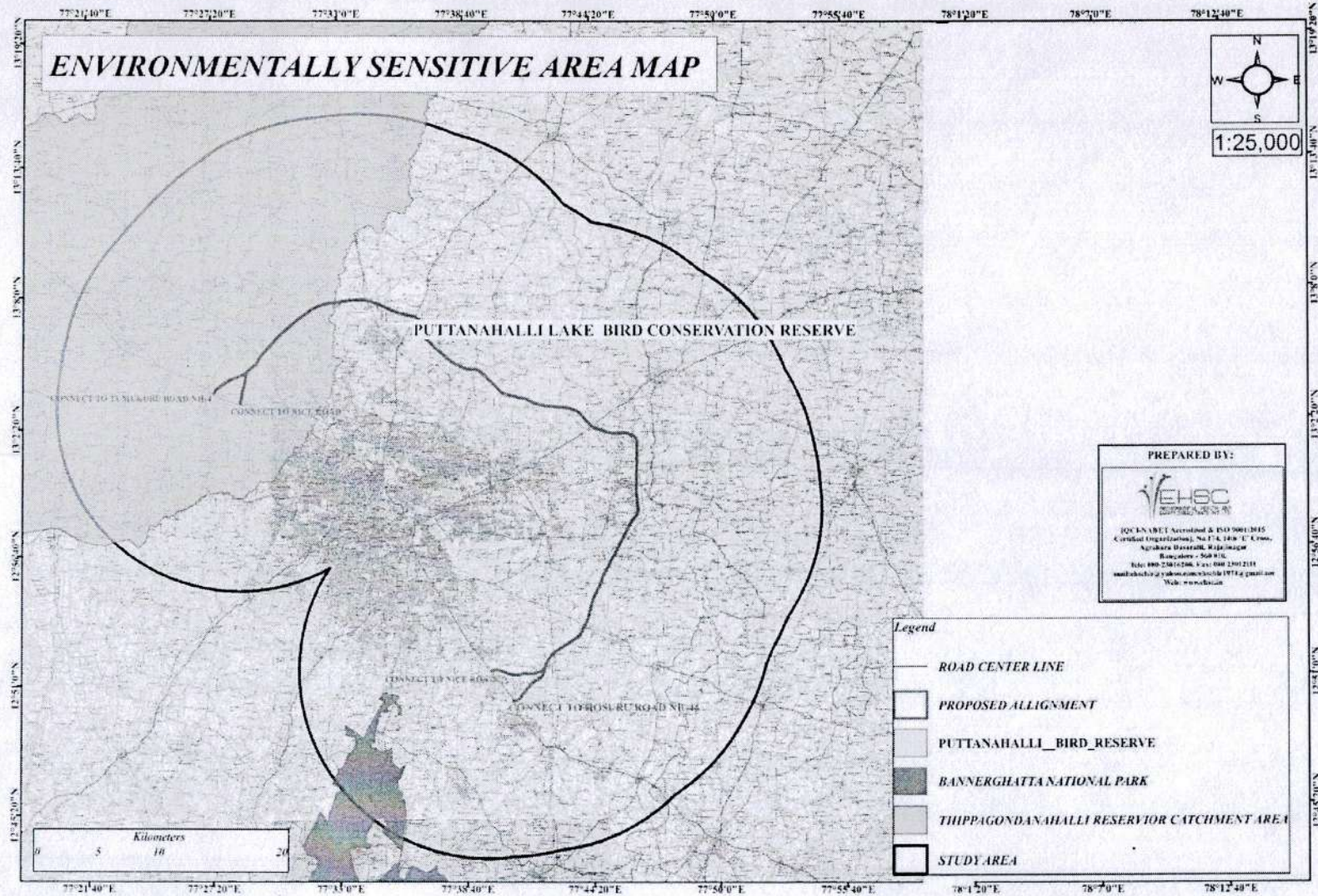


Fig 3.3: Environmental Sensitive Areas in the study area

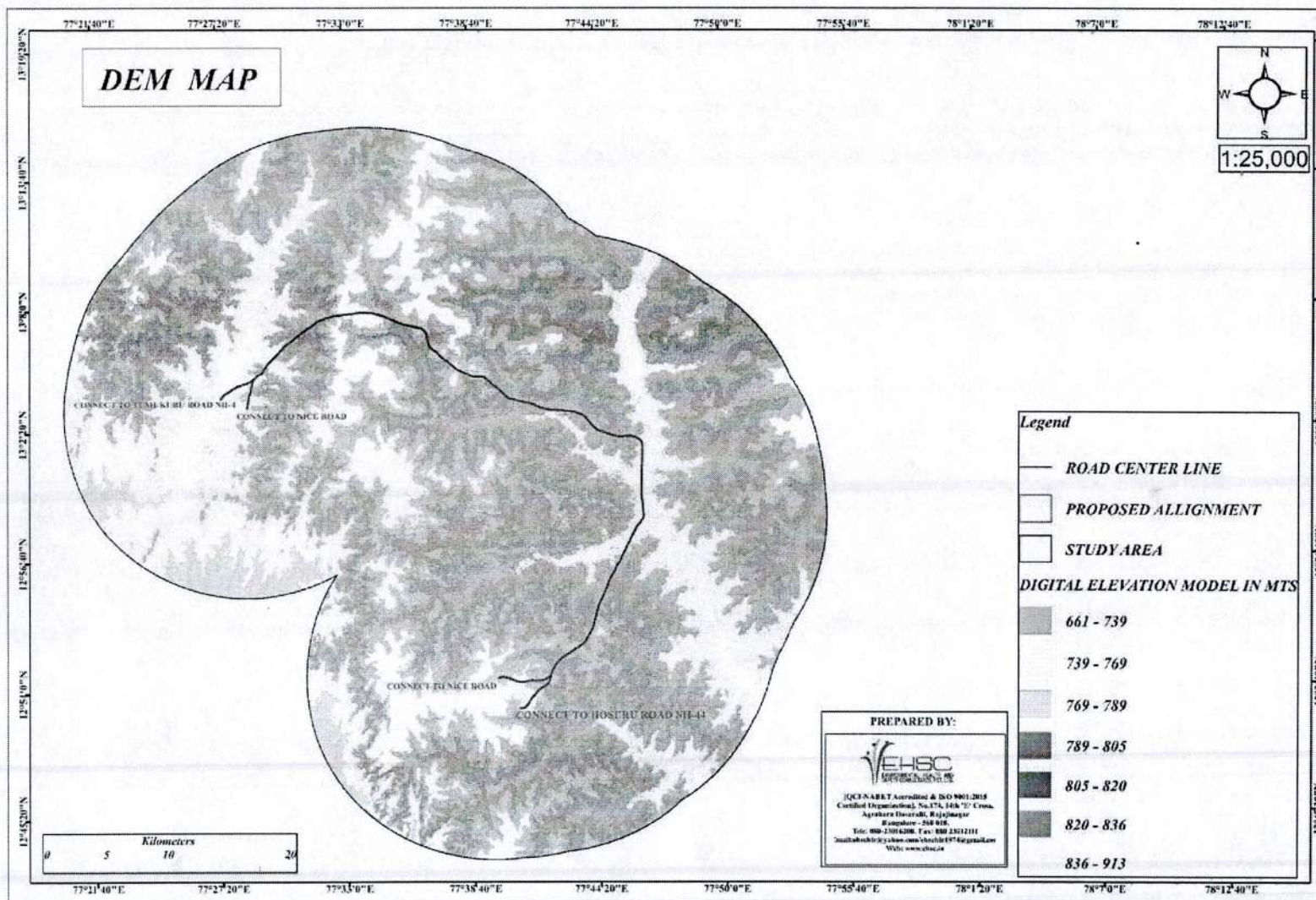


Fig 3.4: Digital Elevation Map (DEM) showing the project alignment and study area

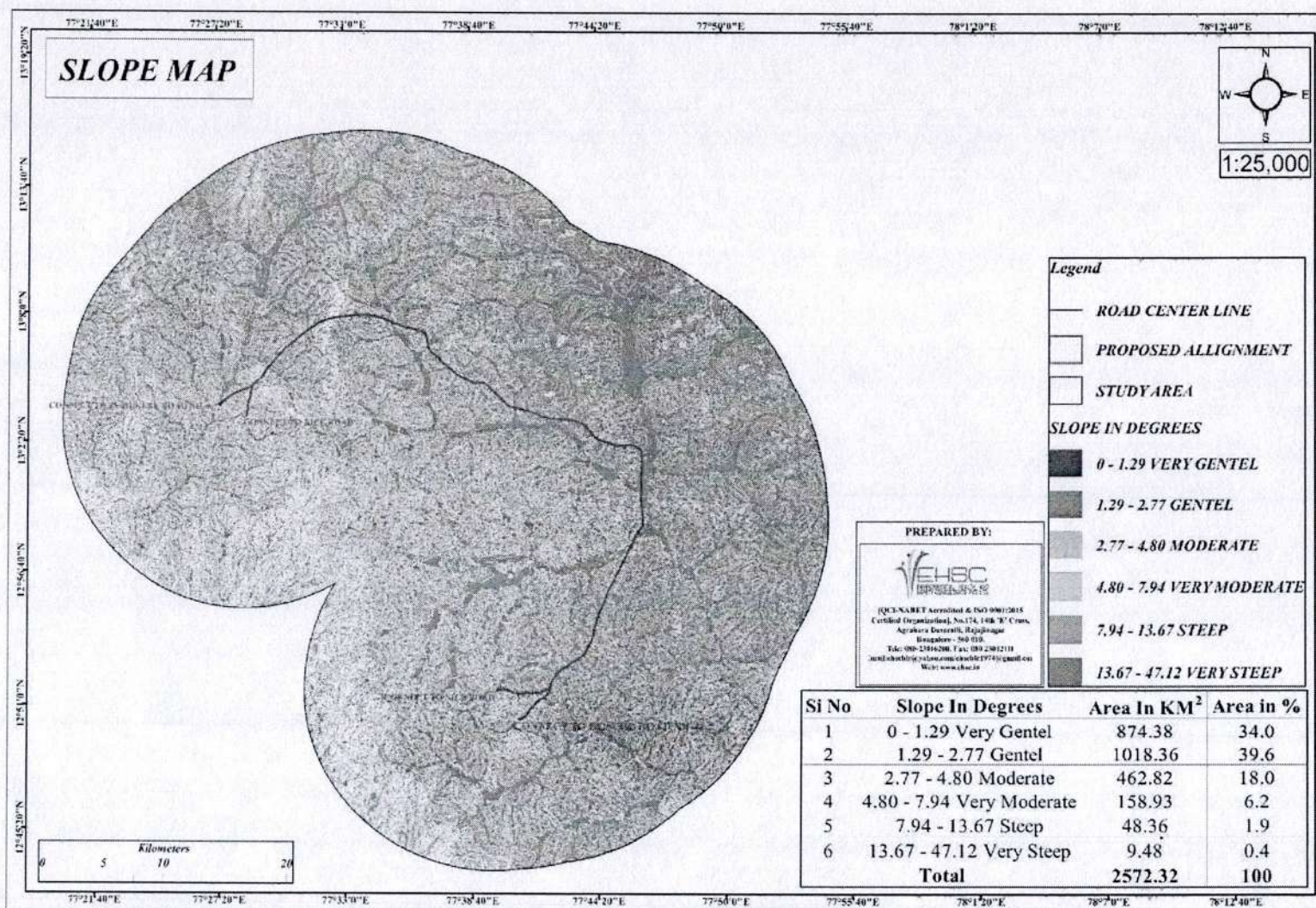


Fig 3.5: Slope map of the project alignment and study area

3.2 Physical Environment

3.2.1 Topography

The proposed project is located in the Deccan Plateau of India. As per DEM map (Fig 3.4), the elevation along the proposed alignment and the study area ranges from 661 m to 836 m. Most of the PRR project alignment falls under Plain terrain (0-10%) as per IRC standards where cutting and filling of earthwork is minimum. The slope map (Fig 3.5) also indicates that the slope ranges from very gentle to very moderate slope all along the alignment (0-7.94%). Hence, slope stability will not affect the proposed project construction.

3.2.2 Climate & Meteorology

Air quality modeling and dispersion studies has been carried out by using the meteorological data which plays a significant role in identifying the general meteorological status of the region and understanding the baseline condition. Secondary meteorological data was collected from IMD.

As per IMD reports, Temperature of Bangalore was ranging from 15.6°C -35.1°C during year 2000 -2017. However, highest mean temperature was recorded in January. In general, December is noted to be the coldest month, with 22°C as the mean temperature. Temperature ranges between 18.2°C to 28.7°C during the post monsoon season. Temperature ranges between 15.6°C to 35.1°C during the winter season. The climate of the district is hot and dry. Hot season starts from middle of the February to end of May. Cold season is from December to middle of February. The annual average rainfall of Bangalore urban district was 848 mm and whereas in 2017, the district has received an annual average rainfall of 890 mm (+4.95%), 861 mm in 2018 (+1.53%), 923 mm in 2019 (+8.84%). Wind rose collected from IMD-Pune also reveals that, the maximum windblown direction is East and West annually. During Pre- monsoon season the same trend was observed.

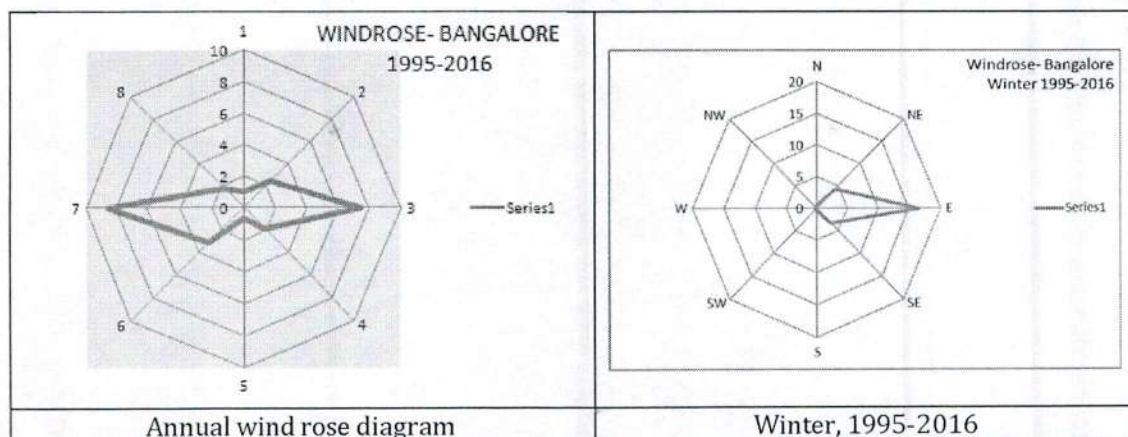


Fig 3.6: Wind direction details obtained from IMD, Pune for Bengaluru city from 1995-2016

3.2.2.1 Meteorological data monitored at site for the study period

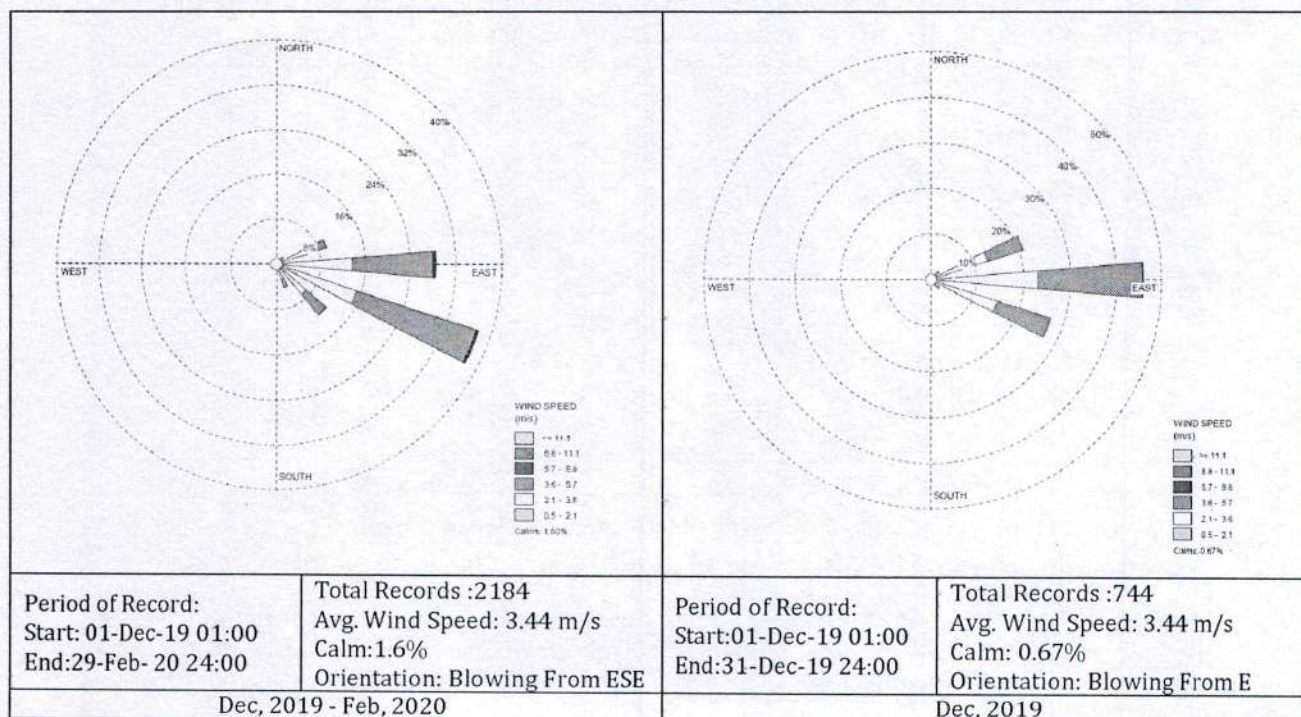
The meteorological factors affect a range of atmospheric features and dispersal of pollutants. The horizontal and vertical distribution of air pollutants in any given season depends on meteorological parameters and their frequent changes. The essential meteorological parameters are wind speed, wind direction, ambient air temperature, relative humidity, rainfall and atmospheric pressure.

Meteorological monitoring at project site was carried out during the study period. Solar Radiation (Watt / sq. m), Relative Humidity (%), Temperature (°C), Rainfall (mm), Wind Direction (Deg), Wind Speed (km/hr), Wind Gust (km/hr) and Dew Point (°C) was recorded through installation of Watchdog 2900 ET. Monthly average meteorological data are given below;

Table 3.1: Meteorological data collected at site

Month		Sensible Heat Flux	Wind Speed - Ws	Temperature - temp	Precipitation Rate	Relative Humidity	Surface Pressure
		W/m ²	m/s	C	mm/hr	%	mb
Max.	Dec, 2019	226.7	5.78	29.0	1.59	100	918
Min.		-999	0	14.6	0	41	913
Avg.		28.3	3.4	20.8	0.0	83.5	915.9
Max.	Jan, 2020	285.7	6.57	31.0	2.03	100	919
Min.		-999	0	12.3	0	16	912
Avg.		17.2	3.2	21.4	0.0	69.6	915.9
Max.	Feb, 2020	349	6.9	32.1	1.36	99	920
Min.		-999	0	12.4	0	16	912
Avg.		67.4	3.9	22.6	0.0	60.4	916.1

During the study period, maximum sensible heat flux observed to be 349 W/m² during February 2020. Maximum Temperature recorded during study period was 32.1°C. Light precipitation of 1.66 mm/hr observed during study period. The monthly average temperature is less than the annual mean temperature (22°C.) in Dec (20.8°C.) and Jan months (21.4°C.) and slightly increasing in February (22.6°C.) during the study period.



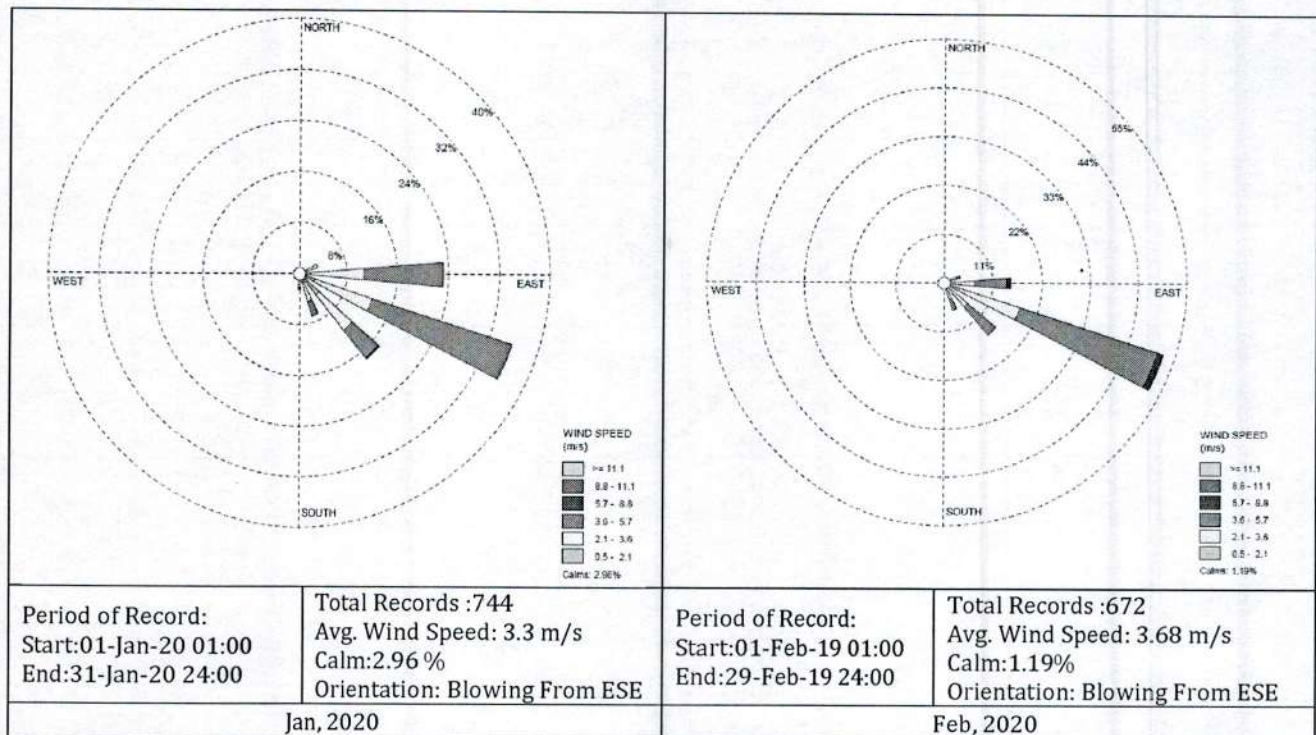


Fig 3.7: Wind rose diagram for the period

During the study period, Avg. Wind Speed is 3.44 m/s with Calm: 1.6% blowing from ESE and the downwind direction was WNW.

3.2.3 Ambient Air Quality

KSPCB is continuously monitoring the AAQ in Bangalore city at various locations. As per the reports of December, 2019, the AAQ index was found to be 'satisfactory (51-100)' at 10 locations out of 13 monitored locations and the prominent pollutant was PM_{10} .⁵ Similarly, in the month of January, 2019, out of 11 monitored locations, 5 locations falling under 'moderate (101-200)' range, 4 locations are 'satisfactory' and 2 locations were in 'good (0-50)' range⁶.

3.2.3.1 Methodology for AAQM

As part of baseline environment studies, AAQM was carried during the study period as per CPCB guidelines. The details of parameters monitored along with map showing sampling locations are as given below;

⁵https://kspcb.gov.in/AQI-Dec_2019.pdf
⁶https://kspcb.gov.in/AQI-JanM_2019.pdf

Table 3.2: Details of AAQM parameters with analysis methodology⁷

Pollutants			Frequency of Monitoring	NAAQM Standards, 2009	Unit	Method of analysis
Dust	PM ₁₀	Particulate Matter	Weekly twice for 24 Hrs throughout the study period	100	µg/m ³	Gravimetric method
	PM _{2.5}	Particulate Matter		60	µg/m ³	Gravimetric method
Gases	SO ₂	Sulphur dioxide		80	µg/m ³	Improved West and
	NO ₂	Nitrogen Di Oxide		80	µg/m ³	Jacob & Hochheisser Modified Na- Arsenate
	O ₃	Ozone	Weekly twice for 1 Hr throughout the study period	180	µg/m ³	Chemiluminescence (Instrument) method
	CO	Carbon monoxide		4	mg/m ³	Instrumental method
	NH ₃	Ammonia	Weekly twice for 24 Hrs throughout the study period	400	µg/m ³	Indophenol Blue method
	C ₆ H ₆	Benzene		5	µg/m ³	Adsorption and desorption followed
	BaP	Benzo(a) pyrene		1	ng/m ³	Solvent extraction followed by GC analysis
Metals	Pb	Lead	Weekly twice for 24 Hrs throughout the study period	1	µg/m ³	AAS method (Instrumental)
	As	Arsenic		6	ng/m ³	AAS method (Instrumental)
	Ni	Nickel		20	ng/m ³	AAS method (Instrumental)

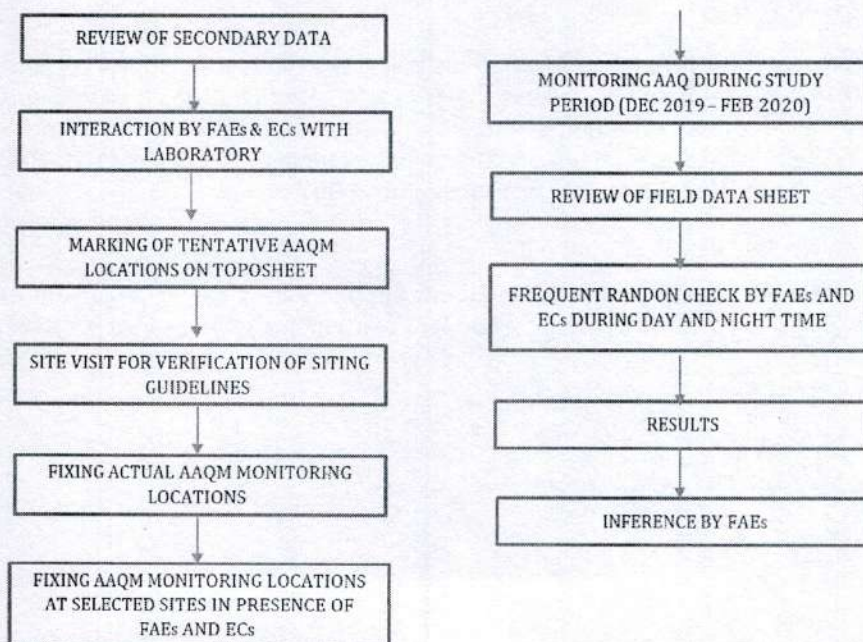


Fig 3.8: Flowchart showing the methodology for AAQM

⁷National Ambient Air Quality Standards - 2009, CPCB, New Delhi.

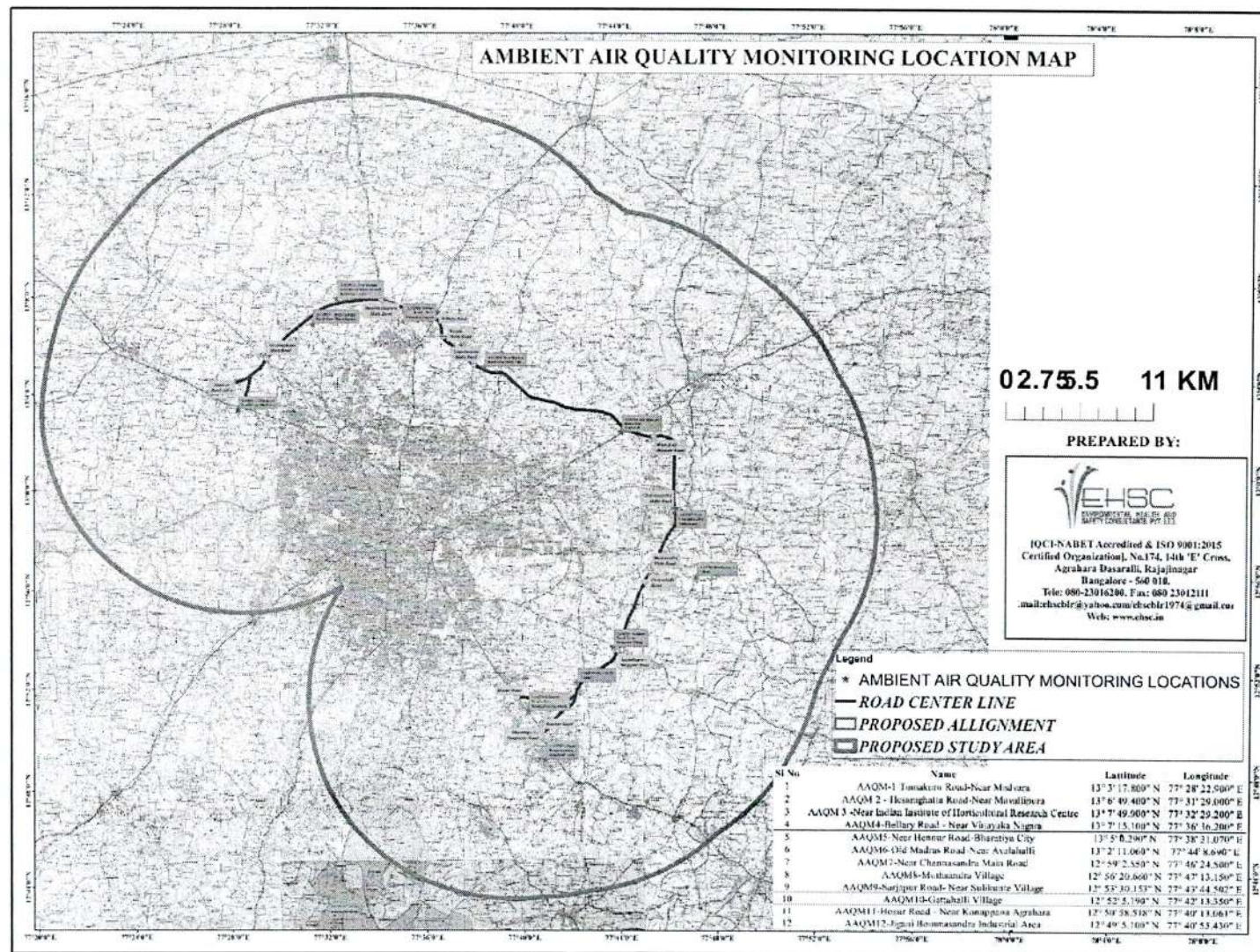


Fig 3.9: Map showing AAQM locations

3.2.3.2 Criteria for setting of AAQM Stations

A network of 12 Ambient Air Quality Monitoring Stations has been selected for assessment of the existing status of air environment within the study area. The selection of monitoring locations is geographically distributed all along the project alignment, land-use and traffic conditions across the proposed alignment including the sensitive receptors along the project. The height of the sampling locations was kept between 3.0 to 6.0 m at all the locations. By considering the Topography, Physical Features, Micro-meteorology data of the region, Proper representation of upwind and downwind directions and ecologically Sensitivity, the sampling locations were chosen. Further, easy accessibility; security, availability of reliable power supply etc were also examined while finalizing the locations. The details of sampling locations are enclosed as Annexure-15 and photographs of AAQM are given in Chapter-15.

3.2.3.3 Results of Ambient Air Quality

Particulate Matter <10 μ : Out of 12 monitored locations, 4 AAQM stations have recorded the higher average values of Particulate matter PM₁₀ as Tumakuru Road (Near Madavara)- 76.96 μ g/ m³, Ballari Road (Near Vinayaka Nagar) - 84.78 μ g/ m³, Jigani Bommasandra Industrial Area-82.17 μ g/ m³ & Near Channasandra Main Road-79.91 μ g/ m³ respectively.

The AAQ monitoring station at Tumakuru Road (Near Madavara) whose average Particulate matter PM₁₀ value is 76.96 μ g/ m³ is closely located to Peenya Industrial Area, which is categorised as severely polluted area by CPCB with Comprehensive Environmental Pollution Index (CEPI) score of 65.11⁸. Thus, the presence of industrial area nearby and the vehicular movement on NH-4 are the major contributors. KSPCB under CEPI action plan continuously monitors the AAQ of Peenya Industrial area at two locations as per NAAQ standards, whose values were found to be 82 μ g/ m³ and 67 μ g/ m³ respectively⁹. At AAQM station Ballari Road (Near Vinayaka Nagar) the average PM₁₀ value were found to be 84.78 μ g/ m³, the monitoring station was close to traffic junction near Ballari road, road dust due to movement of vehicle are the major contributors for the pollutions. Average relative share of paved road & soil dust are the major contributors in PM₁₀ concentrations observed in Bangalore that accounts for 41-58%¹⁰.

The Average AAQ of PM₁₀ at location Jigani Bommasandra Industrial Area was found to be 82.17 μ g/ m³ which is categorized as critically polluted area with CEPI score of 70.99 by CPCB, 2016¹¹. The major source of the pollutant are the particulate matter due to stone cutting and stone polishing industries, automobile effect where the national highway is passing and construction activities within the vicinity of the area¹². At Location near Channasandra Main Road the average AAQ of PM₁₀ concentration recoded as 79.91 μ g/m³. The monitoring station is along the alignment of Channasandra main road, the major source of the pollutants is from the road dust & infrastructure development for IT sector & rapid urbanization due to construction activities around sub-urban areas of Whitefield.

The average minimum and average maximum concentrations for PM₁₀ were recorded as 63.6 μ g/ m³ and 84.78 μ g/m³ (Fig 3.10).

⁸https://kspcb.gov.in/peenya_2019_1852019.pdf

⁹https://kspcb.gov.in/AQI-Dec_2019.pdf

¹⁰ Sumit Sharma, Trilok Singh Panwar and Rakesh Kumar Hooda, sustain.Environ.res.,23(6),393-402(2013)

¹¹https://kspcb.gov.in/CEPI_Action_Plan_Jigani%20and%20Bommasandra_1772019.pdf

¹²[http://www.icontrolpollution.com/articles/air-quality-index-in-industrial-areas-of-bangalore-city-a-case-study-india- php?aid=45555](http://www.icontrolpollution.com/articles/air-quality-index-in-industrial-areas-of-bangalore-city-a-case-study-india-.php?aid=45555)

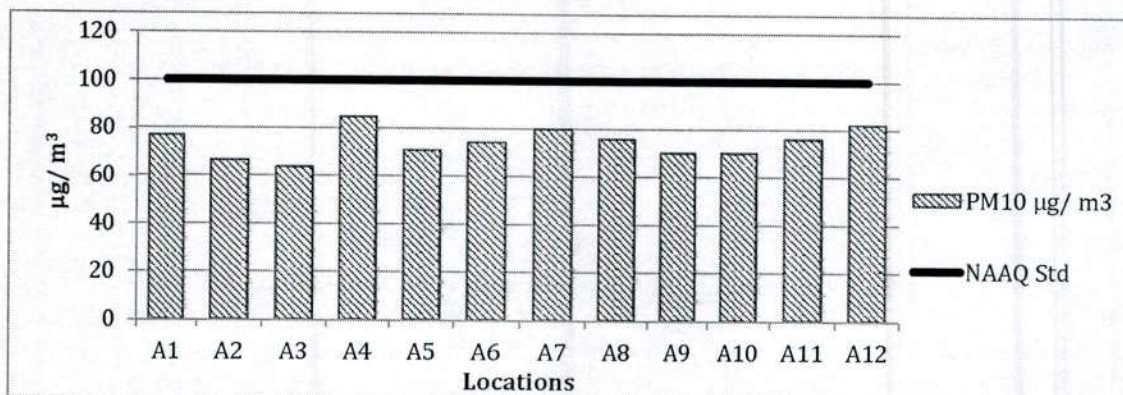


Fig 3.10: Graph showing the results of PM₁₀

Particulate Matter <2.5 μ : The concentrations of PM_{2.5} recorded within the study area range from 7.9 $\mu\text{g}/\text{m}^3$ to 39.7 $\mu\text{g}/\text{m}^3$. The minimum concentration was recorded at AAQ monitoring location A9 and the maximum concentration was recorded at AAQ monitoring location A4.

The average minimum and average maximum concentrations for PM_{2.5} were recorded as 16.35 $\mu\text{g}/\text{m}^3$ and 28.40 $\mu\text{g}/\text{m}^3$ respectively.

The 24-hourly average values of Particulate Matter <2.5 μ & Particulate Matter <10 μ were compared with the NAAQ standards and it was within the applicable limits for all locations in study area (Fig 3.11).

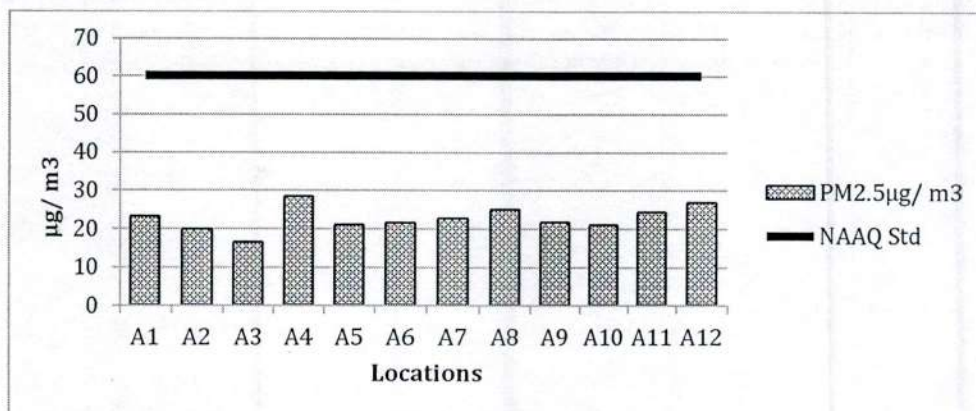


Fig 3.11: Graph showing the results of PM_{2.5}

Health Effects of Particulate Matter <2.5 μ & <10 μ : More than two million premature deaths each year were related to air pollution. In 2012, globally seven million deaths were recorded due to the combined effects of household and ambient air pollution¹³. Several epidemiological studies have shown that exposure to environmental air pollutants is a major cause of increase in hospital admissions for cardiovascular diseases¹⁴. Long-term exposure to fine PM can increase mortality¹⁵, particularly from cardiovascular disease. Continuous exposure to PM containing PAHs and diesel

¹³World Health Organization. Burden of disease from joint effects of household and ambient air pollution for 2012. Cited 2015 Oct 31. Available online: <http://apps.who.int/gho/data/node.home>

¹⁴Burnett et al., 1999; Le Tertre et al., 2002; Maheswaran et al., 2005a, 2005b; Wellenius et al., 2005; Zanobetti and Schwartz, 2005; von Klot et al., 2005; Chang et al., 2005; Zeka et al., 2005; Dominici et al., 2006; Lanki et al., 2006; Ballester et al., 2006

¹⁵Dockery DW, Pope CA, 3rd, Xu X, et al. An association between air pollution and mortality in six U.S. cities. N Engl J Med 1993;329:1753-9. [PubMed] [Google Scholar]

showed an increased risk of bladder cancer¹⁶. Nano sized Particulate Matter can easily pass through the blood-brain barrier and enter the central nervous system, thereby inducing inflammation and stroke, Parkinson's disease, and neurodevelopmental disorders¹⁷. In the recent years, consistent reports w.r.t the impact of air pollutants on the respiratory system has been noted^{18,19,20}. The detrimental effects include decrease in pulmonary function²¹, increase of infections²², increase in respiratory symptoms²³, acute exacerbations of COPD²⁴, onset of asthma, more hospitalizations, increased respiratory mortality¹⁸ above and higher prevalence of childhood asthma²⁵.

Sulfur Dioxide: It is causing illness and lung injury. Further if it is combine with water in the air forms toxic acid aerosols which is possibly cause corrosion of fabrics, metal surfaces and the leaves of plants. Sulfur dioxide causes irritation to the eyes and respiratory system. Exposure to very low concentrations of sulfur dioxide can aggravate chronic pulmonary diseases, such as asthma and emphysema²⁶. The minimum and maximum level of SO₂ recorded within the study area was in the range of 4 µg/m³ to 11.43 µg/m³. As per NAAQ standards, it was found that all sampling stations recorded values much lower than the applicable limit of 80µg/m³. The average minimum and average maximum concentrations for SO₂ were recorded as 6.77 µg/ m³ and 7.80 µg/m³

Oxides of Nitrogen: Oxides of Nitrogen are also an inorganic gaseous pollutant. Oxides of Nitrogen emissions are expected to be seen wherever there is combustion at high temperatures. Oxides of nitrogen are a mixture of gases that are composed of nitrogen and oxygen. Two of the most toxicologically significant compounds are nitric oxide (NO) and nitrogen dioxide (NO₂). Other gases belonging to this group are nitrogen monoxide (or nitrous oxide, N₂O), and nitrogen pentoxide (NO₅)²⁷

The concentrations of NO_x recorded within the study area range from 12.55 µg/m³ to 51.12 µg/m³. And the average minimum and average maximum concentrations for NO_x were recorded as 17.91µg/ m³ and 26.72 µg/m³. As per NAAQs, it was found that all the sampling stations recorded values much lower than the applicable limit of 80µg/m³ (Fig 3.12).

¹⁶Castañó-Vinyals G, Cantor KP, Malats N, et al. Air pollution and risk of urinary bladder cancer in a case-control study in Spain. *Occup Environ Med* 2008;65:56-60. [PubMed] [Google Scholar]

¹⁷Genc S, Zadeoglulari Z, Fuss SH, et al. The adverse effects of air pollution on the nervous system. *J Toxicol* 2012;2012:782462. [PMC free article] [PubMed]

¹⁸Faustini A, Stafoggia M, Colais P, et al. Air pollution and multiple acute respiratory outcomes. *Eur Respir J* 2013;42:304-13. [PubMed] [Google Scholar]

¹⁹Raaschou-Nielsen O, Andersen ZJ, Beelen R, et al. Air pollution and lung cancer incidence in 17 European cohorts: prospective analyses from the European Study of Cohorts for Air Pollution Effects (ESCAPE). *Lancet Oncol* 2013;14:813-22. [PubMed] [Google Scholar]

²⁰Pope CA, 3rd, Burnett RT, Thun MJ, et al. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. *JAMA* 2002;287:1132-41. [PMC free article] [PubMed] [Google Scholar]

²¹Iagorio S, Forastiere F, Pistelli R, et al. Air pollution and lung function among susceptible adult subjects: a panel study. *Environ Health* 2006;5:11. [PMC free article] [PubMed] [Google Scholar]

²²Dominici F, Peng RD, Bell ML, et al. Fine particulate air pollution and hospital admission for cardiovascular and respiratory diseases. *JAMA* 2006;295:1127-34. [PMC free article] [PubMed] [Google Scholar]

²³Delfino RJ, Gong H, Linn WS, et al. Asthma Symptoms in Hispanic Children and Daily Ambient Exposures to Toxic and Criteria Air Pollutants. *Environmental Health Perspectives* 2003;111:647-56. [PMC free article] [PubMed] [Google Scholar]

²⁴Medina-Ramón M, Zanobetti A, Schwartz J. The effect of ozone and PM10 on hospital admissions for pneumonia and chronic obstructive pulmonary disease: A national multicity study. *Am J Epidemiol* 2006;163:579-88. [PubMed] [Google Scholar]

²⁵Nishimura KK, Galanter JM, Roth LA, et al. Early-life air pollution and asthma risk in minority children. The GALA II and SAGE II studies. *Am J Respir Crit Care Med* 2013;188:309-18. [PMC free article] [PubMed] [Google Scholar]

²⁶<https://www.atsdr.cdc.gov/MMG/MMG.asp?id=249&tid=46>

²⁷<http://www.npl.gov.au/resource/oxides-nitrogen-0>

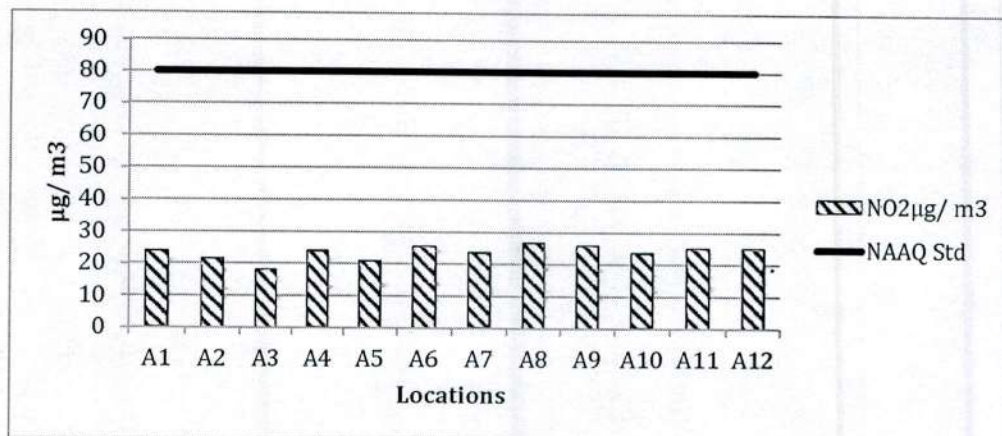


Fig 3.12: Graph showing the results of NO₂

Health Effects of SO₂ and NO_x: Sulfur dioxide is severely irritating to the eyes, mucous membranes, skin, and respiratory tract. Bronchospasm, pulmonary edema, pneumonitis, and acute airway obstruction can occur²⁸. Sulfur dioxide reacts with water in the upper airway to form hydrogen, bisulfite, and sulfite, all of which induce irritation. As a result, reflex bronchoconstriction increases airway resistance²⁸. Elevated levels of nitrogen dioxide can cause damage to the human respiratory tract and increase a person's vulnerability to, and the severity of, respiratory infections and asthma²⁹. Long-term exposure to high levels of nitrogen dioxide can cause chronic lung disease²⁹. The sulfur oxides and nitric oxides in air react with water vapor and other chemicals high in the atmosphere in the presence of sunlight to form sulfuric and nitric acids³⁰ that forms acid rain.

Carbon-Monoxide: It is a colourless, odourless, and tasteless gas that is slightly lighter than air. The higher concentrations of CO affects metabolism. The source for CO is due to photochemical reactions in the troposphere. Combustion of coal, biomass, and petroleum products³¹. The concentrations of CO recorded within the study area range from 0.38 mg/m³ to 3.89 mg/m³.

And the average minimum and average maximum concentrations for CO were recorded as 0.66mg/m³ and 1.42 mg/m³ respectively. The 24-hourly average values of CO were compared with the NAAQs and it was found that all the sampling stations recorded values much lower than the applicable limit of 4 mg/m³ (Fig 3.13).

Health Effects of CO: Short time exposure from breathing carbon monoxide can cause Headache, Nausea and vomiting, Blurred vision, Confusion, Dizziness, Chest pain, Difficulty breathing, Damage to the heart and brain and Unconsciousness³². And longtime exposure from breathing carbon monoxide can cause Miscarriage, Damage to a developing fetus, Seizures, Coma, Heart failure³². Breathing in high amounts of carbon monoxide is life-threatening. Also CO affects the oxidizing capacity of the atmosphere by removing the troposphere's primary oxidant, the hydroxyl (OH)

²⁸<https://www.atsdr.cdc.gov/MHMI/mmg116.pdf>

²⁹<https://www.qld.gov.au/environment/pollution/monitoring/air/air-pollution/pollutants/nitrogen-oxides>

³⁰https://www.researchgate.net/publication/228901085_Gaseous_Pollutants_Formation_and_Their_Harmful_Effects_on_Health_and_Environment

³¹ Dalvi, A., P. R. Shukla, A. Kaginalkar, C. Sharma, and A. P. Mitra. 2006. "A GIS Based Methodology for Gridding Large Scale Emission Inventories: Application to Carbon Monoxide Emissions over Indian Region." *Atmospheric Environment* 40: 2995-3007. doi:10.1016/j.atmosenv.2006.01.013.

³²<https://toxtown.nlm.nih.gov/chemicals-and-contaminants/carbon-monoxide>

radical³³ and by influencing the tropospheric ozone budget³⁴. It can contribute to climate change indirectly by affecting the concentrations of key greenhouse gases such as methane and ozone³⁵.

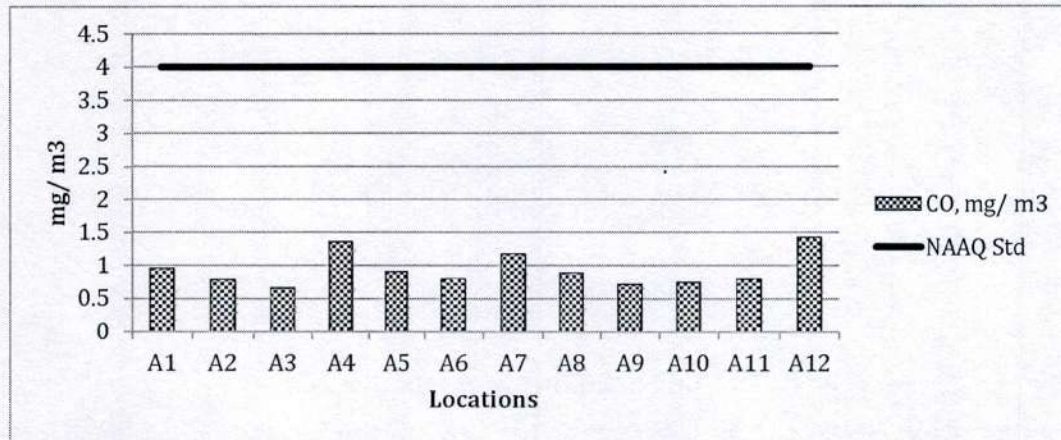


Fig 3.13: Graph showing the results of CO

Lead: Lead is a bluish-white lustrous metal. It is very soft, highly malleable, ductile, and a relatively poor conductor of electricity. It is very resistant to corrosion but tarnishes upon exposure to air. The minimum and maximum level of Lead (Pb) recorded within the study area was in the range of 0.01 $\mu\text{g}/\text{m}^3$ to 0.40 $\mu\text{g}/\text{m}^3$. The 24-hourly average values of Pb were compared with the NAAQ standards and it was found that all the sampling stations recorded values much lower than the applicable limit of 1 $\mu\text{g}/\text{m}^3$.

Health effects of lead: Once taken into the body, lead distributes throughout the body in the blood and is accumulated in the bones. Depending on the level of exposure, lead can adversely affect the nervous system, kidney function, immune system, reproductive and developmental systems and the cardiovascular system³⁶. Lead exposure also affects the oxygen carrying capacity of the blood. The lead effects most commonly encountered in current populations are neurological effects in children and cardiovascular effects (e.g., high blood pressure and heart disease) in adults. Infants and young children are especially sensitive to even low levels of lead, which may contribute to behavioral problems, learning deficits and lowered IQ³⁶.

Nickel: The concentration of Nickle (Ni) recorded within the study area range from 1.46 ng/m^3 to 13.95 ng/m^3 . And the average minimum and average maximum concentrations for Ni were recorded as 5.27 ng/m^3 and 7.90 ng/m^3 respectively. The values of Ni were compared with NAAQs and it was found that all the sampling stations recorded values much lower than the applicable limit of 20 ng/m^3 (Fig 3.14)

Health effects of Nickel: Severe lung damage has been recorded following acute inhalation exposure to nickel carbonyl. Reversible renal effects (in workers), allergic dermatitis (most prevalent in women), and mucosal irritation and asthma (in workers) have been reported following exposure to inorganic nickel compounds³⁷. The most serious harmful health effects from exposure to nickel, such as chronic bronchitis, reduced lung function, and cancer of the lung and nasal sinus, have

³³Warneck, P. (2000), Chemistry of the Natural Atmosphere, 927 pp., Academic, San Diego, California.

³⁴Levy II, H., P. S. Kasibhatla, W. J. Moxim, A. A. Klonecki, A. L. Hirsch, S. J. Oltmans, and W. L. Chameides (1997), Global impact of human activity on tropospheric ozone, *Geophys. Res. Lett.*, 24, 791-794

³⁵Wigley, T. M. L., S. J. Smith, and M. J. Prather (2002), Radiative forcing due to reactive gas emissions, *J. Clim.*, 15(18), 2690-2696, doi:10.1175/1520-0442(2002)015<2690:RFDTRG>2.0.CO;2.

³⁶<https://www.epa.gov/lead-air-pollution/basic-information-about-lead-air-pollution>

³⁷ Nickel and nickel compounds. In: Chromium, nickel and welding. Lyon, International Agency for Research on Cancer, 1990, pp. 257-445 (IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Vol. 49)

occurred in people who have breathed dust containing certain nickel compounds while working in nickel refineries or nickel-processing plants³⁸.

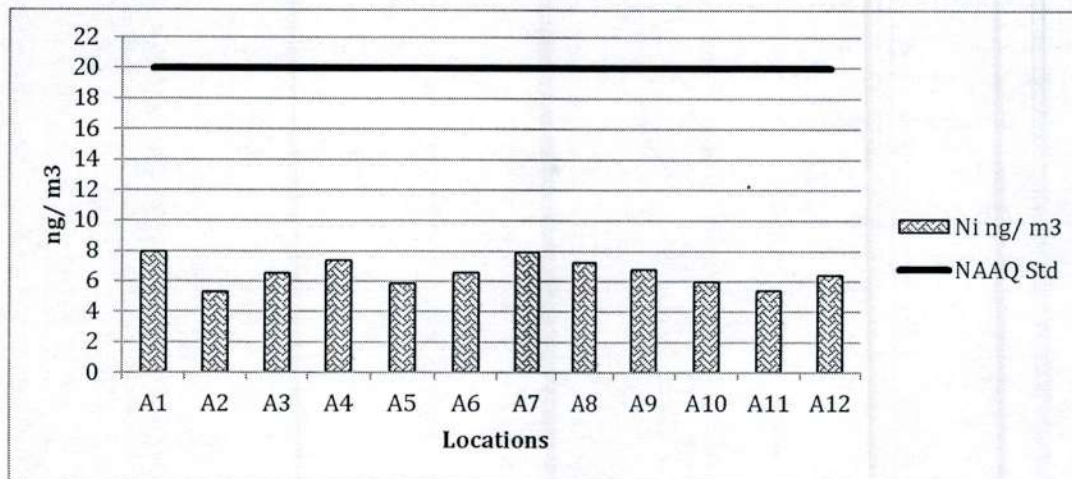


Fig 3.14: Graph showing the results of Ni

Ozone: Ozone is formed when pollutants emitted by vehicles, power plants, industrial boilers, refineries, chemical plants, and other sources react chemically in the presence of sunlight. The minimum and maximum level of Ozone (O_3) recorded within the study area was in the range of $1.25 \mu\text{g}/\text{m}^3$ to $5.73 \mu\text{g}/\text{m}^3$. Upon comparison of the 24-hourly average values with the NAAQs standards, it was found that all the sampling stations recorded values much lower than the applicable limit of $180 \mu\text{g}/\text{m}^3$.

Health effects of ozone: Ozone irritates eyes and damages the air sacs in the lungs where oxygen and carbon dioxide are exchanged, causing eventual hardening of this soft and spongy tissue³⁹. It also causes shortness of breath, wheezing, fatigue, headaches, and nausea, and aggravates respiratory problems such as asthma³⁹. Breathing ozone can trigger a variety of health problems including chest pain, coughing, throat irritation, and airway inflammation⁴⁰. It also can reduce lung function and harm lung tissue. Ozone can worsen bronchitis, emphysema, and asthma, leading to increased medical care⁴⁰.

Ammonia: The minimum and maximum level of Ammonia (NH_3) recorded within the study area was in the range of $1.07 \mu\text{g}/\text{m}^3$ to $6.06 \mu\text{g}/\text{m}^3$. The 24 hourly average values of Ozone were compared with the national ambient air quality standards and it was found that all the sampling stations recorded values much lower than the applicable limit of $400 \mu\text{g}/\text{m}^3$.

Health effects of ammonia: Ammonia is a corrosive substance and the main toxic effects are restricted to the sites of direct contact with ammonia (i.e., skin, eyes, respiratory tract, mouth, and digestive tract)⁴¹. Exposure to low concentrations of ammonia in air or solution may produce rapid skin or eye irritation. Inhalation of ammonia is irritating and corrosive. Exposure to high concentrations of ammonia in air causes immediate burning of the nose, throat and respiratory tract⁴². This can cause bronchiolar and alveolar edema, and airway destruction resulting in

³⁸<https://www.atsdr.cdc.gov/phs/phs.asp?id=243&tid=44>

³⁹https://www.researchgate.net/publication/228901085_Gaseous_Pollutants_Formation_and_Their_Harmful_Effects_on_Health_and_Environment

⁴⁰<https://www.epa.gov/ground-level-ozone-pollution/ground-level-ozone-basics>

⁴¹<https://www.atsdr.cdc.gov/phs/phs.asp?id=9&tid=2>

⁴²https://www.health.ny.gov/environmental/emergency/chemical_terrorism/ammonia_tech.htm

respiratory distress or failure. Inhalation of lower concentrations can cause coughing, and nose and throat irritation.⁴²

Air Quality Index: As per Air Quality Index (AQI), ambient air quality in the study area was observed to be Good and satisfactory. The air quality with respect to SO₂, PM_{2.5} and NO₂ is good.

Table 3.3: Air Quality Index for PM₁₀

Location	PM ₁₀ , µg / m ³	SO ₂ , µg/ m ³	NO ₂ , mg/m ³	AQI	Remarks
A1	76.96	7.06	23.9	77	Satisfactory
A2	66.45	6.77	21.49	66	Satisfactory
A3	63.63	7.6	17.91	64	Satisfactory
A4	84.78	7.17	23.98	85	Satisfactory
A5	70.88	7.44	20.93	71	Satisfactory
A6	74.22	7.04	25.46	74	Satisfactory
A7	79.91	7.8	23.69	80	Satisfactory
A8	75.97	7.25	26.72	76	Satisfactory
A9	70.12	7.29	25.84	70	Satisfactory
A10	70.15	7.49	23.68	70	Satisfactory
A11	76.07	7.4	25.08	76	Satisfactory
A12	82.17	7.39	25.07	82	Satisfactory

Table 3.4: Air Quality Index for PM_{2.5}

Location	PM _{2.5} , µg / m ³	SO ₂ , µg/ m ³	NO ₂ , mg/m ³	AQI	Remarks
A1	23.12	7.06	23.9	39	Good
A2	19.92	6.77	21.49	33	Good
A3	16.37	7.6	17.91	27	Good
A4	28.4	7.17	23.98	47	Good
A5	20.99	7.44	20.93	35	Good
A6	21.45	7.04	25.46	36	Good
A7	22.65	7.8	23.69	38	Good
A8	25.11	7.25	26.72	42	Good
A9	21.7	7.29	25.84	36	Good
A10	21.01	7.49	23.68	35	Good
A11	24.32	7.4	25.08	41	Good
A12	26.88	7.39	25.07	45	Good

3.2.4 Ambient Noise levels

Noise is an important environmental baseline indicator. According to KSPCB reports of Bangalore city noise levels between Jun, 2019 to Dec, 2019, residential and commercial zones noise levels are exceeded the standards when compared to Industrial areas⁴³.

⁴³https://kspcb.gov.in/Noise_jundec_2019.pdf

Table 3.5: Summary of Ambient Air Quality Monitoring Results (98 Percentile)

Location Code	Name of the Location	98 PERCENTILE								
		PM ₁₀ , µg/ m ³	PM _{2.5} , µg/ m ³	SO ₂ , µg/ m ³	NO ₂ , µg/ m ³	Pb, µg/ m ³	Ni, ng/ m ³	CO, mg/ m ³	O ₃ , µg/ m ³	NH ₃ , µg/ m ³
A1	Tumakuru Road-Near Madavara	87.308	33.116	9.2038	33.6356	0.15112	11.2792	1.2802	4.1454	5.5756
A2	Hesaraghatta Road-Near Mavallipura	78.588	26.814	8.8102	30.1552	0.13862	10.0038	1.0502	3.6502	5.1256
A3	Near Indian Institute of Horticultural Research Centre	78.902	21.624	10.3098	24.6894	0.18358	11.2434	0.934	4.0202	4.6218
A4	Ballari Road – Near Vinayaka Nagara	90.686	37.814	10.9154	35.8928	0.26888	10.4808	1.8602	5.0344	5.8622
A5	Near Hennur Road-Bharatiya City	79.056	26.756	10.2402	29.4688	0.20442	9.534	1.1848	4.0648	4.8656
A6	Old Madras Road-Near Avalahalli	81.31	27.81	9.324	37.1434	0.19276	12.6206	0.977	3.7424	5.088
A7	Near Channasandra Main Road	90.028	30.972	10.9424	33.7494	0.33062	11.533	1.7692	5.6702	5.6078
A8	Muthsandra Village	82.842	34.594	10.5672	41.7134	0.31132	11.1972	1.2502	3.9806	4.9226
A9	Sarjapur Road-Near Sulikunte Village	79.558	31.124	9.1302	35.9456	0.128	11.07	0.9248	3.9794	5.1602
A10	Gattahalli Village	82.626	25.424	10.517	36.8664	0.22086	9.4968	1.0802	4.1994	4.7488
A11	Hosur Road – Near Konappana Agrahara	87.056	28.078	11.1694	35.0376	0.13552	11.442	1.1502	4.8802	5.7504
A12	Jigani Bommasandra Industrial Area	90.532	35.774	10.3072	49.349	0.2027	11.3916	1.8502	5.1694	5.399

Source: EHSRDC, Bengaluru.

Note: Below Detectable Limits (BDL) were observed for Arsenic (As), Benzene (C₆H₆) and Benzo (a) Pyrene at all the locations during the monitoring period.

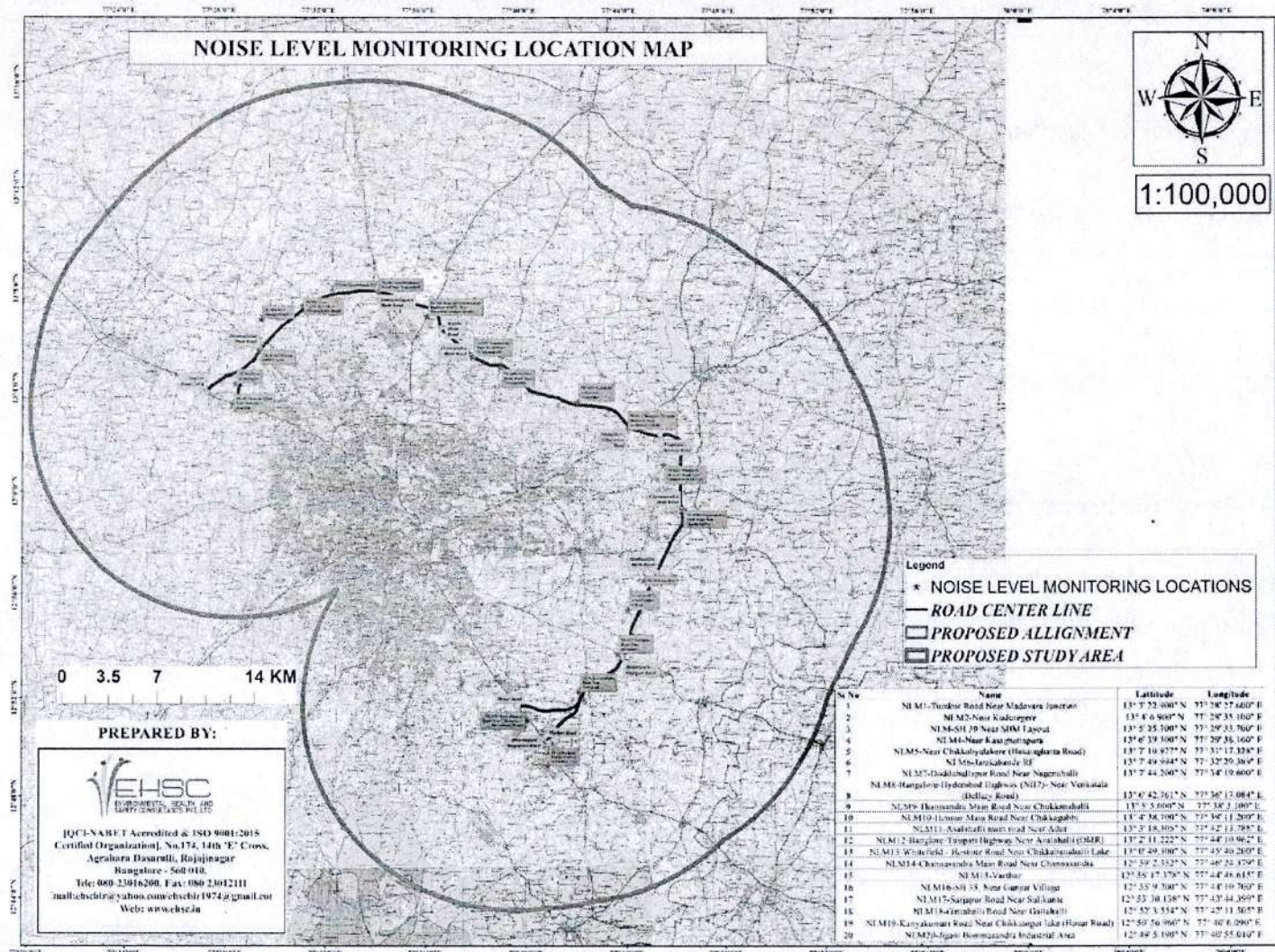


Fig 3.15: Map showing Ambient Noise Level Monitoring locations

As part of the baseline environment studies, ambient noise levels were measured at 20 locations (13 commercial, 4 residential, 2 sensitive and 1 industrial area) using pre-calibrated instrument for 24 Hrs for Leq (day) and Leq (night) as per the CPCB procedure⁴⁴. Map showing the noise level monitoring locations are given below;

Table 3.6: Details of Noise Level Monitoring⁴⁵

Parameters	Frequency	CPCB Standards dB(A) Leq		
		Category	Day	Night
Leq (Day) Leq (Night)	24 hrs	Industrial area	75	70
		Commercial area	65	55
		Residential area	55	45
		Silence zone	50	40

3.2.4.1 Results of Ambient Noise levels

As per the monitoring results, out of 13 commercial area locations, noise levels are exceeded the standards in 11 locations except at 2 locations (N12 and N18) during day time. The noise levels are in the range between 62.15 to 79.77 dB(A). Similarly, during night time 6 locations are exceeded and remaining 7 locations are within the standards. The noise levels are in the range between 36.82 to 63.58 dB(A). Vehicular movement is the major contributor of noise in the commercial area.

Similarly, in case of residential area, all the 4 locations were crossed the standards and ranging between 57.82 to 80.78 dB(A) during day time. Similarly, during night time, N4 -33.9 dB(A) and N5 -43.3 dB(A) are within the limits and N2 -62.54 dB(A) and N15-53.63 dB(A) are exceeded the standards.

In case of Jigani – Bommasandra Industrial area, the noise levels are within the standards (66.46 dBA during day time and 59.19 dBA during night time). Whereas in case of silence zone, Jarakabande RF (N6) and Avalahalli main road near Adhur (N11), the noise levels are exceeded to the standards due to aircraft noise and traffic noise respectively. Map showing the noise level results are given below and the location wise noise levels are provided in Annexure-16.

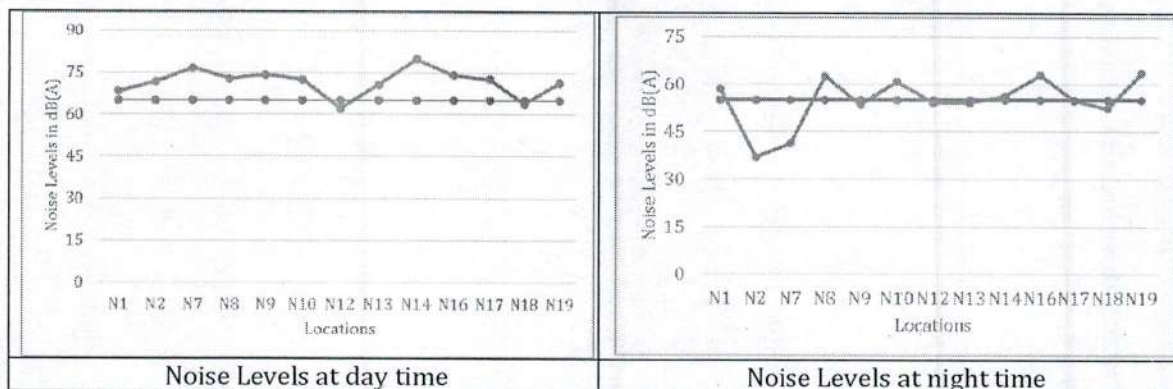


Fig 3.16: Noise Levels in commercial area locations

⁴⁴Protocol for Ambient Noise Level Monitoring (2015), CPCB, New Delhi

⁴⁵Noise (Regulation and Control) Rules (2000), MoEF, Govt. of India

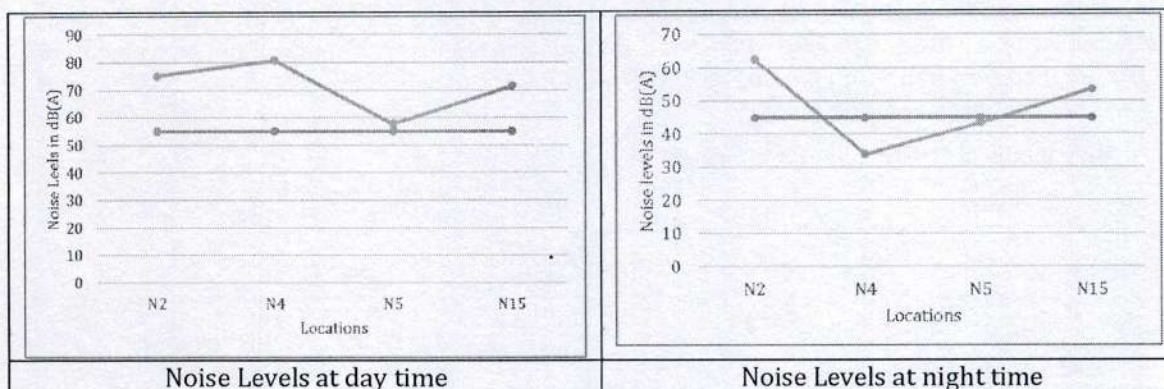


Fig 3.17: Noise Levels in residential area locations

3.2.5 Hydrology, Geology & Minerals

In any given environment, the occurrence and movement of ground water along with its quality & quantity is mainly depends on geographical set-up, climate and rainfall conditions, hydrological features, topography, soil characteristics, rock formations. Therefore, the study envisages identification of the existing surface & ground water conditions within the project site based on its quality, potential and its neighborhood, related to the proposed project; identification of the likely impacts on surface and ground water resources and thereby providing mitigation measures.

3.2.5.1 Methodology

- Secondary data from Central Ground Water Board (CGWB), Geological Survey of India (GSI), other Institutions and Departments.
- Identification of Inter- related and Inter - dependent key factors in the occurrence of ground water, its quality and potential.
- Identification of surface water resources in the project area.
- Assess the ground water resource potential in the project area.
- Identification of site-specific environmental issues and mitigation measures

During the field investigation and survey carried out in the second week of January-2020, surface rock outcrops, geological sections along the alignment, Nala Cuttings and Dug wells were observed. Inventory of wells representing the proposed project corridor and five-kilometer buffer zone was considered. Hydrogeological data of about 31 wells was collected enclosed as Annexure - 17. Field investigation photographs are enclosed in Chapter-15. Secondary information and the data collected during the survey is collected and analyzed to understand the overall groundwater condition in the area. In order to avoid adverse effect on the Surface water & Ground water environment, certain mitigation measures have been proposed.

3.2.5.2 Field studies

Based on the Pre field studies and preparation of Location Map, Drainage Maps, Geological / Litho Boundaries, Possible Geomorphic Units delineated field checks were carried out along the entire stretch of proposed Development of Eight Lane Peripheral Ring Road to gather information on Well Inventory to record the depth to water level, Yields, Quality for potable / Non potable, Yield fluctuations during summer, Sampling of Surface and Groundwater for quality assessment, Marking the litho contacts, Structures such as lineaments, Fractures and or Faults, Ascertaining Geomorphic

units, assessing recharge conditions on field, Identifying possible disturbance to natural stream courses and lakes, etc.

3.2.5.3 Secondary data utilized

Ground Water Directorate have been consulted and the data pertaining to Static Water Levels for the years 2010-2019 collected for correlating the primary data. The available District Reports for Bengaluru Urban and Rural published by CGWB was also referred.

3.2.5.4 Regional geology & structure

Random field traverses were carried out wherever litho units exposed and accessible to ascertain the Geology & Structure of the study area and GPS coordinates captured to mark on the Geological Map given below. Field photographs were captured and documented. Few samples were collected and studied w.r.t. Colour, texture, grain size and disposition in hand specimen to identify the rock type and mapped accordingly correlating with the published Geological Quadrangle map of GSI.

The study area occupies Ultramafic rocks of Sargur Group that occur as numerous enclaves within the Peninsular Gneissic Complex and also as discrete schist belts and bands. Gneiss in general shows banding due to alteration of light colored Quartzo Feldspathic minerals and dark colored Biotite or Hornblende. Peninsular Gneissic Complex of Archaean, Pink and Grey Granites of Closepet Granite belonging to Proterozoic age occupy major portion of the study area comprising Migmatite, Grey Granite, Granitoid Gneiss, Biotite Gneiss and Biotite Hornblende Gneiss which are the oldest and widespread country Rocks in the area. The Granites range from Tonalite-Trondjhemite to Granodiorite. Small Dykes (Felsic Porphyry and Diorite Porphyry) occur across all the rock types including basic dykes which are Gabbroic in nature. Most of the dykes are trending ENE-WSW, NNW-SSE to NNE-SSW. Gravel and Laterite of Cainozoic age occur as capping at isolated patches over the crystalline basement.

Stratigraphy:

Rock Type	Group	Period
Gravel & Laterite	Recent	Cainozoic
Dolerite Dyke	Intrusive	Proterozoic
Pink & Grey Granite, Granodiorite	Closepet Granite	
Migmatite		
Grey Granite, Granitoid Gneiss	Peninsular Gneissic Complex	Archaean
Banded Biotite Gneiss & Hornblende Gneiss		
Ultramafic Shcist	Sargur Group	

*Source: Published GSI Quadrangle Map in the Year 1994.

Local geology: The Study area and its environs comprise Peninsular Gneissic Complex consisting of Migmatite, Grey Granite, Grey Granite Gneiss & Gneissic Granite belonging to Archaean as the major litho units. Schist, Clospet Granite is occurring over the western part of the study area and small laterite cappings on the North eastern portion in the project buffer zone area.

Structure: No major faults or any structural disturbances were observed in the project area due to thick habitation cover except minor fractures and lineaments along the streams and these act as conduits for the movement of surface and groundwater. The movement and occurrence of groundwater is controlled by these structures and these could not be mapped. Dykes are trending E-W, ENE- WSW and NNW-SSE. Few lineaments have been mapped and depicted on geology map given below;

3.2.5.5 Geomorphology

The Geomorphology of the study area and its environs is Pediplain shallow weathered, narrow valleys, Pediment inselberg Complex, Pediment and Residual / Denudational Hills.

3.2.5.6 Mineral resources

No mineral resources are available within Bengaluru Urban District except road metal in the peripheral areas outside the living areas.

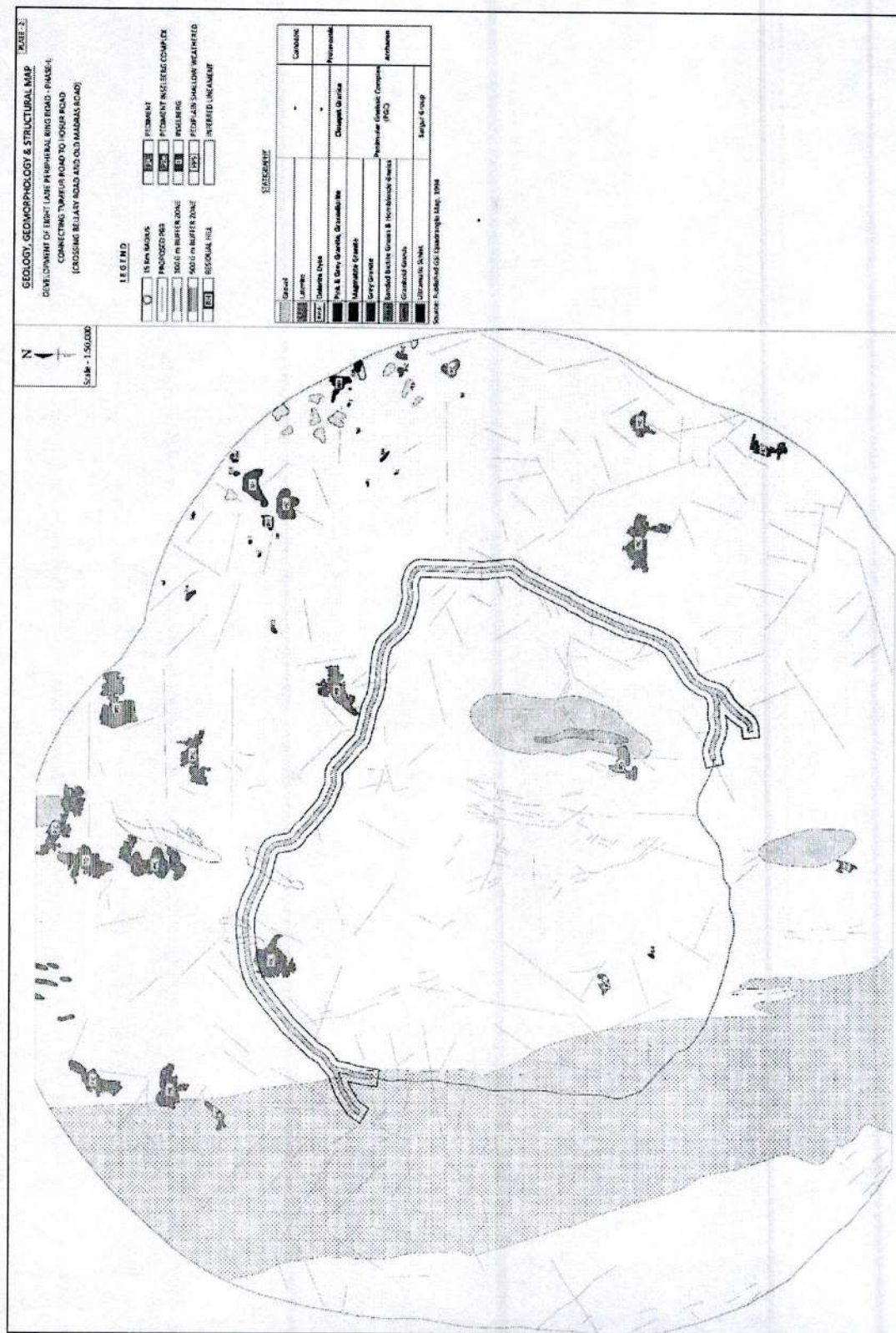
3.2.5.7 Drainage

The proposed project area forms part of Cauvery, South Pennar and Palar basin. Also, other parts of the District are drained by the Cauvery and south Pennar river basins. The project area has very dense drainage which are seasonal. The natural drainage courses have been altered due to urbanization and infrastructure development over the years. Dendritic to sub-dendritic drainage pattern is observed with drainage density varying between 0.1 Kms. / Sq. Kms (Fig 3.19). Dense drainage is observed in the eastern part of the project area while the central part of the project area is occupying sparse drainage. All the stream courses flow from higher reaches to lower levels following topography. Several tanks have been observed in the core and buffer zone. The buffer zone has good network of canal system. Majority of the drainage is flowing South. Majority of the drainage is flowing South.

3.2.5.8 Hydrogeology

The study area comprises of rock formations belonging to Archaean age. Granites and Gneisses of Peninsular Gneissic complex constitute major aquifers in the urban district of Bengaluru. Secondary structures like joints, fissures and fractures present in these formations act as conduits for movement and storage of water. Groundwater occurs in phreatic conditions or unconfined conditions in the weathered zone and under semi confined to confined conditions in fractured and jointed rock formations. The occurrence, movement and recharge to aquifers are controlled by various factors like fracture pattern, degree of weathering, Geomorphologic setup and amount of rainfall received. The recharge conditions are moderate to poor. Several tanks are observed within the core and buffer zone that contribute to recharge.

Water table generally follows the topography of the study area and is at greater depths in the water divide area and topographic heights but occurs at shallow depth in the valleys and low lying terrain and therefore groundwater moves down and follows the gradient from the higher to lower elevations i.e. from recharge area to discharge areas. The general flow direction of groundwater in the study area is south.



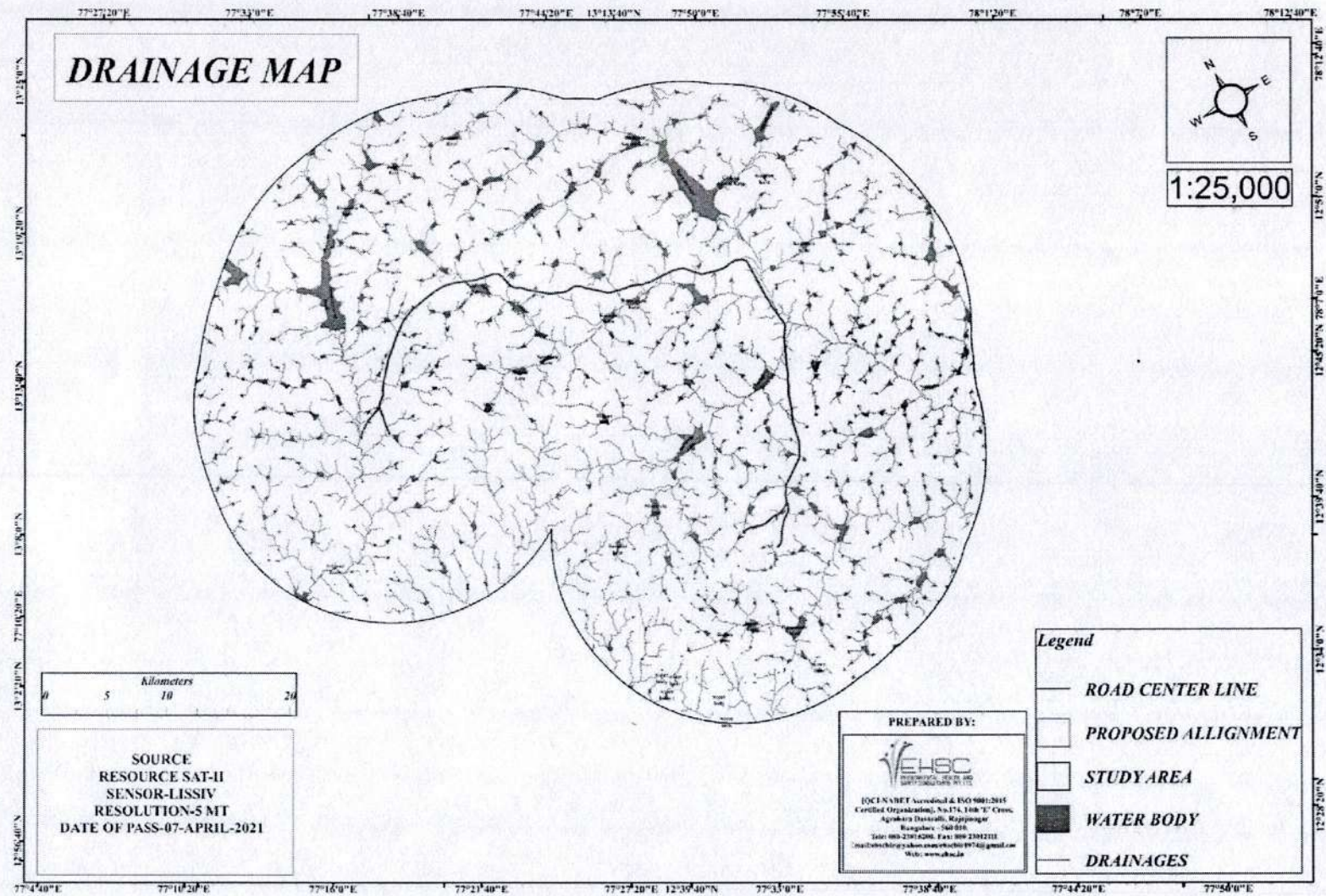


Fig 3.19: Drainage map of the study area

3.2.5.8.1 Hydrogeological Survey

Hydrogeological survey was carried out in the core and buffer zone of the proposed project corridor. 31 Wells were inventoried for deciphering the groundwater regime of the project area. The details of the locations are marked on hydrology map which is enclosed as Annexure 17. Groundwater Samples from 10 Bore wells and surface water samples from 11 lakes representing the study area were collected and subjected to chemical analysis conforming to IS-10500:2012 standards to understand the water quality. The test results are enclosed as Annexure - 17. In total the water quality in the study area is potable to moderately potable.

All the wells inventoried were mostly bore wells with pumps fitted and hand pumps along with two dug wells to decipher the groundwater conditions viz. Depth to water Level, Total Depth, nature and type of weathering, rock type encountered, Yields and their behavior during lean season, recharge conditions etc were recorded as reported by the owners mostly and local enquiry during non-presence of owners.

3.2.5.8.2 Depth to water level

The depth to water level in the study area was measured at feasible locations and recorded during the field study. The depth to water level varied between 40.0 to 95.0 m. In general, the depth to water levels varies between 40.0 to 60.0m bgl. The deepest water levels at more than 100.0 m were reported at Baiappanahalli, Chikka Togur, Huskur, Avalahalli and Immadihalli. The annual water level fluctuation ranges between 3.0 to 15.0 m in the study area. The primary data is compared with the Static water level data obtained from State Groundwater Department for the years 2010-2019. The flow direction follows the general topography of the area and the groundwater flow direction is towards South in the study area.

3.2.5.8.3 Carrying capacity of nalas

The design of CD structure for the drainage system involves (i) calculating the total discharge that the cross-drainage structure will require to drain off (Hydraulic analysis) and (ii) fixing the slope and dimensions of the cross-drainage structures to have adequate capacity to carry the discharge and afford proper maintenance. Hydraulic designs for cross drainage structures are carried out based on the guidelines given in following IRC codes of practice:

- IRC: SP: 13-2004 - Guidelines for the design of small bridges and culverts.
- IRC: SP: 42-2014 - Guidelines for the road drainage.
- IRC: SP: 50-2013 - Guidelines for urban drainage.

Based on the studies, the total estimated discharge from the nalas/ streams in the project area is 764.74 Cumecs and the provision of 1426.20 Cumecs of design discharge has been made to cater the flood. The details of each nala and the proposed structure are given below.

Table 3.7: Carrying capacity of nalas along PRR

Sl.No.	Chainage (m)	Estimated Discharge to cater Flood (m ³ /sec)	Design Discharge (m ³ /sec)	Type of CD Proposed
1	5+25	124.72	132	Minor Bridge
2	2+231	7.37	8.40	Culvert
3	2+643	13.86	16.8	Culvert
4	4+587	54.06	66	Minor Bridge
5	4+814	18.51	25.2	Culvert
6	5+789	10.97	16.8	Culvert
7	6+429	6.42	8.4	Culvert

Sl.No.	Chainage (m)	Estimated Discharge to cater Flood (m ³ /sec)	Design Discharge (m ³ /sec)	Type of CD Proposed
8	7+415	3.95	8.4	Culvert
9	8+673	3.12	8.4	Culvert
10	9+147	1.12	9.3	Culvert
11	9+390	2.99	12.6	Culvert
12	10+241	6.02	8.4	Culvert
13	10+640	4.71	8.4	Culvert
14	11+337	2.15	9.3	Culvert
15	11+596	1.29	9.3	Culvert
16	12+775	10.68	12.6	Culvert
17	19+952	21.28	25.2	Culvert
18	22+212	33.81	39.6	Minor Bridge
19	23+818	5.40	12.6	Culvert
20	24+308	5.68	8.4	Culvert
21	25+208	0.00	22.2	Culvert
22	27+238	0.00	22.2	Culvert
23	28+859	16.48	16.8	Culvert
24	29+069	25.50	33.6	Minor Bridge
25	31+705	2.35	18.6	Culvert
26	32+814	1.37	18.6	Culvert
27	33+239	0.30	18.6	Culvert
28	33+696	42.74	49.5	Minor Bridge
29	34+713	2.03	18.6	Culvert
30	35+724	19.04	25.2	Culvert
31	36+393	4.52	16.8	Culvert
32	37+553	13.29	16.8	Culvert
33	41+483	1.65	18.6	Culvert
34	42+043	30.80	39.6	Minor Bridge
35	42+223	1.11	18.6	Culvert
36	42+507	2.04	18.6	Culvert
37	42+963	1.17	18.6	Culvert
38	43+798	34.86	39.6	Minor Bridge
39	45+488	2.68	18.6	Culvert
40	45+743	6.11	16.8	Culvert
41	46+155	31.33	39.6	Minor Bridge
42	46+684	3.95	16.8	Culvert
43	46+890	0.37	18.6	Culvert
44	47+141	0.12	22.2	Culvert
45	47+272	0.48	18.6	Culvert
46	48+830	5.17	16.8	Culvert
47	49+503	4.39	16.8	Culvert
48	49+681	1.22	18.6	Culvert
49	49+979	10.87	16.8	Culvert
50	50+603	1.54	18.6	Culvert
51	50+921	0.61	18.6	Culvert
52	51+432	0.26	22.2	Culvert
53	52+862	35.37	39.6	Minor Bridge
54	55+222	2.22	18.6	Culvert

Sl.No.	Chainage (m)	Estimated Discharge to cater Flood (m ³ /sec)	Design Discharge (m ³ /sec)	Type of CD Proposed
55	56+052	31.32	39.6	Minor Bridge
56	57+967	3.32	16.8	Culvert
57	58+608	1.29	18.6	Culvert
58	58+936	28.67	33.6	Minor Bridge
59	59+833	7.20	16.8	Culvert
60	61+592	4.08	16.8	Culvert
61	62+173	2.86	18.6	Culvert
62	63+593	25.75	33.6	Minor Bridge
63	64+020	16.20	16.8	Culvert

3.2.5.8.4 Ground water resources

As per CGWB (2008), net annual groundwater availability of the Bangalore Urban district was estimated to be 16,769 ha.m and the total ground water draft for irrigation, domestic and industrial uses was estimated to be 33,027 ha.m with a projected draft of 2,186 ha.m. The draft exceeds the total available ground water resources leaving absolutely nil ground water resources for future use. The stage of ground water development is considered to be quite alarming with an average of 197% for the whole district thereby categorizing the stage of development as Overexploited⁴⁶.

Further, as per the studies conducted by CGWB in 2013, the net annual groundwater availability of the Bangalore Urban district was estimated to be 11,723 ha.m, and the total ground water draft for irrigation, domestic and industrial uses was estimated to be 3,794 ha.m and the existing gross ground water draft for all uses was estimated to be 16,703 ha.m. Thus, draft exceeding the total available ground water resources leaving absolutely nil ground water resources for future use. The stage of ground water development in the district was above 100% and belonged to the over exploited category⁴⁷. As per the recommendations of Groundwater Estimation Methodology-97(GEM-97), average stage of water development is categorized as over exploited at stage of Development 135%⁴⁸.

3.2.5.8.5 Water required for construction activities

Ground water in the project area is over exploited. Hence, secondary treated water will be used for dust suppression activities and thus reduce the dependency on fresh water. Further, water required for construction activities will be sourced from BWSSB. A MoU will be entered with BWSSB to provide fresh as well as treated water for construction activities. The treated water quality shall comply with IS 456: 2000. For labor camps, water will be sourced from BWSSB and further RO treatment will be facilitated for drinking water purpose at labor camps to acquire desired quality.

Table 3.8: Details of water required for construction activities

Sl.No	Details	Water Requirement (KLD)	Remarks
1	Dust suppression at Hot mix plant and batching plant	3	Secondary treated water
2	Dust Suppression at Project site and labor camps	4	Secondary treated water
3	Dust suppression at borrow area	2	Secondary treated water
4	Dust suppression at crushers	0.5	Owner responsibility

⁴⁶gwb.gov.in/district_profile/karnataka/bangalore_urban_brochure.pdf

⁴⁷http://cgwb.gov.in/District_Profile/karnataka/2012/BANGALORE_URBAN-2012.pdf

⁴⁸ CGWB- Groundwater Information Booklet: Bangalore Urban District, Karnataka, March'2013.

Sl.No	Details	Water Requirement (KLD)	Remarks
5	Water for labor camps	22.5	considering 300 labors @ 75 LPCD, BWSSB
6	Water for construction activities	40	Fresh water sourced from BWWSB

3.2.6 Surface & Ground water quality

The proposed alignment of PRR passes through 3 major valley systems namely; Vrishabhavathy Valley, Hebbal Valley and Koramangala- Challaghatta Valley. Some of the lakes such as Chikkabanavara lake, Varthur lake, Yelahanka lake, Kogilu lake, Jakkur lake, Rampura lake, Yellamallappa chetty lake, etc belonging to Madavara lake series, Yellamallappa chetty lake series, and Varthur Lake series are part of the study area for the project.⁴⁹ Further, these lakes are being polluted due to entry of sewage from nearby areas which has led to odour, unaesthetic conditions, foaming, etc. Studies have shown that an acceleration in the development of sewage systems was noticed upon completion of Thippagondanahalli reservoir⁵⁰ and studies shows that Vrishabhavathi valley catchment generates sewage of 522 MLD (41.5%), followed by Koramangala and Challaghatta valley of 410 MLD (32.6%), Hebbal Nagavara valley of 242 (18.8%) and the remaining 84 MLD (7.1%) from Arkavathy and Suvarnamukhi valleys⁵¹. In addition to this, several lakes (Jakkur lake, Yelhanka lake, Thirumenahalli lake, Agrahara lake, etc) are being rejuvenated by BDA, BBMP and other departmental bodies with the objective of rejuvenating the water bodies through interconnecting lake series⁵².

Studies conducted at Anchepalya lake have showed that parameters namely EC (9210 μ S/cm - 9220 μ S/cm), TDS (6410 ppm - 6500 ppm), BOD (48.80 ppm - 55.40 ppm), COD (160.67 ppm - 182.00 ppm), TH (400 mg/L - 632 mg/L) & Chlorides (508.36 mg/L - 451.56 mg/L) exceeded the BIS standards⁵³. Studies at Jakkur lake showed the parameters TDS (870.67 ppm - 947 ppm), BOD (24.20 ppm - 23.60 ppm), COD (79.31 ppm - 48.72 ppm), TH (326.67 mg/L - 346.67 mg/L) & Chlorides (286.84 mg/L - 295.36 mg/L) exceeded the BIS standards⁵⁴. Studies at Rampura lake showed the parameters TDS (1050 ppm - 1135 ppm), DO (0 mg/L), BOD (67.93 ppm - 78.24 ppm), COD (145.86 ppm - 166.48 ppm), TH (382 mg/L - 401 mg/L), Chlorides (420 mg/L - 429 mg/L) & Alkalinity (683 mg/L - 823 mg/L) exceeded the BIS standards⁵⁵. Studies at Rayasandra lake showed the parameters pH (9.12-9.58), TDS (719 ppm), DO (4.63 mg/L), BOD (6.54 ppm - 14.63 ppm) & COD (30.99 ppm) exceeded the BIS standards⁵⁶.

Further, lakes such as Anchepalya lake, Yellamallappa chetty lake, Varthur lake, Rampura lake are considered as highly polluted lakes with high ionic contents, nutrients, oxygen demand and organic contents; Chikkatogur lake and Jakkur lake are considered moderately polluted lakes with low ionic values and Rayasandra lake is considered as less polluted with low ionic values. Results indicated that Yelamallappachetty lake, Rampura lake, Chikkatogur lake are highly influenced by orthophosphate due to the entry of large amount of sewage water. Similarly, Yelamallappachetty lake is highly influenced by alkalinity; Chikkatogur lake and Anchepalya lake are affected by high levels of Hardness; Anchepalya lake is highly influenced by chloride content; Jakkur lake recorded high DO values. As per CPCB water quality criteria; Chikkatogur lake, Rayasandra lake, Varthur lake,

⁴⁹https://www.indiawaterportal.org/sites/indiawaterportal.org/files/bangalore_lake_series_envis_dee_gok.pdf

⁵⁰http://wgabis.ces.iisc.ernet.in/energy/water/paper/urbanfloods_bangalore/city_infrastructure.htm

⁵¹<http://wgabis.ces.iisc.ernet.in/energy/water/paper/ETR114/section9.html>

⁵²<http://wgabis.ces.iisc.ernet.in/energy/water/paper/ETR114/section9.html>

⁵³<http://wgabis.ces.iisc.ernet.in/energy/water/paper/ETR72/lake16.html>

⁵⁴<http://wgabis.ces.iisc.ernet.in/energy/water/paper/ETR72/lake16.html#13>

⁵⁵<http://wgabis.ces.iisc.ernet.in/energy/water/paper/ETR72/lake14.html#28>

⁵⁶<http://wgabis.ces.iisc.ernet.in/energy/water/paper/ETR72/lake14.html#28>

Anchepalya lake, Rampura lake, Yellamallappa chetty lake belongs to Class 'E' and Jakkur lake belongs to Class 'D' & 'E'⁵⁷.

Studies have shown that the Ground water in the District is alkaline with pH ranging from 7.8 to 8.5, TH varying from 100-600ppm, EC ranging from 250 $\mu\text{S}/\text{cm}$ -2000 $\mu\text{S}/\text{cm}$. Similarly, Chloride ranging from 250-1000 mg/L and Nitrate content >45 mg/L were recorded in several patches of Anekal Taluk, Bangalore North and South Taluks of the District. Fluoride content of <1 ppm is recorded throughout the District and >1 mg/L is recorded in several areas of Bangalore South Taluk. Therefore, the parameters such as EC, Fluoride, Arsenic, Iron and Nitrate were found to be more than the permissible limit⁵⁸.

The proposed PRR alignment passes along 6 lakes and about 14 lakes are present within a distance of 500 m from the proposed alignment. The details of the lakes are given as given below;

Table 3.9: List of water bodies along the project alignment

Sl.No	Name of the Lake	Chainage (Kms)	Area (A-G)	Volumetric Capacity (Mcft)	Type
1	Tank near Jarakabande Forest	11+334 Km to 11+564 Km	5-5*	1.68	Seasonal
2	Chinnaganahalli Lake	37+332 Km to 37+416 Km	19-3*	5.72	Seasonal
3	Chikkabanahalli Lake	39+003 Km to 39+227 Km	9-9*	2.83	Seasonal
4	Gunjur Lake	51+931 Km to 52+468 Km	59-13	16.53	Seasonal
5	Chikkatogur Lake	22+130 km to 22+250 km	59-39	18.43	Seasonal
6	Thirumenahalli lake	64+300 km to 64+690 km	16-13*	5.83	Seasonal

Table 3.10: Details of Lakes present within 500 m from the proposed alignment

Sl. No.	Name of the lake	Distance from the PRR alignment (in m)	Area (A-G) ⁵⁹	Volumetric Capacity (Mcft)	Seasonality
1	Thirumenahalli lake	30	22-27	6.81	Perennial
2	Chikkatogur Lake	30	27-3*	9.29	Perennial
3	Koppana aghara lake	50	16-13*	4.67	Seasonal
4	Anchepalya Lake	100	55-39*	14.40	Perennial
5	Aghara lake	150	15-34	5.21	Perennial
6	Kogilu kere	200	78-28	23.62	Seasonal
7	Chokkanahalli lake	240	8-2	2.19	Perennial
8	Cheemasandra kere	270	26-34	6.91	Seasonal
9	Doddabyalakere	310	11-2*	3.32	Seasonal
10	Huskur Lake	340	114-10	37.55	Seasonal
11	Kumbharhalli lake	340	23-2*	5.60	Seasonal

⁵⁷<http://wgbis.ces.iisc.ernet.in/energy/water/paper/ETR101/results.html>

⁵⁸http://cgwb.gov.in/District_Profile/karnataka/2012/BANGALORE_URBAN-2012.pdf

⁵⁹<http://bbmp.gov.in/>, <http://wgbis.ces.iisc.ernet.in/energy/water/paper/ETR101/content.html> & * calculated using google earth

Sl. No.	Name of the lake	Distance from the PRR alignment (in m)	Area (A-G) ⁵⁹	Volumetric Capacity (Mcft)	Seasonality
12	N Nagenahalli lake	400	11-8	2.40	Perennial
13	Palanahalli lake	430	25-28	6.98	Seasonal
14	Yelhanka Lake	440	310-8	88.66	Perennial

Several studies have indicated that the entry of construction waste, debris, etc affects turbidity, total suspended solids, chloride, sulfate and total iron values during construction phase; and affects acidity and nitrate values after construction phase⁶⁰. Similarly, during operation phase, highway runoff including higher deposition of heavy metals due to high traffic volumes may lead to toxicity of water bodies affecting aquatic biota⁶¹. Therefore, it is essential to study the existing water quality of the study area in order to address the construction impacted water quality parameters to minimize the impact on aquatic biota.

3.2.6.1 Criteria for selection of water quality sampling locations

- Surface water sampling: Land use/topography of the area within the alignment and distance from the proposed alignment.
- Ground water sampling: Sources of water availability and purpose.

3.2.6.2 Methodology for collection of water samples

The baseline water quality sampling network was established at 19 locations (9 surface water samples and 10 ground water samples) collected during the study period December 2019 to February 2020 complying with the methodology of sample collection as per CPCB sampling protocols⁶².

- Surface water sampling: Surface water samples were collected from lakes and the Temperature, pH, EC, TDS, TH and TSS were recorded using water testing kit at site. For Dissolved Oxygen, sample was collected in the BOD bottle (300 ml) by adding 1 ml of MnSO₄ followed by 1 ml of alkaline iodide reagent and the stopper was placed immediately and bottle was inverted repeatedly for 2-3 times. Further 1 ml of concentrated H₂SO₄ was added to the solution. Similarly, 1 ml of 1:1 HNO₃ was added to 250 ml of water sample for further analysis of heavy metal.
- Ground water sampling: Ground water samples from the production tube wells were collected after allowing the water to run for about 5 minutes. The Temperature, pH, EC, TDS, TH and TSS were recorded using water testing kit at site and 1 ml of 1:1 HNO₃ was added to 250 ml of water sample for further analysis of heavy metal.

⁶⁰https://www.researchgate.net/publication/26314400_Effects_of_Highway_Construction_on_Stream_Water_Quality_and_Macroinvertebrate_Condition_in_a_Mid-Atlantic_Highlands_Watershed_USA

⁶¹<http://onlinepubs.trb.org/Onlinepubs/trr/1983/948/948-006.pdf>

⁶²CPCB_manual_of_water_analysis.pdf

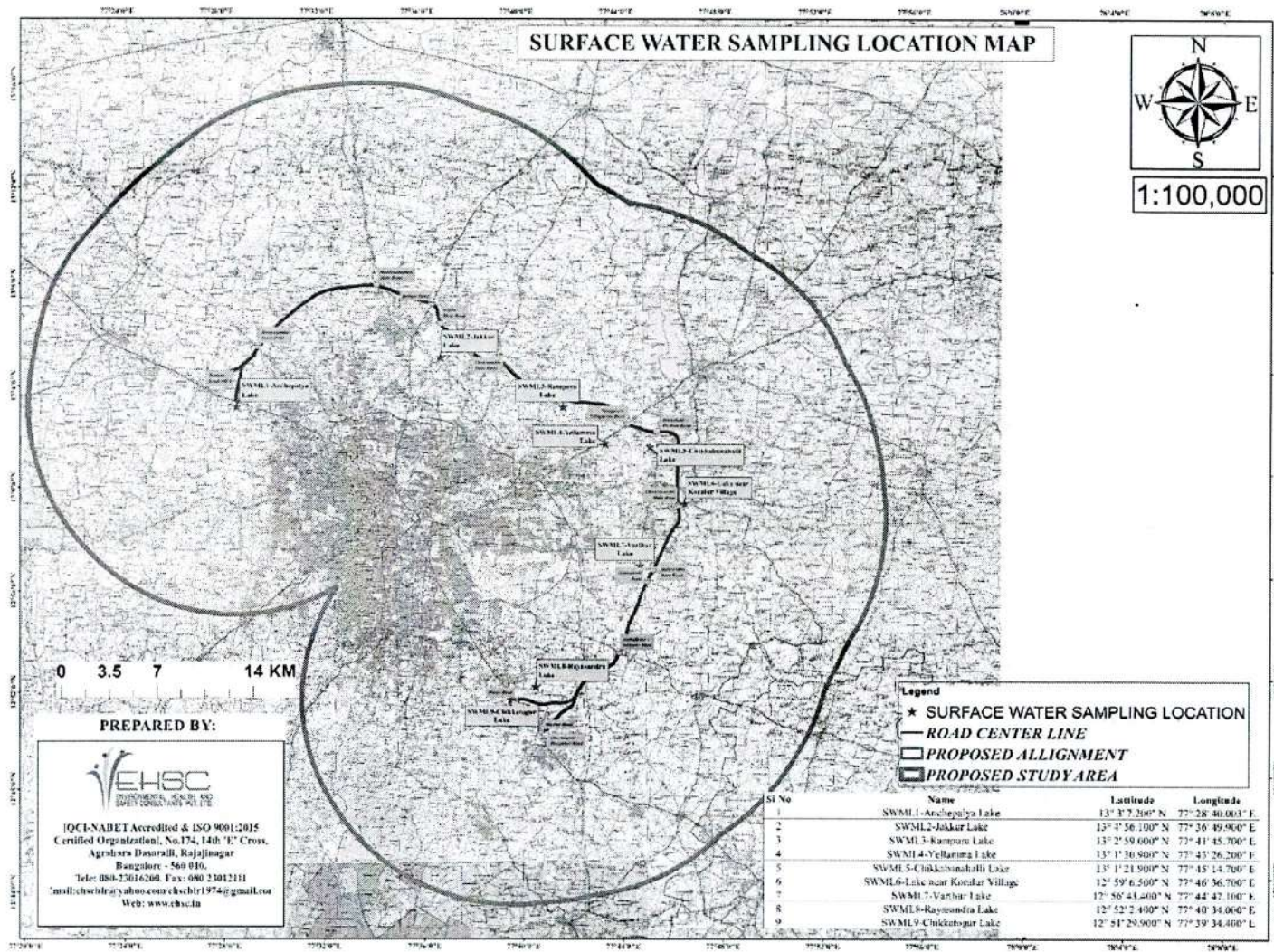


Fig 3.20: Map showing surface water quality sampling locations

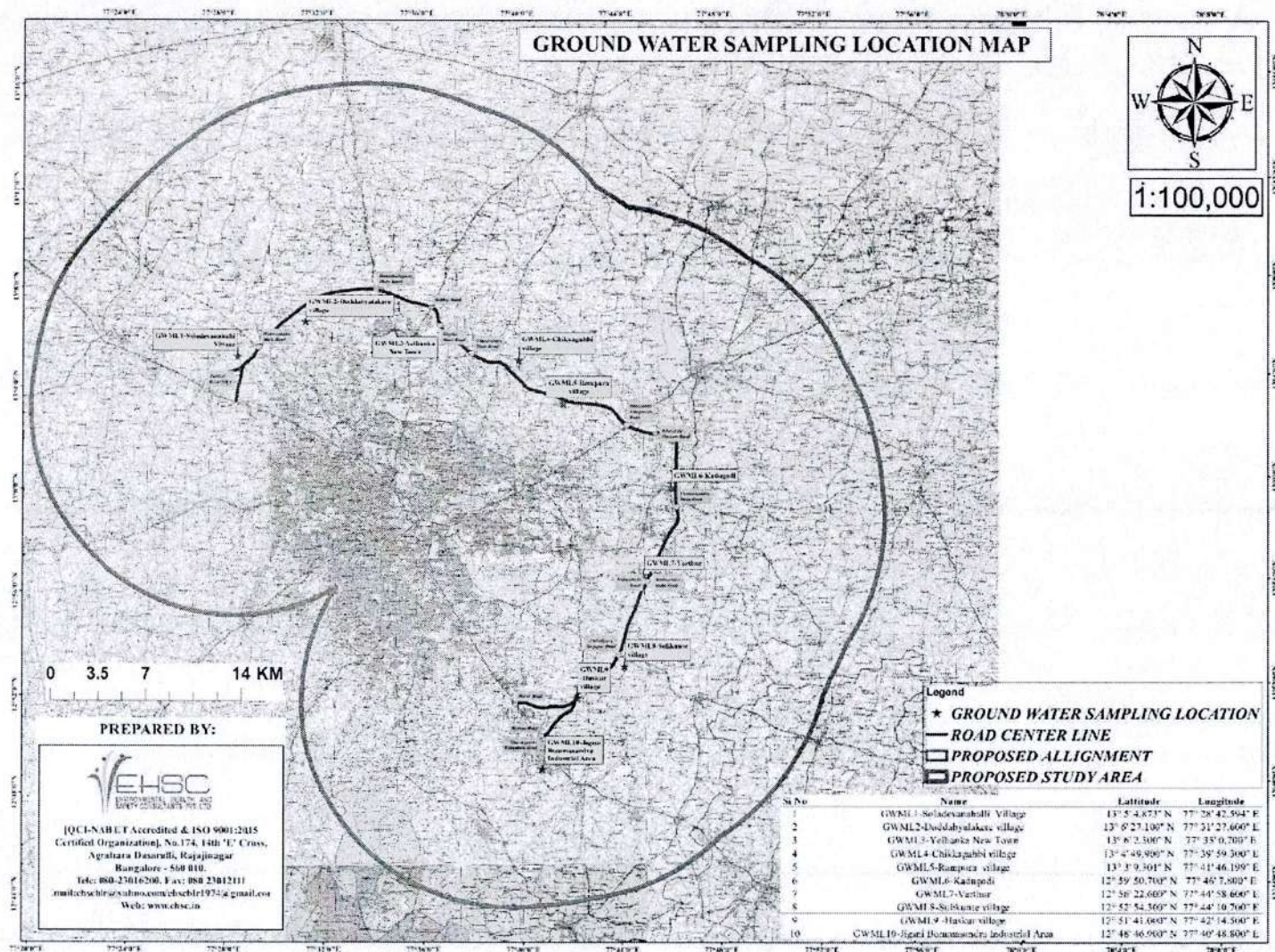


Fig 3.21: Map showing ground water quality sampling locations

Water samples for microbial analysis were collected using separate sterilized bottles. These collected samples were stored in an insulating ice box maintained at 4°C and brought to the laboratory

Water quality tests were conducted as per the protocol specified under APHA, BIS and USEPA. The measured results/values of the samples were compared with IS 10500:2012 (Second Revision) standards for ground water samples & CPCB Water Classes Classification Criteria for surface water samples. The details of surface and ground water sampling locations are given in Annexure 18 & 19 respectively and the photographs are enclosed in Chapter-15;

3.2.6.3 Results & Discussions

3.2.6.3.1 Surface water quality

A. Physical parameters (Temperature, Alkalinity, pH & TSS):

The temperature and Total Suspended Solids range from 22.4 °C (Varthur Lake) to 26.2 °C (Jakkur Lake) and 32mg/L (Chikkabanahalli lake) to 82 mg/L (Jakkur Lake) respectively. The pH of the 9 lakes ranges from 7.32 (Rampura Lake) to 8.31(Jakkur Lake) and as per the CPCB Water quality criteria pH of surface water ranges from 6.5-8.5. Research shows that most of the aquatic organisms prefer pH of 6.5-8.0⁶³ and the acidic nature of water (pH<7) enhances the proliferation of algae forming a thick mat⁶⁴. Alkalinity of the surface water bodies studied ranges from 84 mg/L (Anchepalya Lake) -540 mg/L (Chikkatogur lake). The ideal range of total alkalinity for surface water where fish live is considered to be 60-300 mg/L⁶⁵.

B. Inorganic indicators (Electrical Conductivity, TDS & TH):

The Electrical conductivity of the surface water samples ranges from 477 µs/cm (Anchepalya lake) to 2080 µs/cm (Chikkatogur lake). Electrical Conductivity ranging from 0 to 800 µS/cm is considered good for irrigation and drinking water purposes and EC values higher than 1000 µS/cm indicates land degradation and heavy run off. Similarly, TDS and Total Hardness of the surface water samples range from 772 mg/L (Jakkur lake) to 1434 mg/L (Chikkatogur lake) and 92 mg/L (Anchepalya lake) to 452 mg/L (Chikkatogur lake) respectively.

C. Major cations (K, Ca, Mg & Na):

The major cations in the surface water occur due to the inorganic minerals dissolved from the rocks and soils present in contact with the water bodies. The Potassium values ranges from 10.3 mg/L (Anchepalya lake) to 29.64 mg/L (Chikkatogur lake), Calcium values ranges from 19.2 mg/L (Anchepalya lake) to 113.6 mg/L (Chikkatogur lake), Magnesium values ranges from 10.69 mg/L (Anchepalya lake) to 44.71 mg/L (Chikkabanahalli lake) and Sodium values ranges from 49 mg/L (Anchepalya lake) to 137.2 mg/L (Yellamallappa Chetty Lake).

D. Major anions (NO₃, Cl, SO₄, F, NO₂, CO₃, HCO₃ & PO₄):

Nitrate concentration in surface water ranges from 1 mg/L to 5.0 mg/L. Nitrate values in the surface water samples of lakes ranges from 6.46 mg/L (Anchepalya lake) to 38.1 mg/L (Rayasandra lake) and this is mainly due to the bacteriological oxidation of nitrogenous materials in soil and entry of domestic sewage and agricultural runoff.

⁶³Addy, K., Green, L., & Herron, E. (2004). pH and Alkalinity. Kingston: University of Rhode Island.

⁶⁴Singh, M. R., & Gupta, A. (2017). Water pollution-sources, effects and control.

⁶⁵Hand book of Fisheries and Aquaculture. 2006. Indian Council of Agricultural Research. New Delhi

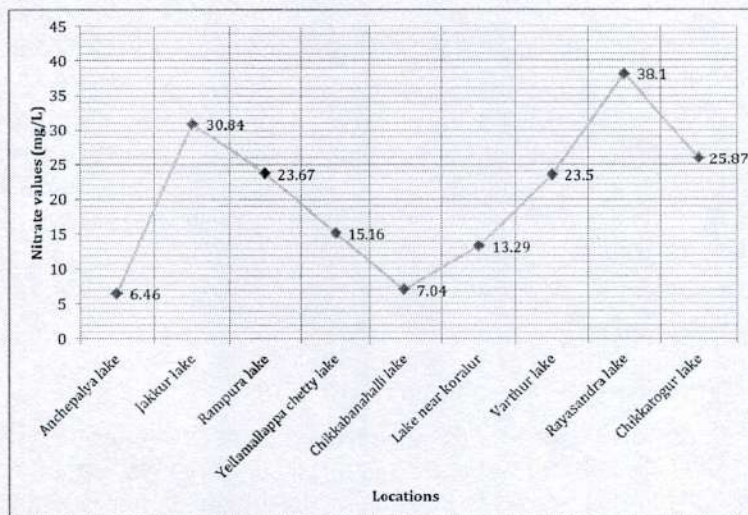


Fig 3.22: Nitrate (mg/L) at different locations

Chloride values in the surface water samples of lakes ranges from 52.6 mg/L (Anchepalya Lake) to 283.82 mg/L (Rayasandra Lake). The concentrations of sulphate anions generally ranges from 2 mg/L to 80 mg/L and the Sulphate values in the surface water samples collected in the lakes ranges from 40.82 mg/L(Rampura Lake) to 104.5mg/L (Chikkatogur lake). Chloride and sulphate anions commonly found in the surface water are released during the dissolution and dissociation of common salt deposits in geologic formations.

Fluoride concentrations in surface water is observed to be <0.1 mg/L. However, the concentration of Fluoride value ranges from 0.23 mg/L (Rampura lake) to 0.66 mg/L (Jakkur lake).Nitrite values ranges from 0.02 (Rampura lake & Chikkabanahalli lake) mg/L to 2.5 mg/L (Rayasandra lake), Total phosphate values ranges from 0.56 mg/L (Anchepalya lake) to 12.83 mg/L(Chikkatogur lake), Bicarbonate values ranges from 84 mg/L (Anchepalya lake) to 540 mg/L(Chikkatogur lake) and Carbonates were not detected in any lakes except Jakkur lake with a value of 64 mg/L.

E. Heavy metals (Pb, As, Cd, Cr, Cu, Zn, Fe & Hg):

Presence of heavy metals such as Lead, Arsenic, Cadmium, Chromium, Copper, Zinc, and Iron have a major impact on human health. As per the CPCB standards, the concentrations of lead is usually <0.1 mg/L, Arsenic concentrations ranging from 0.05 mg/L to 0.2 mg/L, copper concentrations <1.5 mg/L, Zinc concentrations <15 mg/L and Iron concentrations ranging from 0.3 mg/L to 50 mg/L.

In the surface water samples collected from the lakes, the Lead values ranges from 0.006 mg/L (Lake near Koralur) to 0.013 mg/L (Rampura lake);Arsenic values ranges from 0.005 mg/L (lake near Koralur) to 0.023 mg/L (Rayasandra lake); Cadmium values ranges from 0.004 mg/L(lake near Koralur & Chikkatogur lake) to 0.013 mg/L (Rayasandra lake); Total Chromium values ranges from 0.006 mg/L(Anchepalya lake) to 0.134 mg/L (Rampura lake); Iron values ranges from 0.06 mg/L (Jakkur Lake) to 3.943 mg/L (Yelle mallappa chetty lake);Copper values ranges from 0.007 mg/L(Anchepalya lake & Jakkur lake) to 0.053 mg/L (Rampura lake) and Zinc values ranges from 0.007mg/L(Chikkabanahalli lake) to 0.149mg/L (Yelle mallappa chetty lake). Mercury was not detected in any of the collected samples.

F. Organic indicators (DO, BOD & COD):

The optimum Dissolved Oxygen concentration supporting fish is observed to be 5 mg/L. The typical concentrations of BOD and COD for streams and rivers are observed to be < 2 to 65 mg/ L and < 2

mg/L to 100 mg/L respectively. However, in the study, DO levels were found to be ranging from 4.6 mg/L (Rampura lake & Varthur lake) to 5.2 mg/L (lake near Koralur), BOD levels ranging from 12mg/L (Jakkur lake & Chikkabanahalli lake) to 94 mg/L (Varthur lake) and COD levels ranging from 41.6 mg/L (Jakkur Lake) to 416 mg/L (Rampura lake). This is mainly due to the entry of organic matter from dead and decaying materials washed into the water bodies through rainwater which increases the nutrient availability leading to algal blooms thereby reducing the concentration of Dissolved Oxygen and increasing Biochemical Oxygen Demand.

G. Total coliform:

The total coliform in the study was found to be in the range of 2100 MPN/100 ml (Chikkabanahalli lake) to 540×10^4 MPN/100 ml (Rampura lake and Varthur lake). This is mainly due to the entry of fecal contaminants, sewage and washing of animals/cattles by the nearby villagers into the water bodies.

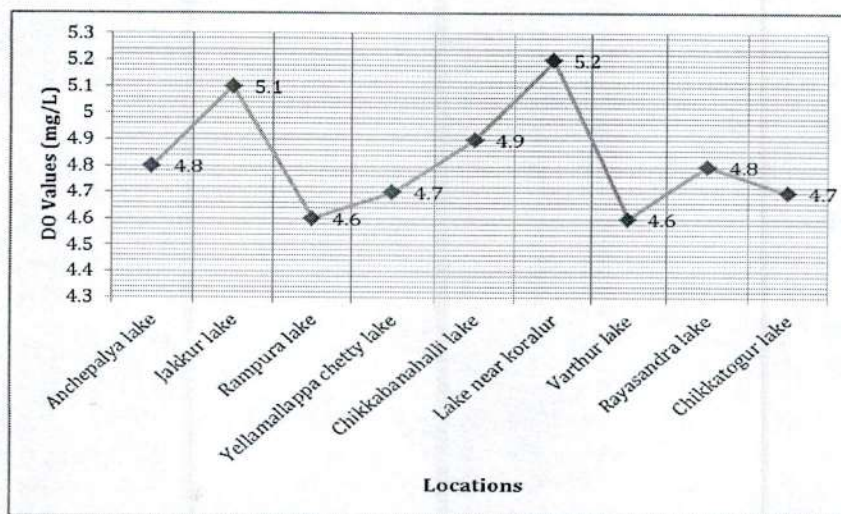


Fig 3.23: DO (mg/L) at different locations

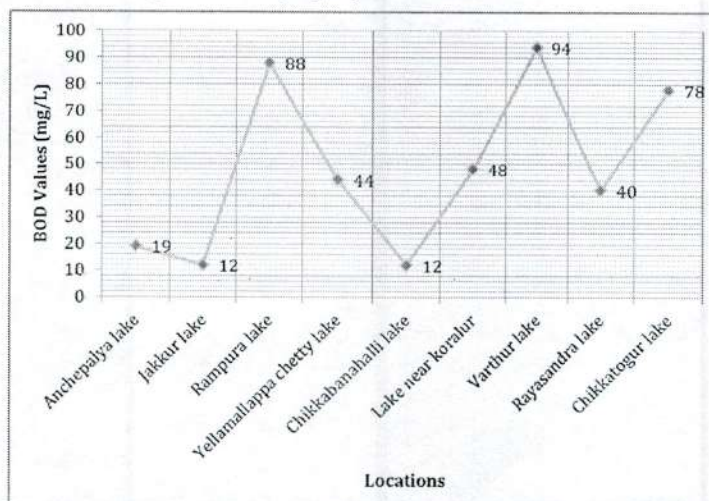


Fig 3.24: BOD (mg/L) at different locations

H. Water quality criteria as per CPCB Guidelines:

Sampling Station Code	Name of the sampling station	Water quality criteria
SW 1	Anchepalya Lake	D
SW 2	Jakkur Lake	E
SW 3	Rampura Lake	E
SW 4	Yellamallappa chetty Lake	E
SW 5	Chikkabanahalli Lake	E
SW 6	Lake near Koralur Village	E
SW 7	Varthur Lake	E
SW 8	Rayasandra Lake	E
SW 9	Chikkatogur Lake	E

Note: A- Drinking Water Source without conventional Treatment but after disinfection

B- Outdoor Bathing (Organized).

C- Drinking Water source with conventional treatment followed by disinfection

D- Propagation of wild life, fisheries.

E- Irrigation, industrial cooling, controlled waste Disposal.

From the above table, out of 9 samples, 1 sample belongs to criteria 'D' (11.11%) and 8 samples belongs to criteria 'E' (88.89%) thereby concluding that all the collected water samples are suitable for irrigation purposes only.

I. Water Quality Index

Water Quality Index of all the 9 surface found to be "unsatisfactory" as per KSPCB Guidelines since all the samples had Dissolved Oxygen levels >4.0 mg/L (agrees with the criteria ≥ 4.0 mg/L), BOD levels >3.0 mg/L (disagrees with the criteria ≤ 3.0 mg/L) and varying *Total coliform* levels 2100 MPN/100 ml to 540×10^4 MPN/100 ml (disagrees with the criteria ≤ 5000 MPN/100ml).

3.2.6.3.2 Ground water quality

A. Physical parameters (pH, Temperature, Alkalinity):

The temperature of the ground water samples collected ranges from 24.7°C (Soladevanahalli Village) to 28.4°C (Doddabyalakere Village). The pH ranges from 6.66 (Rampura Village) to 7.68 (Soladevanahalli Village) and Alkalinity of the ground water studied ranges from 94 mg/L (Yelhanka New Town) to 420mg/L (Kadugodi). As per the IS 10500:2012 Standards (Second revision) pH values ranges from 6.5-8.5 and alkalinity values ranges from 200-600 mg/L and all the values are well within the standards.

B. Inorganic indicators (EC, TDS, TH):

The Electrical conductivity of the ground water samples ranges from 658 μ S/cm (Yelhanka New Town) to 2900 μ S/cm (Jigani Bommasandra Industrial area). Similarly, TDS and Total Hardness of the ground water samples range from 480mg/L (Yelhanka New Town) to 1918mg/L (Jigani Bommasandra Industrial area) and 156 mg/L (Yelhanka New Town) to 888mg/L (Jigani Bommasandra Industrial area) respectively. As per the IS 10500:2012 Standards (Second revision) TDS values ranges from 500-2000 and TH values ranges from 200-600 mg/L and all the values are well within the standards except for TH at Kadugodi (668 mg/L), Varthur (660 mg/L) and Jigani Bommasandra Industrial Area (888 mg/L).

C. Major cations (K, Ca, Mg, Na):

The major cations in the water occur due to the inorganic minerals dissolved from the rocks and soils present in contact with the water bodies. The Potassium values ranges from 1.9 mg/L (Rampura Village) to 11.65 mg/L (Chikkagubbi Village), Calcium values ranges from 34.4 mg/L (Yelhanka New Town) to 192 mg/L (Jigani Bommasandra Industrial Area), Magnesium values ranges from 17.01 mg/L (Yelhanka New Town) to 99.14 mg/L (Jigani Bommasandra Industrial Area) and Sodium values ranges from 52.39 mg/L (Yelhanka New Town) to 157.4 mg/L (Kadugodi). As per the IS 10500:2012 Standards (Second revision), all the values are well within the standards.

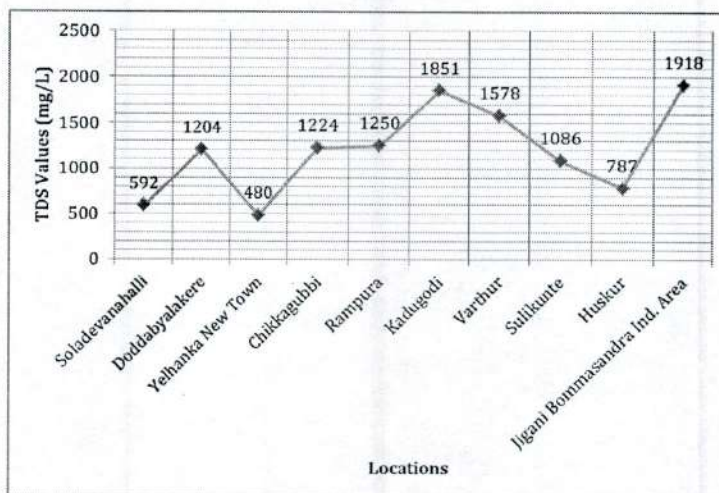


Fig 3.25: TDS (mg/L) at different locations

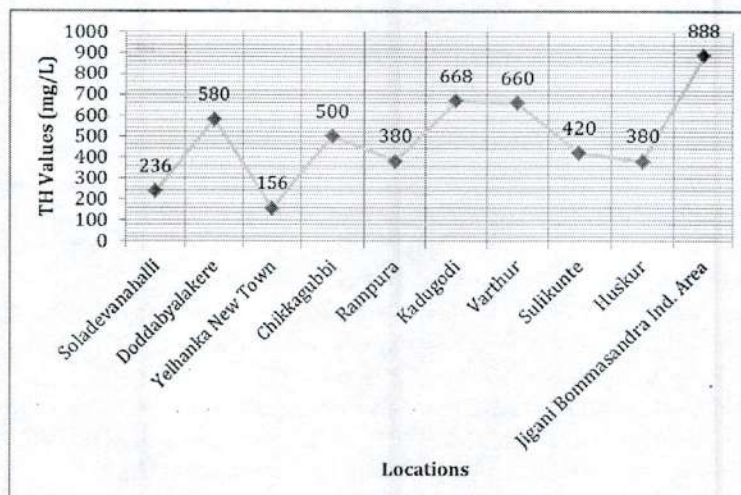


Fig 3.26: TH (mg/L) at different locations

D. Major anions (NO₃, Cl, SO₄, F, HCO₃, PO₄):

Nitrate values in the ground water samples of ranges from 10.51mg/L (Kadugodi) to 43.35mg/L (Jigani Bommasandra Industrial Area) and these values are well within the IS 10500:2012 Standards.

Similarly, Chloride values in the ground water samples of ranges from 119.11mg/L (Soladevanahalli Village) to 445.45mg/L (Kadugodi). The concentrations of sulphate anions in the ground water samples collected ranges from 7.37mg/L (Soladevanahalli Village) to 180mg/L (Sulikunte Village). Chloride and sulphate anions found in the ground water due to improper disposal of municipal solid waste, industrial waste, sewage, sludge, etc⁶⁶.

Fluoride in ground water occurs due to weathering of rocks and utilization of agricultural fertilizers and combustion of coal. Consumption of water with fluoride concentration >1.5 mg/L causes dental fluorosis. Fluoride concentrations in ground water was found to be ranging from 0.18 mg/L (Sulikunte Village) to 0.59 mg/L (Kadugodi) and was found to be well within the standards.

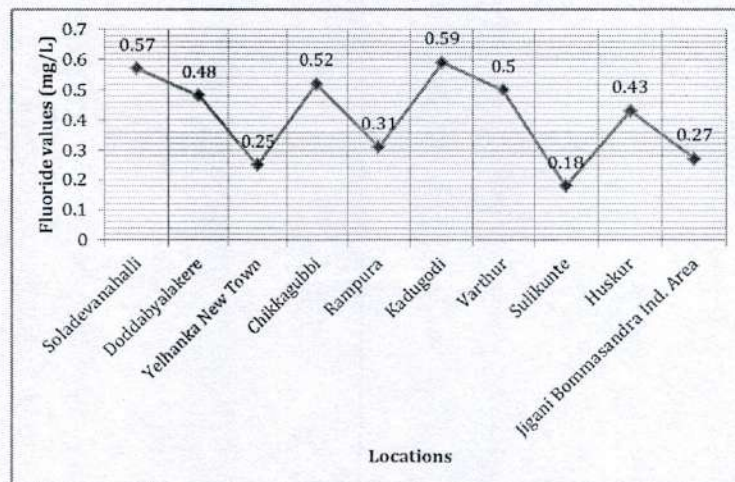


Fig 3.27: Fluoride (mg/L) at different locations

Total phosphate values ranges from 0.14 mg/L (Jigani Bommasandra Industrial area) to 0.43 mg/L (Varthur) and Bicarbonate values ranges from 94 mg/L (Yelhanka New Town) to 420 mg/L (Kadugodi). The values were found to be well within the standards.

E. Heavy metals (Pb, As, Cr, Cu, Zn, Fe):

In the ground water samples collected, the Lead values ranges from 0.006 mg/L (Varthur & Sulikunte Village) to 0.008mg/L (Huskur Village & Jigani Bommasandra Industrial area); Arsenic values ranges from 0.006mg/L (Yelhanka New Town) to 0.018mg/L (Huskur Village); Total Chromium values ranges from 0.006 mg/L (Soladevanahalli Village) to 0.127mg/L (Jigani Bommasandra Industrial Area); Iron values ranges from 0.009mg/L (Sulikunte Village) to 0.721mg/L (Rampura Village); Copper values ranges from 0.005mg/L (Huskur) to 0.022mg/L (Kadugodi) and Zinc values ranges from 0.023mg/L (Yelhanka New Town) to 0.445mg/L (Chikkagubbi Village). All the values are well within the standards except Total Chromium at Jigani Bommasandra Industrial area (0.127 mg/L) and Iron at Yelhanka New Town (0.38 mg/L), Rampura Village (0.721 mg/L) & Jigani Bommasandra Industrial area (0.575 mg/L).

F. Total coliform:

The total coliform in the study was found to be in the range of <1.8 MPN/100 ml to 350 MPN/100 ml. This is mainly due to the open defecation activities which lead to the entry of fecal contaminants and sewage into the ground water table as a long term impact in its occurrence.

⁶⁶Venkatesan, G., & Swaminathan, G. (2009). Review of chloride and sulphate attenuation in ground water nearby solid-waste landfill sites. Journal of environmental engineering and landscape management, 17(1), 1-7.

3.2.7 Soil characteristics

Roads serve as lifeline for transportation of food and other important commodities. Many of them are required on day to day basis. It is an important service that plays a major role in enhancing social and economic activities. However, construction of road has also resulted in environmental pollution especially, on soil⁶⁷. In general, the materials used for road construction affect the chemical composition of the surrounding environment (through the toxicity of leachate, runoff and groundwater) while the design and construction methods cause mechanical damage (erosion, soil disruption, watershed changes). The desirable properties of soil to be used for roads construction includes stability, incompressibility, good drainage and ease of compaction.

3.2.7.1 Objectives

Soil studies were carried out with an aim to understand the soil types and structure. Further, it is vitally important to understand the properties of the soil, and to use this information in the planning and design phases of the project. This section describes on the type of soil found in the study area, methodology followed during sampling of soil, analysis of soil samples and developing nutrient index and summarizing the quality of soil.

3.2.7.2 Soil types and cropping pattern

The texture of soil in the study area varied from loam to sandy loam. Loam is a mixture of sand, silt and clay at a 40-40-20 ratio by weight. This prevents it from being to "heavy" but still provides good water retention, porosity and permeability. Sandy loam soils are capable of quickly draining excess water but cannot hold significant amounts of water. Therefore, the potential for erosion varies along the alignment (Fig: 3.29). The texture of soil in the study area varied all along the alignment. The texture type in the sampled soils found to be sandy loam, loam and silt loam. The soil samples were collected from a depth of 15-30 cm and the texture triangle values shown most of soil belongs to loamy. These loamy soils are favorable for road construction. Due to spatio-temporal variations in soil moisture, the map showing soil type indicates that, the soil texture all along the alignment of the road as Clay, moderate clay and Loamy. Clay is the finest size soil particle. It consists of tiny microscopic flat, scale-like particles which give clay its "plastic" properties.

Most of the land owners along the proposed alignment are involved in agriculture and plantation practices like growing of Ragi, Vegetable crops (Beans, Field beans, Ridge gourd, Bitter gourd, Bottle gourd, Radish, Carrot, Ivy gourd, Snake gourd, Ladies finger), Leafy vegetable (Spinach, Amaranthus, Coriander, Chenopodium, Malabar spinach), Horticulture crops (Banana, Jamun, Sapota, Jackfruit, Mango, Butter fruit, Fig, Chakota), Commercial crops (Coconut & Areca nut), Plantation crops (Eucalyptus & Teak) and floriculture crops (Rose, Jasmine, Crossandra, Marigold, Sevanti).

3.2.7.3 Scope and methodology

A preliminary survey was conducted in the study area and soil sampling network was created based on the terrain conditions, land use pattern, soil types and peak construction activities along the alignment. Accordingly, 15 Soil samples were collected from different locations within the study area. Standard Operation Procedures as specified in Manual of Food and Agricultural Organization, M L Jackson method and Soil manual of Department of Agriculture and Co-operation, Ministry of Agriculture were considered for the analysis of physico-chemical parameters. The details of soil sampling locations are enclosed as Annexure-20 and the photographs are enclosed in Chapter-15.

⁶⁷Bai J, Cui B, Wang Q, Gao H and Ding Q. Assessment of heavy metal contamination of roadside soils in Southwest China. *Stochastic Environmental Research and Risk Assessment*, 23(3): 341-347 (2009)

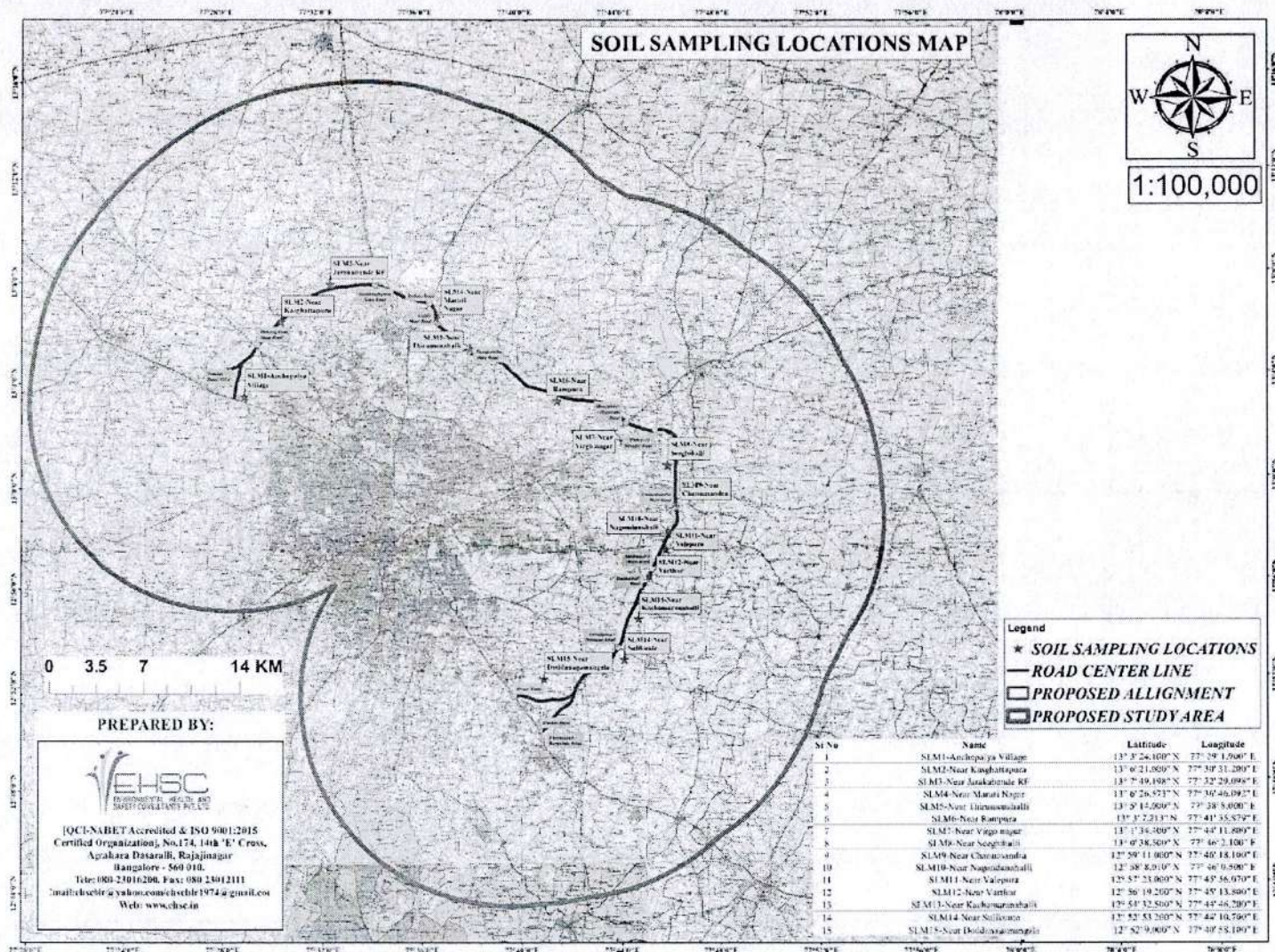


Fig 3.28: Map showing soil sampling locations

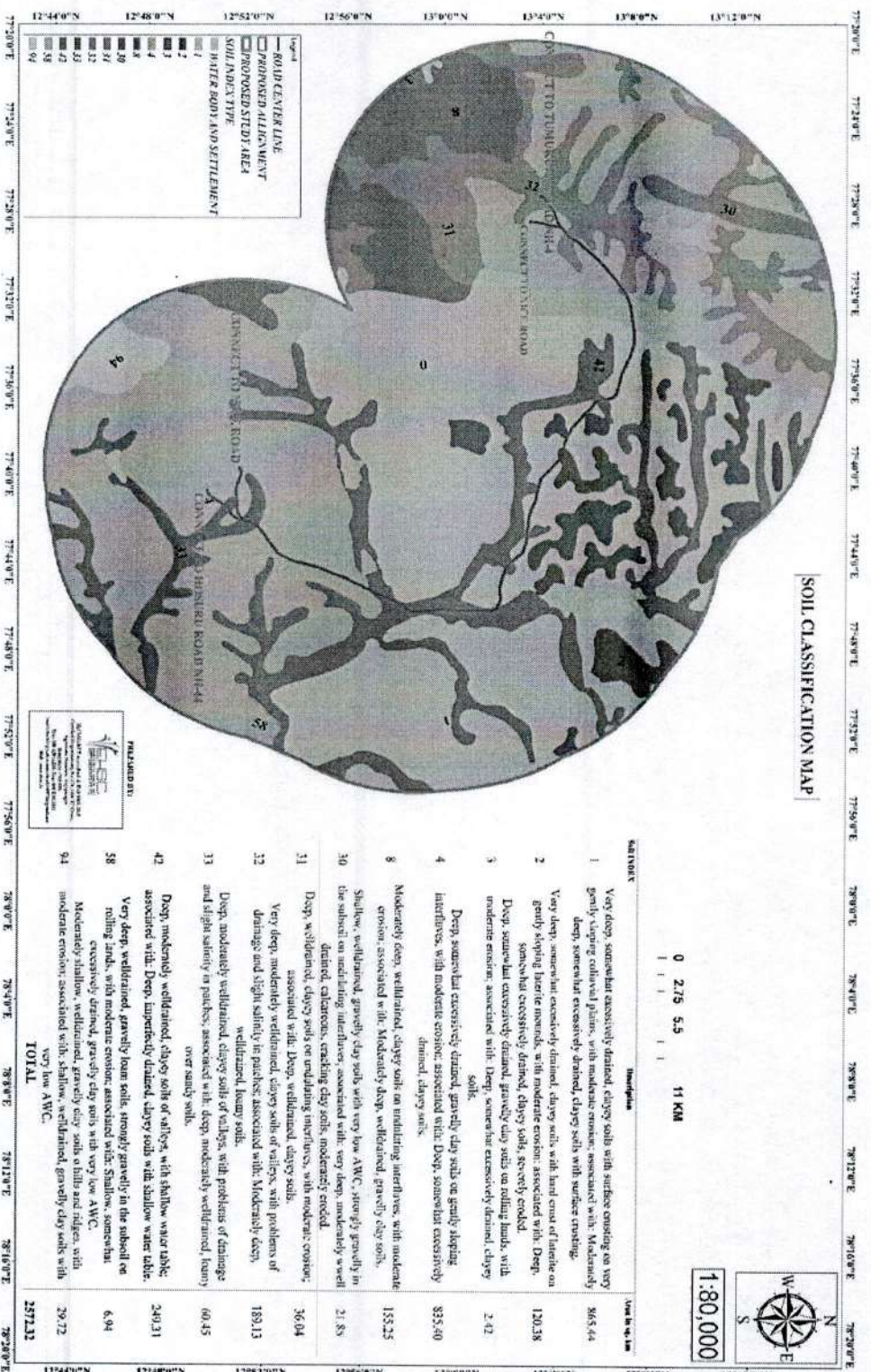


Fig 3.29: Map indicating types of soil in the study area

3.2.7.4 Analysis and interpretation of soil quality results

The soil quality analysis results are enclosed as Annexure-20 and the interpretation of the results are as given below;

Table 3.11: Interpretation of soil quality analysis data

Sl. No.	Parameters	Unit	Maximum Value	Minimum value	Interpretation	Reference
I Physical parameters						
1	Texture	--	--	--	Out of 15 soil samples collected, 9 samples have Sandy loam texture followed by 5 samples with loam texture and only one sample have silt loam texture. Texture varied from sandy loam to loam. Sandy loam soils are capable of quickly draining excess water. Loamy soils have good water retention, porosity and permeability this will helps in the drainage of water during construction phase.	--
2	Bulk Density	g/cc	1.95	1.25	Bulk density values > 1.80g/cc indicates restricted root growth and 1.25 indicates Bulk densities that affect root growth. Bulk density is an indicator of soil compaction and soil health. It affects infiltration, available water capacity, soil porosity and soil microorganism activity which contribute to the compaction of soil during road construction.	--
II Chemical parameters						
1	pH	-	7.59	7.1	Maximum pH of 7.59 was recorded at S-7 Virgonagar indicating alkaline soil reaction and minimum of 7.1 was recorded at S-2 near Kasghattapura neutral soil reaction indicating neutral effects on the road construction materials.	http://www.dird-pune.gov.in/L_R_GUI/DELINES/LAB_MANU/AL22052014.pdf Water Resources Department, Govt. of Maharashtra
2	Electrical Conductivity	µs/cm	541	70.26	Electrical Conductivity is the indicator of soluble salts present in the soil, which in turn provides information on salinity level of soil. Maximum EC of 541 µs/cm was recorded at S-14 near Sulikunte whereas minimum of 70.26µs/cm was recorded at S-	http://waterresources.rajasthan.gov.in/6guidelines_soil_prop.asp ; Water Resources

Sl. No.	Parameters	Unit	Maximum Value	Minimum value	Interpretation	Reference
					4 Maruthinagar. The results indicate medium salinity with 0.16 to 0.50 approximate salt concentrations. The overall analysis results indicate that soil is normal in nature.	Department, Govt. of Rajasthan.
III	Major Nutrients					
1	Organic Carbon	%	0.80	0.40	Maximum OC of 0.80 % was recorded at S-9 Channasandra indicating high nutrient rating and minimum of 0.40 % was recorded at S-6 Rampura indicating low nutrient rating. This indicates the setting of cement by adsorbing calcium ions liberated during hydration will be more and thereby favouring road construction activities.	"Soil Test Methodology" (1992), Edited B.S. Mathur. SSAC (BAU) Tech. Bull. 3/92. Pp. 312. Department of Soil Sciences and Agriculture Chemistry, Birsa Agriculture University, Ranchi).
2	Available Nitrogen as N	kg/ha	371.45	176.18	Maximum N of 371.45 Kg/ha was recorded at S-6 Rampura indicating medium nutrient and minimum of 176.18 Kg/ha was recorded at S-4 Maruthinagar indicating low nutrient rating.	
3	Available Phosphorus as P ₂ O ₅	kg/ha	29.79	14.24	Maximum P of 29.79 Kg/ha was recorded at S-14Sulikunte and minimum of 14.24 Kg/ha was recorded at S-3Jarakabande Reserve Forest indicating low nutrient rating.	
4	Available Potassium as K	kg/ha	286.72	161.28	Maximum K of 286.72 Kg/ha was recorded at S-2Near Kasghattapura and minimum of 161.28Kg/ha was recorded at S-13near Kachamaranahalli indicating medium nutrient rating.	
IV	Secondary Nutrients					
1	Calcium as Ca	meq/L	62	3.2	Maximum value of Ca of 62meq/L was recorded at S-5 Near Thirumenahalli and minimum of 3.2 meq/L was recorded at S-3 Near Jarakabande Reserve Forest. The hygroscopic properties of Ca effectively stabilizes soils through the attraction of moisture and subsequent evaporation resistance, improving compaction during construction which in turn ensures a strong and durable base material.	==

Sl. No.	Parameters	Unit	Maximum Value	Minimum value	Interpretation	Reference
2	Magnesium as Mg	meq/L	10.4	0.5	Maximum value of Mg of 10.4meq/L was recorded at S-5Near Thirumenahalli and minimum of 0.5 meq/L was recorded at S-9 Channasandra.	--
V	Micro Nutrients					
1	Zinc as Zn	mg/kg	16.21	0.58	Maximum value of Zn of 16.21 mg/kg was recorded at S-6 Near Rampura and minimum of 0.58 mg/kg was recorded at S-4 Maruthinagar.	"Soil Test Methodology" (1992), Edited B.S. Mathur. SSAC (BAU) Tech. Bull. 3/92. Pp. 312. Department of Soil Sciences and Agriculture Chemistry, Birsa Agriculture University, Ranchi
2	Manganese as Mn	mg/kg	79.7	5.92	Maximum value of Mn of 79.7 mg/kg was recorded at S-2near Kasghattapura and minimum of 5.92 mg/kg was recorded at S-5near Thirumenahalli.	
3	Copper as Cu	mg/kg	70.6	0.95	Maximum value of Cu of 70.6 mg/kg was recorded at S-5near Thirumenahalli and minimum of 0.95 mg/kg was recorded at S-4near Maruthinagar.	
4	Barium	mg/kg	9.15	0.90	Maximum value of Barium of 9.15 mg/kg was recorded at S-1near Anchepalya village and minimum of 0.90 mg/kg was recorded at S-8near Seeghihalli.	NYS DEC. 2006. New York State Brownfield Cleanup Program Development of Soil Cleanup Objectives Technical Support Document. New York State Department of Environmental Conservation and New York State Department of Health, Albany, NY. http://www.dec.ny.gov/chemical/34189.html
5	Cadmium	mg/kg	0.10	ND	Maximum value of Cadmium of 0.10 mg/kg was recorded at S-6near Rampura village.	
6	Lead	mg/kg	5.77	0.55	Maximum value of Lead of 5.77 mg/kg was recorded at S-6near Rampura village and minimum of 0.55 mg/kg was recorded at S-13near Kachamaranahalli.	
7	Nickel	mg/kg	2.00	0.22	Maximum value of Nickel of 2 mg/kg was recorded at S-2near Kasghattapura village and minimum of 0.22 mg/kg was recorded at S-3near Jarakabande RF.	
8	Iron	mg/kg	9.33	1.077	Maximum value of Iron of 2 mg/kg was recorded at S-2 near Kasghattapura village and minimum of 0.22 mg/kg was recorded at S-3near Jarakabande RF.	

3.2.7.5 Developing nutrient index

Fertility Status of soils: Classification of the nutrient status/nutrient levels (low, medium or high) of the particular area is done based on the results, nutrient indices and soil test values based on a rating chart and the results are as follows:

Table 3.12: Rating Chart for Soil Test values and their Nutrient Indices

1. Soil pH			
	Acidity	Neutral	Alkaline
Range	Below 6	6-8	Above 8
Soil Reaction Index	I	II	III
2. Electrical Conductivity			
	Normal	Critical	Injurious
Range (µmhos/cm)	below 1000	1000-2000	above 2000
Salt index	I	II	III
3. Organic Carbon			
	Low	Medium	High
Range (%)	Below 0.5	0.5-0.75	Above 0.75
Nutrient index	I	II	III
4. Available Phosphorus			
	Low	Medium	High
Range (Kg/ha)	Below 22	22-54	Above 54
Nutrient index	I	II	III
5. Available Potassium			
	Low	Medium	High
Range (Kg/ha)	Below 123	123-296	Above 296
Nutrient index	I	II	III
6 Nutrient Index			
Nutrient Index	Range	Remarks (OC, N, P, K)	
I	Below 1.67	Low	
II	1.67-2.33	Medium	
III	Above 2.33	High	

Nutrient index= [(1x No. of samples in low category) + (2 x No. Samples in medium category) + (3 x No. of samples in high category)] / Total number of samples The values are:

Characteristics	Nutrient index	Remarks	Characteristics	Nutrient index	Remarks
Organic carbon	1.86	Medium	Nitrogen (N)	1.133	Low
pH	2.26	Medium	Phosphorus (P)	1.466	Low
Electrical Conductivity	1	Low	Potassium (K)	1.86	Medium

3.2.7.6 Summary

The soil analysis results indicate that, soil texture varied from sandy loam to loam. Sandy loam soils are capable of quickly draining excess water. Loamy soils have good water retention, porosity and permeability this will helps in the drainage of water during construction phase. Organic carbon falls in medium category indicating the setting of cement by adsorbing calcium ions liberated during hydration will be more and thereby favouring road construction activities. pH values fall under medium nutrient index which indicates that the soil supports road structures⁶⁸. Phosphorus is

⁶⁸ A.J.W. Biggs¹ and K.M. Mahony² South West Region, Department of Natural Resources, Mines and Energy, Toowoomba, Australia. Southern Queensland Region, Department of Main Roads, Toowoomba, Australia.

particularly reactive with aluminium, iron, and calcium at specific soil pH. In neutral soils, insoluble phosphorus compounds are formed with iron, aluminium, and manganese. Above pH 7.0, calcium, magnesium, and sodium are increasingly soluble and phosphorus forms insoluble compounds containing calcium and magnesium contributing to increased stability to road structures. Electrical conductivity values within 800 $\mu\text{mhos/cm}$ are considered as normal nature of soil supporting road construction activities and in the present study, all the samples were observed to be in the normal range. Nitrogen and Phosphorus values falls under low nutrient rating. The Potassium values fall under medium nutrient rating and however, this does not have any effect for construction of roads. Analysis results of Micro nutrients viz., Zinc as Zn, Manganese as Mn, Copper as Cu, Barium, Cadmium, Lead, Nickel and Iron reveals that, the soil supports commercial developments in the study area and road construction in particular⁶⁹. Overall results of soil quality analysis were found to be supportive to road construction activities.

3.3 Land use assessment

3.3.1 Introduction

Land is a limited resource having competing demands. Industrialization and urbanization has resulted in accelerated land degradation. Bangalore city is popularly known as 'the garden city' of India is experiencing rapid urban growth and consequent to the software boom, the city is now referred as 'IT Capital' of India. In Bangalore City, agglomerations have been considered the magnets that attract investment, which leads to development of industrial and service sector, employment generation, migration and population growth. This process has significant implications in terms of land use changes especially in the context of privatization and globalization. This has led to "urban sprawl"- an outgrowth of urban areas caused by uncontrolled, uncoordinated and unplanned growth. This outgrowth is clearly seen along the periphery of cities, along highways, and along roads connecting a city which was not visualized during planning, policy and decision-making.

Studies have shown that in developing countries, where urbanization rates are high, urban sprawl is a significant contributor of the land use change which also leads to erosion of landscape elements such as water bodies, vegetation, etc. With the fact that the growth in Bangalore is experiencing significant implications on land use, it is evident that the amount of dispersion and dispersed growth is taking place in radial direction across Bangalore. It was also noted that the land use change from open land into vegetation was significant while the major land use that contributed to the increase of built-up was by the open land use class⁷⁰.

Further, urban agglomerations have resulted in decrease of agricultural land due to conversion of land to urban land use or discontinuation of agricultural activities in anticipation of conversion to urban areas. This has resulted in lands being left undeveloped as vacant land or converted into layouts for considerable period of time to speculate higher land values.

Presently, large scale changes in economic structure, the in-migration population growth/changes and spatial distribution are likely to affect the land use pattern as per the changing needs of the different economic activities and people⁷¹. Remote Sensing and GIS Techniques have been used for land use spatio-temporal analysis which focuses on changes in population, structure, privatization, urbanization and industrialization which has led to the major changes in land use and land cover in spatial perspective.

⁶⁹NYS DEC. 2006. New York State Brownfield Cleanup Program Development of Soil Cleanup Objectives Technical Support Document. New York State Department of Environmental Conservation and New York State Department of Health, Albany, NY. <http://www.dec.ny.gov/chemical/34189.html>

⁷⁰Sudhira, H. S., & Ramachandra, T. V. (2007). Characterising urban sprawl from remote sensing data and using landscape metrics.

⁷¹Iyer, N. K., Kulkarni, S., & Raghavawamy, V. (2007, June). Economy, population and urban sprawl a comparative study of urban agglomerations of Bangalore and Hyderabad, India using remote sensing and GIS techniques. In PRIPODE Workshop on Urban Population, Development and Environment Dynamics in Developing Countries (pp. 1-37).

3.3.2 Approach and methodology

Reconnaissance survey has been carried out in the month of September 2019 and April, 2021 to understand the study area features. GPS coordinates of important features such as water bodies, road junctions, nalas were recorded. High resolution satellite imageries were obtained from National Remote Sensing Center (NRSC) Hyderabad and then prepared land use maps, crop land, forest, habitation, drainage, environmental sensitive locations, slope map, soil types maps, DEM map, location of industries map were prepared. Geocoded False Colour Composite scene of IRS-IC LISS III with PAN merged data on 1:10,000 scales overplayed with Survey of India (SOI) Topo sheet was used to primary features followed by georeferencing of the Toposheets. Based on this, various thematic maps and land use and land cover map were prepared.

ARC GIS 9.2 and ERDAS IMAGINE 9.1 are used for extracting the land use, land cover layers, from SOI Topo sheets and satellite imageries as part of land use/land cover studies by using RS and GIS techniques. Maximum likelihood classification has been used to extract the LU/LC features from the procured high-resolution satellite imageries. As per NRSC guidelines⁷², land use/land cover classes include agriculture land, forest, wetlands, settlements, built-up land etc. The feature classes were identified based on the visual interpretation of the satellite imagery coupled with field observations. Land use/land cover statistics for the areas under each of these categories were obtained based on the digitized datasets and analysis.

Ground truthing has been carried in February, 2020 and February, 2022. Using GPS, coordinates of selected features such as junctions, water bodies, temples, drainages, etc were recorded and superimposed on satellite imageries to understand the deviations. Based on this, final images were prepared.


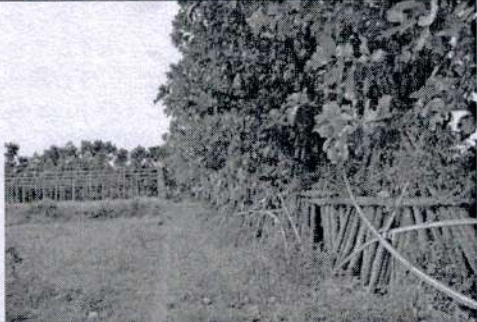

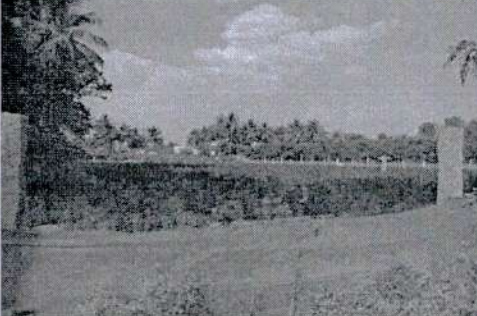




3.3.3 Results and observations

Land use land cover of the study area of 2,572.32 Sq. Km indicate that, area predominantly covered with Fallow land (27%) followed by agricultural land (22%) and built up area (20%). The Current Fallow land is large in the study area since the Satellite captured the image in the Month of April. In Karnataka, sowing and harvesting period start from June fortnight to October fortnight. Plantation activities in the study area mainly include banana, coconut, areca nut, teak, eucalyptus, etc and floriculture is also observed in the study area. Waterbodies comprising of 3% of the study area. Land use maps of the study area based on the recent satellite imagery (Scale 1:25,000) is enclosed as Annexure-21.

Table 3.13: Land use and land cover data of project alignment and study area

Sl. No.	Land use	Area (Sq. Km.)	Percentage (%)
1	Built up area	519.07	20
2	Agricultural land	569.49	22
3	Barren land	206.38	8
4	Fallow land	695.53	27
5	Plantation	450.90	18
6	Water bodies	64.95	3
7	Forest	66	2
Total		2572.32	100

⁷²https://www.nrsc.gov.in/sites/default/files/pdf/ebooks/Chap_2_LULC.pdf

	
Coconut plantation 13°03'34.07" N, 77°28'39.18" E	Teak and Neem plantation with vineyards 13°03'47.88" N, 77°28'43.24" E
	
Eucalyptus plantation 13°07'47.28" N, 77°34'14.72" E	Floriculture (Rose plantation) 13° 6'45.71"N, 77°32'52.78"E
	
Water body 13° 7'8.46"N, 77°35'12.01"E	Fallow land not ploughed for a season 13° 7'18.95"N, 77°33'57.47"E
	
Built up area 13° 7'46.44"N, 77°34'28.87"E	Barren land with sparse plant growth 13° 6'2.50"N, 77°37'35.75"E
Land use & land cover in the study area	

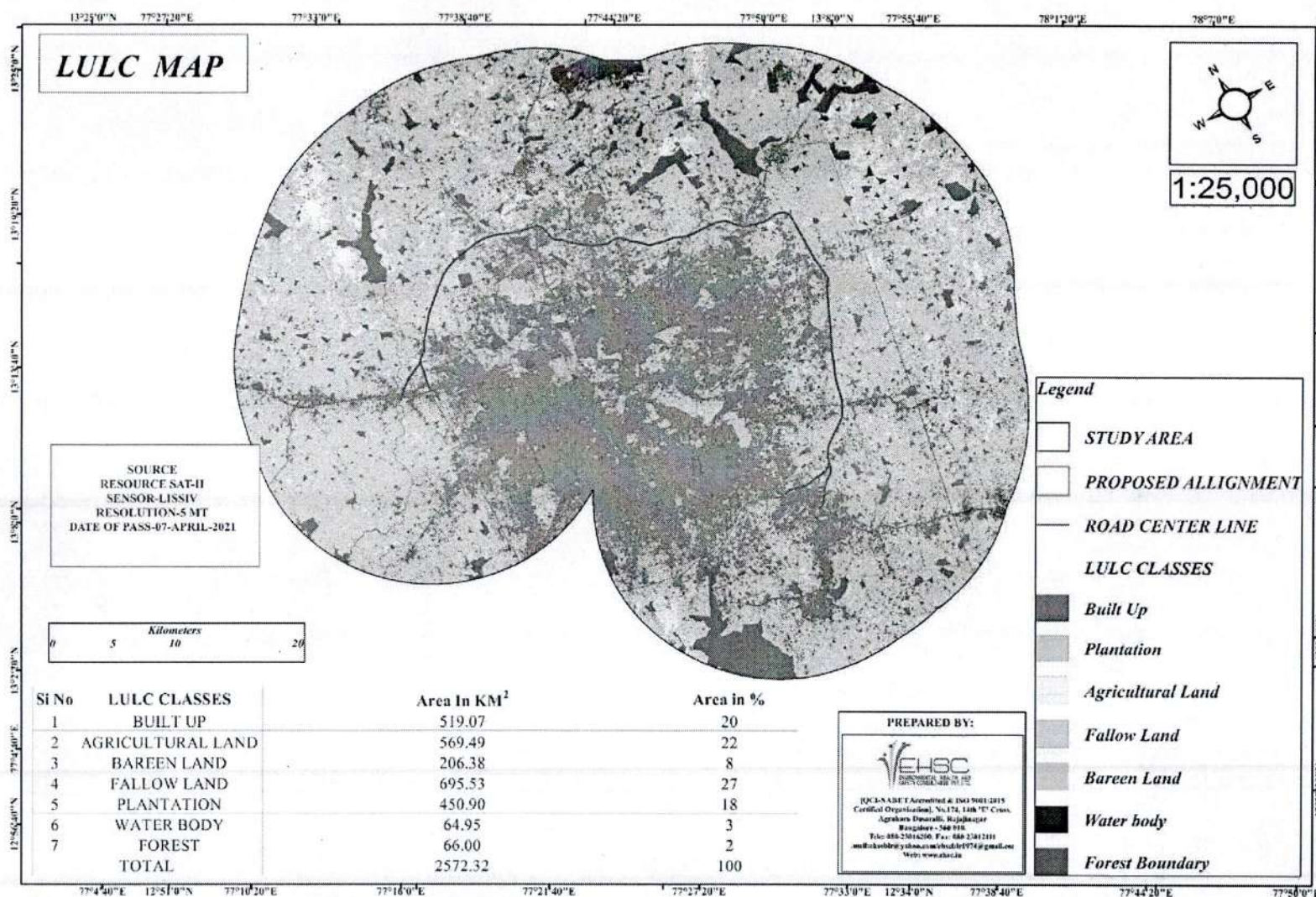


Fig 3.30: Map showing land use and land cover in the study area (15 km radius)

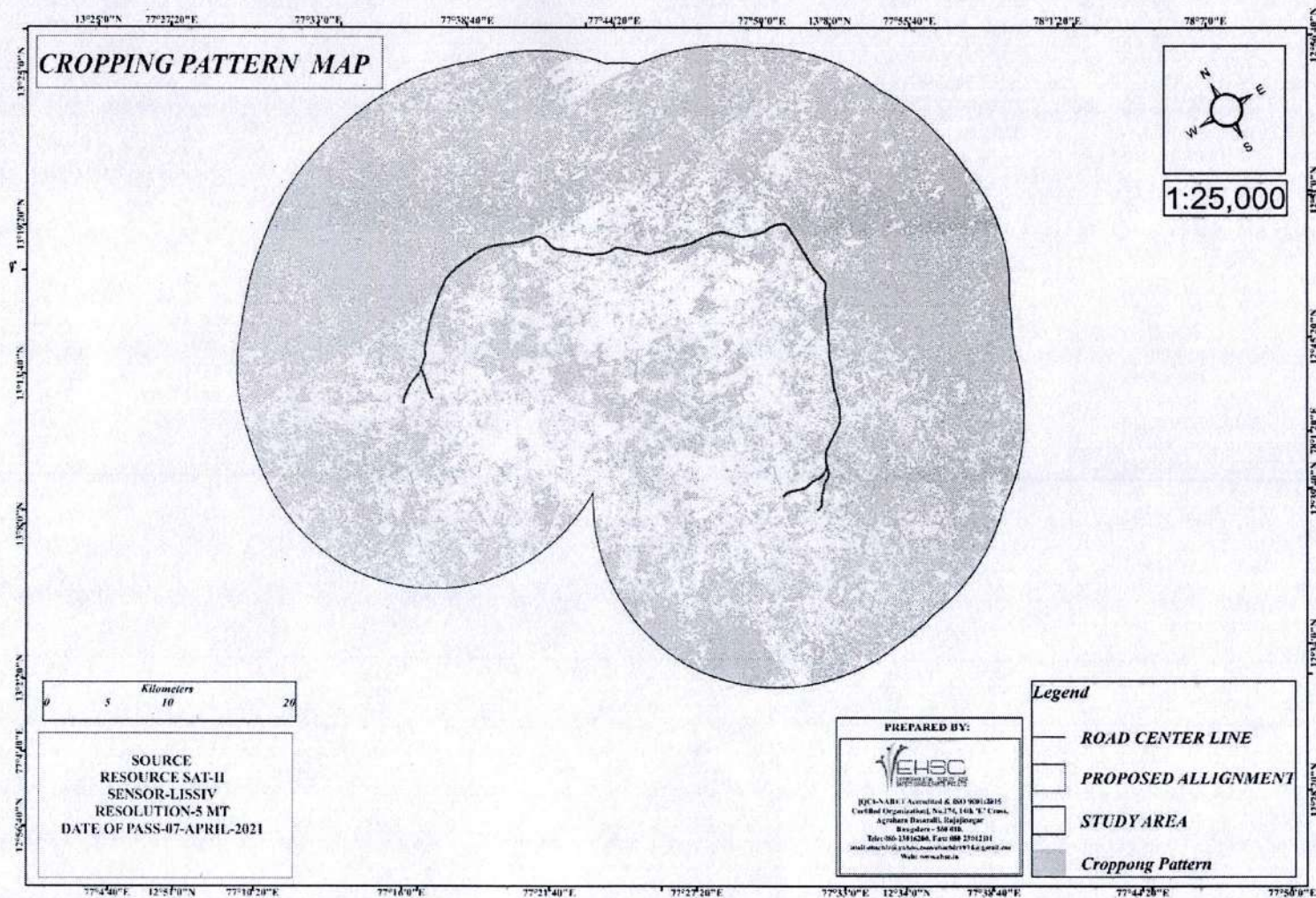


Fig 3.31: Map showing crop lands

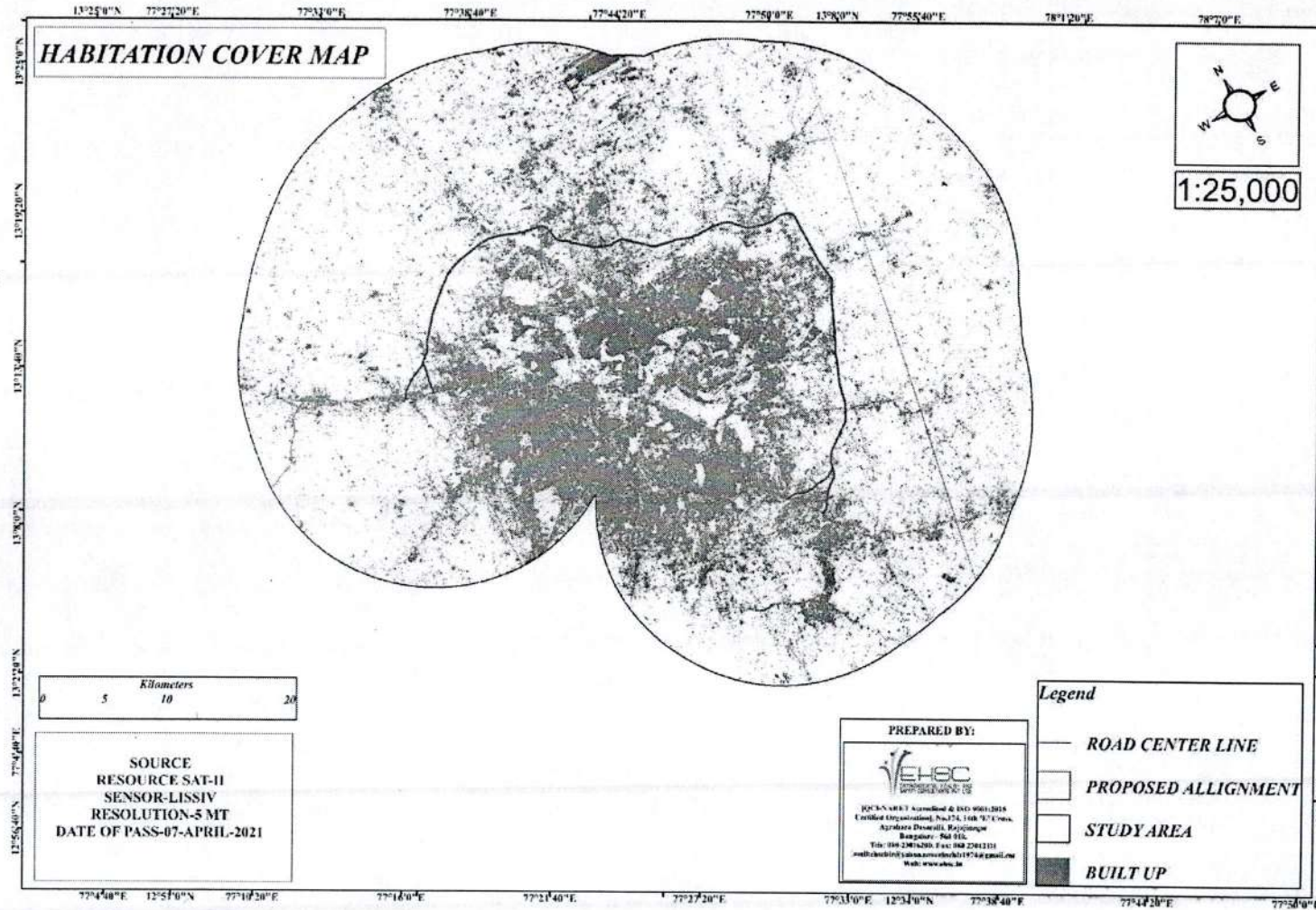




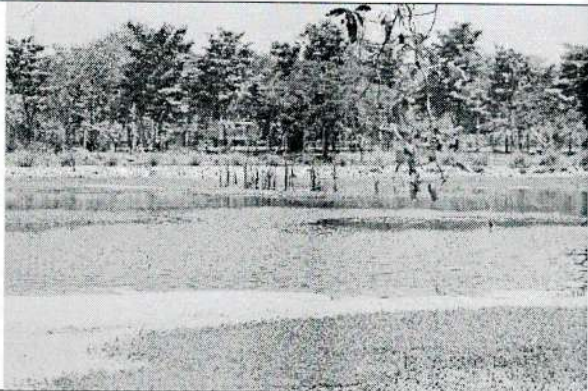

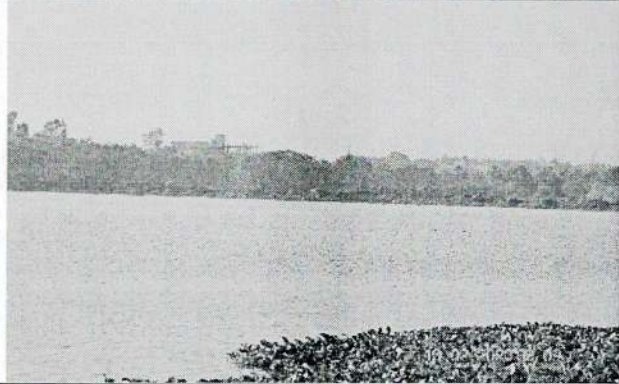
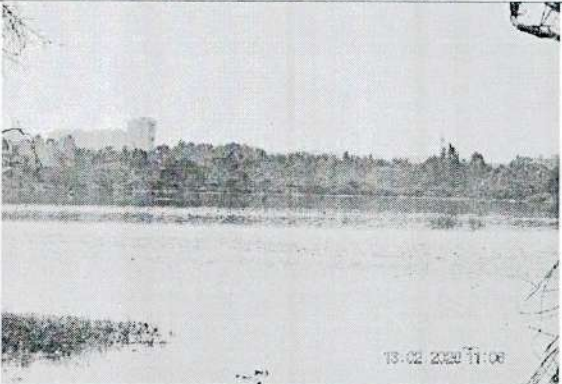
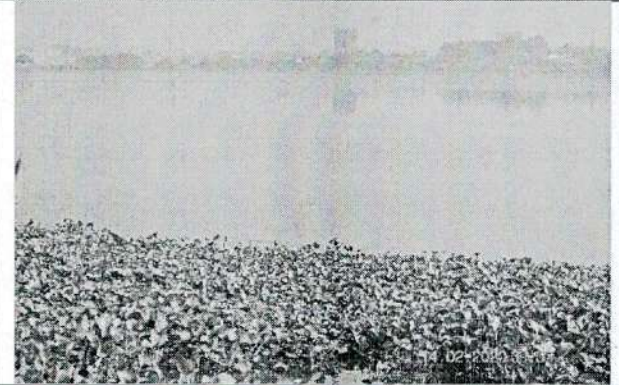

Fig 3.32: Map showing the habitations

3.4 Biological Environment

3.4.1 Description of the project site and Study area

A. Project Site	
Soil type	Soil type vary from loam to sandy loam all along the alignment.
Adjacent Site surrounding features	Agriculture lands followed by settlements
Previous land-use	Agriculture and Residential
Existing plant species available within the project site	<i>Cocos nucifera</i> , <i>Grevillea robusta</i> , <i>Eucalyptus globules</i> , <i>Acacia nilotica</i> , <i>Mangifera indica</i> , <i>Tectona grandis</i> , <i>Azadirachta indica</i> , etc.
B. Study area	
Climate & Rainfall	Humid to Semi-arid climate. The average temperature is around 23.1°C. The mean annual rainfall is about 875mm.
Soil type	Red Loamy Soil, Red Sandy Soil, Laterite Soil & Clay Soil.
Land use of the study area	Agriculture lands, Reserve Forests, Residential area & industrial area.
Crops grown in the study area	Plantation - Mango, Guava, Sapota, Coconut, Areca nut, Silver Oak, Teak, Eucalyptus. Seasonal crop - Beans, Tomato, Ragi, Carrot, Radish, chilli, Maize, Cucumber. Perennial crop – Rose
Protected areas and ecologically sensitive areas	<ul style="list-style-type: none"> Bannerghatta National Park – 7.75 Km Puttenahalli Bird Conservation Reserve – 1.49 Km
Reserve Forest within the study area	Jarkabandekaval RF (Fig 3.3)
Applicability of Forest Clearance	Yes, Project requires diversion of 7.73 Ha of Jarakabandekaval RF
Applicability of Wildlife Clearance	No
Forest types	Dry deciduous type with thorny undergrowth.
River and Stream	<ul style="list-style-type: none"> Arkavathi River 2.38Km from Ch-0+500 Vrishabhavathi River 8.67Km from Ch-0+000

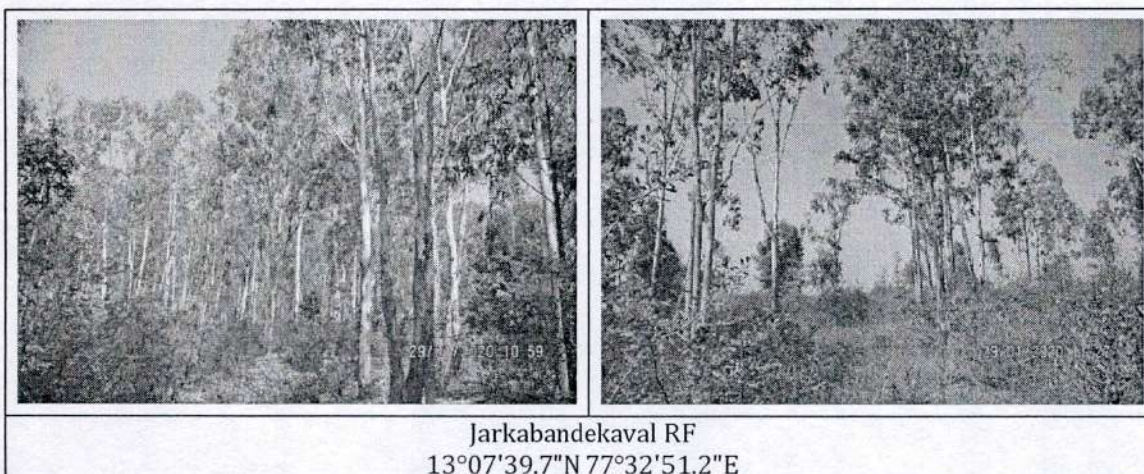
	
Coconut Plantation Near Channasandra 12°58'50.7"N 77°46'21.4"E	Rose Plantation near Bileshivale 13°03'25.9"N 77°41'27.8"E
Project alignment	

	
Puttenahalli Lake 13°6'43.61"N 77°34'34.99"E	Sheelavanthakere 12°57'50.29"N 77°44'36.10"E
	
Anchepalya lake 13°03'10.1"N 77°28'42.2"E	Chikkabanavara lake 13°05'9.6"N 77°30'21.2"E
	
Yellemallappachetty lake 13°01'17.2"N 77°43'24.9"E	Rayasandra Lake 12°52'9.83"N 77°40'49.59"E
Study area	

3.4.1.1 Jarakabandekaval Reserve Forest

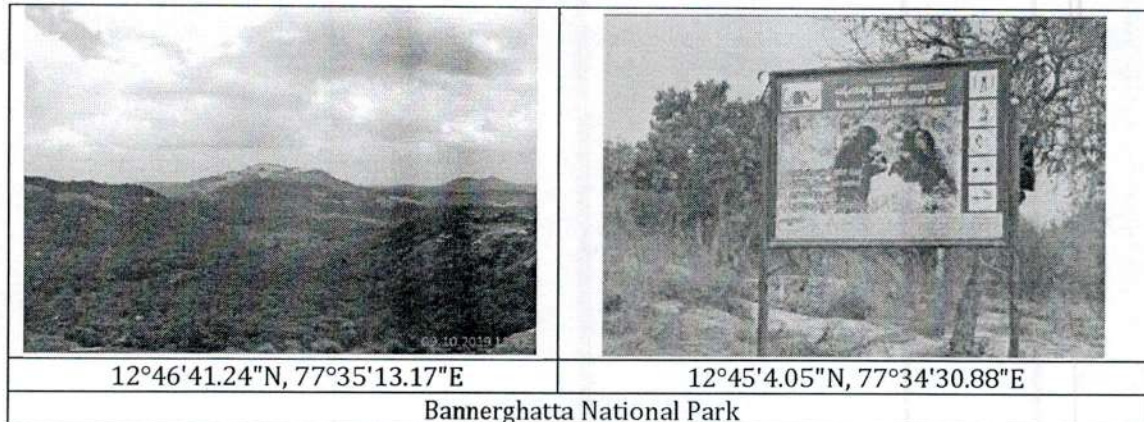
Jarakabandekaval Reserve Forest belongs to Bengaluru North sub-division, Bangalore Range and Yeshwanthpur section, notified on 29.05.1896 (G-10407-FT-F-153-95), covers an area of 199.92 Ha and as per Champion and Seth classification the forests belong to Dry Deciduous Scrub (5/DS₁) type. Some of the dominant floral species includes *Lantana camara* L., *Acacia auriculiformis* Benth.,

Santalum album Linn., *Albizia amara* (Roxb.) B. Boivin, *Tamarindus indica* L., *Canthium parviflorum* L., *Dodonaea viscosa* (L. fil.) J.G. West, *Senna siamea* (Lam.) H.S. Irwin & Barneby, *Dalbergia latifolia* Roxb., *Erythroxylum monogynum* Roxb., *Cassia fistula* L., *Pterocarpus marsupium* Roxb., *Ixora pavetta* Andrews, *Tectona grandis* L.f., *Gardenia gummifera* L.f., *Wrightia tinctoria* (Roxb.), *Leucaena leucocephala* (Lam.) de Wit, *Hardwickia binata* Roxb., *Eucalyptus* Spp., *Butea monosperma* (Lam.) Taub. *Albizia lebbeck* (L.) Benth. The project requires diversion of 7.73 Ha of forest land belonging to Jarakabandekaval RF which attracts the provisions of Forest (Conservation) Act, 1980. To compensate the forest diversion, 14.60 ha (36.10 acres) of land has been identified in Sy. No 156 of Mantapa Village, Jigani Hobli, Anekal Taluk, Bangalore Urban District which is adjacent to Bannerghatta National Park and found suitable for compensatory afforestation and management point of view.



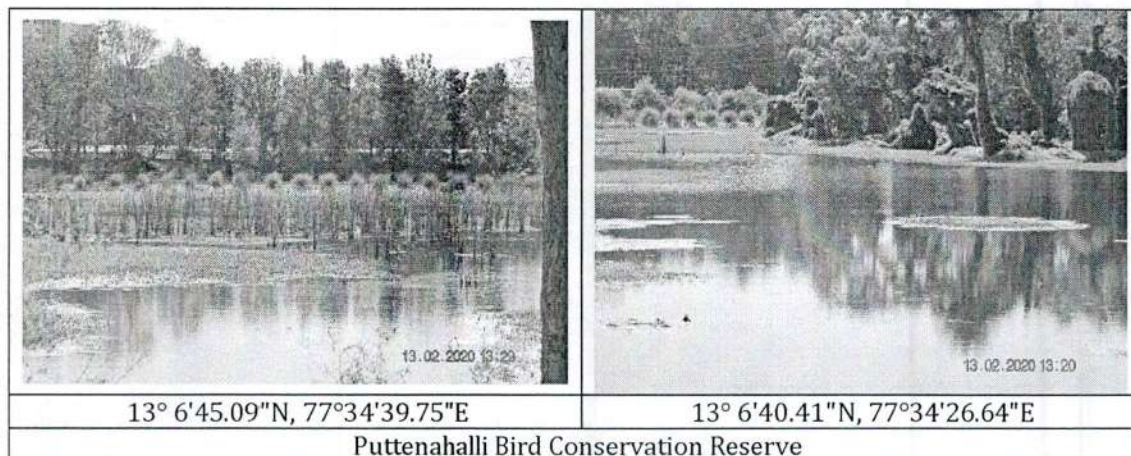
3.4.1.2 Bannerghatta National Park

Bannerghatta National Park (BNP) lies between the 12°34' and 12°50' N latitudes and between 77°31' and 77°38' E longitudes and spread over an area of 260.51 sq. km and located at a distance of 7.75 Km from the boundary of the project site and 7.42 Km from the notified ESZ. As per Champion & Seth classification (1968), the forest land of Bannerghatta National Park belongs to the category "Scrub Forest, Tropical dry forests and Tropical moist mixed forests". Some of the dominant floral species involves *Anogeissus latifolia* (Roxb. ex DC.) Wall. ex Guill. & Perr., *Chloroxylon swietenia* DC., *Acacia leucophloea* (Roxb.) Willd., *Acacia catechu* (Roxb.) Kurz., *Stereospermum chelonoides* DC., *Zizyphus* spp., *Diospyros* spp., *Santalum album* L., *Shorea roxburghii* Don, *Azadirachta indica* A. Juss., *Terminalia* spp., *Dendrocalamus strictus* (Roxb.) Nees, *Pterocarpus marsupium* Roxb., *Dalbergia latifolia* Roxb., *Dalbergia peguensis* Thoth., *Gmelina arborea* Roxb. ex Sm., *Lagerstroemia parviflora* Roxb., *Boswellia serrate* Roxb. ex Colebr., *Dendrocalamus strictus* (Roxb.) Nees, *Tectona grandis* L.f., *Lagerstroemia microcarpa* Wight, *Bombax ceiba* L., *Adina cordifolia* (Roxb.) Brandis, *Ficus virens* W.T. Aiton and other species of *Ficus*.



3.4.1.3 Puttenahalli Bird Conservation Reserve

Puttenahalli lake located near Attur and Puttenahalli villages is declared as "Puttenahalli Lake Bird Conservation Reserve" under Wildlife (Protection) Act, 1972 in view of protecting, propagating and developing wildlife therein or its environment and to protect the important habitats like fresh water swamps. The reserve is 1.49 Km from the project road. Some of the important avifaunal species recorded are Darters, Painted storks, Black-crowned Night Herons, Purple Herons, Pond Herons, Egrets, Asian Open bill Storks, Eurasian Spoonbills, Spot-billed Pelican, Little Grebe, Little Cormorant, Spot-billed Ducks, Purple Moorhen and other water-birds. Observations of endangered and migratory birds from the Northern Himalayas and Siberia have also been made and several birds belongs to threatened category as per IUCN Conservation Status⁷³.



3.4.1.4 Wildlife habitats

The project alignment covers most of the agriculture and plantation land; a portion of alignment also passes through Jarakabandekaval Reserve Forest. The project involves diversion of 7.73 Ha of forest land belonging to Jarakabandekaval Reserve Forest and attracts the provisions of Forest (Conservation) Act, 1980. Where, indirect evidence confirmed that the presence of Indian Peafowl (Schedule-I), construction of road may cause loss of habitat. Apart from this, the project alignment 7.75 Km away from the Bannerghatta National Park and the alignment are already covered by

⁷³Forest, Environment And Ecology Secretariat notification No: FEE 389 FWL 2014 Bengaluru, dated: 29-04-2015.

settlements on either sides. Hence there will be minimal impact on wildlife; however care should be taken to control the road kills and dumping of solid waste in forest limits.

3.4.1.5 Status of lakes in the study area

The existing lakes in study area were biologically dead, due to excessive entry of sewage water, dumping of solid waste, increased eutrophication cause predominant growth of water weeds like *Eichhornia crassipes*, *Typha angustifolia*, *Pistia stratiotes*, *Polygonum barbatum* & *Alternanthera philoxeroides*, etc.

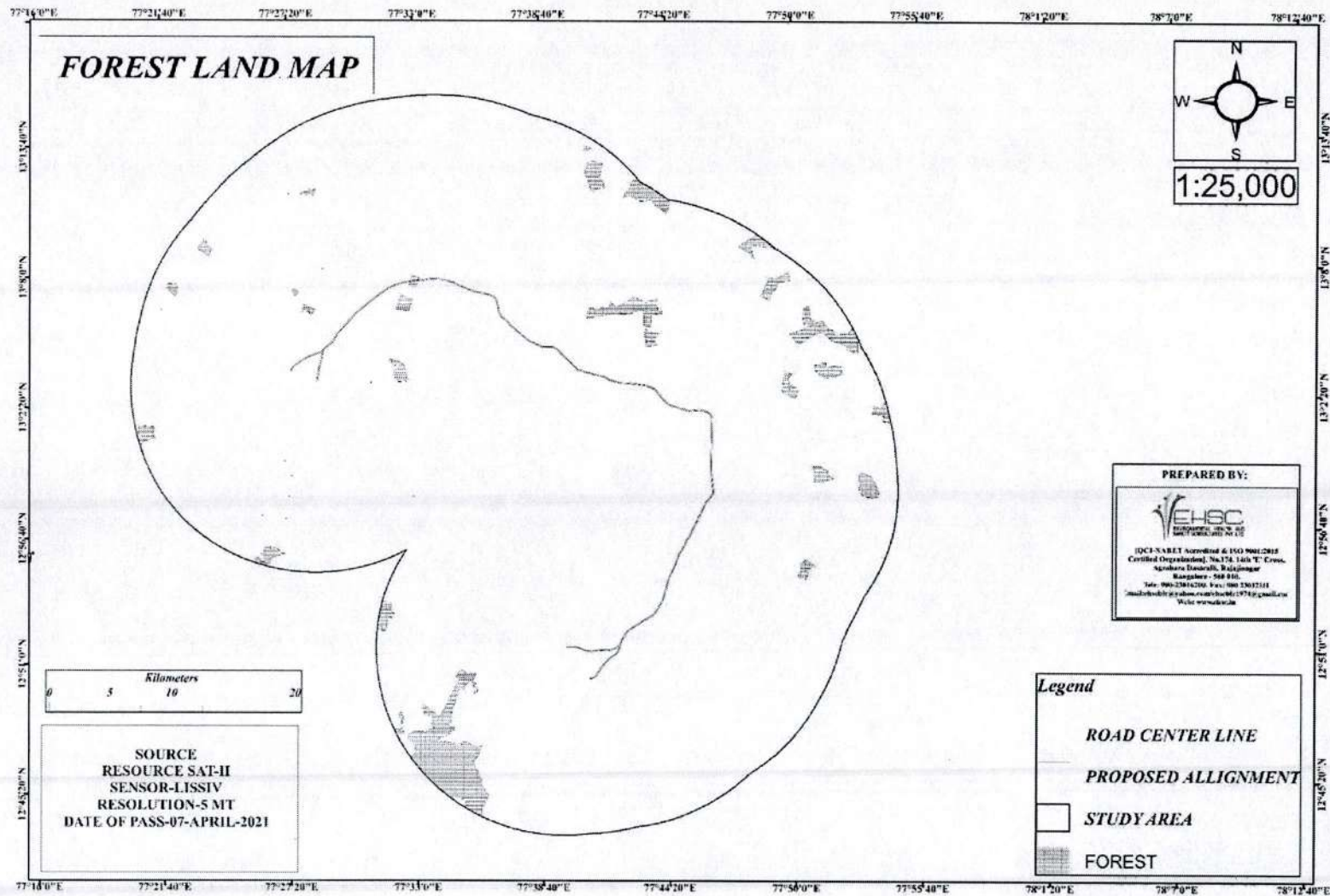


Fig 3.33: Map showing the RF in the study area

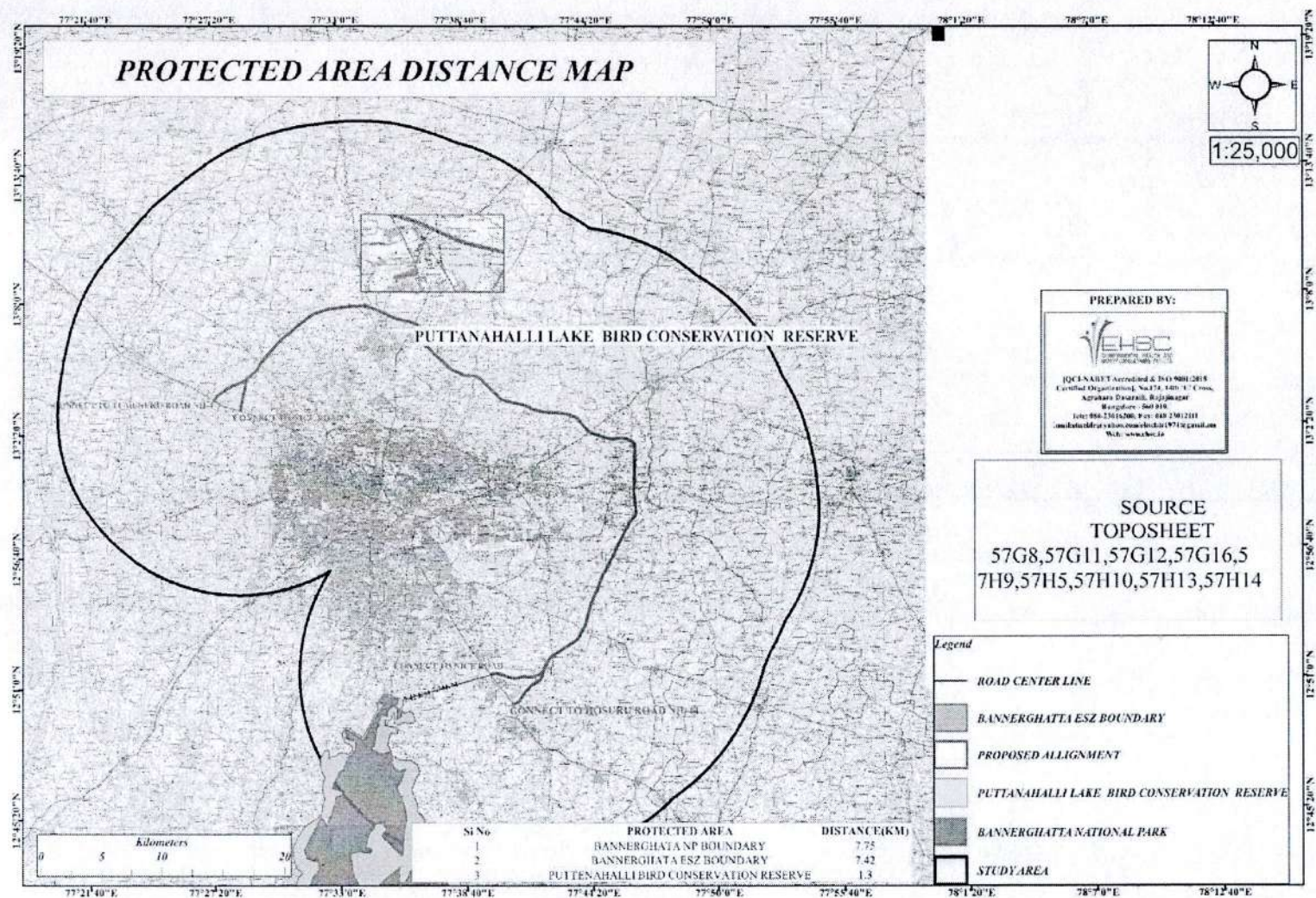


Fig 3.34: Map showing the distance of protected areas from the proposed PRR alignment

3.4.2 Methodology

In order to understand the ecological status of the project site and study area, the total tree enumeration carried out all along the alignment of 73.5 Km (100m RoW) from January to February, 2020 and February, 2022, 4 teams consisting of 4 members each were created and enumerated at different chainage intervals, MAPinr, Google Earth (google apps) and on ground stone pillars were cross verified to fix the exact boundaries of the alignment. Random sampling locations were selected to assess the ecological status in Project alignment and Study area. Checklist of the existing flora and fauna species along with IUCN and RET status has been recorded.

3.4.2.1 Primary data

A. Primary data - Flora and Fauna with in Project Alignment.

Sl. No.	Habitat	Method	Size of the quadrat (m)/ Length (m)	Time and duration of sampling
1	Trees	Complete Enumeration	73.5 km	January & February 2020 and February, 2022 Winter season, One time data collection
2	Shrubs	Quadrat method	10 x 10	
3	Herbs and Grass		5 x 5	
4	Fauna	Transact and Point count method	-	
5	Butterflies		-	
6	Avi-fauna		-	

B. Primary data - Flora and Fauna in the Study area

Sl. No.	Habitat	Method	Size of the quadrat (m)/ Length (m)	Number	Time and duration of sampling
1	Fauna	Transact and Point count method	1000	7	January & February 2020, Pre monsoon, One time data collection
2	Butterflies			7	
3	Avi-fauna		--	7	

3.4.2.2 Secondary data

Working plan of Bangalore Urban Forest Division⁷⁴, Botanical Survey of India⁷⁵, Zoological Survey of India⁷⁶, IUCN Red Data Book⁷⁷, Wildlife Schedules from Wildlife (Protection) Act, 1972, Book of Indian Birds⁷⁸, ENVIS, FRLHT⁷⁹, Butterflies of India⁸⁰, Reptiles of India⁸¹, Handbook on Weed identification⁸² and Common Dry land Trees of Karnataka⁸³, Snacks of Coorg⁸⁴, Feathered Jewels of Coorg⁸⁵ were referred. Faunal distribution in the region were studied through the discussion was held with local people and respective Forest Divisions. The unidentified species shall be verified by using BSI, FRLHT data base and will be cross checked with experts by taking photographs and collecting specimens.

⁷⁴Forest working plan of Bangalore Urban Forest Division (2002-12), Range Gowda I.F.S., Deputy Conservator of Forests, Working Plan and Survey, Chikmagalur., Government of Karnataka, Karnataka Forest Department

⁷⁵http://www.bsienviis.nic.in/Database/RedlistedPlants_3940.aspx

⁷⁶ <http://www.zsi.gov.in>

⁷⁷<http://www.iucnredlist.org/>

⁷⁸Salim Ali (2012), The Book of Indian Birds, Bombay Natural History Society, Thirteenth Edition, Revised by J.C Daniel

⁷⁹<http://enviis.frlht.org/indian-medicinal-plants-database.php>

⁸⁰Arun Pratap Singh (2011), Butterflies of India, Om Book International, Uttar Pradesh.

⁸¹J C Daniel (2002), The Book of Indian Reptiles and Amphibians, Oxford University Press, BNHS, Bombay.

⁸²<http://www.agritech.tnau.ac.in/agriculture/PDF/Weed%20identification.pdf>

⁸³A Kavitha, N Deepthi, N Ganesan, S C Gladwin Joseph (2012), Common Dry Land Trees of Karnataka, ATREE, Bangalore, India.

⁸⁴Sathish (2008), Snakes of Coorg, Coorg wildlife society, Karnataka.

⁸⁵Dr. S V Narasimhan (2004), Feathered jewels of Coorg, Coorg wildlife society, Karnataka.

3.4.3 Results and Discussions

3.4.3.1 Project alignment: Flora

3.4.3.1.1 Composition of trees, shrubs and herbs

A total of 122 trees species (n=36,824) belonging to 41 families were found within the alignment (Table-3.15 and 3.16), the predominant tree species recorded were *Eucalyptus globulus* Labill (n=11053), *Cocos nucifera* L. (n=5976), *Mangifera indica* L. (n=4254), *Eucalyptus tereticornis* L. (n=2488), *Tectona grandis* L.f. (n=3038), *Grevillea robusta* A. Cunn. ex R. Br. (n=1712), *Pongamia pinnata* (L.) Pierre (n=1615), *Azadirachta indica* A. Juss. (n=1065) and *Manilkara zapota* (L.) Van Royen (n=945). All the recorded species in the project site are common to the region and no Rare Endangered and Threatened species (RET) were recorded. Out of 36,824 trees, 13,355 trees were falling in TG Halli Catchment area and 631 trees falling in Jarakabande RF where forest diversion of 7.73 Ha is proposed.

Further, out of 36,824 trees, 14,308 plantation trees (38.66%) including 13,542 Eucalyptus trees, 12,378 horticulture trees (33.61%) and 10,138 other trees (27.53%) were recorded. The project involves removal of 32,175 trees including 13,542 *Eucalyptus* sp. However, there is a possibility of retaining 4,649 trees within the green space (5 m x 2) of RoW. The details of the trees species recorded in the project alignment are as follows;

Sl.No.	Particulars	Entire alignment	TG Halli catchment area	Jarakabandekaval RF
1	Total trees recorded	36,824	13,355	631
2	Eucalyptus	13,542	7,113	600
3	Trees retained in 5m (excluding eucalyptus)	4,649	1,317	10
4	Trees to be removed (excluding eucalyptus & Green space)	18,633	4,925	21

The girth class distribution shows that maximum number of stems falls under the girth class of 30-60 cm (22,341 trees) which contributes to 60.67 % of the total individuals followed by the girth class of 60-90 cm (9,880 trees) which contributes to 26.83 % of the total individuals and the girth class of 90-120 cm (3,772 trees) which contributes to 10.24 %.

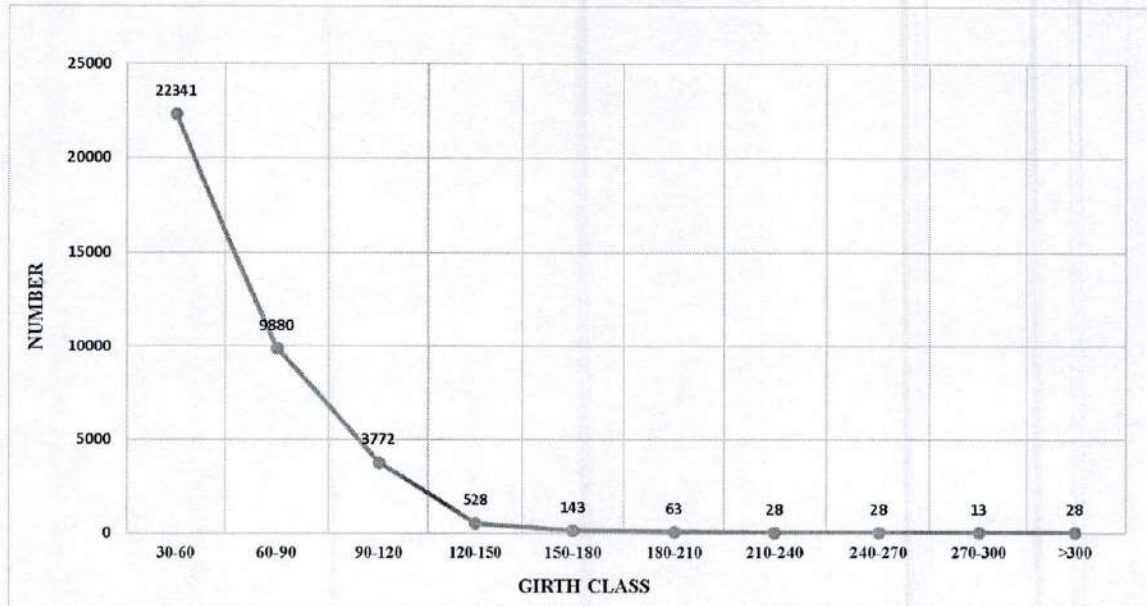


Fig 3.35: Graph showing girth class distribution and number of trees

Basal area calculations reveal that the total basal area of species is 1304.99m²/ha out of which the maximum basal area of tree species was attained by *Cocos nucifera* L. (360.07 m²/ha), followed by *Eucalyptus globulus* Labill (261.68 m²/ha) and *Tectona grandis* L.f. (111.54 m²/ha). Whereas, minimum Basal area was found in *Eucalyptus grandis* W.Hill (0.01 m²/ha), *Mallotus philippensis* (Lam.) Muell.Arg. (0.01 m²/ha), *Tabebuia aurea* (Silva Manso) Benth. & Hook.f. ex S.Moore (0.01 m²/ha), *Bougainvillea glabra* Choisy (0.01 m²/ha) and *Alangium salvifolium* (L.f.) Wangerin (0.01 m²/ha).

The Volume of Tree Species within the alignment is estimated to be 3004.35 m³ of which *Cocos nucifera* L. (926.99 m³) and *Eucalyptus globulus* Labill (666.21 m³) are the predominant tree species. The carbon sequestration capacity of existing trees within the alignment is estimated to be 3728.69t/yr of which *Cocos nucifera* L. (1112.04 t/yr.) and *Eucalyptus globulus* Labill (798.13t/yr), are major carbon sequesters in the alignment.

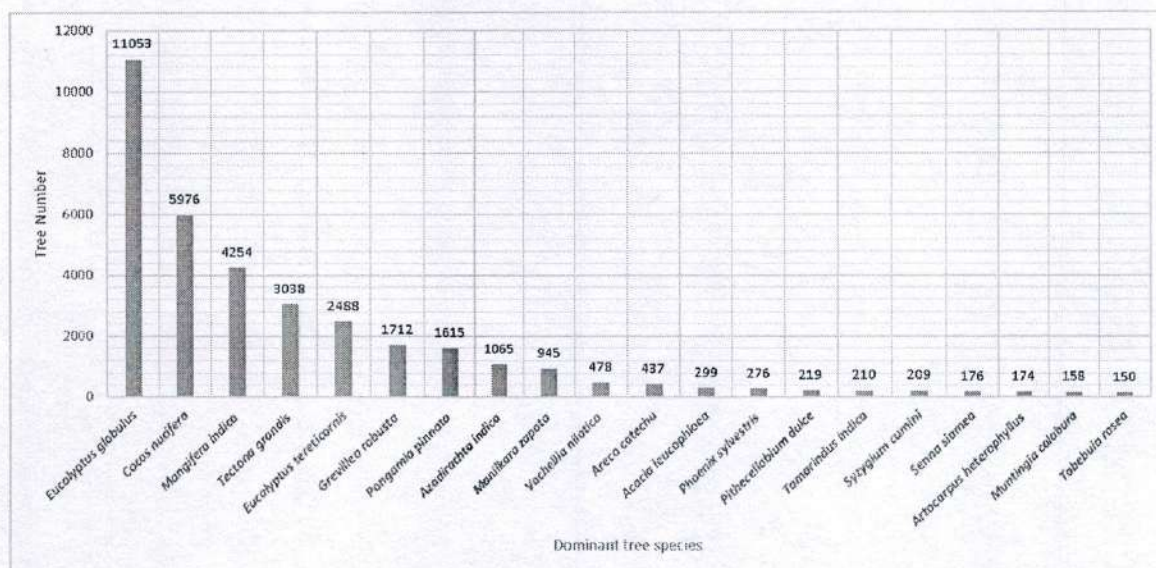


Fig 3.36: Graph showing volume of 20 dominant tree species recorded

A total of 47 species belongs to 20 families of herbs, 22 species of shrubs belonging to 14 families and 6 climbers belonging to 5 families were recorded. As per the IUCN conservation status 2020, species like *Alternanthera sessilis* (L.) R.Br. ex DC., *Aristida purpurea* Nutt., *Brachiaria ramosa* STAPP, *Cenchrus purpureus*, *Mimosa pudica* L., *Gardenia gummifera* L.f. etc., were least concerned remaining species were Not Assessed.

Checklist of Tree species with IUCN conservation status, Girth class distribution, Basal Area, Volume and Carbon sequestration, check list of herbs, shrubs and climbers with IUCN status are tabulated in Annexure-22.

The study area flora includes *Swietenia mahagoni* (L.) JACQ, *Dolichandra spp.*, *Pongamia pinnata* (L.) Pierre, *Grevillea robusta* A. Cunn. ex R. Br., *Samanea saman* (Jacq.) Merr. *Dalbergia sissoo* (Roxb.) Kuntze, *Millingtonia hortensis* L.f., *Casuarina equisetifolia* L., *Eucalyptus spp.*, *Tamarindus indica* L., *Azadirachta indica* A. Juss., etc were recorded. Herbs such as *Alternanthera sessilis* (L.) R.Br. ex DC., *Amaranthus viridis* L., *Brachiaria ramosa* L., *Mimosa pudica* L., *Croton bonplandianum* BAILL., *Parthenium hysterophorus* L., *Portulaca oleracea* L., *Sida acuta* Burm.f., *Tridax procumbens* L., *Sonchus asper* (L.) Hill 1769, *Cynodon dactylon* (L.) Pers., etc Climbers such as *Clitoria ternatea* L., *Cocculus hirtus* (L.) Diels, etc Shrubs such as *Calotropis procera* (Aiton) W.T.Aiton, *Lantana camara* L., *Dodonaea viscosa* Jacq., *Calotropis gigantea* (L.) Dryand., *Bougainvillea glabra* Choisy etc. Water weeds such as *Polygonum barbatum* L., *Eichhornia crassipes* (Mart.) Solms, *Typha angustifolia* L., *Pistia stratiotes* L., *Alternanthera philoxeroides* (Mart.) Griseb. etc.

Table 3.14: Chainage wise list of trees recorded within the RoW

SI No.	Chainage	Number of trees	SI No.	Chainage	Number of trees
1	0+000 to 1+000	599	39	38+000 to 39+000	519
2	1+000 to 2+000	1271	40	39+000 to 40+000	645
3	2+000 to 3+000	1719	41	40+000 to 41+000	505
4	3+000 to 4+000	232	42	41+000 to 42+000	557
5	4+000 to 5+000	674	43	42+000 to 43+000	138
6	5+000 to 6+000	283	44	43+000 to 44+000	193
7	6+000 to 7+000	314	45	44+000 to 45+000	203
8	7+000 to 8+000	657	46	45+000 to 46+000	750
9	8+000 to 9+000	492	47	46+000 to 47+000	426
10	9+000 to 10+000	1466	48	47+000 to 48+000	561
11	10+000 to 11+000	297	49	48+000 to 49+000	442
12	11+000 to 12+000	585	50	49+000 to 50+000	264
13	12+000 to 13+000	557	51	50+000 to 51+000	322
14	13+000 to 14+000	161	52	51+000 to 52+000	767
15	14+000 to 15+000	806	53	52+000 to 53+000	946
16	15+000 to 16+000	290	54	53+000 to 54+000	394
17	16+000 to 17+000	363	55	54+000 to 55+000	355
18	17+000 to 18+000	1164	56	55+000 to 56+000	563
19	18+000 to 19+000	670	57	56+000 to 57+000	21
20	19+000 to 20+000	595	58	57+000 to 58+000	201
21	20+000 to 21+000	160	59	58+000 to 59+000	242
22	21+000 to 22+000	1444	60	59+000 to 60+000	171
23	22+000 to 23+000	751	61	60+000 to 61+000	238
24	23+000 to 24+000	279	62	61+000 to 62+000	102
25	24+000 to 25+000	357	63	62+000 to 63+000	41
26	25+000 to 26+000	581	64	63+000 to 64+003	497
27	26+000 to 27+000	451	65	64+000 to 65+000	45
28	27+000 to 28+000	534	66	65+000 to 65+950	40
29	28+000 to 29+000	705	67	65+950 to 66+950	433
30	29+000 to 30+000	1402	68	66+950 to 67+950	188
31	30+000 to 31+000	607	69	67+950 to 68+950	313
32	31+000 to 32+000	530	70	68+950 to 69+350	229
33	32+000 to 33+000	1283	71	69+350 to 70+350	51
34	33+000 to 34+000	309	72	70+350 to 71+350	259
35	34+000 to 35+000	149	73	71+350 to 72+350	518
36	35+000 to 36+000	323	74	72+350 to 73+431	616
37	36+000 to 37+000	759			
38	37+000 to 38+000	250			

Table 3.15: Checklist of tree species recorded within the RoW

Sl.No	Scientific Name	Local Name	Family	Nos.	IUCN Conservation Status-2021	RET Status	USES
Peripheral Ring Road (65.950 km)							
1	<i>Acacia auriculiformis</i> Benth.	Kadu seege	Fabaceae	73	Least Concern	Common	Pulp wood
2	<i>Acacia leucophloea</i> (Roxb.) Willd.	Beala	Fabaceae	267	Least Concern	Common	Medicinal Siddha, Folk
3	<i>Aegle marmelos</i> (L.) Correa	Bilwapatre	Rutaceae	3	Near Threatened	Common	Medicinal and Traditional
4	<i>Alangium salvifolium</i> (L.f.) Wangerin	Ankole mara	Alangiaceae	1	Not Assessed	Common	Edible and timber Siddha, Folk
5	<i>Albizia amara</i> (Roxb.) B.Boivin	Chigure	Fabaceae	32	Least Concern	Common	Fodder, fuel wood and timber
6	<i>Albizia lebbek</i> (L.) Benth.	Baage	Fabaceae	116	Least Concern	Common	Timber
7	<i>Albizia odoratissima</i> (L.F.) BENTH.	Aenu baage	Fabaceae	16	Least Concern	Common	Edible and Medicinal
8	<i>Alstonia scholaris</i> (L.) R.Br.	aelele haale	Apocynaceae	6	Least Concern	Common	Ornamental Homeopathy and Medicinal
9	<i>Anacardium occidentale</i> L.	Gaerumara	Anacardiaceae	73	Not Assessed	Common	Medicinal
10	<i>Annona reticulate</i> L.	Rampala	Annonaceae	4	Least Concern	Common	Medicinal and edible
11	<i>Annona squamosa</i> L.	Sithapala	Annonaceae	2	Least Concern	Common	Medicinal and edible
12	<i>Araucaria columnaris</i> J.R Forst Hook.	Christmas tree	Araucariaceae	6	Least Concern	Common	Ornamental
13	<i>Araucaria heterophylla</i> (Salisb.) Franco	Christmas tree	Araucariaceae	8	Vulnerable	Common	Ornamental
14	<i>Areca catechu</i> L.	Adike	Arecaceae	433	Not Assessed	Common	Medicinal, edible and traditional
15	<i>Artocarpus heterophyllus</i> Lam.	Halasu	Moraceae	148	Not Assessed	Common	Edible and medicinal
16	<i>Azadirachta indica</i> A.Juss.	Bevu	Meliaceae	953	Least Concern	Common	Medicinal, edible and traditional
17	<i>Balanites aegyptiaca</i> (L.) Delile	Ingala	Zygophyllaceae	3	Least Concern	Common	Medicinal
18	<i>Bauhinia malabarica</i> ROXB.	basavanapaada	Fabaceae	4	Least Concerned	Common	Medicinal
19	<i>Bauhinia purpurea</i> L.	Basavanapadu	Fabaceae	5	Least Concerned	Common	Ornamental & medicinal
20	<i>Bauhinia racemosa</i> LAM.	Basavanapada	Caesalpiniaceae	21	Not Assessed	Common	Medicinal
21	<i>Bismarckia nobilis</i> Hildebr. & H.Wendl	Thale Gari	Arecaceae	2	Least Concern	Common	Ornamental
22	<i>Bombax ceiba</i> L.	Kempu Buruga	Malvaceae	5	Least Concern	Common	Edible and Medicinal

Sl.No	Scientific Name	Local Name	Family	Nos.	IUCN Conservation Status-2021	RET Status	USES
23	<i>Boswellia serrata</i> ROXB.	Dhupa	Burseraceae	2	Not Assessed	Common	Medicinal
24	<i>Bougainvillea glabra</i> Choisy	Paper flower	Nyctaginaceae	1	Least Concerned	Common	Ornamental
25	<i>Butea monosperma</i> var. <i>lutea</i>	Muthugada mara	Fabaceae	30	Least Concern	Common	Ornamental
26	<i>Carica papaya</i> L.	Papaya	Caricaceae	15	Data Deficient	Common	Edible and Medicinal
27	<i>Caryota urens</i> L.	Bagane	Arecaceae	11	Least Concern	Common	Medicinal
28	<i>Cassia fistula</i> L.	Kakke mara	Fabaceae	3	Least Concern	Common	Ornamental and medicinal
29	<i>Casuarina equisetifolia</i> (Benth.) L.A.S. Johnson	Sarve mara	Casurinaceae	9	Least Concern	Common	Fuel, erosion control, and as a windbreak
30	<i>Chloroxylon swietenia</i> (Roxb.) DC.	Hurugalu	Rutaceae	7	Vulnerable	Common	Timber, medicinal and fuel wood, Traditional
31	<i>Cinnamomum sulphuratum</i> NEES.	Chakke mara	Lauraceae	1	Vulnerable	Common	Folk
32	<i>Cinnamomum verum</i> J. Presl	Chakke mara	Lauraceae	1	Not Assessed	Common	Medicine and Edible
33	<i>Citrus maxima</i> (Burm.) Merr.	Bublimara	Rutaceae	3	Least Concern	Common	Medicinal & Edible
34	<i>Citrus medica</i> L.	Helikai	Rutaceae	8	Least Concern	Common	Medicinal & Edible
35	<i>Cocos nucifera</i> L.	Tengu	Arecaceae	5384	Not Assessed	Common	Edible and Medicinal
36	<i>Commiphora caudata</i> (Wight & Arn.) Engl.	Konda Mavu	Burseraceae	4	Not Assessed	Common	Medicinal
37	<i>Cordia dichotoma</i> FORST. F.	Alale	Cordiaceae	23	Least Concern	Common	Edible and Medicinal
38	<i>Dalbergia latifolia</i> Roxb.	Beete mara	Fabaceae	1	Vulnerable	Common	Medicinal
39	<i>Dalbergia sissoo</i> DC.	Agara	Fabaceae	11	Least Concern	Common	Timber
40	<i>Delonix regia</i> (Hook.) Raf.	May tree	Fabaceae	10	Least Concern	Common	Ornamental
41	<i>Eucalyptus globulus</i> Labill	Nilagiri	Myrtaceae	11002	Least Concern	-	Medicinal
42	<i>Eucalyptus grandis</i> W. Hill	Neelagiri mara	Myrtaceae	1	Near threatened	Common	Medicinal
43	<i>Eucalyptus tereticornis</i> L.	Neelagiri	Myrtaceae	2488	Least Concern	Common	Medicinal
44	<i>Ficus benghalensis</i> L.	Aladamara	Moraceae	25	Not Assessed	Common	Edible and Medicinal
45	<i>Ficus benjamina</i> L.	Peeladamara	Moraceae	2	Least Concern	Common	Medicinal and Ornamental
46	<i>Ficus carica</i> L.	Attimara	Moraceae	10	Least Concern	Common	Medicinal and Ornamental
47	<i>Ficus elastica</i> ROXB. EX. HORNE.	Goni	Moraceae	3	Not Assessed	Common	Ornamental
48	<i>Ficus hispida</i> L.F.	Adavi atthi	Moraceae	4	Not Assessed	Common	Medicinal
49	<i>Ficus racemosa</i> L.	Attimara	Moraceae	57	least Concern	Common	Medicinal

Sl.No	Scientific Name	Local Name	Family	Nos.	IUCN Conservation Status-2021	RET Status	USES
50	<i>Ficus religiosa</i> L.	Arali mara	Moraceae	27	Not Assessed	Common	Medicinal and Traditional
51	<i>Ficus virens</i> Aiton	Basari mara	Moraceae	1	Least Concern	Common	Medicinal
52	<i>Gliricidia sepium</i> (Jacq.) Walp.	Gobbarada gida	Fabaceae	18	Least Concern	Common	Medicinal
53	<i>Gmelina arborea</i> L.	Shivane	Lamiaceae	15	least Concern	Common	Medicinal
54	<i>Grevillea robusta</i> A. Cunn. ex R. Br.	Silver oak	Proteaceae	1589	least Concern	Common	Folk
55	<i>Hardwickia binata</i> Roxb.	Kamara	Fabaceae	1	least Concern	Common	Medicinal and dyeing
56	<i>Holoptelea integrifolia</i> (Roxb.) Planch.	Tabasi mara	Ulmaceae	11	Not Assessed	Common	Medicinal
57	<i>Jacaranda mimosifolia</i> D. Don	Aalada mara	Bignoniaceae	1	Vulnerable	Common	Ornamental
58	<i>Kigelia africana</i> (LAMK.) BENTH.	Mara sowthekai	Bignoniaceae	1	Least Concern	Common	Medicinal
59	<i>Lagerstroemia speciosa</i> Deepu & Pandur.	Nandi mara	Lytharaceae	12	Not Assessed	Common	Medicinal, folk
60	<i>Leucaena leucocephala</i> (Lam.) de Wit	Chigurakku	Fabaceae	68	Not Assessed	Common	Fodder, fuel wood and medicinal
61	<i>Limonia acidissima</i> L.	Aranamullu	Rutaceae	7	Not Assessed	-	Medicinal, folk
62	<i>Madhuca longifolia</i> (KOEN.) MACLER	Hippe	Sapotaceae	5	Not assessed	-	Medicinal, folk
63	<i>Magnolia champaca</i> (L.) Baill. ex Pierre	Sampige mara	Magnoliaceae	1	Least Concern	Common	Ornamental
64	<i>Mallotus philippensis</i> (Lam.) Muell.Arg.	Kumkuma mara	Euphorbiaceae	1	Least Concern	Common	-
65	<i>Mangifera indica</i> L.	Mavina mara	Anacardiaceae	4139	Data Deficient	Common	Edible and Fuel wood
66	<i>Manilkara zapota</i> (L.) VAN ROYEN	Sapota	Sapotaceae	726	Not Assessed	Common	Edible and medicinal
67	<i>Melaleuca viminalis</i> (Sol. ex Gaertn.) Byrnes	Bottle brush	Myrtaceae	1	Least Concern	Common	Ornamental
68	<i>Melia azedarach</i> L.	Hebbevu	Meliaceae	29	Least Concern	Common	Medicinal, Pulp wood and plywood
69	<i>Melia dubia</i> Hiern, Non Cav.	Kadu Bevu	Meliaceae	4	Not Assessed	Common	Medicinal, folk
70	<i>Millingtonia hortensis</i> L. fil.	Akashamallige	Bignoniaceae	27	Not Assessed	Common	Ornamental
71	<i>Moringa oleifera</i> Lam.	Nugge	Moringaceae	48	Least Concern	Common	Edible, medicinal and cosmetics
72	<i>Morus alba</i> L.*	Hippunerale	Moraceae	4	Not Assessed	Common	Medicinal

Sl.No	Scientific Name	Local Name	Family	Nos.	IUCN Conservation Status-2021	RET Status	USES
73	<i>Muntingia calabura L.</i>	Gasagase Mara	Muntingiaceae	122	Not Assessed	Common	Edible
74	<i>Murraya koenigii (L.) SPR</i>	karibevu	Rutaceae	4	Least Concern	Common	Medicinal
75	<i>Neolamarckia cadamba (Roxb.) Bosser</i>	Kaduavalatige	Rubiaceae	21	Not assessed	Common	Ornamental and pollution control
76	<i>Peltophorum pterocarpum (DC.) K.Heyne</i>	Copperpod	Fabaceae	78	Least Concern	Common	Medicinal
77	<i>Persea americana Mill.</i>	Butterfruit	Lauraceae	2	Least Concern	Common	Medicinal
78	<i>Phoenix sylvestris (L.) Roxb.</i>	Echallu mara	Arecaceae	266	Not Assessed	Common	Medicinal, Edible, ornamental
79	<i>Phyllanthus emblica L.</i>	Betta Nalli	Phyllanthaceae	95	Least Concern	Common	Edible and Medicinal
80	<i>Pithecellobium dulce (Roxb.) Benth.</i>	Seeme hunase	Fabaceae	218	Least Concern	Common	Edible, medicinal and agroforestry
81	<i>Polyalthia longifolia (Sonn.) Thwaites</i>	Ashoka mara	Annonaceae	131	Not Assessed	Common	Ornamental and windbreak
82	<i>Pongamia pinnata (L.) Pierre</i>	Honge	Fabaceae	1370	Least Concern	Common	Medicinal
83	<i>Prosopis juliflora (Sw.) DC.</i>	Ballari jaali	Fabaceae	21	Not Assessed	-	Fuelwood
84	<i>Psidium guajava L.</i>	Guava	Myrtaceae	76	Least Concern	Common	Edible and Medicinal
85	<i>Pterocarpus marsupium Roxb.</i>	Honne mara	Fabaceae	16	Near Threatened	Common	Medicinal and Timber
86	<i>Roystonea regia (Kunth) O.F.Cook</i>	Gaali mara	Arecaceae	2	Least Concern	Common	Ornamental
87	<i>Samanea saman (Jacq.) Merr.</i>	Male mara	Fabaceae	36	Least Concern	Common	Folk
88	<i>Santalum album Linn.</i>	Srigandha mara	Santalinaceae	21	Vulnerable	Common	Medicinal and Timber
89	<i>Saraca asoca (Roxb.) Willd.</i>	Ashoka	Fabaceae	8	Vulnerable	Common	Ornamental
90	<i>Senegalia catechu (L.f.) P.J.H.Hurter & Mabb.</i>	Catechu	Fabaceae	35	Least Concern	Common	Medicinal and Timber
91	<i>Senegalia ferruginea (DC.) Pedley</i>	Banni	Fabaceae	4	Not assessed	Common	Timber
92	<i>Senna siamea (Lam.) H.S.Irwin & Barneby</i>	Simetangedi	Fabaceae	161	Least Concern	Common	Medicinal
93	<i>Sesbania grandiflora (L.) Poiret</i>	Agase mara	Fabaceae	3	Not assessed	Common	Medicinal
94	<i>Simarouba glauca DC.</i>	Simaruba	Simaroubaceae	71	Least Concern	Common	Medicinal
95	<i>Spathodea campanulata P.Beauv.</i>	Neerukayi mara	Bignoniaceae	26	Least Concern	Common	Ornamental and timber
96	<i>Swietenia mahagoni (L.) JACQ</i>	Mahogani	Meliaceae	26	Near Threatened	Common	Timber
97	<i>Symplocos racemosa Roxb.</i>	Bala Doddli	Symplocaceae	3	Not Assessed	Common	Timber
98	<i>Syzygium cumini (L.) Skeels</i>	Jambuneral	Myrtaceae	204	Least Concern	Common	Edible and Medicinal

Sl.No	Scientific Name	Local Name	Family	Nos.	IUCN Conservation Status-2021	RET Status	USES
99	<i>Syzygium jambos</i> (L.) ALSTON	Paneerale	Myrtaceae	1	Least Concern	Common	Edible and Medicinal
100	<i>Tabebuia argentea</i> (Bur. & Schum.) Britton.	-	Bignoniaceae	8	Not Assessed	Common	Ornamental
101	<i>Tabebuia aurea</i> (Silva Manso) Benth. & Hook.f. ex S.Moore	Silver trumpet tree	Bignoniaceae	1	Not Assessed	Common	Ornamental
102	<i>Tabebuia rosea</i> DC.	Pink poui	Bignoniaceae	150	Least Concern	-	Ornamental
103	<i>Tamarindus indica</i> L.	Hunase mara	Fabaceae	188	Least Concern	Common	Edible and medicinal
104	<i>Tectona grandis</i> L.f.	Tega	Verbenaceae	2336	Not Assessed	Common	Timber
105	<i>Terminalia arjuna</i> (Roxb.) Wight & Arn.	Arjuna mara	Combretaceae	5	Not Assessed	Common	Edible and medicinal
106	<i>Terminalia catappa</i> L.	Badami	Combretaceae	17	Least Concern	Common	Edible, medicinal and Agroforestry
107	<i>Terminalia elliptica</i> Willd.	Matthi mara	Combretaceae	3	Not Assessed	-	Timber
108	<i>Thespesia populnea</i> (L.) Sol. ex Corrêa	Gante mara	Malvaceae	11	Least Concern	Common	Ornamental and medicinal
109	<i>Toona ciliata</i> M. Roem.	Noga mara	Meliaceae	6	Least Concern	Common	Medicinal
110	<i>Vachellia nilotica</i> (L.) P.J.H.Hurter & Mabb	Kari jali	Fabaceae	404	Least Concern	Common	Timber
111	<i>Wrightia tinctoria</i> R.Br. ssp. laevis (Hook.f.) Pichon	Halle	Apocynaceae	4	Least Concern	Common	Medicinal
112	<i>Ziziphus jujuba</i> Lam	Bore Hannu	Rhamnaceae	11	Least Concern	Common	Edible and medicinal
113	<i>Ziziphus mauritiana</i> Lam.	Kare hannu	Rhamnaceae	12	Least Concern	Common	Edible and medicinal
114	<i>Ziziphus oenoplia</i> Mill.	Bore	Rhamnaceae	7	Not Assessed	Common	Edible and medicinal
Total A				34217			
Towards Tumkur Road (3.4 km)							
1	<i>Acacia auriculiformis</i> Benth.	Kadu seege	Fabaceae	1	Least Concern	Common	Pulp wood
2	<i>Acacia leucophloea</i> (Roxb.) Willd.	Beala	Fabaceae	31	Least Concern	Common	Medicinal Siddha, Folk
3	<i>Aegle marmelos</i> (L.) Correa	Bilwapatre	Rutaceae	1	Near Threatened	Common	Medicinal and Traditional
4	<i>Albizia lebbeck</i> (L.) Benth.	Baage	Fabaceae	1	Least Concern	Common	Timber
5	<i>Alstonia scholaris</i> (L.) R.Br.	aelele haale	Apocynaceae	1	Least Concern	Common	Ornamental Homeopathy and Medicinal
6	<i>Areca catechu</i> L.	Adike	Arecaceae	4	Not Assessed	Common	Medicinal, edible and

Sl.No	Scientific Name	Local Name	Family	Nos.	IUCN Conservation Status-2021	RET Status	USES
							traditional
7	<i>Artocarpus heterophyllus</i> Lam.	Halasu	Moraceae	11	Not Assessed	Common	Edible and medicinal
8	<i>Azadirachta indica</i> A.Juss.	Bevu	Meliaceae	85	Least Concern	Common	Medicinal, edible and traditional
9	<i>Butea monosperma</i> var. <i>lutea</i>	Muthugada mara	Fabaceae	1	Least Concern	Common	Ornamental
10	<i>Cocos nucifera</i> L.	Tengu	Arecaceae	395	Not Assessed	Common	Edible and Medicinal
11	<i>Dalbergia latifolia</i> Roxb.	Beete mara	Fabaceae	1	Vulnerable	Common	Medicinal
12	<i>Dalbergia sissoo</i> DC.	Agara	Fabaceae	1	Least Concern	Common	Timber
13	<i>Delonix regia</i> (Hook.) Raf.	May tree	Fabaceae	3	Least Concern	Common	Ornamental
14	<i>Eucalyptus globulus</i> Labill	Nilagiri	Myrtaceae	45	Least Concern	Common	Medicinal
15	<i>Ficus benghalensis</i> L.	Aladamara	Moraceae	9	Not Assessed	Common	Edible and Medicinal
16	<i>Ficus racemosa</i> L.	Attimara	Moraceae	13	least Concern	Common	Medicinal
17	<i>Glimea arborea</i>	Kashmiri mara	Lamiaceae	1	Not Assessed	Common	Pulp,Packing
18	<i>Gliricidia sepium</i> (Jacq.)Walp.	Gobbarada gida	Fabaceae	5	least Concern	Common	Manure plant
19	<i>Grevillea robusta</i> A. Cunn. ex R. Br.	Silver oak	Proteaceae	15	least Concern	Common	Folk
20	<i>Leucaena leucocephala</i>	Subbabull	Fabaceae	4	Least Concern	Common	Fodder and Timber
21	<i>Mangifera indica</i> L.	Mavina mara	Anacardiaceae	44	Data Deficient	Common	Edible and Fuel wood
22	<i>Manilkara zapota</i> (L.) VAN ROYEN	Sapota	Sapotaceae	5	Not Assessed	Common	Edible and medicinal
23	<i>Melia azedarach</i> L.	Hebbevu	Meliaceae	1	Least Concern	Common	Medicinal, Pulp wood and plywood
24	<i>Melina arborea</i>	White Teak	Lamiales	1	Not Assessed	Common	Pulping and packing
25	<i>Michelia Champka</i>	Sampige	Magnoliaceae	1	Least Concern	Common	Medicinal
26	<i>Moringa oleifera</i> Lam.	Nugge	Moringaceae	2	Least Concern	Common	Edible, medicinal and cosmetics
27	<i>Muntingia calabura</i> L.	Gasagase Mara	Muntingiaceae	7	Not Assessed	Common	Edible
28	<i>Peltophorum pterocarpum</i>	Copper pod	Fabaceae	3	Not Assessed	Common	Medicinal and Decoration
29	<i>Phoenix sylvestris</i> (L.) Roxb.	Echallu mara	Arecaceae	10	Not Assessed	Common	Medicinal, Edible, ornamental
30	<i>Phyllanthus emblica</i> L.	Betta Nalli	Phyllanthaceae	2	Least Concern	Common	Edible and Medicinal
31	<i>Polyalthia longifolia</i> (Sonn.) Thwaites	Ashoka mara	Annonaceae	17	Not Assessed	Common	Ornamental and windbreak
32	<i>Pongamia pinnata</i> (L.) Pierre	Honge	Fabaceae	227	Least Concern	Common	Medicinal
33	<i>Samanea saman</i> (Jacq.) Merr.	male mara	Fabaceae	10	Least Concern	Common	Edible and Medicinal

Sl.No	Scientific Name	Local Name	Family	Nos.	IUCN Conservation Status-2021	RET Status	USES
34	<i>Santalum album</i> Linn.	Srigandha mara	Santalinaceae	3	Vulnerable	Common	Medicinal and Timber
35	<i>Senegalia chundra</i> (Roxb. ex Rottler) Maslin	Bili Jali Mara	Fabaceae	4	Not Assessed	Common	Timber
36	<i>Senna siamea</i> (Lam.) H.S.Irwin & Barneby	Seeme tangadi	Fabaceae	3	Least Concern	Common	Ornamental and Fuel wood
37	<i>Spathodea adiantum</i> P.Beauv.	Tulip tree	Bignoniaceae	1	Not Assessed	Common	Medicinal
38	<i>Spathodea campanulata</i> P.Beauv.	Neerukayi mara	Bignoniaceae	10	Least Concern	Common	Ornamental and timber
39	<i>Syzygium cumini</i> (L.) Skeels	Jambuneral	Myrtaceae	2	Least Concern	Common	Edible and Medicinal
40	<i>Tabebuia rosea</i>	Pink poui	Bignoniaceae	1	Least Concern	Common	Ornamental
41	<i>Tamarindus indica</i> L.	Hunase mara	Fabaceae	15	Least Concern	Common	Edible and medicinal
42	<i>Tectona grandis</i> L.f.	Tega	Verbenaceae	97	Not Assessed	Common	Timber
43	<i>Vachellia nilotica</i> (L.) P.J.H.Hurter & Mabb	Kari jali	Fabaceae	67	Least Concern	Common	Timber
44	<i>Ziziphus jujuba</i> Lam	Bore Hannu	Rhamnaceae	2	Least Concern	Common	Edible and medicinal
Total B				1163			
Towards Hosur Road (4.08 km)							
1	<i>Acacia leucophloea</i> (Roxb.) Willd.	Beala	Fabaceae	1	Least Concern	Common	Medicinal Siddha, Folk
2	<i>Annona squamosa</i> L.	Sithapala	Annonaceae	1	Least Concern	Common	Medicinal and edible
3	<i>Artocarpus heterophyllus</i> Lam.	Halasu	Moraceae	15	Not Assessed	Common	Edible and medicinal
4	<i>Azadirachta indica</i> A.Juss.	Bevu	Meliaceae	27	Least Concern	Common	Medicinal, edible and traditional
5	<i>Bauhinia malabarica</i> ROXB.	basavanapaada	Caesalpiniaceae	4	Least Concern	Common	Medicinal
6	<i>Cocos nucifera</i> L.	Tengu	Arecaceae	197	Not Assessed	Common	Edible and Medicinal
7	<i>Dalbergia sissoo</i> DC.	Agara	Fabaceae	6	Least Concern	Common	Timber
8	<i>Delonix regia</i> (Hook.) Raf.	May tree	Fabaceae	8	Least Concern	Common	Ornamental
9	<i>Eucalyptus globulus</i> Labill	Nilagiri	Myrtaceae	6	Least Concern	Common	Medicinal
10	<i>Ficus racemosa</i> L.	Attimara	Moraceae	8	least Concern	Common	Medicinal
11	<i>Grevillea robusta</i> A. Cunn. ex R. Br.	Silver oak	Proteaceae	108	least Concern	Common	Folk
12	<i>Leucaena leucocephala</i> subsp. <i>ixtahuacana</i>	Chigurakku	Fabaceae	13	Not Assessed	Common	Fodder, fuel wood and medicinal
13	<i>Mangifera indica</i> L.	Mavina mara	Anacardiaceae	71	Data Deficient	Common	Edible and Fuel wood
14	<i>Manilkara zapota</i> (L.) VAN ROYEN	Sapota	Sapotaceae	214	Not Assessed	Common	Edible and medicinal
15	<i>Melaleuca viminalis</i>	Bottle brush	Myrtaceae	1	Least Concern	Common	Ornamental

Sl.No	Scientific Name	Local Name	Family	Nos.	IUCN Conservation Status-2021	RET Status	USES
	(Sol. ex Gaertn.) Byrnes						
16	<i>Muntingia calabura</i> L.	Gasagase Mara	Muntingiaceae	29	Not Assessed	Common	Edible
17	<i>Peltophorum pterocarpum</i> (DC.) K.Heyne	Copperpod	Fabaceae	31	Least Concern	Common	Medicinal
18	<i>Pithecellobium dulce</i> (Roxb.) Benth.	Seeme hunase	Fabaceae	1	Least Concern	Common	Edible, medicinal and agroforestry
19	<i>Polyalthia longifolia</i> (Sonn.) Thwaites	Ashoka mara	Annonaceae	7	Not Assessed	Common	Ornamental and windbreak
20	<i>Pongamia pinnata</i> (L.) Pierre	Honge	Fabaceae	18	Least Concern	Common	Medicinal
21	<i>Psidium guajava</i> L.	Balehannu	Myrtaceae	4	Least Concern	Common	Edible and Medicinal
22	<i>Samanea saman</i> (Jacq.) Merr.	male mara	Fabaceae	1	Least Concern	Common	Edible and Medicinal
23	<i>Saraca asoca</i> (Roxb.) Willd.	ashoka mara	Fabaceae	15	Vulnerable	Common	Medicinal
24	<i>Senna siamea</i> (Lam.) H.S.Irwin & Barneby	Seeme tangadi	Fabaceae	12	Least Concern	Common	Ornamental and Fuel wood
25	<i>Spathodea campanulata</i> P.Beauv.	Neerukayi mara	Bignoniaceae	2	Least Concern	Common	Ornamental and timber
26	<i>Syzygium cumini</i> (L.) Skeels	Jambunale	Myrtaceae	3	Least Concern	Common	Edible and Medicinal
27	<i>Tamarindus indica</i> L.	Hunase mara	Fabaceae	7	Least Concern	Common	Edible and medicinal
28	<i>Tectona grandis</i> L.f.	Tega	Verbenaceae	605	Not Assessed	Common	Timber
29	<i>Terminalia arjuna</i> (Roxb.) Wight & Arn.	Arjuna mara	Combretaceae	7	Not Assessed	Common	Edible and medicinal
30	<i>Terminalia catappa</i> L.	Badami	Combretaceae	13	Least Concern	Common	Edible, medicinal and Agroforestry
31	<i>Thespesia populnea</i> (L.) Sol. ex Corrêa	Gante mara	Malvaceae	1	Least Concern	Common	Ornamental and medicinal
32	<i>Vachellia nilotica</i> (L.) P.J.H.Hurter & Mabb	Kari jali	Fabaceae	7	Least Concern	Common	Timber
33	<i>Ziziphus jujuba</i> Lam	Bore Hannu	Rhamnaceae	1	Least Concern	Common	Edible and medicinal
Total C				1444			
Grand Total (A+B+C)				36824			

Note: * also a shrub

3.4.3.1.2 Species of Economic and Social Values

The trees species recorded within the alignment were commonly found and they have Social and Economic values in the society. Species like *Mangifera indica* L., *Pongamia pinnata* (L.) Pierre, *Azadirachta indica* A. Juss are used in day to day life, they have cultural importance as well as economic importance.

- **Edible/medicinal value:** *Syzygium cumini* (L.) Skeels., *Mangifera indica* L., *Artocarpus heterophyllus* Lam., *Annona squamosa* L., *Carica papaya* L., *Cinnamomum sulphuratum* NEES., *Cinnamomum verum* J. Presl, *Moringa oleifera* Lam., *Phyllanthus emblica* L., *Saraca asoca* (Roxb.) Willd., *Citrus medica* L. and *Manilkara zapota* (L.) VAN ROYEN. *Pithecellobium dulce* (Roxb.) Benth., *Psidium guajava* L.,
- **Ornamental value:** *Araucaria columnaris* (J.R.Forst.) Hook., *Bauhinia racemosa* LAM., *Bougainvillea glabra* Choisy, *Casuarina equisetifolia* (Benth.), *Melaleuca viminalis* (Sol. ex Gaertn.) Byrnes, *Delonix regia* (Hook.) Raf., *Jacaranda mimosifolia* D. Don, *Magnolia champaca* (L.) Baill. ex Pierre, *Millingtonia hortensis* L. fil., *Tabebuia rosea* DC. and *Polyalthia longifolia* (Sonn.) Thwaites., *Phoenix sylvestris* (L.) Roxb.,
- **Timber value:** *Santalum album* Linn. *Dalbergia latifolia* Roxb., *Acacia catechu* (Roxb.) Kurz., *Acacia auriculiformis* Benth., *Vachellia nilotica* (L.) P.J.H.Hurter & Mabb, *Albizia lebbek* (L.) Benth., *Dalbergia sissoo* DC., *Hardwickia binata* Roxb., *Holoptelea integrifolia* (Roxb.) Planch., *Pterocarpus marsupium* Roxb., *Santalum album* Linn. and *Swietenia mahagoni* (L.) JACQ, *Tectona grandis* L.f., *Terminalia arjuna* (Roxb.) Wight & Arn.

Further, the Hon'ble Supreme Court of India vide its Judgement Dt:25.03.2021 in SLP No. 25047 of 2018 (Association For Protection of Democratic Rights & ANR. Vs. the State of West Bengal & ORS.) states as follows;

"....It is, therefore, imperative to make a realistic assessment of the economic value of a tree, which may be permitted to fell, with reference to its value to environment and its longevity, with regard to factors such as production of oxygen and carbon sequestration, soil conservation, protection of flora/fauna, its role in habitat and ecosystem integrity and any other ecologically relevant factor, distinct from timber/wood...."

Further, it was informed that the value of tree shall be estimated keeping in view of other ecological factors and thereby the BDA shall approach the Tree Expert Committee constituted for further inspection and obtaining approval for removal of trees/ transplantation of trees.

In view of this, the valuation of trees recorded along the PRR alignment (73.5 Km) are estimated as per the NPV prepared by the Central Empowered Committee (CEC) dt: 02.01.2007. Therefore, the value of trees/Ha has been estimated considering the value of timber and fuel wood, NTFPS, fodder, Eco-tourism, bio-prospecting, Eco-logical services, flagship species and Carbon sequestration value. In view of this, a total of 32,175 trees are estimated to be removed along the proposed PRR alignment valuing to about Rs. 1,34,27,700/- (Rs. 1.34 Cr).

3.4.3.1.3 Species of Ethano-Botanical / Ethano - Medicinal Value

Azadirachta indica A. Juss., is considered to be a pharmacy in its own right in India, it contains a number of medically active substances including triterpenoid bitters, tannins and flavonoids. It is one of the most important detoxicants in Ayurvedic medicine and a potent febrifuge.

Moringa oleifera Lam has been used as a traditional medicinal source. Additionally, besides being edible, all the parts of the Moringa tree have long been employed for the treatment of many diseases, and therefore, it was called a "Miracle vegetable". The fruit of *Carica papaya* L. is the rich source of vital protective nutrients like vitamins A, B, C & Several minerals.

Aegle marmelos (L.) Correa, *Balanites aegyptiaca* (L.) Delile, *Boswellia serrata* Triana & Planch., *Citrus medica* L., *Commiphora caudata* (Wight & Arn.) Engl., *Dalbergia latifolia* Roxb., *Kigelia africana* (LAMK.) BENTH, *Pithecellobium dulce* (Roxb.) Benth., *Terminalia elliptica* Willd., *Wrightia tinctoria* (Roxb.) and *Ziziphus jujuba* Lam. are some of the Ethano-Botanical species found within the Project

3.4.3.1.4 Species of cultural values

Out of 36,824 trees recorded in the PRR alignment, a total of 1550 trees possessing cultural values such as *Arali mara*, *Alada mara*, *Attimara*, *Hunase mara*, *Nerale*, *Bilvapatre*, *Bevu* and *Nelli* with GBH >200 cm are recorded.

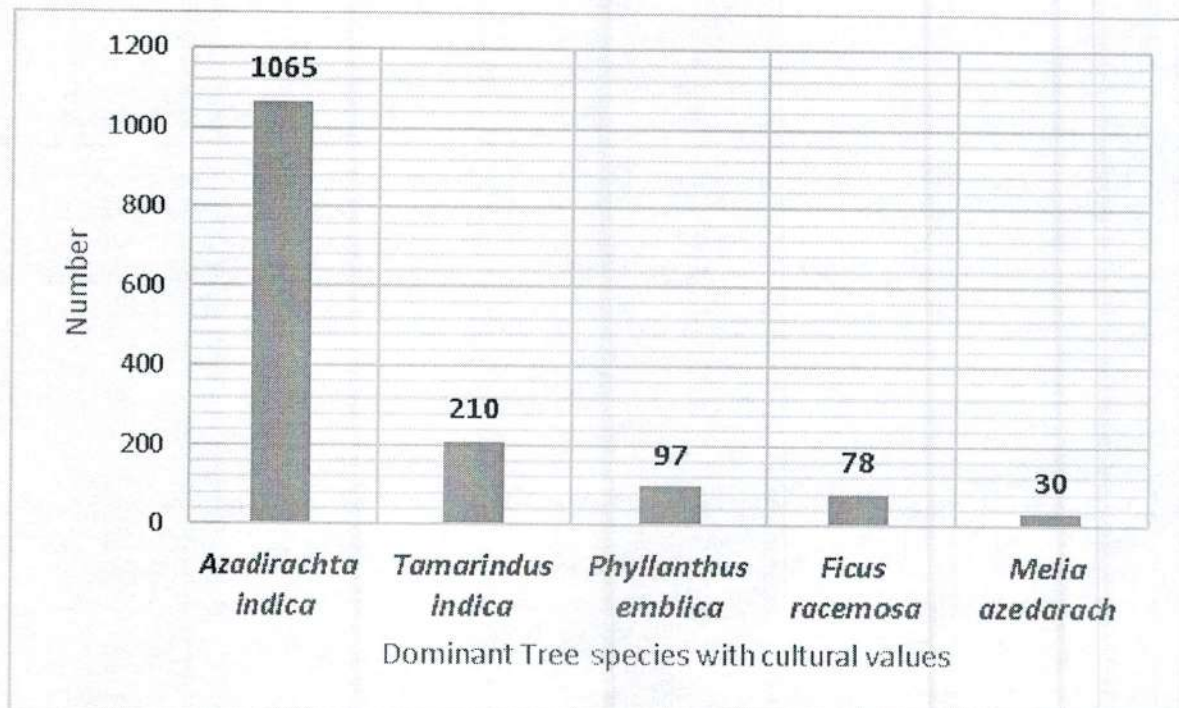


Fig 3.37: Graph showing GBH of 5 dominant tree species with cultural values recorded

3.4.3.1.5 Keystone species

Ficus benghalensis L., *Ficus benjamina* L., *Ficus carica* L., *Ficus elastica* ROXB. EX. HORNEM, *Ficus hispida* L.F., *Ficus racemosa* L., *Ficus religiosa* L. and *Ficus virens* AIT. are some of the keystone species recorded all along the project alignment.

3.4.3.2 Project alignment: Fauna

3.4.3.2.1 Avifaunal composition

About 31 avifaunal species (n=125) belonging to 23 families were recorded at the project site. The most dominant avifaunal species recorded in the project site were Black Kite (n=27), Common Myna (n=15), Pied Bushchat (n=11) and Red Wattled Lapwing (n=11).

Conservation status and Wildlife Schedules

As per IUCN Conservation status, 2020 most of the avifaunal species belongs to Least Concern Category Except Black-headed ibis which is Near Threatened. According to Wildlife (Protection) Act,

1972 Schedule I species were Black Kite, Brahminy kite and Common buzzard, Schedule V species is House Crow. Rest of the species belongs to Schedule IV.

Migratory status

The migratory status of most of the species recorded in the project site are considered to be Resident except Barn Swallow i.e., Migratory and Black-headed ibis.

Nocturnal/diurnal species

All the species recorded in the project site are diurnal in nature Except Spotted owl which is Nocturnal in Nature.

Keystone species

There are no notified keystone species as such recorded within the project alignment.

3.4.3.2.2 Butterfly composition

About 17 Butterfly species (n=31) belonging to 4 families were recorded with Blue Pansy (n=4) and Indian Cabbage White (n=4) as the predominant species recorded at the project site. As per IUCN Conservation status 2020, Common Crow, Grass jewel and Small Grass Yellow are least concerned rest of the species is Not Assessed. According to Wildlife (Protection) Act, 1972 Schedule IV species recorded in Project site is Common Crow. Schedule II species were Common Grass yellow and Common Jezebel.

3.4.3.3 Study area: Fauna

3.4.3.3.1 Avifaunal composition

About 47 avifaunal species (n=2327) belonging to 31 families were recorded at the Study area. Out of which, Purple Swamp Hen (n=453), Common swallow (n=351), Spot billed duck (n=206), and Great Cormorant (n=128) are the dominant species recorded in the study area. About, 10.20 % of the species belongs to the family Ardeidae, 6.12 % of the species belongs to the family Accipitridae.

Conservation status and Wildlife Schedules

The Spot-billed pelican, Painted Stork, Oriental Darter and Black-headed ibis falls under the category Near Threatened and remaining bird species falls under the category Least Concerned as per the IUCN Conservation status, 2020. The Black Kite, Black-shouldered Kite, Brahminy kite and Indian Peafowl belonging to the schedule I of the Indian Wildlife (Protection) Act, 1972. Similarly, 39 bird species belongs to schedule IV and 2 bird species belongs to schedule V.

Migratory status

The Little stint is the only migratory bird recorded in study area. Barn swallow, Common Coot, Glossy ibis, Great white pelican, Oriental Darter, Painted Stork, Spot-billed pelican and White Wagtail are the Residential Migrants and the remaining species are Residents.

Nocturnal/diurnal species

Indian Hare is the mammal which is having both nocturnal and diurnal characteristics in nature. The red wattled lapwing is the bird species which nocturnal in nature and where remaining all the species recorded in the study area is diurnal in nature.

Keystone species

There are no notified keystone species as such recorded in the study area. But the kite family birds play a major role in keeping the environment clean (scavengers) and balancing the other species population under control (Predators).

3.4.3.3.2 Butterfly composition

A total of 19 butterfly species (n= 53) were recorded in the study area which are found to be common to the region. Of which, Cabbage Butterfly (n=15) and Common Grass yellow (n=5) are the predominant species recorded in the study area. The Common Crow, Crimson rose and Small Grass Yellow falls under the category Least Concerned and remaining species are Not Assessed as per the IUCN Conservation status, 2020. The common crow falls under the schedule IV and Common Jezebel falls under the schedule II as per the Indian Wildlife (Protection) Act, 1972 similarly, butterfly species belonging to the families Nymphalidae (53 %) and Pieridae (32 %) are predominantly recorded in the study area.

3.4.3.3.3 Mammals and Insects recorded at the study area

Indian Hare and Indian Palm Squirrel were recorded in the study area. Both fall under the category Least Concern as per IUCN Conservation status, 2020. The Signature spider is recorded in the study area which is categorized as Not Assessed as per IUCN Conservation status, 2020.

3.4.3.3.4 Species recorded during other seasons

Water Birds namely: Studies conducted on abundance and diversity of avifaunal species recorded in about 15 lakes in Bangalore City recorded species such as Common Moorhen, Pied, Kingfisher, Mallard, Northern Pintail, Comb Duck, Northern Shoveler, Common Greenshank, Pheasant-tailed Jacana, River Tern, Black-crowned Night-heron, Grey Wagtail, Asian Openbill, Common Kingfisher, Rosy Pelican, Purple Heron, Night Heron, Garganey, Little Ringed Plover, Yellow Wagtail, Large Pied Wagtail, etc⁸⁶. Studies at Puttenahalli Lake Birds Conservation Reserve recorded Cotton Pygmy Goose, Common Pochard, Brown Crake, Ruddy-breasted Crake, Slaty-breasted Rail, Watercock, Pintail Snipe, Common Snipe, Eurasian Curlew, Temminck's Stint, Small Pratincole, Kentish Plover, Brown-headed Gull, Whiskered Tern, Western Reef, Eurasian Spoonbill, Wire-tailed Swallow, Oriental Skylark, Citrine Wagtail, etc⁸⁷.

Insectivores Birds namely: Studies conducted on insectivorous birds located in Bangalore region includes Common Iora, Little Swift, Common Woodshrike, Tawny-flanked Prinia, Wire-tailed Swallow, Red-rumped Swallow, Great Grey Shrike, Asian Paradise-flycatcher, Red-throated Pipit, Tickell's Blue-flycatcher, Verditer Flycatcher, Oriental Magpie-robin, Great Tit, Rufous Woodpecker, Thick-billed Warbler, Large-billed Leaf-warbler, Greenish Warbler, Eurasian Blackbird, Paddyfield Warbler, Eurasian Blackbird, Eurasian Hoopoe, White-bellied Fantail, White-browed Fantail and White-throated Fantail⁸⁸.

Migratory Birds namely: Migratory birds recorded by Puttenahalli Neighbourhood Lake Improvement Trust (PNLIT) in Puttenahalli Lake Bird Conservation Reserve includes Osprey, Ruddy Shelduck, Comb Duck, Eurasian Pigeon, Northern Shoveler, Northern Pintail, Common Pochard, Baillon's Crake, Pintail Snipe, Spotted Redshank, Marsh Sandpiper, Green Sandpiper, Ruff, Pied Avocet, Greater Flamingo, Glossy Ibis, White Stork, Clamorous Reed Warbler, Red-throated Pipit, Marsh Harrier, Hen Harrier, Pallid Harrier, Greater Spotted Eagle, Osprey⁸⁹.

3.4.3.4 Conclusion

The project alignment consists of good number of trees (n=36,824) belonging to 122 tree species, dominant species found all along the alignment were *Eucalyptus globulus* Labill, *Cocos nucifera* L., *Mangifera indica* L., *Eucalyptus tereticornis* L., *Tectona grandis* L.f., *Grevillea robusta* A. Cunn. ex R.

⁸⁶Rajashekara, S., & Venkatesha, M. G. (2010). The diversity and abundance of water birds in lakes of Bangalore city, Karnataka, India. *Biosystematics*, 4(2), 63-73.

⁸⁷<http://www.puttenahallilake.in/lake-resources/lake-articles/bird-profile-of-bangalore-lakes/list1>

⁸⁸Rajashekara, S., & Venkatesha, M. G. (2014). Insectivorous bird communities of diverse agro-ecosystems in the Bengaluru region, India. *Journal of Entomology and Zoology Studies*, 2(5), 142-155.

⁸⁹<http://www.puttenahallilake.in/lake-resources/lake-articles/bird-profile-of-bangalore-lakes/list2>

Br., and *Pongamia pinnata* (L.) Pierre. All the recorded tree species are commonly found, some of them were medicinal, edible and timber yielding; they have economic and social values in the region. *Ficus spp.* is the keystone species found within the project alignment. Tree of 30 cm GBH were dominant throughout the alignment, totaling to 22,341 individuals. Analysis of carbon sequestration potential of tree species reveals that the trees species (n=36,824) of >30 cm GBH have sequestered 3728.09 tonnes of carbon. Schedule I species like Black Kite, Brahminy kite and Common buzzard were found within the project alignment. Whereas Black Kite, Black-shouldered Kite, Brahminy kite and Indian Peafowl are the Schedule I species found in Study area.

Altogether for the entire length of PRR, 36,824 trees have been recorded within the 100 m RoW. Further, out of 36,824 trees, 14,308 plantation trees (38.66%) including 13,542 Eucalyptus trees, 12,378 horticulture trees (33.61%) and 10,138 other trees (27.53%) were recorded. However, there is a possibility of retaining 4,649 trees within the green space (5 m x 2) of RoW. Out of 36,824 trees, about 13,542 trees belong to *Eucalyptus spp.* which are considered to be responsible for ground water depletion in the region. Hence, as per the Government Order dt:25.02.2017 these trees have to be removed. About 2,597 tree species possessing social and cultural significances such as Bilvapatre, Ankole, Bevu, Kadu Nelli, Srigandha, Banni, Arali mara, etc with higher success rate will be considered for transplantation.

Further, the proposed alignment passes for about 20.9 km within the TG Halli catchment area where a total of 13,355 trees were recorded within 100 m RoW. Of which, 1,317 trees will be retained within the proposed green space of width 5m x 2. Therefore, a total of 12,038 trees will be removed within the TG Halli catchment area. Hence, out of 36,824 trees recorded in the proposed PRR alignment, about 32,175 trees (13,542 Eucalyptus trees) are proposed to be removed. Further, there is a possibility of retaining 4,649 trees within the green space (5 m x 2) within RoW.

3.5 Aquatic Environment

In this age of economic growth coupled with substantial population increase, more and more regions of the world are finding their water resources quite inadequate. The time is fast approaching with alarming pace. Experts opine, when man will not be able to commend enough supplies from rivers and ground water as well, the sources he has been dependent upon since ages. The economic aspect of water conservation and use a problem to count on its own merit and, of-late, it is assuming more importance than ever with the increased multipurpose use of resources and the growing disproportion between 'demand and supply'. Every wrong step taken in handling the said resources, a move, which, at first glance, might seem to be economically complementary and viable for the given situation, result in sizeable losses after a gap of time. "Let us not", Engels says. "However, flatter ourselves over much at our conquests over nature; for each subjugation takes its revenge on us" at an opportune time and at the very right place. It is a tangled web we weave and there is really no getting away from the fury of nature when things do not go as they are meant to. Prognostication will help to find 'just' solutions to the problems of conserving and using water resources'. Long-range forecasting has enabled us to establish a number of sound and workable principles of water planning conservation and use. These principles, in effect, will determine technological policy in the development of the water economy.

The drainage pattern in the area is governed by the gravitic ridge running North to North-East and South to South-East. The drainage towards the East is made up of a network of nalas, flowing from West to East. The River Arkavathy flows in the Bengaluru North Taluk covering a small distance and the Dakshini Pinakini stream towards the border of the District to the North-east of the Anekal Taluk. The Vrishabavathy River, a tributary of the Arkavathy River, flows in the District. Basavanahole, originating beyond Muthayala-madu, passé through Anekal Taluk to join the River Arkavathy near Kanakapura.

There are innumerable smaller, as also, larger water sheets in the Country whose number and extent are yet to be assessed correctly, and, their potentialities for irrigation needs as also piscicultural programmed determined. Tanks, unlike the reservoirs, are built across, mostly seasonal streams to impound water for small-scale irrigation needs. Unlike the larger biotopes, almost all the tanks are infested with aquatic macrophytes and such conditions, generally, are applicable to similar water bodies in the Southern States in the Country.

In the absence of the proper management measures for each of the tanks, the said water-sheets have been silted-up and water-holding capacities is being reduced year-wise. The infestation of noxious weeds too is hastening the silting-up of tanks, as also accounting to great loss of the water through evapo-transpiration. In the absence of adequate desirable management measures, majority of the perennial tanks, even in the rain-fed areas, have been converted into seasonal ones, the result being 'low' agricultural production and inadequate fish-culture programmes.

3.5.1 Scope of work

The scope of the present study with reference to the aquatic life, fish species in particular, covers the following points;

- Physico-chemical features of the surface water samples
- Assessment of the plankton biomass
- Assessment of the littoral organisms
- Assessment of the fish species present
- To record any rare, endangered or threatened fish species present
- Assess the ecological impact, if any, on the fish germplasm present, on the drawal or otherwise of the tank water
- Suggest measures to protect, conserve and for the augmentation of the fish species present
- To suggest undertaking 'fisheries developmental activities in the tanks studied.

Lakes considered for the study along the PRR includes Anchepalya Lake, Yelahanka Lake, Agrahara Lake, Cheemasandra Lake, Chinnaganahalli Lake, Chikkabanahalli Lake, Koralur Lake, Varthur Lake and Chikkatogur Lakes.

3.5.2 Methodology

A. Physico-chemical features:

WATER: The physico-chemical features of the surface water samples such as Ambient air and water temperatures, transparency, pH, Dissolved Oxygen, Free Ammonia, Free Carbon-dioxide, Total Hardness, Total Alkalinity, Silicate, Phosphate, Nitrate, Calcium, Iron, Potassium and specific conductivity were assessed in the field and the laboratory as per the guidelines suggested by the American Public Health Association (APHA).

B. Biological features:

- **PLANKTON:** for the assessment of the plankton constituents, 100 lts. of the water sample from the tank was passed through a plankton net of 21 XXX Nylobolt silk cloth (70 meshes/cm with an aperture size of 0.067 mm) in terms of catching efficiency of the microscopic plankton constituents. The samples so collected were fixed in 5.00% formaldehyde solution and were subjected to both qualitative and quantitative analyses by utilizing a microscope and the Sedgwick Rafter Plankton counting cell.

- **LITTORAL FAUNA:** The littoral organisms present in the littoral areas were collected by operating a 'D'frame net in the shallow areas by covering a distance of 20 ft. the collections, along with the debris, were sieved through a No. 40 sieve and the fauna segregated were fixed in 5.00% formaldehyde solution and were subjected to detailed systematics.
- **FISH SPECIES:** Fishing operations, where possible only, were undertaken by operation cast-net and small-meshed nylon net as good many tanks under study were found completely or so macrophytes choked etc.
- **FISHERMAN COOPERATIVE SOCIETIES:** Fisherman Cooperative Societies have been recognized and tanks coming under their jurisdiction have been leased-out to for a period ranging from 5-10 years.

3.5.3 Results and discussion

3.5.3.1 Water Chemistry

- **Colour and odour:** The surface water from the tanks presented clear features, coupled with slightly greenish tinge. The odour in majority of the water bodies was 'tolerable'.
- **Air and water temperature:** of the physical features, light and heat are considered quite essential for photosynthetic activities which depends, in effect, on the latitude and altitude; also, on the depth of water column at a given time. Air temperature ranged from 22.0C to 26.50C, was slightly higher than that of water the readings being 22.20C to 25.80C.
- **pH:** pH in the alkaline side, as observed in the studies carried out ranged from 7.41 to 8.18 is ideally suited for sound productive norms. Acidic waters with values below 6.5 and alkaline medium with readings above 8.5 tend to bear 'low productive status'.
- **Dissolved Oxygen:** amongst the chemical substances in natural waters. The 'dissolved Oxygen is of considerable importance, it being a regulator of metabolic processes of floral and faunal representatives inhabiting, also as an indicator of the water quality. Oxygen regime, when monitored over a considerable period, provides data on the nature of the medium and its productive potential. DO values recorded during the present studies ranged from 4.6 to 4.9 mg/L and were in 'moderate' format.
- **Free CO₂:** Free CO₂, whereas recorded 'nil' values in 5 out of 9 tanks, the lowest value of 3.8 mg/L (Chinnaganahalli lake) and highest value of 14.8 mg/L (Varthur Lake- a highly polluted water body, located just below Bellandur tank, the most polluted tank in certain tanks studied).
- **Free ammonia:** Free ammonia, indicator of polluted conditions, recorded 'nil' values in 7 out of 9 tanks studied. Only Yelhanka tank (0.03 mg/L) and Varthur lake (0.6 mg/L) presented the values, whence the desirable limit is 0.5 mg/L. Whereas, Yelhanka receives water from sewage-fed biotope located in the upstream stretch, Varthur lake on the other hand, located just below the highly polluted Bellandur tank, receives the foul medium; also from industries and human habitations in the vicinity.
- **Total hardness:** total hardness is an important parameter of the medium which indicates the presence of alkaline earth and is being used for domestic needs, industrial and agri-based purposes. Water can be classified into 'soft' (<75.0 mg/L), moderately hard (<75-150mg/L), hard (150-300mg/L) and very hard (>300mg/L) based on hardness. The total hardness of the surface water samples of the water bodies studied recorded values ranging from 96.0 mg/L (moderately hard) to 440.0 mg/L (very hard) indicating that the medium falls under "hard" type category only. The analytical data indicates that 29% of the surface water samples are 'soft'; 14% moderately hard; 50% hard and 7% very hard. The waters bearing

'high hardness' values may cause encrustation of water supply distribution systems. There is also some suggestive evidence that long-term consumption of extremely 'hard waters' might lead to increased incidences of Urolithiasis, Anencephaly, Prenatal mortality, some type of cancer and cardio-vascular disorders.

- Nitrate: nitrate being a major constituent of protein, occupies an important place in the aquatic system. A concentration of 0.2 to 0.5 mg/L of inorganic nitrogen has been recognized being favourable for medium to high levels of productive features. The nutritive status of the tanks studied recorded 'very high values- 6.03 to 28.00 mg/L which may get stabilized in the days to follow.
- Iron: iron, with values ranging from BDL to 0.58 mg/L indicate that it is in very 'poor' concentrations and its role in the over-all productivity of the medium is the water bodies studied is 'quite inadequate'.
- Calcium: calcium is one of the dominant cations in the surface waters with its concentration varying from 8.0mg/L to 92.00mg/L. weathering to dissolution of Calcium Carbonate, limestone and Dolomite and Calc-silicate minerals (amphiboles, pyroxene, olivine, biotite, etc) are the most common source of calcium in the medium. Calcium, the essential nutrient for the plant growth and in minerals, plays an important role on the development of cell, bones and nervous systems. One possible adverse effect from ingesting excessive concentrations of Calcium for a considerable period may be an increased 'high risk of kidney stones'. The values recorded in the present study being from 20.08 to 92.00 mg/L falls within permissible limits of 200.00 mg/L.
- Potassium: Potassium in effect, is an important ingredient for all algae; under 'low' concentrations, however, the growth and photosynthesis of algae is 'poor' and respiration is 'high'. The values recorded are 10.30 to 43.91 mg/L in the studies carried out, appears to be on the higher side.
- Specific conductivity: specific conductivity determines the amount of water soluble salts present in the medium and it also provides symptoms of State of Mineralization in any given aquatic ecosystem. Their values for fresh waters ranges from 25.0 to 500.0 micromhos/cm. in the present instance, involving 9 tanks studied, the values ranged from 481.0 to 2250.0 micromhos/cm- quite high (except Anchepalya lake (value of 481.00 micromhos/cm), remaining tanks indicated values ranging from 1067.0-2250.0 micromhos/cm.

In general, the tanks studied, although presented alkaline features, but 'low' in nutrient status mainly due to the influence of pollution.

3.5.3.2 Plankton

The plankton diversity and its richness represented by both the phyto-plankton and zoo-plankton constituents in a lentic water body such as 'tank', depend primarily on the prevailing ecological conditions. The productivity in such situations has a direct bearing upon the piscine fauna prevailing and the role of the plankton biomass- the primary food of scores of planktivores, from their developmental stages and upto their adulthood. Plankton, in effect, forms the natural food for good many wild, also the farmed fish species. In a fresh water eco-system, the abundance of varied groups of the plankton constituent varies at different times depending upon the nutrients available naturally in the medium and the foraging stress these experience from carps and other environmental conditions at the time.

The plankton constituents of the tanks studied recorded a very 'poor' picture. It is also true to record here that the seasons and the prevailing ecological conditions also impact the population of the plankton biomass.

The phytoplankton numerically ranged between 3 and 283 u/l and the zooplankton between 3 and 1088 u/l. Phytoplankton is represented by Myxophyceae- *Anacystis cyanea*, *Oscillatoria tenuis* and *Spirolina major*; Chlorophyceae by *Coelastrum chodatii*, *C. cambricum*, *Mougeotia lactivirens*, *Quadrigula closteroides*, *Arthrodesmus octocornis*, *Ulothrix zonata* and *Oedogonium crenylocastatum* and Bascillariophyceae by *Fragilaria capucina*, *Melosira ambigua*, *Navicula radiosa*, *Synedra ulna*, *Opephora martyi* and *Denticula thermalis*. The zooplankton is represented by Protozoa-*Arcella mitrata*, *Filinia longiseta*, *Diaphnosoma brachyurum*, *Daphnia magna*, *Ceriodaphnia reticulata*, *Simocephalus exspinosus*, *Bosmina longirostris*, *Keratella guardata*, *K. valga*, *Cypris subglobosa*, Cyclops and nauplius and the miscellaneous by vegetative parts and insects appendages (Annexure-23).

3.5.3.3 Littoral fauna

An important biological component of a given water-body, be it a fluvial or impounded system, is its diverse biological representation which is well adapted to face any natural hazards, be it a sudden water gushings, periodic floods of varied magnitudes, rolling and disturbing actions of gravel, stones, etc. In spite of all these 'negative influences' on their biological processes, these, by natural inbuilt instinct and survival aptitude, survive to further their respective populations. The qualitative and the quantitative faunistic elements collected from the tanks studied are listed in Annexure-23.

The faunal elements collected are primarily represented by developing and adult stages of insects belonging to order Ephemeroptera- *Caenis* spp. and *Cloeon* spp.; Order Odonata- *Urothemis signata*, *Anax* sp. and *Enallagma* spp.; Order Hemiptera- *Plea striola*, *Notonecta glauca*, *Limnometra fluviorum*, *Diplonychus rusticum*, *Micronecta merope*, *Laccotrophes maculatus*, *L. ruber* and *Hydrometra elongate* and Order-Diptera- *Culex* spp. and Chironomous; Molluscs by *Bellamya bengalensis*, *Thiara (Melanoides) tuberculata*, *Lymnaea luteola* and *Cyraulox convexus*; Fish by *Gambusia affinis* and *Oreochromis mossambicus* and Arthropoda by *Macrobrachium* spp.

3.5.3.4 Fish and fisheries

Tanks, as denoted in the State, refer to both ponds and tanks/lakes, constructed for specific purpose viz; irrigation, drinking, water supply, washing and bathing. Most of the water bodies being irrigational in utility, retain water from a few months (seasonal 6 to 7 months; long seasonal 9-10 months/yr) to a year (perennial). The tanks in general are studied in almost all districts, close to taluk head-quarters and certain villages and also, in the city and its surrounding areas.

A random survey of tanks present in the State represented by nineteen districts during seventies (1964-1965) by CIFRI, Govt. of India, brought out a total number of water bodies to be 22,743 commanding a water spread area of 2,72,407 ha. The total number of perennial tanks recorded in the Bengaluru District at the time was around 102 and seasonal tanks being 1691 with their total water spread being 3340 and 19,288 ha respectively. A decade or earlier, the unified Bengaluru district had more than 200 perennial and around 450 seasonal and long seasonal tanks. Their numbers got drastically reduced by the actions of the Government and the Public as well and, in their place, residential lay-outs and gardens have been established.

Fish fauna in the tanks located in the State during the earlier times were numerous, uniform in Genera in all the districts and were represented by mostly medium and small size species. Several river drainages in the State determined largely the available forms as the tanks within the

catchment of a particular lotic water body are apt to show almost similar fish species. The fish species recorded during seventies formed the bulk of the catches. River fishes occasionally, found in certain tanks too. Sixty-eight fish species were observed from the tanks in the State during the seventies comprised of transplanted Gangetic carps- *Gibelion catla*, *Labeo rohita* and *Cirrhinus mrigala*; medium carp-*Labeo bata*, *L. calbasu*, *Systomus sarana*, *Cirrhinus reba* and minor weed fishes such as *Puntius dorsalis*, *P. sophore*, *P. amphibious*, *Pethia ticto*, *Rasbora daniconius*, *Amblypharyngodon mola* and predatory catfish such as *Channa marulius*, *C. orientalis*, *C. striatus*, *C. punctatus*, *Mystus vittatus*, *Mastacembelus armatus*, *Glossogobius girius* and others.

Till about 1970-1980, the fish species available from the tanks was almost similar and the District Bengaluru (present) was no exception. In order to boost fish production from these water sheets, in addition to the Indian major carps and the exotic *Cyprinus carpio* introduced earlier, stocking of herbivorous grass carp- *Ctenopharyngodon idella*, silver carp- *Hypophthalmichthys molitrix* and big head- *Aristichthys nobilis* was undertaken. This effort had some negative impact on the sustainability of indigenous fish species hence decline in their respective population was noticed, clandestine and deliberate stocking of exotic Tilapia species, *Oreochromis mossambica*, *Tilapia nilotica* and the African catfish, *Clarias gariepinus*. Virtually, brought-in very severe results whence their presence and role that these played resulted in the extermination of all the fishes indigenous to these water bodies. Presently, nearly 95-95% of the tanks hold only the Tilapia fish, the African catfish and countable larvicidal fishes such as *Gambusia affinis*, *Poecilia reticulata*. The studies carried out in the recent past, revealed that only the Yelhanka tank presented resemblance of harbouring, in addition the cultural species introduced, also a nominal percentage of minnows/weed fishes too. The fishery of the tanks studied, an alga of others, is in a very 'dependable' conditions and it may take time to bring these back to their original position of earlier decades of the last century.

The checklist of aquatic macrophytes is given below and littoral fauna and fish species recorded during the studies along with the physico chemical characteristics of lakes is given in Annexure-23;

Table 3.16: Checklist of Aquatic macrophytes recorded from the tanks studied in Bengaluru North and South Districts

	Species	Type	Distribution
1	<i>Azolla pinnata</i> R. Brown	Floating	In all 6 species; species in India
2	<i>Salvinia molesta</i> Mitchell	Floating	10 species; almost cosmopolitan
3	<i>Colocasia esculenta</i> Linnaeus	Sub-tropical	Native in Tropical Asia; 6 species
4	<i>Pistia stratiotes</i> Linnaeus	Floating	1 species; pan-tropics
5	<i>Ipomoea aquatica</i> Forsskal	Littoral	500 species; old world tropics and sub-tropics; naturalised in the new world
6	<i>Cyperus castaneus</i> Willdenow	Littoral	380 species; cosmopolitan; mostly tropical
7	<i>Cyperus compressus</i> Linnaeus	-	-
8	<i>Cyperus corymbosus</i> Rottbol	-	-
9	<i>Cyperus cuspidatus</i> Kunth	-	-
10	<i>Cyperus natans</i> Vahl var nutans	-	-
11	<i>Ludwigia adscendens</i> Linnaeus	Littoral	75 species; almost cosmopolitan
12	<i>Paspalum conjugatum</i> Bergius	Littoral	330 species; tropical and warm regions
13	<i>Polygonum barbatum</i> Linnaeus	Littoral	150 species; cosmopolitan
14	<i>Eichhornia crassipes</i> (Martius) Floating Solma-Laubach	Floating	7 species; tropical America and Africa; in most tropical and warm regions of the world
15	<i>Typha domingensis</i> Persoon	Littoral/sub-littoral	8 species; cosmopolitan

3.6 Social Environment

Details provided in Chapter-7.

Chapter

4

ANTICIPATED IMPACTS & MITIGATION MEASURES

Due to the various project activities, potential impacts on the environment of varying magnitude are anticipated. Most of the impacts are likely to occur during the construction phase of the project. This section discusses the anticipated impacts on the physical, biological and social environment due to the project. Impacts have been assessed based on the information collected from the primary and secondary data sources. Construction activities will be carried out for 3 years.

4.1 Impacts during construction phase

4.1.1 Air Environment

4.1.1.1 During pre-construction and construction phase

Site preparation:

- Emission of dust due to site clearance and excavation activities
- Emission of dust and exhaust gases due to use of heavy vehicles and machinery etc.
- Emission of dust due to procurement and transport of raw materials from borrow areas/quarries to construction sites.

Construction activities:

- Mixing of road materials
- Operation of hot mix plants, concrete batching plants and asphalt mixing plants.
- Operation of hot mix plants leads to the emission of high levels of SO₂, HC and hydrocarbons.
- During the heating process of bitumen production, volatile toxic gases are released.
- Handling and storage of aggregates at the asphalt plants
- Construction and allied activities including blasting
- Operation of DG sets

Transportation of raw materials:

- Gaseous emissions from vehicular movements carrying construction materials
- Unloading of construction materials causes emission of dust
- Dust emissions may cause reduction in growth rate, deposition of dust on leaves, photosynthetic activity, necrosis, leaf curling, abscission, etc in the plants.
- Dust emissions during transportation of fly ash cause severe health effects.

Earthwork, borrow areas and quarrying activities:

- Continuous exposure to dust emissions may cause respiratory disorders, eye irritation, cough, chest pain, infections, etc in human

- Utilization of pre-cast structures are safer and more efficient since the roadwork can be completed during off-peak hours/short period of time thereby reducing the need for time-consuming roadway closures.
- The precast structures can be fabricated under environmentally controlled conditions resulting in better outcome.
- Utilization of precast structures reduces manpower during construction phase.
- Precast concrete panels can ease congestion at busy intersections and are a good choice for ramps and other locations where heavy traffic presents a challenge during construction phase.
- Utilization of precast structures saves time and trouble faced during winter season, since it eliminates the need to pour concrete in cold-weather conditions.
- Construction activities/works will be avoided during monsoon period/rainy days located near to lakes/natural drains/nala.
- Erection of barricades and water sprinkling shall minimize the deposition of dust on the waterbodies thereby reducing the impact on avifauna and aquatic biota.
- Provision of separate collection and disposal mechanism for synthetic hydraulic oil shall be made to avoid water pollution 4 lake bed areas.
- It will be ensured that, drains/nalas leading to lakes/any water bodies will not be disturbed in any case during any of the construction activities except for haul roads for which, temporary culverts/box drains will be provided for ensuring smooth undisturbed flow. This exercise will be undertaken during pre-construction stage.
- No vehicle washing bays will be located within 500m from any water body.
- Silt/sediment Fencing will be undertaken at major soil disturbed areas to arrest silt/sediment transport (major locations include top soil storage area, borrow area, plant/office site and near water bodies). Continuous drainage arrangements will be undertaken to channelize surface run-off and discharged to nearest water body (lake/drain) after silt/sediment trap/desilting arrangements. 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 design of silt / sediment fencing and trap arrangement are provided in Annexure-18.
- To improve the stability and continued working conditions within the PRR area (i.e., ROW area), the water stagnated during the construction activities due to curing activities and in general, during monsoon period, stagnated will be pumped through temporary pumping arrangements to ensure dry conditions and will be channelized to nearby available drains/culverts ensuring its adequacy and also ascertaining prevailing conditions by ensuring no overflow situations. Wherever possible, channelized to nearby lakes with silt/sediment trap arrangements. This would likely increase the water table marginally by 0.2-0.5m (within 100-250m from the alignment) by recharging aquifers. Embankment protection works like stone pitching /turfing will be undertaken.

(Ref: PMGSY Environmental Codes of Practice -ECOP-11.0, 12.0, The Karnataka Lake Conservation and Development Authority Act, 2014, Wetlands (Conservation and Management) Rules, 2017, Supreme Court order dt: 05.03.2019).

Impact on water resources and surface hydrology:

- In the entire project, water for construction activities will be sourced from nearby BWSSB and usage of secondary treated water for dust suppression activities reduces pressure on external fresh water resources. A MoU in this regard will be undertaken prior to executing the work operations at site.
- Fuel storage areas will be earmarked within the construction sites with covered arrangements on impervious flooring including storage of onsite hazardous wastes (300 Ltrs/Annum) and

disposal of same to KSPCB authorized reprocessors/recyclers. Fuel storage and vehicle washing areas will be located at least 200m away from all cross-drainage structures and water bodies including natural drains/nalas. Additionally, Oil Interceptors will be provided at all vehicle washing areas to collect waste oil carried through washing water and segregated and disposed off the same to KSPCB authorized reprocessors/recyclers. This arrangement will also ensure to trap bituminous contents by trap mechanism.

- As per the topographical surveys, the proposed alignment passes/crosses on 63 nalas/streams/drains for which, CD structures (Minor Bridges and Culverts) are proposed to ensure safe flow of water and to minimize the impacts associated with surface hydrology.
- Provision of garland drains at crushers, hot mix plants and batching plants to check erosion and runoff will be ensured.
- Adequate drainage system will be ensured for surface run off using culverts, minor bridges, etc.
- In the event of spillage of chemical or accident of vehicles carrying vehicles noticed or brought to the notice, the patrolling team will alert the emergency personnel and also statutory/emergency authorities for immediate containment, including awareness to public around the water bodies on the situation, blocking the channel drains leading to water bodies.
- CCTV cameras will be installed along the alignment exposed to water bodies (preferably lakes) to ascertain intensity of damage and control damage.
- Emergency Personnel will be deployed always at the point of alignment exposed to waterbodies to monitor and ensure no untoward accidents occur, supported with intercom/wireless facility to handle emergencies immediately.

(Ref: PMGSY, Environmental Codes of Practice - ECoP-13.0).

Labor camps:

- The location of the labor camps will be at least 500m away from the nearest lake.
- Temporary drainage arrangements will be undertaken around construction spots to avoid stagnation of water. The channelized water will be collected in temporary sedimentation tank.
- RO Arrangements will be made in the labor camps area towards supply of safe drinking water. The supplied water will be tested on quarterly basis for IS 10500:2012 drinking water quality standards from MoEF&CC recognized Environmental Laboratory and ensured for potable use to safeguard health concern of the labourers.
- Sanitation facilities viz., Mobile Toilets (10 No.s), Bathrooms (10 No.s) will be provided at the Labor camps area including mobile toilets (2 No.s at each spot). Mobile STP (20KLD capacity based on SBR Technology) will be provided for scientific disposal of sewage. The treated sewage will be reused for dust suppression purposes around construction spots, vehicle movement. Further, Pest Control activities will be undertaken once in a year at Labor Camp area to maintain standards of hygiene.
- Solid wastes (75Kgs/day) from the labor camps will be segregated into organic (45Kgs/day) & inorganic wastes (30Kgs/day) through different colored bins (Blue Bin for dry waste & Green Bin for Wet waste) located at different places within the camps. Organic solid wastes such as, kitchen wastes, food wastes, vegetable/fruits wastes will be handed over to nearby piggeries and Inorganic wastes such as, waste papers, glass pieces, carton boxes, milk packs/sachets, empty packaged food covers and boxes will be disposed to BBMP authorized scrap dealers/waste recyclers.

(Ref: PMGSY Environmental Codes of Practice - ECoP-10.0, 11.0).

4.1.4 Soil Environment

4.1.4.1 Anticipated impacts

Land acquisition:

- Land acquisition leads to loss of productive land, loss of soil fertility, soil biodiversity and degradation.
- Removal of structures leads to generation of construction debris. About 20.93 MT of construction debris will create confined augmented absorptions of toxic heavy metals in the soil, which may reach toxic levels through the food chain.

Agriculture and removal of vegetation:

- Removal of trees and vegetation & earth works including quarrying leads to erosion and loss of top soil. About 36,824 number of trees will be removed thereby erosion of soil is anticipated.
- Loss of 33,83,625 Cum of top soil leads to loss of productivity of Agro-Horticultural lands along the alignment. Loss of embankment soil and stability loss for the road is anticipated. This impact is restricted to the ROW.
- Borrow areas in agricultural areas (if any) affects the topsoil quality of the land.

Storage and use of top soil:

- Improper handling of excavated earth leads to blocking of natural drainage. The absence of good drainage systems leads to problems related to erosion and water stagnation causing an increase in probability of being affected through waterborne diseases and unsanitary conditions in surrounding 500 mt.
- Top soil from the borrow area will lose its fertility if not handled properly. Also the borrow area become potential breeding ground for mosquitoes and other bacterial infection disease. The transportation of borrow and quarry materials also cause dust nuisance.
- Elevated sections of road in all sections, particularly all high embankments along the box culverts and the box culverts approaches would be vulnerable to erosion and need to be provided proper slope protection measures to prevent erosion.

Construction activities:

- Laying of pavements leads to reduction of ground water recharge area. Since the road networks are less permeable compared to soil, this will result in higher amounts of surface runoff.
- Siting of borrow areas near residential and agricultural lands affects the topsoil quality and nearby drainage system.
- Vehicle, machine operation & maintenance cause contamination by fuel & lubricants compaction. These conditions leads to low soil fertility, which in turns implies low agricultural productivity and reduce source of livelihood in the affected cropped areas around 500 m along the alignment⁹⁶.
- Construction of embankments causes blockage of cross drainages resulting in flooding.
- Utilization of scarified bitumen used oil and diesel spills, Emulsion sprayer and laying of hot mix, Production of hot mix and rejected materials in the construction site causes hydrocarbon contamination leading to reduction of soil fertility.
- Compaction of soil will occur due to movement of heavy machinery and vehicles and also during setting up of construction camps and stockyards.

⁹⁶1 Oyem, Isama Lawrence Rank, 2 Oyem, Isama Lawrence 1 petroleum and Natural Gas Processing Department Petroleum Training Institute P.M.B. 20 Effurun Delta State Nigeria. 2Petroleum and Natural Gas Processing Department Petroleum Training Institute Effurun, Delta State, Nigeria Effects of Crude Oil Spillage on Soil Physico-Chemical Properties in Ugborodo Community, Vol. 3, Issue. 6, Nov - Dec. 2013 pp-3336-3342, ISSN: 2249-6645

- The sites where construction vehicles are parked and serviced are likely to be contaminated due to leakage or spillage of fuel and lubricants. Unwarranted disposal of construction spoil and debris leads to soil contamination.

Labor camps:

- Sanitation & waste (labor camps) causes contamination from wastes. Discharge of sewage from the labor camps will lead to modification in biological, chemical, and physical properties of the soil. This will consequently affect the dynamics of microbiota, organic matter decomposition, nutrient cycling, physical structure of the soil, and pest and plant disease severity.
- Soil contamination may take place due to waste disposal from the labor camp.

4.1.4.2 Mitigation measures

Land acquisition:

- Reuse of the construction debris for scientific disposal of construction debris to avoid contamination.
- Debris disposal site will be identified in barren and infertile land.
(Ref: PMGSY Environmental Codes of Practice ECoP-6.0).

Agriculture and removal of vegetation:

- Turfing of road embankment slopes.
- Top soil from borrow areas will be stored in stockpiles within 2 meters height with proper covering.
- In case the borrow pit is on agricultural land, the depth of borrow pits shall not exceed 45 cm and may be dug out to a depth of not more than 30 cm after stripping the 15 cm top soil 30 cm aside.
- Development of compensatory afforestation and borrow area rehabilitation.
- The design of embankment gradients will be 1:2, the slopes of the embankments are perceived to be stable for all stretches of road. These sections of the road embankment would need stone pitching or turfing. Turfing of road embankment slopes.

(Ref: PMGSY Environmental Codes of Practice -ECoP-6.0, IRC: 36 - 1974, IRC: 10-1961).

Storage and use of top soil:

- Embankment protection through pitching & turfing will be done.
- To avoid any embankment slippage, the borrow areas will not be dug continuously, and the size and shape of borrow areas will be decided by the BDA.
- Borrow areas situated less than 0.8 km (if unavoidable) from villages and settlements should not be dug for more than 30 cm after removing 15cm of topsoil and should be drained.
- Excavated earth will be reused as embankment, median & shoulder fill materials. The quantification of excavated earth and its usage is as given in Chapter-9.
- Excess material to be used for filling up of borrow areas identified as given in Chapter-2.
- The borrow areas will be selected as per IRC guidelines (IRC: 10:1961) in a scientific manner with due care of local environment and social sensitivity. The top soil from the borrow area will be preserved separately and will be re-used for rehabilitation. Locations for probable borrow areas as identified along the road has been presented in Chapter-2.
- During construction period, drainage alteration and downstream erosion / siltation is anticipated, due to the improved design and added capacity of the cross-drainage structures, an improvement in the drainage characteristics of the surrounding area is anticipated. Adequate slope protection measures are proposed as part of engineering design. Removal of trees to

facilitate construction will cause erosion problems until the proposed avenue plantation is established. The regular cleaning of the drains by the Contractor will ensure that these structures will not be overloaded or rendered ineffective due to overload.

(Ref: PMGSY Environmental Codes of Practice -ECoP-6.0, IRC 10: 1961).

Construction activities:

- Pitching, stabilization of soil and slope protection measures will be taken to reduce soil erosion.
- Runoff from the construction site will be channelized through silt traps.
- Catch drains and catch pits will be provided to drain out the hazardous chemicals.
- To avoid spillage of fuel and lubricants, the vehicles and equipment will be properly maintained and repaired. Maintenance will be carried out on impervious platforms with spill collection provisions.
- Oil interception chambers (3 No's) will be provided to channelize the surface run off and the oil will be skimmed off manually from the chamber and will be disposed off in approved landfill sites.
- Usage of oil interceptors.
- Non reusable bituminous wastes will be dumped in 30cm thick clay lined pits with the top 30cm layer covered with fertile soil for supporting vegetation growth.
- Toe drainage and placing sands bags near toe drainage in order to increase shear resistance actuating forces causing slip.
- Reducing seepage by lowering seepage head by constructing ring wells with sand bags near the toe drainage.
- Restoration of compacted soil areas will be undertaken soon after project work completion.
- The movement of construction vehicles shall be limited to designated haulage road. So that compaction of nearby productive land may be saved. Provision of reclaiming of nearby land has also been kept to cure the soil compaction in nearby productive lands. However, this is a short duration impact. Appropriate measures should be taken to minimize the area of soil compaction.
- The fuel will be stored in separately designated area with RCC surface to prevent any soil contamination due to spillage
- In order to prevent soil contamination bitumen waste will be disposed-off at designated landfill site only.

(Ref: PMGSY Environmental Codes of Practice -ECoP-9.0, 10.0, 13.0).

Labor camps:

- Sewage generated from the labor camps will be treated in mobile STP of capacity 20 KLD and the treated water will be reused for dust suppression activities around the peak construction area. Hence, contamination of soil will not be anticipated.
- Overflow of service and washing areas will be passed through from oil interceptors to prevent soil contamination.
- Mobile STP will be provided in labor camps to prevent any soil contamination due to sewage discharge.
- Waste management system will be adopted in construction camps to prevent soil contamination.

(Refer Environmental Codes of Practice -ECoP-3.0, 9.0, 10.0, 13.0, Solid waste management rules, 2016, CPCB and KSPCB guidelines).

4.1.5 Land use assessment

4.1.5.1 Anticipated impacts

- Construction of PRR, excavation activities, vehicular movements, residential and commercial development, demand for infrastructure, etc leads to change in land use in the surrounding areas.
- Creation of construction site, site offices, workers camps, stockyards, haul roads, excavation activities, operation of machineries, movement of heavy vehicles, etc leads to loss of productive soil and compaction of soil affecting inherent fertility and also leads to retarded growth of vegetation in the area.
- Utilization of local land resources for the project is one of the major impact on land use. Land acquisition of 1036.51 Ha along 73.5 Km with RoW of 100 m leads to loss of productive agricultural land, forest land and water bodies. The project also envisages removal of trees (36,824 trees) and roadside structures (1,395 structures) which also leads to permanent changes in the existing land use pattern.
- Road construction activities involve alterations in the local physiography and drainage patterns. The impacts on physiography may include destabilization of slopes due to cut and fill operations.
- Commercial activities and area development infrastructures activities led to increase in built up areas.

4.1.5.2 Mitigation measures

- Compensatory afforestation will be carried out in the ratio 1:10 to balance the number of trees removed.
- Parallel cross drainage structures will be added to improve local physiography and drainage

4.1.6 Solid & Hazardous waste storage, handling and disposal

4.1.6.1 Anticipated impacts

Earth works:

- Road construction activities generate wastes such as; vegetation waste, demolition waste, excavated earthworks, construction waste, chemical wastes and municipal wastes etc. which causes unaesthetic conditions leading to health problems.
- Estimated quantity of coarse aggregate (54, 66,120 MT) and fine aggregate (8, 82,280 MT) is utilized for construction activities. The quarries for these aggregates and borrow earth are locally available. Therefore, no significant impact is noticed.
- The project requires demolition of 1,395 Nos. of structures which generates demolition waste and debris (20.93 MT) due to dismantling of existing cross drainage structures and roadside residential and commercial structures may lead to entry of toxic heavy metals into the soil and nearby waterbodies.

Labor camps:

- Improper disposal of sewage (18KLD) and solid wastes (45Kgs/day) from labor camps area leads to the formation of leachate thereby causing soil pollution, surface and ground water pollution.
- Indiscriminate plastic waste disposal on land makes the land infertile due to its impervious nature and also affects the animals.
-
-

Utilization of hazardous materials for construction activities:

- Used oils will be generated from DG sets which affects soil and aquatic biota upon entry into soil and water environment.
- Improper disposal of chemical wastes may lead to fire or explosion.
- Improper handling of hazardous materials such as bituminous material-asphalt waste and tar during transportation and construction activities may enter into waterbodies thereby increasing the turbidity.
- Unused iron and welding electrodes of 4,863 MT (5% of total steel requirement) is expected during construction activities. Improper handling of these affects surface water quality and aquatic life.

4.1.6.2 Mitigation measures

Earth works:

- Solid and hazardous wastes generated will be stored in the leak proof bins. Scientific segregation of solid waste at site and regular disposal to BBMP landfills. Storage area of 10 x 10 m will be covered with zinc sheets and the ground will be covered with impervious layer to avoid leachate run off. Pest control will be done periodically at quarterly once. Monthly surface water quality testing will be undertaken as per IS 10500 Drinking Water Quality Standards to ascertain the quality of water and to take necessary corrective actions based on the same.
- Water sprinkling will be done 3 times a day to avoid fugitive emissions and the excavated earth and muck will be designated areas at lower contours.
- Demolition wastes and debris shall be stored separately in dumping yards located 1000 m away from the sensitive locations such as settlements, forest areas, schools, etc and lined with impermeable membrane/concrete. These wastes shall be reused for construction and filling purposes as per the Construction and Demolition (C&D) Waste Management Rules, 2016.

(Ref: Environmental Codes of Practice -ECOP-4.0, 10.0, Solid and hazardous waste management rules, 2016, Construction and Demolition Waste Management Rules, 2016).

Labor camps:

- Plastic waste will be segregated at source and handed over to KSPCB authorized recyclers.
- Mobile STPs are used to treat the sewage generated from labor camps and solid waste generated shall be segregated, stored in separate bins and disposed off to KSPCB authorized disposal sites.

(Ref: Environmental Codes of Practice -ECOP-3.0, 10.0, Solid waste management rules, 2016).

Utilization of hazardous materials for construction activities:

- Used Oil will be handled scientifically using oil interceptor and disposed to KSPCB Authorized reproprocessors.
- Chemical wastes shall be stored in sealed containers and handled and disposed off safely. The storage area of chemical wastes shall be located away from water bodies and places with risk of fire occurrences.
- Hazardous and other wastes (Bituminous material-asphalt waste, tar) will be stored in stockyards with paved bases and handled as per Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016(Refer IRC: SP: 39).
- The leftovers of welding electrodes and iron components will be handed over to the nearby engineering works centre so as to remould and reuse them for making other iron works.

Possibilities of utilizing the debris / waste materials available in and around the project area:

- Construction and Demolition waste (CDW) can be recycled and used as used as general bulk fill, sub-base material in road construction, fills in drainage projects and for making new concrete⁹⁷.
- Debris generated due to demolition of structures along PRR can be utilized as aggregate/road material as it is satisfying the MoRTH (ministry of road transport & highways) requirements⁹⁸.
- Construction and Demolition waste (CDW) can be used as aggregate in road pavement design thereby reducing traffic congestion due to dumping on road sides and preventing from soil and water pollution⁹⁹.
- CDW can be used in the highway embankments and precast structures since the recycled C&D wastes exhibits stress-dependent and moisture-sensitive characteristics¹⁰⁰.
- Fly ash can be used as replacement of cement in construction of concrete pavements¹⁰¹.
- Recycled glass from landfills can also be used in road and path construction¹⁰².
- Various forms of plastic waste bi-products can be used in the construction of roads as quarried rock for aggregates replacement. Plastic wastes provide extra durability and elasticity which is due to the higher melting point. This also reduces maintenance costs^{103&104}.
- Vegetation waste/ timber generated due to removal of trees can be used for fencing of trees/saplings and the foliage as manure during operation phase.

4.1.7 Hydrology and geology

4.1.7.1 Anticipated impacts

Geological environment:

As the project site is over Granite gneiss and infrastructure facilities like Eight Lane Roads, ROB's under passes, etc. Buildings and other sanitary facilities emerge after construction, only topography will be altered. The foundations require excavation of pits and blasting of rock which has a negligible impact as the pits shall be filled back with stony waste & gravel that shall be stabilized. However, likely impact on the geological resources will occur from the extraction of materials (borrow of earth, granular sub base and aggregates for base courses and bridges) which is temporary.

Seismic Tectonics:

Seismic activity with respect to the proposed project site was studied at the possibility during the post project scenario. It was observed that no major earth quakes occurred in the region during the past 25 years. However, during 2005-06 tremors were reported from Gauribidanur Seismic recording station which is about 85 Kms from the proposed site¹⁰⁵. The seismic zoning map has been referred to know the zone in which the project site is falling. The proposed project site is falling on Zone-II which has very low risk of damage¹⁰⁶.

⁹⁷<https://tifac.org.in/index.php/8-publication/164-utilisation-of-waste-from-construction-industry>

⁹⁸Raju, S.S.V. & Rani, K. & Chowdary, Venkaiah & Kvgd, Balaji. (2010). Utilization of building waste in road construction. Indian Journal of Science and Technology. 3. 894-896. 10.17485/ijst/2010/v3i8/29904.

⁹⁹<http://www.ijarset.com/upload/2017/december/7-IJARSET-VISHAL.pdf>

¹⁰⁰ Zhang J, Gu F, Zhang Y, Use of building-related construction and demolition wastes in highway embankment: Laboratory and field evaluations, Journal of Cleaner Production (2019).

¹⁰¹Ahmed, I. (1991). Use of waste materials in highway construction. Joint Transportation Research Program, 299.

¹⁰² Australian Food and Grocery Council (2010) 'Recycled Glass a Sustainable Alternative in Road Construction', www.afgc.org.au/media-releases/286-recycled-glass-a-sustainable-alternative-in-road-construction.html, accessed 20 July 2011

¹⁰³Relph, M. K. (2011) 'Where the roads are paved with plastic', www.abc.net.au/environment/articles/2011/04/18/3192740.htm, accessed 5 June 2011

¹⁰⁴Rokdey, S. N., Naktode, P. L., & Nikhar, M. R. (2015). Use of plastic waste in road construction. International Journal of Computer Applications, 7, 27-29.

¹⁰⁵Seismic Hazard Analysis for the Bangalore Region: T.G. Sitharam and P. Anbazhagan, Dept. of Civil Engineering, IISc, Bangalore, Karnataka. 8th Feb'2006

¹⁰⁶NDMA, GOI

Impact on natural drainage:

The proposed project corridor length crosses about 63 minor & major drainages and also few tanks. Construction activities such as excavation, storage of debris, muck, etc may affect the streams which are seasonal that carry huge volume of storm water and contribute to recharge of groundwater as such these needs to be protected. This may also cause flooding during monsoon season.

Impact on Surface Water:

Consequent to development of Peripheral Ring Road, the runoff during monsoon from paved roads exceeds the normal capacity of the tank thereby overflow and flooding is anticipated.

Impact on Ground Water

Groundwater usage/groundwater extraction during construction phase will likely lead to reducing the ground water table/levels.

Storm water Management:

Blockage of drainage pattern due to construction activities and implementation of PRR may affect the water percolation capacity of storm water run-off thereby causing decline in water levels.

4.1.7.2 Mitigation measures

Geological environment:

The collapse can be avoided by formation of benches of 1.5 m to 3.0 m height for working conveniently and making access to sub surface levels for pit formation.

Seismic Tectonics:

As the underlying rock granite gneiss is massive and hard it required blasting and fly rock is inevitable for which controlled blasting by deploying time delay detonators, placing of moist clay bags, provision of earplugs and goggles to workmen is suggested.

Impact on natural drainage:

The safety buffer zone of 30.0 m to be left to protect the natural stream course and maintained periodically with desilting and cleaning. The safety buffer zones specifically pronounced in the orders of the Hon'ble National Green Tribunal, Principal Bench, New Delhi shall be strictly adhered to. Maintenance of streams by removing debris periodically may minimize the impact on drainage pattern.

(Ref: PMGSY Environmental Codes of Practice - ECoP-11.0, 12.0).

Impact on Surface Water:

- To avoid flooding or inundation the streams shall be maintained by clearing the debris and periodical maintenance during pre-monsoon period.

Impact on Ground Water:

No groundwater extraction currently involved in the proposal, hence, as such no impact anticipated on the reduction of groundwater levels. However, it shall be ensured that, NOC from KGWA will be obtained if the need arises in the future.

Chapter
4

ANTICIPATED IMPACTS & MITIGATION MEASURES

Due to the various project activities, potential impacts on the environment of varying magnitude are anticipated. Most of the impacts are likely to occur during the construction phase of the project. This section discusses the anticipated impacts on the physical, biological and social environment due to the project. Impacts have been assessed based on the information collected from the primary and secondary data sources. Construction activities will be carried out for 3 years.

4.1 Impacts during construction phase

4.1.1 Air Environment

4.1.1.1 During pre-construction and construction phase

Site preparation:

- Emission of dust due to site clearance and excavation activities
- Emission of dust and exhaust gases due to use of heavy vehicles and machinery etc.
- Emission of dust due to procurement and transport of raw materials from borrow areas/quarries to construction sites.

Construction activities:

- Mixing of road materials
- Operation of hot mix plants, concrete batching plants and asphalt mixing plants.
- Operation of hot mix plants leads to the emission of high levels of SO₂, HC and hydrocarbons.
- During the heating process of bitumen production, volatile toxic gases are released.
- Handling and storage of aggregates at the asphalt plants
- Construction and allied activities including blasting
- Operation of DG sets

Transportation of raw materials:

- Gaseous emissions from vehicular movements carrying construction materials
- Unloading of construction materials causes emission of dust
- Dust emissions may cause reduction in growth rate, deposition of dust on leaves, photosynthetic activity, necrosis, leaf curling, abscission, etc in the plants.
- Dust emissions during transportation of fly ash cause severe health effects.

Earthwork, borrow areas and quarrying activities:

- Continuous exposure to dust emissions may cause respiratory disorders, eye irritation, cough, chest pain, infections, etc in human

Labor camps:

- Emission of gases due to utilization of firewood as fuel at the construction site
- The impact of dust at construction sites is rather adverse, but localized in nature. No serious health problem is likely to be caused. However, impacts of gaseous emissions on human health as mentioned in Chapter-3 (Section 3.2.3.1) are likely to be anticipated.

4.1.1.2 Anticipated impacts estimated using AERMOD

Pre- construction and construction activities like site clearing, tree cutting, movement of personnel and material, construction activities, construction of haul roads for movement of construction materials will cause emission of dust.

The initial site clearing will be followed by site preparation activities such as grading, excavation of footings and foundations and backfilling operations.

Excavation of work sites in urban areas causes disturbance due to the emission of particulate matter in the area. Fugitive dust emissions from the construction activities are mainly due to the following activities:

- Site preparation and grading/excavation at the construction site
- Onsite travel on paved and unpaved surfaces
- Aggregate and soil loading and unloading operations
- Wind erosion of the disturbed areas.

Combustion emissions (exhaust) during construction activities are from:

- Diesel construction equipment used for site preparation, grading, excavation, trenching and construction of onsite structures
- Water trucks used to control construction dust emissions
- Diesel-powered welding machines
- Pickup trucks and Diesel trucks used to transport materials around the construction site
- Diesel trucks used to deliver concrete, fuel, and construction supplies to the construction site
- Automobiles used by workers to commute to the construction site.

Estimation of ambient air impacts from construction and operational phases of the project is carried out using the EPA approved AERMOD model which requires hourly breakdown of wind speed, wind direction and other meteorological parameters. The emission sources for the construction site are grouped into three categories:

- Area source: construction dust emissions and windblown dust emissions during construction phase.
- Point source: exhaust emissions from stationary vehicles used for construction and Operation of DG during construction phase.
- Line source: Vehicles moving from and to the project (Within the project site) during operation phase.

AERMOD model is used for predictions of emissions of Particulate matter with mitigation measures and without mitigation measures. Further, CALINE model were used for the prediction of emissions from the movement of vehicles during operation phase of the project. While running the model, receptors were placed around the construction site and 1 Km grid was selected for the study. In a typical day, construction will be carried out in an area of 100 m X 250 m and 250 KVA DG set will be operated and the same has been considered for Air quality modeling studies. The isopleths are drawn for the critical parameter PM as identified.

The model results reveal that, impact on the ambient air will be moderately polluted if no mitigations measures in-place. The typical day model output reveals that maximum GLC observed in the core construction area up to $109.45 \mu\text{g}/\text{m}^3$ and impact observed till 2 kms from the core construction zone. However, with the implementation of EMP, the dust load will be reduced to $76.814 \mu\text{g}/\text{m}^3$ will fall in the satisfactory range of AQI. Isopleths drawn for without and with mitigation scenario for all the three sections is enclosed in Annexure-15 and the results are given below.

Table 4.1: Air quality modelling results

Section	Without Mitigation, $\mu\text{g}/\text{m}^3$	With mitigation, $\mu\text{g}/\text{m}^3$
Section -1	98.822	69.581
Section -2	109.450	76.814
Section -3	108.705	76.856

4.1.1.3 Mitigation measures

Site preparation:

- Vehicles used for transportation of construction materials on public roadways will be provided with a cover, or the materials will be sufficiently wetted and loaded onto the trucks by providing at least one foot of freeboard.
- Periodic maintenance of all vehicles, equipments and machineries used for construction shall be done to ensure that the emissions levels are as per norms of CPCB.
- Barricading the project site on either side of the of the RoW to reduce dispersion of dust

Construction activities:

- During unloading activities, the height from which building materials will be dropped shall be controlled to a minimum height of at least 3ft to contain the fugitive dust generation.
- DG sets will be engaged in the construction site will be equipped with suitable stack height.
- All the DG sets to be used during the construction will comply as per CPCB guidelines.
- As per KSPCB Guidelines, the hot-mix plants with dust extraction unit will be installed in downwind direction from nearby settlement and located at least 500 m from the nearest habitation.
- Water will be sprinkled 3 times a day in the line and earth mixing sites, asphalt mixing site and service roads. In filling subgrade, water spraying is needed to solidify the material. After the impacting, water will be sprayed regularly to prevent dust.
- It will be ensured that the human settlements will be 500 m away from the downward wind direction of asphalt mixing plant.
- About 20 feet high barricades will be used on either side of the RoW and around the construction site to suppress the dust.
- Monthly Ambient Air Quality Monitoring (Chapter-6) will be carried out to assess the pollution load during construction phase.

(Ref: PMGSY, Environmental Codes of Practice ECoP-13.0).

Transportation of raw materials:

- Disturbed areas in the project site will be frequently watered to prevent the emissions of fugitive dust.
- The speed limit of vehicles will be restricted to 15-20 kmph within construction zone.

- Construction equipment vehicle tyres will be cleaned free of dirt prior to entering the construction zone.
- Gravel ramps of at least 20 ft in length will be provided at the tyre washing section
- In order to avoid fugitive emissions, vehicles delivering loose and fine materials like sand and fine aggregates will be covered by tarpaulin sheets to reduce spills on roads.
- The transport contractors will strictly not allow the construction vehicles without emission certificates or vehicles not meeting the emission norms into the construction zone.
- Trucks carrying fly ash will have sufficient free board and covered with tarpaulin and in semi wet form. Storage will also be done in semi-wet form to avoid fugitive dust emissions.

(Ref: PMGSY, Environmental Codes of Practice - ECoP-10.0).

Earthwork, borrow areas and quarrying activities:

- Green Mesh will be used to cover debris where ever excavated muck are dumped & demolition activities are carried, to suppress fugitive dust emission.
- The unpaved surfaces used for haulage of borrow materials will be maintained dust free through sprinkling of water twice a day during the period of use.
- Use of Personal Protective Equipment's (PPE) for all the labor.

(Ref: PMGSY, Environmental Codes of Practice - ECoP-14.0).

Labor camps:

- Provision of LPG gases for cooking
- Dust suppression activities will be carried out during non-monsoon months

4.1.2 Noise Environment

4.1.2.1 Anticipated impacts

Site clearance:

- Movement of vehicles and heavy machineries
- Establishment of labor camps, onsite offices, stock yards, etc

Construction activities:

- Construction activities including operation of machineries devices for breaking concrete), earth-moving machines, pile drivers, pneumatically driven devices and combustion engines⁹⁰.
- Construction noise sources include pneumatic hammers, air compressors, bulldozers, loaders, dump trucks (and their back-up signals), and pavement breakers⁹¹
- Other noise sources include operation of hot mix plants, batching plants, etc.
- Noise pollution (75-85 dB (A)) during pre-construction and construction phase may cause discomfort and health issues such as headaches, irritation, angst, etc to the labourers and residential areas located within 500 m from the proposed alignment. List of sensitive receptors located near the project site is given in Chapter-7.
- Noise levels in the range of 80 – 95 dB (A) are expected to be produced during construction activities. The increasing noise levels due to drilling, blasting and allied construction activities will disturb the avi-fauna and faunal burrow animal habitats like reptiles.
- Continuous exposure to noise during construction phase may cause headaches, stress, hearing problems, etc amongst the labor force and the nearby residents located within a distance of 500 m. The permissible time of exposure to noise for labours is given in Table 4.2 below.

⁹⁰ Brno University of Technology, Faculty of Civil Engineering, Veveří 331/95, 60200 Brno, Czech Republic

⁹¹<http://noisepollution.weebly.com/sources-of-noise-pollution.html>

- Operation of DG sets at the construction site will create noise pollution (200m radius) and will induce vibration effects.
- No Exposure in Excess of 115 dB(A) is to be permitted at construction site.

Table 4.2: Permissible Exposure in cases of continuous Noise

SI No	Total Time of exposure (Continuous or a number of short term exposures) per day, in hours	Sound pressure level in dB(A)
1	8	90
2	6	92
3	4	95
4	3	97
5	2	100
6	1.5	102
7	1	105
8	0.75	107
9	0.5	110
10	0.25	115

Source: Noise Pollution Regulations in India, 2001 by CPCB

Transportation of construction materials:

- Movement of heavy vehicles involved in transportation of construction materials, earthworks from the borrow areas/quarries.

4.1.2.2 Noise level predictions using dhwani PRO noise model

dhwaniPRO noise model developed to undertake construction, industrial and traffic noise propagation is used to predict the impact of noise on receptors from the source of noise generation. It is also used to predict impact due to group noise sources in the industrial complex (multiple sound sources) and traffic⁹². Various noise source and receptors were considered within 500 m from ROW. For every one-point source the nearest habitat/ sensitive area is considered as receptor and the predicted noise levels at receptor site are as follows and the isopleths drawn for noise levels is enclosed in Annexure-16.

Table 4.3: Noise level modelling results during Day time

⁹² Environmental Impact Assessment, A practical guide for Professional practice, 2016, A K A Rathi, PP110

Sl. No.	Name of the source location	Model noise level in dB(A) within source location	Name of the receptor location	Model noise level in dB(A) at receptor (without barrier)	Model noise level in dB(A) at receptor (with barrier)	CPCB std day time
1	Tumkur Road	68.3	Kuduregere	40	38	65 dB(A)
2	Near SBM Layout	75.16	Kasghattapura	33	30	
			Chikbyalakere	44	44	
3	Doddaballapur Road	76.56	Jarakabande RF	35	34	
4	Bangalore-Hyderabad Highway	72.73	Palanahalli Village	36	34	
5	Thanisandra Main Road Chokkanahalli	74.12	Agrahara Layout	40	38	
6	Old Madras Road	62.15	Adur	45	36	
			Avalahalli	38	36	
7	Hennur Main Road Chikkagubbi	72.47	Hegde Nagara	38	36	
8	Whitefield-Hoskote Road Chikkabanahalli	70.50	Chikkabanahalli Village	41	36	
9	Channasandra Main Road	79.77	Channasandra village	40	37	
			Nagondanahalli Village	43	39	
10	Varthur	71.43	Varthur Village	46	46	
11	SH-35 Near Gunjur	74.03	Kachamaranahalli	37	35	
12	Sarjapura Road Near Sulikunte	72.60	Tigala Choudenahalli	37	35	
13	Gattahalli Road Near Gattahalli	63.76	Huskuru	42	41	
14	Hosur Road	71.40	Chikkatogur	37	34	
			Doddanagamangala	25	22	

Table 4.4: Noise level modelling results during Night time

Sl. No.	Name of the source location	Model noise level in dB(A) within source location	Name of the receptor location	Model noise level in dB(A) at receptor (without barrier)	Model noise level in dB(A) at receptor (with barrier)	CPCB std Night time
1	Tumkur Road	58.38	Kuduregere	40	38	55 dB(A)
2	Near SBM Layout	62.54	Kasghattapura	33	30	
			Chikbyalakere	44	43	
3	Doddaballapur Road	41.26	Jarakabande RF	36	34	
4	Bangalore-Hyderabad Highway	62.54	Palanahalli Village	35	34	
5	Thanisandra Main Road	53.43	Agrahara Layout	40	38	

Sl. No.	Name of the source location	Model noise level in dB(A) within source location	Name of the receptor location	Model noise level in dB(A) at receptor (without barrier)	Model noise level in dB(A) at receptor (with barrier)	CPCB std Night time
	Chokkanahalli					
6	Old Madras Road	54.09	Adur	45	36	
			Avalahalli	38	37	
7	Hennur Main Road Chikkagubbi	60.75	Hegde Nagara	38	37	
8	Whitefield-Hoskote Road Chikkabanahalli	54.05	Chikkabanahalli Village	41	39	
9	Channasandra Main Road	56.25	Channasandra village	39	37	
			Nagondanahalli Village	40	39	
10	Varthur	53.63	Varthur Village	46	46	
11	SH-35 Near Gunjur	62.87	Kachamaranahalli	37	35	
12	Sarjapura Road Near Sulikunte	54.74	Tigala Choudenahalli	37	35	
13	Gattahalli Road Near Gattahalli	52.25	Huskuru	42	41	
14	Hosur Road	63.58	Chiktuguru	37	34	
			Doddanagamangala	25	22	

4.1.2.3 Mitigation measures

Site clearance:

- Machinery and vehicles will be maintained regularly
- Installation of Silent Zone boards at all places where-ever human activities are noticed. Proper training to labourers in handling various equipments, tools and other related items will be provided.
- Rubber beadings and proper support to the ground with thick blankets of rubber mats are preferred to minimize the impact of vibration due to utilization of heavy equipments.
- Frequent greasing of the moving parts of the equipment and covering them with rubber sheets will be ensured to arrest the vibration.

Construction activities:

- Noise barriers in the form of barricade and proper signages (no horn zones) will be used to minimize the noise pollution. Details of proposed noise barriers along sensitive receptors are given in Chapter-9.
- Hot mix plants will be installed as per the guidelines of KSPCB (preferably on wastelands). High noise producing generators such as concrete mixers, generators, graders, etc. will be provided with noise shields.
- Construction activities will be carried out with pre cast structures wherever possible near sensitive areas/receptors in downwind direction and shall be complied with noise pollution regulations.

- Controlled blasting method will be deployed which reduces increased noise levels and also reduces vibrations effect, including erection of tall barricades (40ft height) around construction spots.
- Blasting activities will be carried out as per the Explosives Act, 1884 and the Explosives Rules, 2008.
- Placing the DG sets on the rubber cushion padding, enclosed and maintained well in good condition reduces the noise levels at least 4 dB. DG sets with acoustic enclosures complying with CPCB standards will be operated only during normal power outages. These will be placed in rubber cushion padding to reduce vibration effects.
- Noise standards will be strictly imposed for all construction vehicles. All construction equipments will conform to noise levels of less than 90dB (A).
- Silencers and mufflers will be used to minimize the noise levels during construction phase. Ear plugs must be provided to all employees and laborers while working, irrespective of the noise levels as protection, to receive the noise and as well as exposure of the same for a longer period.
- Construction activities will be carried out only between 6 am to 6 pm and completely suspended during night time to avoid psychological distress on local people and faunal species in Jarakabande RF.
- No honking boards will be displayed within the construction areas. Further, security men will be deployed at construction spots to guide smooth movement of vehicles without any disturbance to villagers and also to maintain ambience environment without honking situations.
- Workers will be provided with earplugs, helmets along with periodic health check-ups as provided in chapter-6.
- The noise levels must be periodically monitored (Chapter-6) in the project area to control the same as and when necessary.
- Supervisory staff must check and monitor to ensure that the workers follow all the above said measures while at work.

(Ref: CPCB and KSPCB Guidelines; The Explosives Act, 1884 and the Explosives Rules, 2008; The Noise Pollution (Regulation and Control) Rules, 2000 & its amendments, ECoP 14.0)

Transportation of construction materials:

- During construction phase, the drivers of trucks coming to the project area carrying debris and other materials, muck etc will be instructed with sign boards and not to use shrill horns for any purpose.

(Ref: IRC: 67- 2010)

4.1.3 Water Environment

4.1.3.1 Thippagondanahalli Reservoir Catchment Area

Thippagondanahalli Reservoir (TGR) was considered as an important source of drinking water for Bangalore. However, deterioration in the water quality along with the gradual reduction in the inflow of water into the Thippagondanahalli Reservoir (TGR) during 1990s was observed due to urbanization⁹³.

Ground water quality data (2010-2014) by KSPCB revealed that the water quality of Arkavathy River had deteriorated to class 'E' with high concentrations of Nickel and Manganese. The available secondary data also shows that the values of EC, TDS, Calcium hardness have increased over the years. Ground water exploitation in the TG Halli catchment area is observed due to drilling of

⁹³Srinivasan, Veena. (2016). The transition from water scarcity to water pollution in Thippagondanahalli Halli catchment, India..

borewell upto a depth of 800 ft or much below in and around lakes for extensive irrigation and domestic purposes.

Activities such soil excavation, sand mining, dumping of muck, debris, wastes, etc has been observed due to lack of backshore fencing and protection. Encroachment of agricultural lands, entry of sewage, industrial liquid wastes, pesticides, etc has led to eutrophication which has severely affected the catchment area. The presence of Ramky landfill site (Sy. No. 8 of Mavallipura village) deteriorated the quality of ground water and aquifers in the region due to the seepage of toxic leachate. Pollution in major lakes such as Madavara lake, Doddabidarakallu lake, Dasarahalli lake, Kammagondanahalli lake, Chikkabanavara lake, Abbigere lake, etc was also observed. Most of the drains in the TG Halli catchment area belonging to Peenya industrial area carries wastewater and industrial waste from textile, paper metal and alloy industries, etc which ultimately pollutes Arkavathy River.

Studies have shown that between the years 2003 to 2014, a decrease in agricultural lands and an increase in built-up area in the TG Halli catchment area have been observed. These significant land use/land cover changes were observed due to increased number of construction and layouts.⁹⁴

Govt. of Karnataka had issued notification on 18.11.2003, 12.01.2004 and on 20.07.2019 regarding protection and conservation of Thippagondanahalli Reservoir catchment area. This notification in overall regulates/restricts TG Halli within the catchment area especially on activities/industries causing water pollution, solid waste disposal & also regulating operations of quarrying/mining/stone crushers. There are no restrictions regarding the construction of roads or linear alignment infrastructure activities in the said notification. The project location bearing toposheet Nos. 57 G/12 and 57 H/9 are also a part of the TG Halli Reservoir catchment area notification where Kumudavathy and Arkavathy river catchment exists. The length of the PRR within the said catchment area is 20.9 Kms. In view of protecting and conserving the said catchment area, precautionary measures will be undertaken while executing the project activities which are as follows.

4.1.3.2 Anticipated impacts

Impact on T. G. Halli catchment:

- Disposal of sewage and solid waste from labour camps and construction waste are the predominant sources of pollution in the catchment area.
- Removal of 4,925 trees (excluding 7,113 Eucalyptus trees) affects the hydrological regime and water quality in the catchment area.
- Deposition of dust, dumping of earthworks, debris, etc affects the quality of water and may causes blockage of existing drainage in the catchment area.
- During construction/executing works on site as per the alignment, the project likely influences in changing the natural flow pattern of run-off during the monsoon period and causes neighbourhood flooding due to flow restrictions.
- Improper handling and disposal of muck will change the natural flow pattern of the surface runoff in the natural drains/nala criss-crossing the alignment neighborhood flooding and moderate loss of crops/plantation.
- Affects the carbon sequestration capacity of trees thereby increasing the CO₂ levels in the atmosphere leading to global warming.
- Affects the micro-climatic conditions of the region affecting rainfall pattern and water yield in the catchment area.
- Causes change in land cover which affects the monsoon rainfall.

⁹⁴https://empri.karnataka.gov.in/storage/pdf-files/Reports/Final%20Report%20on%20TGR_Volume-1.pdf

- Increases the temperature of the region leading to urban heat island effect.
- Increase in temperature of water of the streams and water bodies may also be noticed affecting aquatic biota⁹⁵.
- Affects evapo-transpiration thereby altering the moisture content in the atmosphere.

Impact on lakes:

- Due to various activities such as site clearing, grading, levelling, removal of vegetation/trees along the alignment, excavation, cutting and filling works, stock piling of materials etc., as part of pre-construction and construction, these processes will loosen the soil and during monsoon days, surface run-off will carry these sediments and results in sedimentation of nearby lakes/drains and affects the capacity of the water body and in turn creates turbid conditions affecting phytoplanktons/zoo planktons survival due to poor sunlight penetration and reduced inherited quality of water quality of the lake/drain.
- Deposition of dust on nearby lakes may be anticipated due to construction activities which affects the penetration of sunlight thereby increasing BOD and phytoplankton productivity threatening the survival of aquatic biota.
- Construction activities and construction of engineering structures along lakes may affect the avifaunal habitat and aquatic fauna of the lakes especially in the 6 lakes where the alignment passes.
- Synthetic hydraulic oil used in the precast structures affects /deteriorates the surface water quality causing water pollution.
- The entry of surface run off during monsoon / flooding into the lakes leads to siltation thereby reducing the volumetric capacity of the lakes and entry of lake water into nearby agricultural field affecting the soil quality and agricultural yield. This in turn alters the physico- chemical inherent characteristics of the water body by increasing turbidity, colour, organic load (BOD), suspended solids significantly and also affecting the aquatic biota by reducing the sunlight penetration.
- Excessive flooding of lake water into nearby agricultural land leads to entry of pesticides into the water affecting aquatic biota.
- The entry of toxic waste substances due to runoff into the lakes affects the water quality, causes algal blooms, death of fishes.
- Entry of plastic waste due to runoff into the lakes affects the fish fauna and aquatic birds due to the entry of plastic substances into their systems.

Impact on water resources and surface hydrology:

- Compaction of soils due to construction activities result in impermeable surfaces leads to flooding in the study area.
- Extraction of ground water for various construction and road laying works for curing/cleaning of machineries/equipments will result in further depletion of ground water levels.
- Fuel spill/hazardous waste spill viz., used oil from O&M of temporary DG sets, oil leakage and lubricants spill from washing of vehicles or during maintenance of vehicles and in parking areas will leach into the ground and results in ground water contamination in long term thereby affecting the potability nature of the water and causes health concerns on the surrounding villagers dependent on neighborhood borewells for routine usage for domestic and plantation purposes.
- Runoff from construction sites containing hot mix plants, batch plants, etc. affects the water quality of nearby water bodies.

⁹⁵<https://isha.sadhguru.org/rally-for-rivers/how-trees-mitigate-climate-change/>

- Construction activities may lead to loss of nearby water supply sources such as hand pumps, wells, etc.
- Usage of water supply for construction activities may affect the existing water resources.
- As per the topographical surveys, the proposed alignment passes/crosses on 63 nalas/streams/drains. Construction of CD works affects water quality in the study area.
- Due to spillage of chemicals and also in the event of accidents of vehicles carrying chemicals, this would flow along the surface of the road and channelize its course as per the road drainage arrangements and affect the water bodies connected with the drainage arrangements. This results in depletion of the water quality of the waterbody by reduced DO level, increased BOD and COD levels, causing odour nuisance and change of colour affecting inherent characteristics of waterbody making it unfit for any further use. This also in turn affects the aquatic ecosystem resulting fish deaths, reduced plankton's growth.

Labor camps:

- Stagnated water in construction sites leads to creation of mosquitoes breeding sites and affects the health of the workforce affecting their productivity through infection and also causes unhygienic environment.
- Impact will be anticipated on health of the workforce if untreated water is supplied to labor camps area, thereby resulting likely fatal concerns.
- Insanitary conditions, unscientific treatment and disposal of sewage (18KLD) from labor camps area will lead to sub-surface soil pollution and ground water pollution through infiltration factors, thereby, affecting the ground water quality of the region. Further, this creates unaesthetic conditions in the site, attracts mosquitoes/fly, thereby chances of deteriorating the health of the workers in unhygienic conditions will arise.
- Improper collection, handling, storage & disposal of solid wastes (organic solid waste:45Kgs/day) from labor camps will result in formation of leachate during precipitation/rainy days thereby indirectly affecting the ground water quality of the region through infiltration factors.

4.1.3.3 Mitigation measures

Impact on T. G. Halli catchment:

- In TG Halli Catchment area, labor camps will not be erected.
- Plantation of trees to the number of trees removed in the catchment area in the ratio 1:10 will be carried out in the catchment area.
- Muck will not be stored / filed near nala / streams to ensure natural flow of water in the drain / nala across the proposed alignment.
- Temporary garland drain arrangement shall be made to control the surface run off.
- The supernatant water will be pumped and reused for dust suppression purposes around the construction site and also around vehicle haul roads plying to & fro from the site.
- Cross Drainage structures (Minor Bridges/Culverts) will be planned for construction during summer months and shall complete before onset of monsoon to avoid flooding.

(Ref: PMGSY Environmental Codes of Practice-ECOP-12.0, GoK notification on protection and conservation of TG Halli reservoir catchment area).

Impact on lakes:

- In lake bed areas, pre-cast construction technique will be used to avoid pollution.

- Utilization of pre-cast structures are safer and more efficient since the roadwork can be completed during off-peak hours/short period of time thereby reducing the need for time-consuming roadway closures.
- The precast structures can be fabricated under environmentally controlled conditions resulting in better outcome.
- Utilization of precast structures reduces manpower during construction phase.
- Precast concrete panels can ease congestion at busy intersections and are a good choice for ramps and other locations where heavy traffic presents a challenge during construction phase.
- Utilization of precast structures saves time and trouble faced during winter season, since it eliminates the need to pour concrete in cold-weather conditions.
- Construction activities/works will be avoided during monsoon period/rainy days located near to lakes/natural drains/nala.
- Erection of barricades and water sprinkling shall minimize the deposition of dust on the waterbodies thereby reducing the impact on avifauna and aquatic biota.
- Provision of separate collection and disposal mechanism for synthetic hydraulic oil shall be made to avoid water pollution 4 lake bed areas.
- It will be ensured that, drains/nalas leading to lakes/any water bodies will not be disturbed in any case during any of the construction activities except for haul roads for which, temporary culverts/box drains will be provided for ensuring smooth undisturbed flow. This exercise will be undertaken during pre-construction stage.
- No vehicle washing bays will be located within 500m from any water body.
- Silt/sediment Fencing will be undertaken at major soil disturbed areas to arrest silt/sediment transport (major locations include top soil storage area, borrow area, plant/office site and near water bodies). Continuous drainage arrangements will be undertaken to channelize surface run-off and discharged to nearest water body (lake/drain) after silt/sediment trap/desilting arrangements. 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 design of silt / sediment fencing and trap arrangement are provided in Annexure-18.
- To improve the stability and continued working conditions within the PRR area (i.e., ROW area), the water stagnated during the construction activities due to curing activities and in general, during monsoon period, stagnated will be pumped through temporary pumping arrangements to ensure dry conditions and will be channelized to nearby available drains/culverts ensuring its adequacy and also ascertaining prevailing conditions by ensuring no overflow situations. Wherever possible, channelized to nearby lakes with silt/sediment trap arrangements. This would likely increase the water table marginally by 0.2-0.5m (within 100-250m from the alignment) by recharging aquifers. Embankment protection works like stone pitching /turfing will be undertaken.

(Ref: PMGSY Environmental Codes of Practice -ECoP-11.0, 12.0, The Karnataka Lake Conservation and Development Authority Act, 2014, Wetlands (Conservation and Management) Rules, 2017, Supreme Court order dt: 05.03.2019).

Impact on water resources and surface hydrology:

- In the entire project, water for construction activities will be sourced from nearby BWSSB and usage of secondary treated water for dust suppression activities reduces pressure on external fresh water resources. A MoU in this regard will be undertaken prior to executing the work operations at site.
- Fuel storage areas will be earmarked within the construction sites with covered arrangements on impervious flooring including storage of onsite hazardous wastes (300 Ltrs/Annum) and

Storm water Management:

To harness the rainwater harvesting structures shall be adopted to augment the declining water levels. Percolation pits at every 500 m shall be constructed with dimensions 4m X 3 m X 3m depth all along the periphery of the proposed site to recharge the aquifer.

4.1.8 Biological Environment

4.1.8.1 Anticipated impacts

Removal of Trees / other Vegetation:

The alignment is surrounded by Agriculture land, Reserve forests followed by good number of lakes provide habitat for avifaunal and faunal species. About 122 species of trees were recorded in the entire alignment (73.5 Km) with Ecological, Economic and Social Importance. Removal of 36,824 trees and clearance of vegetation cause disturbance in Microclimate, habitat loss and disturbance of vegetation and sensitive plant communities. As per primary data 3 Schedule-I Species are recorded within the alignment, removal of these trees cause loss of habitat and destruction, thereby leads to migration of avifauna. Removal of these trees can make alteration and physical disturbance, increased risk of Soil erosion and release of CO₂.

Biophysical changes (air, water, noise, soil) likely to affect the ecological resources:

During Construction and operational phase, there will be changes in the ecosystem it can be immediate or later effect.

Air: During construction phase removal of trees of girth >30 cm with the carbon sequestration capacity of 3,728 tonnes need to be removed for the construction of road which may lead to increased global warming. Activities like land clearing, ground excavation will lead to the formation of particulate matter into the atmosphere. Dust is inevitable consequences of road construction when the material is dry they form a fairly dust cloud when mobilized may cause difficulty in breathing to the nearest residing humans and as well as local fauna.

Water: During construction phase surface run-off carries pollutants from the site to downstream lakes. Pollutants such as diesel and oil, toxic chemicals, and building materials like cements can also soak in to the ground water. Dust formed during the construction phase may accumulate on the surface of the water bodies, the removal of trees and excavation of soil leads to loosening of top soil followed by soil erosion and as settlement of soil in the lakes leads to aging of lakes which reduces the water capacity in the lake along with change in water quality. Deposition of dust on water bodies may decrease the penetration of sunlight, increase the BOD levels, increase the productivity of phytoplankton and other photosynthetic plants which threatens survival of aquatic life.

Noise: During construction phase due to utilization of heavy machines, demolition of building, movement of vehicles noise will be generated which will directly impact on Avifauna and Fauna residing in the nearest habitats.

Soil: Removal of trees and clearance of vegetation during construction phase result soil erosion. There will be land clearing activity which leads to the bearing runoff and sediments.

Impact of dust deposition on water bodies and tropic structure:

Dust emissions during construction phase and Intensive movement of vehicles are the source of dust emission. Deposition of dust on surface water of downwind lakes may affect photosynthetic plants and threatens survival of aquatic life.

Loss of agricultural lands:

Project alignment traverse in cultivated lands of 555.57 ha which includes practice of growing Ragi, Jowar and other vegetable crops.

Noise and other disturbance to birds and other wild animals - Intensity, duration & frequency:

As per the Noise and Vibration report the noise levels ranges from 57.82 dB(A) to 80.78 dB(A) in day time and 33.9 dB(A) to 63.58 dB(A) at night time. Construction activities and vehicular movement during construction phase generate noise, which directly impact on behavioral changes as they cope with noise intruding on their environments. As bird calls often distinguish males and females of the species, invasive noise can alter their mating cycles, others choose to nest away from the noise, leaving their accustomed habitat and predators may have difficulty in detecting prey and move beyond their normal range. Similarly, Prey animals may not hear the approach of a predator, resulting in higher kill rates and decreased population, altering the ecosystem.

Loss of habitat:

Removal of trees during construction phase leads to loss of habitat for various avifaunal species, smaller mammals like squirrels and roosting sites for bats in the region.

Impact on RET and schedule I species:

No RET species were recorded at the project site or study area. However, Schedule I species such as Black kite, Brahminy kite and common buzzard found in the project site and Indian peafowl, Black shouldered kite, Black kite and Brahminy kite found in the study area may be affected due to loss of habitat. Possibilities of behavioral changes due to construction activities may be anticipated.

Invasion of alien species:

As per primary data collected during the ecological studies there were few invasive alien species found all along the Alignment (*Leucaena leucocephala* (Lam.) de Wit, *Acacia auriculiformis* Benth, *Eucalyptus* spp., *Alternanthera philoxeroides* (Mar.) Griseb., *Cardamine hirsuta* L., *Cassia occidentalis* L., *Croton bonplandianum* Baill., *Euphorbia heterophylla* L., *Mimosa pudica* L., *Parthenium hysterophorus* L., *Portulaca oleracea* L., *Sida acuta* Burm. fil., *Sonchus asper* (L.), *Sonchus oleraceus* L., *Tridax procumbens* L., *Calotropis gigantea* (L.), *Calotropis procera* R.Br., *Lantana camara* L., *Prosopis juliflora* (SW.) DC. *Passiflora foetida* L. However, care should be taken to avoid introduce of alien species, native species will be selected for the development of the green belt.

4.1.8.2 Mitigation measures

- Restriction of movement within RoW to avoid trampling of vegetation in the nearby agricultural lands.
- Green belt development plan and avenue plantation (Chapter-9) will be carried out in 1:10 ratio as per NHAI guidelines. Transplantation of trees will also be carried out for tree species as given in Chapter-9.
- Conservation plan for schedule I species (Chapter-9) minimizes the impact on Scheduled species in the region.
- Construction period will be restricted only during day time, noise will be mitigated by providing acoustic enclosure, wildlife signs, Traffic signs and speed limits may decrease the impact of noise on animal behavior and movements.
- Erection of barriers along construction sites may reduce the deposition of dust on plants and water bodies.

- Frequent watering during the construction phase (thrice a day) to avoid dust deposition of dust on plants / trees.
- Construction of road will be avoided during rainy season and 5 m of green belt will be developed on either sides of the project alignment to combat the soil erosion, surface runoff and to prevent the eutrophication of lakes.
- Excavation and controlled blasting activities will be restricted to day to avoid noise and vibrations.
- The solid waste and sewage waste generated during the construction phase from the labor camp must be treated and disposed by providing adequate facilities to combat deterioration of soil quality and water quality of nearby lakes which indirectly affects the local biodiversity.

(Ref: Environmental Codes of Practice -ECOP-11.0, 12.0, 13.0, 16.0, 19.0, IRC: 67- 2010, GNHP Guidelines, 2015, Wildlife (Protection) Act, 1972, The Forest (Conservation) Act, 1980, The Karnataka Preservation of Trees Act, 1976).

4.1.9 Aquatic biota

4.1.9.1 Anticipated impacts

Aquatic macrophytes-problems and their use/control:

Aquatic weeds have always existed, but, since few decades, their ill-effects have been magnified by man's more intensive use of natural and man-made water bodies, modifying these into weirs, dams and canals, polluting them with farm, city/industrial waste waters and by introducing aggressive plant species into new locations/habitats. These aqua-flora amongst the most prolific on earth, grow luxuriantly in the Tropics in particular, weight hundreds of tons/ha and can be a serious threat/hindrance to a Nation's development efforts. Most of the lakes in the study area witnessed such growth.

As aquatic vegetation spreads, they disperse the water snails that cause Schistosomiasis – the insidious, debilitating disease prevalent in many developing Nations. Additionally, these plants foster Malaria, Encephalitis and other mosquito borne diseases since, small, sheltered pools perfect for mosquito breeding, are found between the floating plants. Eradication of the aquatic weeds has, quite often, or to a large extent, has proved quite impossible and, even, reasonable control is difficult.

Turning these very weeds to productive use would be desirable to considerable extent since; these aquatic weeds constitute as a 'free gift/crop' of great potential value- a highly productive crop that requires 'no tillage, fertilizer, seed, or cultivation'. These aqua-produce have potential for exploitation as animal feed, human food, soil additives, fuel production and waste water treatment source.

Pollution:

Availability of potable water and in enough quantity at the right time and place is a pre-requisite of the economic and social development of any nation. But, most unfortunately, the serious problem that haunts the Country, in general, presently is the impact of man induced 'pollution' in the aquatic environment. Man has made quite a few blunders in water conservation and use, the worst of them being massive pollution of lotic, as also, lentic water bodies. Pollution, arguably, is the most serious long-term biological hazard of the 20th Century since its effects are eventually felt, through the food chain, on even the highest form of life, including human beings. The aquatic pollution and degradation of the resources are more serious where; in particular, urbanization and industrialization had advanced to a high degree. The alarming increase of human population in the Country and the rapid pace of its industrialization have created problems of disposal of waste

products being generated. As is the fact that clean potable water is an essential human requisite for sustenance of life, it is also a sine-quo-non for the production irrigation crops and for augmenting fisheries development.

To the polluting agencies, in the recent times, there have been added an array of pesticides and insecticides which, in effect, are further seriously aggravating the problem of pollution, both from the point of view of the public health as well as aquaculture practices. Should the water quality of the Country's lotic and lentic fresh water resources get degraded beyond certain limits, the situation may go out of control which may not only adversely affect all of uses water is put to such as domestic, agriculture, industrial, power generation, aesthetic recreational, navigational, aquacultural programmes, etc., but the entire aquatic system may be thrown out of gear and may lead towards a severe 'biological imbalance'. The latter, if it happens, would be an ecological disaster'.

Siltation:

Over 1500 large and good many medium, small dams, also minor major tanks in the Country at large and in the State of Karnataka suffer, presently, from over-siltation problems, the reason being fast deterioration of the watershed, man's intrusion on account of developmental activities, forest fires, over-grazing, un-wise agricultural practices, dumping of civic wastes etc. A disturbing aspect is the inadequacy of data on the volume of solids transported by the biotopes located in the upstream stretches, during monsoon season, to the recipient ones lying in the lower strata. This would provide an answer to the question of the rate at which the capacities of the water bodies is decreasing as a result of their progressive filling with sand, mud, etc. and at what rate these will totally cease to function.

The order of magnitude of this data should, at least, be known since, in addition to sound development of tank reservoir fisheries in a given time, irrigated agriculture in particular being long-term developmental projects, could be accorded priorities for achieving the envisaged goals. At least the order of the magnitude of this data should be known because, in addition to sound development of tank-fisheries in a given time and situation, irrigated agriculture in particular, being long-term developmental projects could be accorded priorities for achieving the envisaged goals.

Impact on aquatic biota in tanks:

Importance of tanks in and around Bengaluru North and South districts has been emphasizes in various studies. From holding rain water to be used for agriculture and related purposes, the tanks also have a dominant role in the recharge of ground water. These ecologically rich water resources abounding in flora and fauna, fish and other aquatic organism's indicative of rich biological productivity have undergone enormous decline and degradation in the recent times due to multiple demands on these biotopes. The adverse results, in good many instances, are manifested in their disappearance, shrinkage through eutrophication, siltation, etc. Entry of unchecked, untreated sewage and effluents from industries into these have further compounded this state of affairs with the organic load affecting water quality too in the tanks and also the water seeping below. These factors, together with the presence of noxious gases, aquatic weeds, algal blooms cause serious stress to the aquatic life prevailing. To sum-up, these valuable water bodies as desirable aquatic habitats serving human needs, have thus greatly diminished and are in urgent need of restoration.

In the absence of proper management measures for each of the tanks, these have been silted-up and water holding capacities are being reduced year-wise. The infestation of noxious aquatic macrophytes too is hastening the splitting-up of tanks, as also accounting to great loss of the water through evapo-transpiration. In the absence of adequate desirable management measures, majority

of the perennial tanks, even in the rainfed regions, have been converted into seasonal ones, the result being 'low' agricultural production and in-adequate fish – culture programmes.

4.1.9.2 Mitigation measures

- Herbivorous fish for the control of aquatic vegetation along with fish species seeking rehabilitation shall be introduced into the lakes.
- Entry of pollutants and debris into the water bodies during the construction phase shall be prevented.

4.1.10 Social Environment

Details provided in Chater-7.

4.2 Impacts during operation phase

4.2.1 Air Environment

4.2.1.1 Anticipated impacts

During operational phase of the project, air pollution is due to the movement of vehicles on the road are mainly confined from diesel powered heavy vehicles. PM emission due to dust on the road and also from vehicular emissions will also impact the air quality of the area. Air Quality modeling has been studied for emission of CO. Prediction was done using California LINE source Dispersion model (CALINE). CALINEpro model is a graphical windows-based user interface designed by M/s Envitrans. Following input data were considered to study the impact from traffic emission, decade wise studies has been carried out:

Year	Total traffic count, per day		
2022	8169	11142	11468
2032	13663	18224	21573
2042	21710	28613	31765

As the model require hourly data, to know the worst-case scenario and to consider the peak traffic count, 8 hrs data is considered. Following value was input to the CALINEpro model, which is traffic emission modelling software based on CALINE3.

Year	Total traffic count, per hour		
2022	1022	1393	1434
2032	1708	2278	2696
2042	2714	3277	3970

Emission rate for the vehicles was considered as 1.5 g/km-hr as per Bharath stage IV norms. Following results were observed. Corresponding modeling results in a graphical representation are enclosed as Annexure-15.

Year	Predicted concentration of Carbon Monoxide, $\mu\text{g}/\text{m}^3$		
2022	49.9	92.1	86.1
2032	81.4	148.7	159.6
2042	127.5	212.7	230.7

It is observed that, there will be slight increase in the value of CO after the implementation of the project due to increase in traffic count. Even though, there is Increase in the concentration of pollutant observed till 2.5 kms from the proposed road, the concentration level is well below the

NAAQ standards (4 mg/m^3). Hence, the air pollution from the said project will not have major impact.

Dust generation will be minimized during the operation stage as the all road shoulders are proposed to be paved and all slopes and embankments shall be turfed as per best engineering practices. However, there will be increase in air pollution due to movements of vehicles dependent on time, traffic volume, emission rates of auto exhausted pollutants and prevailing metrological conditions of the region.

4.2.1.2 Mitigation measures

- The air quality shall improve due to the plantation activity carried out in the ROW during the end of construction phase.
- Bharat stage VI norms will be imposed along with other measures such as the reduction of vehicular emissions, ensuring vehicular maintenance, etc.
- For about 31,761.81 t/yr of CO₂ emission reduction will be anticipated upon implementation of PRR thereby reducing GHG emissions to the atmosphere^{107,108,109}
- Periodic monitoring of air pollution during operation phase shall be implemented as given in Chapter-6.

(Ref: NAAQ Standards, Central Motor Vehicles Act, 1988, CPCB Guidelines)

4.2.2 Noise Environment

4.2.1.1 Anticipated impacts

- Increase in movement of vehicles/traffic may cause noise pollution.
- Noise pollution from movement of vehicles may affect the residents/sensitive receptors located within 50 m from the alignment.

4.2.1.2 Mitigation measures

- Noise barriers will be installed all along the project road in a phase wise manner. Predicted noise levels during operation phase are given in Table 4.5.
- Green belt development and avenue plantation also forms an effective sound barrier during the operation stage.
- Awareness to people regarding prevention of development of sensitive land uses adjacent to the project corridors shall be carried out minimize the impact of noise pollution on human health.
- Periodic monitoring of noise pollution during operation phase shall be implemented as given in Chapter-6.

(Ref: GNH Policy, 2015, CPCB Guidelines)

¹⁰⁷Sharma, N., Singh, A., Dhyani, R., & Gaur, S. (2014). Emission reduction from MRTS projects—a case study of Delhi metro. *Atmospheric Pollution Research*, 5(4), 721-728

¹⁰⁸ARAI (Automotive Research Association of India), 2008. Draft Report on Emission Factor Development for Indian Vehicles, Report Submitted to CPCB/MoEF as a Part of Ambient Air Quality Monitoring and Emission Source Apportionment Studies.

¹⁰⁹CPCB (Central Pollution Control Board) Status of the Vehicular Pollution Control Programme in India, Ministry of Environment and Forest, New Delhi, India (2010).

Table 4.5: Predicted noise levels during operation phase

Sl. No.	Category of vehicles	Maximum permissible noise levels in dB(A)		CPCB Standards dB(A)	
		Without barrier	With installation of noise barriers	Day	Night
1	Two wheelers (petrol driven)	80	44	65	55
2	All passenger cars, all petrol driven 3 wheelers and diesel driven 2 wheelers	82	46		
3	Passenger or light commercial vehicles including 3 wheeled vehicles fitted with diesel engine with gross vehicle weight upto 4000 kg	85	49		
4	Passenger or commercial vehicles with gross vehicle weight above 4000 kg and upto 12000 kg	89	53		
5	Passenger or commercial vehicles with gross vehicle weight above 12000 kg	91	55		

4.2.3 Water Environment

4.2.3.1 Anticipated impacts

- Improper drainage arrangements create water stagnation on the surface of the road and results reduced vehicle speed/slow movement causing oil/lubricants spillage due to water thrust during movement.

4.2.3.2 Mitigation measures

- As per the design plan of the proposed PRR with RoW of 100m, 2m covered drain (box type) will be provided at the edge of carriage way and 1m drain (box type) at the edge of service road on both sides of the median including 5m open drain at the centre of the median to carry surface run-off and disposal of same to nearest natural drain/lake after silt/sediment trap arrangements. These arrangements will ensure reduced flooding of water in and around the PRR areas ensure safe traffic flow. Drainage provisions will be in accordance with IRC: SP: 50: 2013 guidelines for the project
- Semi-pervious/Grass pavers will be provided in Footpath track and 5m open drain in the median area exposed to mother earth helps in recharging the ground water table gradually in the long term.
- Periodic monitoring of nearby surface and ground water sources during operation phase shall be implemented as given in Chapter-6.

(Ref: IS 10500: 2012, BIS/APHA guidelines)

4.2.4 Soil Environment

4.2.4.1 Anticipated impacts

Oil spillage:

- Accidental vehicle spills lead to soil pollution
- During the operation stage, soil pollution due to accidental vehicle spills or leaks is a low probability as one of the main objectives of the project is to reduce accidents, but potentially disastrous to the receiving environment should they occur. These impacts can be long term and irreversible depending upon the extent of spill.

4.2.4.2 Mitigation measures

Oil spillage:

- Periodic monitoring of soil pollution during operation phase shall be implemented as given in Chapter-6.
- Oil receptor will be proposed at 30 meters from any uncontrolled source of ignition.
- A total of 3 oil interceptors will be provided. The arrested materials will be disposed as per MoEF&CC and SPCB guidelines. The location of all fuel storage and vehicle cleaning area will be at least 500 m from the nearest drain / water body.

4.2.5 Land use assessment

4.2.5.1 Anticipated impacts

- Urbanization, industrialization, agglomeration, development of shops, hotels, canteens, restaurants, dhabas, petrol bunks, etc alongside the PRR alignment changes the existing land use pattern of the region thereby enhancing the economic status of the region.
- The production of raw materials required for Asphalt Paving may cause emissions of CO₂, greenhouse gases (GHG), acidification of soils and eutrophication of lakes. During the operation phase asphalt paving act as a black body and absorbs incoming solar radiations and releases back during night, this will increase the temperature of microclimate thereby contributing to Urban Heat Island Effect.

4.2.5.2 Mitigation measures

- The development of commercial and residential activities shall be encouraged as per the provision of BDA Act and Town Planning Act.
- Development of green belt on either side of the alignment and at the median reduces the absorption of solar radiations by asphalt pavement thereby decreases the temperature variations.

4.2.6 Solid & Hazardous waste storage, handling and disposal

4.2.6.1 Anticipated impacts

- Disposal of solid and plastic waste by the passengers may be anticipated during operation phase.
- Oil spills/chemical spills may be anticipated in case of accidents of vehicles transporting hazardous substances.

4.2.6.2 Mitigation measures

- Separate colored bins will be installed on either side of the alignment at regular intervals of 3 km
- Oil interceptors will be installed for avoiding the flow hazardous substances into the nearby waterbodies.

(Ref: Solid Waste Management Rules, 2016 and CPCB guidelines).

4.2.7 Biological Environment

4.2.7.1 Anticipated impacts

Zone of influence arising due to project for whole life span: The proposed project alignment starts at Tumakuru road and ends at Hosur road by cover a distance of 73.5 Kms. As per land use and land cover data the alignment is covered by Fallow land (27%) followed by agricultural land (22%) and plantation (18%). Project for whole life span, may influence upto radius of 2 km from the project alignment in ESE direction (as per wind rose data) and lakes within 1 Km from the Project site (29 Lakes). However, by the development of two rows of green belt on either side of the alignment and at the middle, can restrict zone of influence to 500 Meters.

Air: During operation phase, emission of air pollutants is anticipated due to movement of vehicles which gets deposited on the nearby flora thereby reducing their photosynthetic activity.

Noise: Movement of vehicles during the operation phase may cause behavioral changes in the avifaunal species in the region.

4.2.7.2 Mitigation measures

- Project alignment is surrounded by Agriculture lands, Reserve Forest and Settlements; hence there will be influence on environment. However, development of 2 rows of green belt all along the alignment may restrict the zone of influence to 500 m.
- To combat the loss of vegetation/Habitat loss two row of green belt will be developed on either side of the alignment; 2-year-old sapling of native species will be selected and planted with a spacing of 3m in 1st row and 6m in 2nd row. About 2,597 (30-100 cm) trees of high conservation values and ecological important will be transplanted to the green belt area. However, 1,59,503 plants will be planted in co-ordination with forest department (MoU) for which the cost will be allotted as per Common Sanctioned Scheduled Rates 2018-2019 for the development of compensatory Afforestation.
- Traffic signs and Speed limits will be displayed at village limits to avoid road kills.

(Ref: NHAI, CPCB Guidelines, IRC: SP: 21 – 2009, IRC 67-2010).

4.2.8 Social Environment

Details provided in Chapter-7.

4.3 Evaluation of Impacts

Leopold Matrix method¹¹⁰ is the widely used tool to identify the cause effect relationships. In this method magnitude of interaction will be assigned using a value ranging from 1 to 5 and scale of importance from 1-10 will also be assigned. It's a valuable tool for assessing the impacts during the project life cycle. Severity criteria of magnitude of impact adopted is given in table below (Table-4.3) and score ranges of impact evaluation based on matrix score is given below in Table 4.4. Impact evaluation matrix is given in Table 4.5.

¹¹⁰ Environmental Impact Assessment, A practical guide for Professional practice, 2016, A K A Rath, Pp 50-53

Table 4.6: Severity criteria

Sl.No	Category	Description	Impacts	
			Adverse	Beneficial
1	No impact		0	0
2	No appreciable impact	Short term, reversible	-1	1
3	Significant impact	Long term, reversible	-2	2
4	Major impact	Irreversible but lesser extent	-3	3
5	High impact	Irreversible but medium extent	-4	4
6	Permanent impact	Irreversible severe impact	-5	5

Table 4.7: Score ranges

Sl.No	Total Score	Outcome
1	+ve / -ve	Beneficial impact/ adverse impact
2	0-300	No appreciable beneficial impact / adverse impact
3	300-600	Appreciable but reversible adverse impact – mitigation measures are needed
4	600-900	Significant adverse impacts, most of the impacts are reversible. Mitigation measures are crucial
5	900-1200	Major adverse impacts, most of the impacts are reversible. Alternative site selection to be considered
6	>1200	Permanent irreversible adverse impact, alternatives to the project need to be explored.

Impact→ Attributes↓		Magnitude→ Importance↓	CONSTRUCTION PHASE															OPERATION PHASE															Impact score										
			Site clearing					Transportation of materials					Earth work, borrow areas, crushers, hot mix plants, batching plants, etc					Construction activities					Labor camps					Road Traffic						Accidents					Oil spills & hazardous materials				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5		1	2	3	4	5					
Physical	Air quality	9	-3					-1					-2					-2					-1					3					-1					-1					-72
	Noise Levels	7	-1					-1					-1					-2					-1					-1					-1					-1					-56
	Water quality	7	-2					-1					-1					-2					-1					-1					-3					-1					-77
	Soil	7	-3					-1					-2					-2					-1					-1					-1					-2					-84
	Solid waste	6	-2										-1					-2					-2															-2					-42
	Hydrology	6	-1					-1					-1					-3																									-36
	Land use	10	-5										-2					-3										3															-70
	Risk & hazards	10	-3					-1					-2					-2															-1					-2					-110
Biological	Terrestrial biota	10	-5					-1					-1					-1										2															-60
	Aquatic life	6	-1										-1					-2																				-2					-36
Social	Land acquisition	10	-5										-1					-2																									-80
	R&R	10	-5																																								-50
	Employment& business opportunities	7	2					1					1					4					2					5															105
																																	-668										

Based on the evaluation of impacts, the project score is -668 and categorized under 'Significant adverse impacts, most of the impacts are reversible. Mitigation measures are crucial (600-900)'.

Chapter
5

ANALYSIS OF ALTERNATIVES

5.1 Project Alignment

PRR project is proposed for implementation to make the road network as 'circle' with the existing NICE road on the other part of Bangalore city. Existing city internal road networks are already crowded with traffic and development on either side of the road and further expansion of these roads are techno-economically and socially not feasible. Hence, any road planning alternative to PRR inside the city (within ORR) is not viable.

5.2 Petronet MHB pipeline alignment

PRR alignment is passing adjacent to Petronet MHB petroleum pipeline at CH 28+350 km to CH 31+615 km and crossing the petroleum alignment at CH 38+824 km and CH 6+875 km. Wherever, it is passing adjacent sufficient RoW of 6 m (left side) and 12 m (right side) from the Petronet pipeline has been provided. At crossing locations, flyover is proposed to avoid the impact on pipelines. Further, all precautionary measures as proposed in Chapter-7 will be considered while implementation of project road in this section.

5.3 Construction of project alignment near Lakes

Bangalore city and its surrounding environs has series of lakes and over a period of time, these lakes are suffering with many problems such as entry of sewage, solid waste dumping, catchment distraction, etc. Many researchers and institutions including the Hon'ble High Court of Karnataka (WP 817/2008, Environment Support Group v/s State of Karnataka & others), National Green Tribunal (OA No. 222/2014, Forward Foundation v/s State of Karnataka) and Supreme Court (CA No. 5016/2016 Mantri Techzone Pvt Ltd v/s Forward Foundation) in several instances emphasize on needs of conserving and protection of lakes besides infrastructure requirement for the growing city.

BDA being owning several lakes in the city and undertaken restoration and rejuvenation of lakes, while designing the project alignment, utmost care has been considered to avoid lake and its areas. Considering the topographical features, design specifications and land acquisition notification on PRR alignment and at unavoidable situations, project alignment is passing near 6 lakes viz., Tank at Jarakabande Forest, Chinnaganahalli lake, Chikkabanahalli lake, Gunjur lake, Thirumenahalli lake and Chikkatogur lake. In order to minimize the impact on wetlands and as part of engineering measures flyovers are proposed near these lakes with precast construction and as part of biological measures, BDA will take up restoration and rejuvenation of these lakes as part of CER at the later stages. The structural designs and typical Map showing the PRR alignment and flyover proposed on lake are given below.

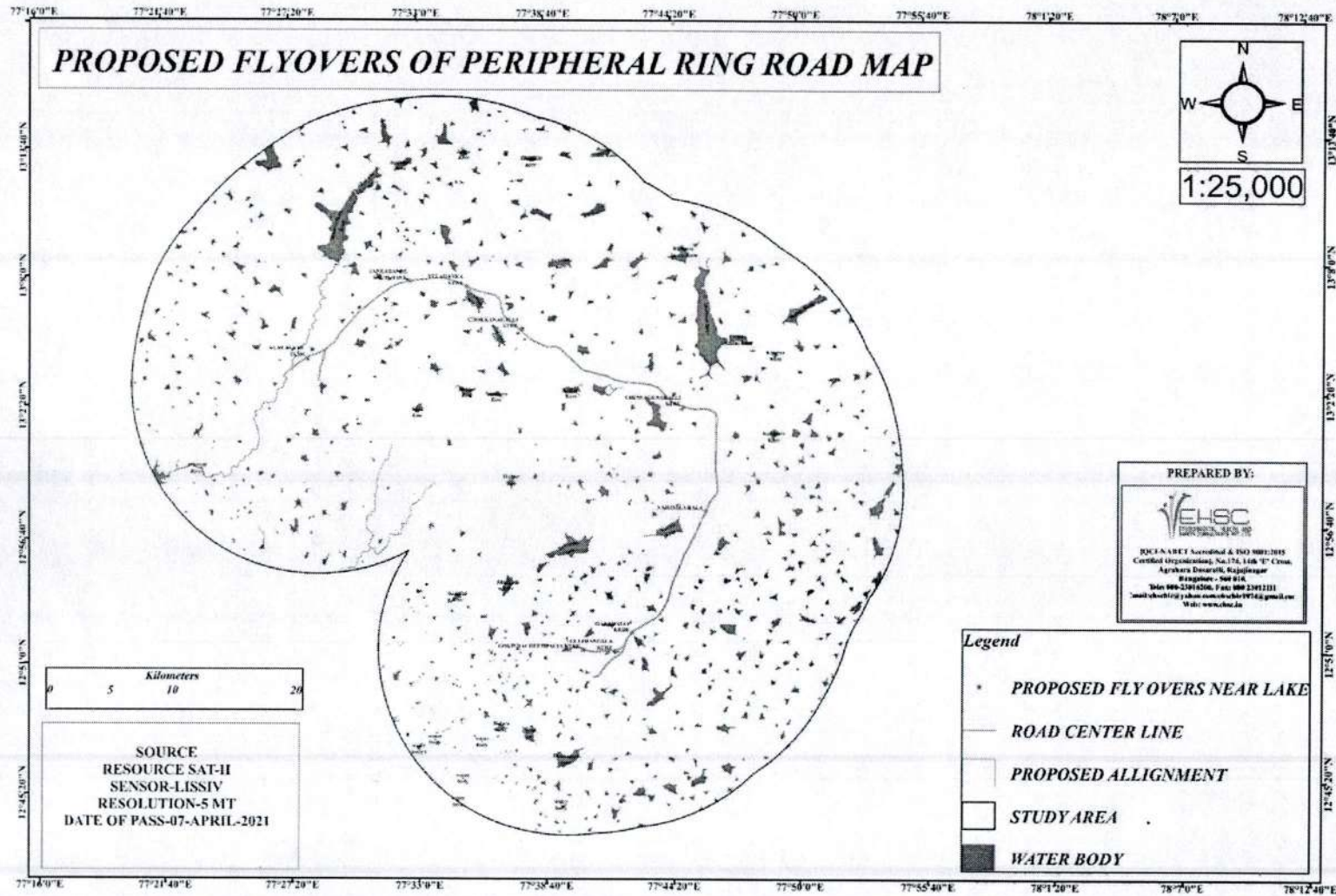


Fig 5.1: Flyovers proposed along 6 lakes falling within the proposed PRR alignment

5.3.1 Structural designs

The structural designs for both main road and service road bridges are carried out in accordance with guidelines of IRC. The design of precast PSC post tensioned girder, deck slab, pier cap, substructure, abutment and foundation, design forces on metallic bearings will be part of detailed design documents.

5.3.1.1 Superstructure

The superstructure consists of 30m simply supported spans with expansion joints at alternate Pier and at both Abutment locations. The superstructure girders and diaphragms will be designed for bending, shear and torsion based on the results obtained from Grillage analysis using STAAD PRO analysis software. The end diaphragms will be designed both for service and jacking conditions. The deck slab will be analysed as a continuous slab supported on girders. The entire design will be done as per IRC: 112 for different limit states with corresponding partial safety load factors. The design loads in addition to self weight of structure will be superimposed dead loads due to wearing coat, crash barrier and IRC live loads with appropriate impact factors. The live loads will be placed in superstructure cross section at appropriate location in transverse direction to obtain the critical maximum design forces in the member to be designed. The live load will be considered for STAAD analysis as a moving load in longitudinal direction with an interval of 100mm.

5.3.1.2 POT cum PTFE bearings

The longitudinal girders are supported on POT bearings placed below every girder. The design vertical load on POT bearings will be arrived from STAAD grillage analysis used for analysis of superstructure. The lateral forces due to braking, wind and seismic will be arrived manually. The bearing movement will be considered with appropriate strain due to shrinkage, creep of concrete, Global temperature variations and zero movement point at pinned bearing location. The design forces furnished will be considered by the bearing vendor for fabrication. Pot bearings shall be made up of Cast Steel.

5.3.1.3 Foundation

Piers

Foundations will be with 1200mm diameter cast in situ piles. Pile cap with minimum thickness of 1800mm will be provided over the piles. The bottom of pile cap shall be above low water level. The piles bottom will be anchored inside top of hard rock for a depth as per design requirements. The design forces in piles will be considered from Pier - Pile and pile cap space frame analysis. The various forces acting at bearing level will be applied at top of the pier. The water pressure will be applied from maximum at the scour level in the analysis. The scour depth is considered up to top of hard rock. The soil, if any above top of rock, below pile cap bottom will be ignored in the analysis considering scour. The pile cap will be designed based on the reactions from piles for bending and shear. The adequacy of thickness of pile cap will also be verified for punching shear. The entire design will be done as per IRC: 112 for different limit states with corresponding partial safety load factors.

Abutments

Abutments will be analysed similar to Piers. The abutments lateral earth pressure and live load surcharge will be considered by RE wall pressure behind Abutment piers.

5.3.1.4 Substructure

Pier & Pier cap

The piers will be supported at top of pile cap. The piers will be designed as a free vertical cantilever fixed at top of pile cap. The forces from superstructure and acting on the body of the pier due to wind, seismic and water current in addition to self-weight of structure will be considered in design. The slenderness of pier will be checked in both the directions as per IRC: 112 codal provisions and considered in design accordingly. The design of Pier will be made both in SLS & ULS conditions for axial load and biaxial bending.

The pier cap will be designed as a horizontal cantilever member fixed at face of pier. The loads from superstructure at bearing locations will be considered in design for shear, flexure and torsion.

The design of Pier cap will be made both in SLS & ULS conditions.

Abutments

The Abutments will be designed as a free cantilever fixed at top of pile cap. The forces from superstructure on one side and earth pressure from earth fill side will be considered in design. The design of Abutments will be made both in SLS & ULS conditions. The design of abutment cap will be similar to pier cap.

5.3.1.5 Miscellaneous

- Crash barriers will be as per IRC standard details
- Approach slab will be as per MORT&H details.
- Theoretical pile capacity will be verified with field initial pile load tests for vertical and lateral force.
- Anti-carbonate paint will be considered for the exposed concrete surfaces.
- The concrete elements exposed to water will be treated with coal tar epoxy or equivalent to protect from saline water in the river.
- POT bearings and expansion joints will be as per IRC codal requirements.
- Wearing coat will be as per MORT&H specifications

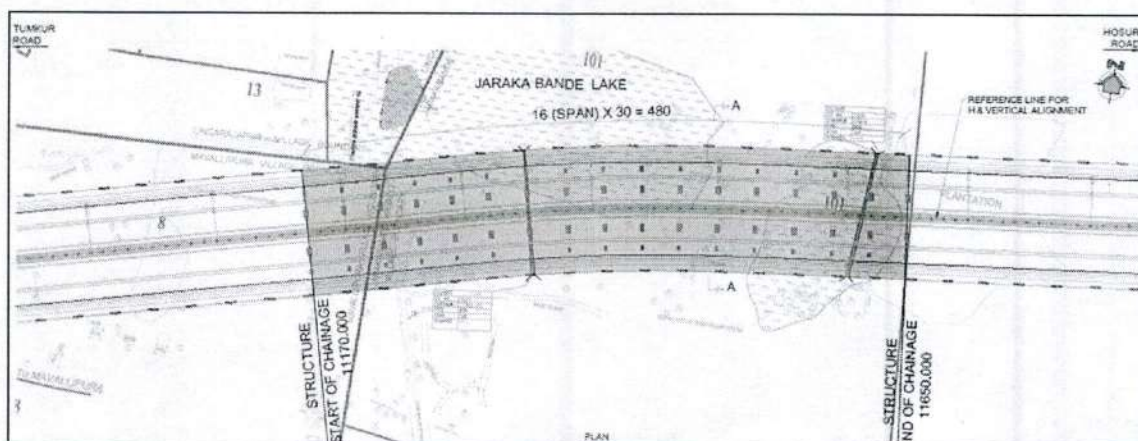


Fig 5.2: Flyover proposed along Jarakabande Lake

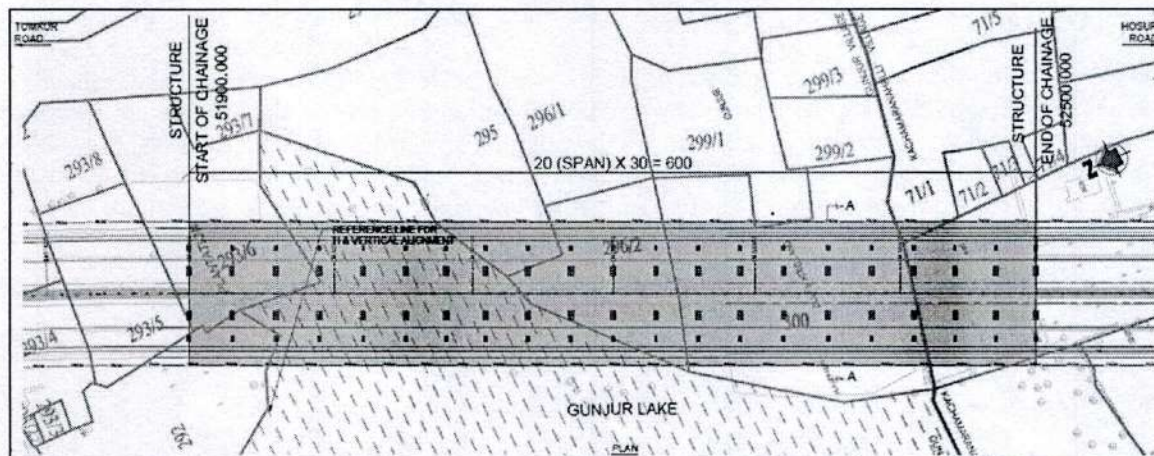


Fig 5.3: Flyover proposed along Gunjur Lake

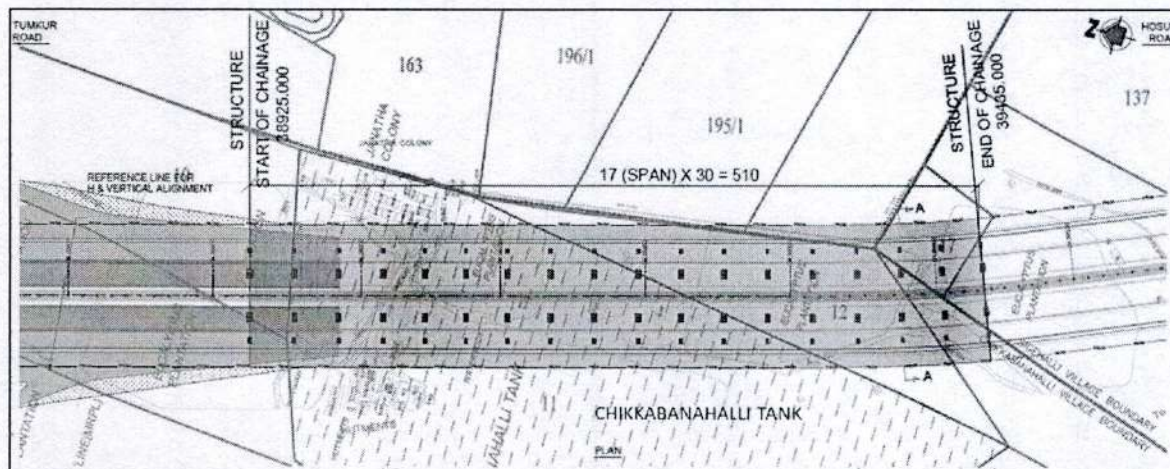


Fig 5.4: Flyover proposed along Chikkabanahalli Lake

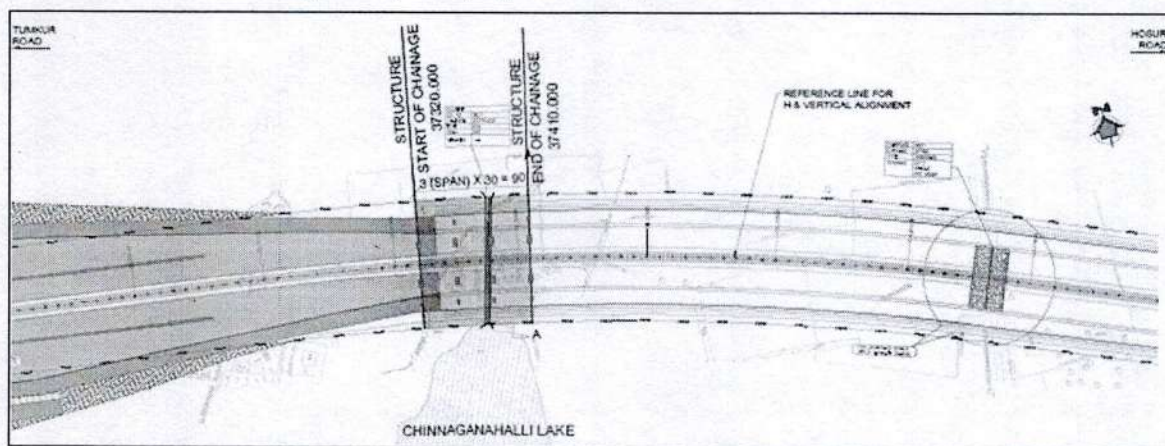


Fig 5.5: Flyover proposed along Chinnaganahalli Lake

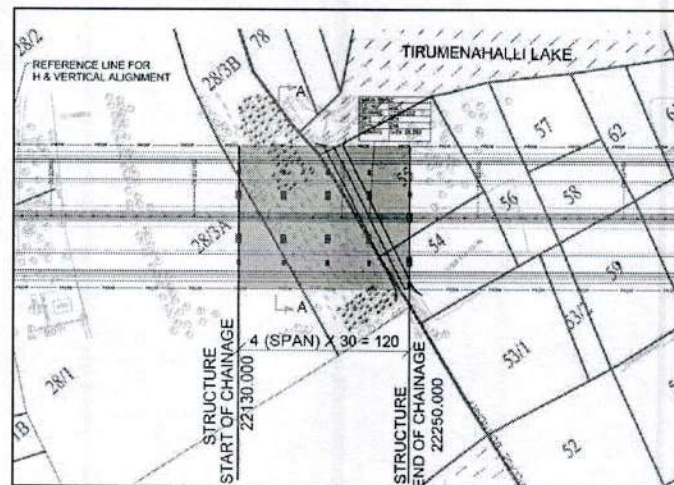


Fig 5.6: Flyover proposed along Thirumenahalli Lake

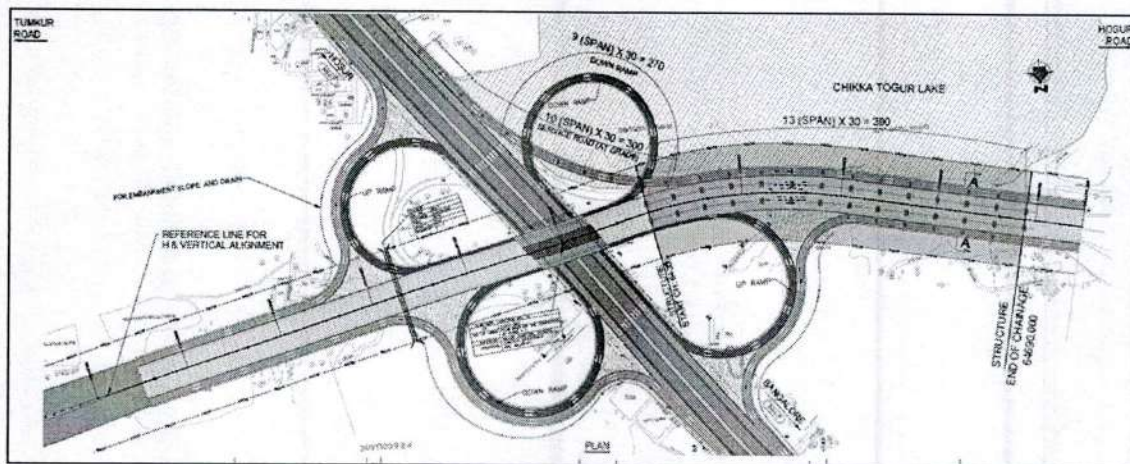


Fig 5.7: Flyover proposed along Chikkatogur Lake

5.4 Technology

Use of solar energy at relevant places in place of conventional energy and implementation of Intelligent Transport System (ITS) for better traffic management and surveillance are some of the alternative technologies planning to implement in PRR project. Details of these are provided in Chapter-2.

Chapter
6

ENVIRONMENTAL MONITORING PROGRAM

The purpose of the monitoring programme is to ensure that the objectives of the project are achieved through the mitigation measures, to suggest ongoing improvements of the proposed management plan and result in desired benefits to environment and local population of the region.

6.1 Monitoring of Environmental Parameters

Monitoring of various environmental parameters during construction phase is important to assess the pollution load from the project and compare the same with that of baseline data collected during EIA studies. To ensure effective implementation of the mitigation measures, it is essential to carryout environment monitoring programme as detailed below.

Table 6.1: Environmental Monitoring Program for Construction phase (3 years)

Environmental Attribute	Parameters to be Monitored	Standards / Methodology	Frequency of Monitoring	Proposed Locations	Responsibility	Supervision	Estimated Cost (Rs./-)
Ambient Air Quality Monitoring	PM ₁₀ , PM _{2.5} , NO ₂ , SO ₂ and CO	NAAQ Standards, 2009 CPCB Guidelines	Weekly twice for 24 Hours	Batching Plant, Hot mix plant and stone crusher, Soladevanahalli, Mavallipura, Venkata, Agrahara, Doddagubbi, Cheemasandra, Seegehalli, Varthur, Doddanagamangala (12 Nos.)	Contractor through MOEF&CC Recognized Labs	BDA	16,83,840/-
Ambient Noise Level Monitoring	Leq Day, Leq Night in dB(A)	CPCB guidelines	Once in 15 days	Batching Plant, Hot mix plant and stone Soladevanahalli, Mavallipura, Venkata, Agrahara,	Contractor through MOEF&CC Recognized Labs	BDA	2,52,000/-

Environmental Attribute	Parameters to be Monitored	Standards / Methodology	Frequency of Monitoring	Proposed Locations	Responsibility	Supervision	Estimated Cost (Rs./-)
				Doddagubbi, Cheemasandra, Seegehalli, Varthur, Doddanagamangala (12 Nos.)			
Soil Quality	pH, EC, Mg, Ca, Alkalinity, Cl, Na, K, Organic Carbon, PO ₄ , SAR, N and Salinity	Standard Operation Procedures developed using M L Jackson, Manual of FAO and Soil manual of Department of Agriculture and Co- operation, Ministry of Agriculture, Govt. of India.	Monthly once	Kuderegere, Kalthammanahalli, Jarakabandekaval, Venkata, Agrahara, Doddagubbi, Cheemasandra, Virgonagar, Seegehalli, Varthur, Kodathi, Doddanagamangala (12 Nos.)	Contractor through MOEF&CC Recognized Labs	BDA	1,16,640/-
Surface water quality of Lakes	pH, Temperature, EC, TDS Alkalinity, TH, TSS, DO, BOD, COD, NO ₃ , PO ₄ , Cl, SO ₄ , Na, Fe, K, Ca, NO ₃ , Mg, SAR, Total Nitrogen, Oil & grease, E-Coli and Total coliform, Pb, As, Cd, Cr, Cu, Zn, Total Chromium, Hg, F, NO ₂ ,	CPCB guidelines, APHA, 23 rd Edition	Monthly once	Tank near Jarakabande Forest, Tirumenahalli Lake, Chinnaganahalli Lake, Chikkabanahalli Lake, Gunjur Lake, Chikkatogur Lake Anchepalya Lake Koppaanaagrahara lake, Agrahara lake, Doddabyalakere (10 Nos.)	Contractor through MOEF&CC Recognized Labs	BDA	2,34,600/-

Environmental Attribute	Parameters to be Monitored	Standards / Methodology	Frequency of Monitoring	Proposed Locations	Responsibility	Supervision	Estimated Cost (Rs./-)
	Carbonate, Bicarbonate, Phenolic compounds, Residual Sodium carbonate, Silica						
Ground water quality	pH, Temperature, EC, TDS, Alkalinity, TH, NO ₃ , PO ₄ , Cl, SO ₄ , Na, K, Ca, Mg, F, Fe, Pb, As, Cr, Hg, NO ₂ , Carbonate, Bicarbonate, Cd, Cu, Zn, <i>T. coliform</i>	CPCB guidelines, IS 10500:2012 (Second Revision) standards	Monthly once	Borewell each near Labour camps area, Project Site office, Solid waste handling area, Hazardous wastes handling area, Vehicle Washing Bay area (5 Nos.)	Contractor through MOEF&CC Recognized Labs	BDA	73,900/-
Sub-Total / month							23,60,980/-
Sub-Total A - For 36 months							8,49,95,280/-
Aquatic life	Limnological and biological studies	--	Quarterly	Chikkabanahalli Lake, Thirumenahalli lake, Anchepalya Lake, Rampura lake, Huskur Lake, Yelhanka Lake, Chinnaganahalli lake, Rayasandra Lake, Chikkabanavara lake, Chikkatogur lake (10 Nos.)	Contractor through MOEF&CC Recognized Labs	BDA	1,60,000/-
Health check ups	Spirometry, Pulse Oxymetry, Blood Test, Lung Function Test, Eye	--	Six monthly once	Labor camp	Environmental Cell of Contractors appointed by the BDA	BDA	1,50,000/-

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Environmental Attribute	Parameters to be Monitored	Standards / Methodology	Frequency of Monitoring	Proposed Locations	Responsibility	Supervision	Estimated Cost (Rs./-)
	test, Physical fitness tests						
Sub-Total / 6 months							3,10,000/-
Sub-Total B - For 36 months							18,60,000/-
Total (A+B)							8,68,55,280/-

Table 6.2: Environmental Monitoring Program for Operation phase (3 years)

Environmental Attributes	Parameters to be Monitored	Standards/ Methodology	Frequency of Monitoring	Proposed Locations	Responsibility	Supervision	Estimated Cost for 6 months in (Rs./-)
Ambient Air Quality Monitoring	PM ₁₀ , PM _{2.5} , NO ₂ , SO ₂ and CO	NAAQ Standards, 2009, CPCB Guidelines	Monthly Once	Soldevanahalli, Mavallipura, Venkata, Agrahara, Doddagubbi, Cheemasandra, Seegehalli, Varthur, Doddanagamangala (9 Nos.)	Contractor through MOEF&CC Recognized Labs	BDA	9,47,160/-
Ambient Noise Level Monitoring	Leq Day, Leq Night in dB(A)	CPCB Guidelines	Monthly Once	Soldevanahalli, Mavallipura, Venkata, Agrahara, Doddagubbi, Cheemasandra, Seegehalli, Varthur, Doddanagamangala (9 Nos.)	Contractor through MOEF&CC Recognized Labs	BDA	5,67,000/-
Surface water quality of nearby Lakes	pH, Temperature, EC, TDS, Alkalinity, TH, TSS, DO, BOD, COD, NO ₃ , PO ₄ , Cl, SO ₄ , Na, Fe, K, Ca, NO ₃ , Mg, SAR,	CPCB guidelines, APHA, 23 rd Edition	6 monthly	Anchepalya Lake, Koppanaagrahara lake, Agrahara lake, Doddabyalakere (4 Nos.)	Contractor through MOEF&CC Recognized Labs	BDA	93,840/-

Environmental Attributes	Parameters to be Monitored	Standards/ Methodology	Frequency of Monitoring	Proposed Locations	Responsibility	Supervision	Estimated Cost for 6 months in (Rs./-)
	Total Nitrogen, Oil & grease, <i>E-Coli</i> and <i>Total coliform</i> , Pb, As, Cd, Cr, Cu, Zn, Total Chromium, Hg, F, NO ₂ , Carbonate, Bicarbonate, Phenolic compounds, Residual Sodium carbonate, Silica						
Soil Quality	pH, EC, Mg, Ca, Alkalinity, Cl, Na, K, Organic Carbon, PO ₄ , SAR, N and Salinity	Standard Operation Procedures developed using M L Jackson, Manual of FAO and Soil manual of Department of Agriculture and Co-operation, Ministry of Agriculture, Govt. of India.	6 monthly Once	Kuderegere, Jarakabandekaval, Venkata, Doddagubbi, Cheemasandra, Seegehalli, Varthur, Doddanagamangala (8 Nos.)	Contractor through MOEF&CC Recognized Labs	BDA	77,760/-
Sub-Total for 6 months							16,85,760/-
Total A for 3 years							1,01,14,560/-
Aquatic life	Limnological and biological studies	--	6 Monthly once	Chikkabanahalli Lake, Thirumenahalli lake,	Contractor through	BDA	48,000/-

Environmental Attributes	Parameters to be Monitored	Standards/ Methodology	Frequency of Monitoring	Proposed Locations	Responsibility	Supervision	Estimated Cost for 6 months in (Rs./-)
				Yelhanka Lake, Chinnaganahalli lake, Rayasandra Lake, Chikkatogur lake (6 Nos.)	MOEF&CC recognized Labs		
Health check ups	Spirometry, Pulse Oxymetry, Blood Test, Lung Function Test, Eye test, Physical fitness tests	--	6 monthly once	Toll plaza and maintenance employees	Environmental Cell of Contractors appointed by the BDA	BDA	1,50,000/-
Sub-Total B for 6 months							1,98,000/-
Total B for 3 years							11,88,000/-
Total (A+B)							1,13,02,560/-

Note: The above estimated costs are arrived based on CPCB Rate list for the parameters mentioned and Lumpsum in case the standard rates are not available.

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6.2 Monitoring of Greenbelt / Tree Plantation

- During pre-construction phase, removal of trees within the ROW shall be ensured so as to avoid cutting of other trees adjacent. During tree transplantation, selectively identified trees shall be picked up for plantation to ensure success rate.
- During construction phase, frequent watering (thrice a day) at construction site to ensure remove deposition of dust on adjacent trees and vegetation.
- During operation phase, survival rate of tree transplantation, corrective measures and success rate of tree plantation shall be monitored.
- The cost estimates for monitoring of green belt and tree plantation will be incorporated in green belt development plan in Chapter-9.

6.3 Monitoring of Labor camps

During construction phase, labor camps will be developed near the construction site with facilities such as Housing, LPG, Drinking Water, Sanitation, crèches, health care facilities, etc. which has to be monitored frequently (fortnightly once) to avoid impact on surrounding environment. The cost estimate for the same is provided in Chapter-9.

6.4 Monitoring of Risk and Hazards

During construction phase, monitoring of risks and hazards associated with petroleum pipeline and construction activities shall be ensured as it is critical in nature. Risk Expert shall be appointed to ensure proper safety during construction activities near pipeline on daily basis and weekly monitoring of general construction activities to ensure health and safety issues as detailed in Chapter-7 are addressed.

6.5 Monitoring of Land Acquisition, R&R

Land acquisition, R&R activities are important phase in the project wherein direct discussions and negotiations with community shall be carried out for smooth, better and conflict free implementation of the project. Under the guidance of Dy. Commissioner (LAQ, R&R), Social Experts will be in constant touch with the local community to ensure the required support from community and also to address the needs of local community. All land acquisition, R&R including CER activities shall be monitored on weekly basis by the social experts and engage NGOs for proper guidance.

6.6 Monitoring during sourcing of construction materials

During construction phase, emission of dust is one of the major environmental issue faced. This is mainly due to excavation activities, transportation of earthworks or construction materials from borrow areas, hot mix plants, crushers, etc. Further, keen observation and monitoring is essential during excavation activities and transportation of such materials by taking precautionary measures such as installing sign boards wherever excavation is being carried out, avoid formation of water pools which leads to several water borne diseases, covering construction materials with tarpaulin sheets, etc. Fortnightly visit will be planned to understand the local impacts from the identified borrow areas and quarries and to ensure mitigation measures suggested are in place. The cost estimate for monitoring is presented incorporated under borrow area management plan (Chapter-9).

6.7 Preparation of Compliance Reports

The Environmental Cell of BDA will convene a meeting quarterly once in a year and review the progress of environmental and social mitigation measures including management plans. The cell will also review the compliance conditions of various statutory clearances and public grievances. Accordingly, six monthly compliance reports to EC conditions and also to other clearance conditions will be prepared and submitted to Regional Office, MOEF&CC, Bangalore

and also to Regional Office, KSPCB on 01 June and 01 December of every calendar year without fail for monitoring of EC conditions.

Table 6.3: Summary of Environment and Social Monitoring

Sl. No.	Particulars	Project phase	Frequency
1	Ambient Air Quality Monitoring	Construction	Weekly twice
		Operation	Monthly
2	Noise Level Monitoring	Construction	Fortnightly
		Operation	Monthly
3	Surface Water Quality of lakes	Construction	Monthly
		Operation	Six monthly
4	Ground Water Quality	Construction	Monthly
		Operation	--
5	Soil Quality	Construction	Monthly
		Operation	Six monthly
6	Aquatic life of lakes	Construction	Quarterly
		Operation	Six monthly
7	Health Checkups of labors	Construction	Six monthly
		Operation	Six monthly
8	Green belt / Tree Plantation	Pre construction	Daily
		Construction	Weekly
		Operation	Weekly
9	Labor Camps	Construction	Fortnightly
		Operation	--
10	Risks and Hazards	Construction	Daily and Weekly
		Operation	Quarterly
11	Land Acquisition, R&R	Construction	Weekly
		Operation	--
12	Sourcing of Construction materials and earth work	Construction	Fortnightly
		Operation	Quarterly
13	Compliance report preparation	Construction	Six monthly
		Operation	Six monthly
14	Environment Cell Meetings	Construction	Quarterly
		Operation	Six monthly

6.8 Guidelines for pollution control

Various guidelines and protocols are available for best environmental management practices to be implemented during project construction, operation and maintenance phases of the project. The contractor and the BDA shall refer these guidelines while implementation of the project during its life cycle.

Table 6.4: List of guideline manuals for pollution control

Sl. no.	Name	Document code	Publication Agency
1	Code of practice for road signs	IRC:67- 2010	IRC
2	Environmental Codes of Practice	2010	NRRDA
3	Environmental guidelines for rails/roads/highway projects	1989	MoEF&CC
4	Environmental Impact Assessment Guidance manual for highways	2010	MoEF&CC
5	Environmental Impact Assessment Notification	S.O.1533(E) dated 14.09.2006	MoEF&CC
6	Guide to laboratory establishment for plant	ISBN 978-92-5-	FAO and GOI

Sl. no.	Name	Document code	Publication Agency
	nutrient analysis	105981-4	
7	Guideline for requirements for Environmental Clearance for road projects	IRC: 93-2001	IRC
8	Guidelines for Developing Green belts	PROBES/75/1999-2000	CPCB
9	Guidelines for Environmental Impact Assessment of Highway Projects	IRC: 104-1988	IRC
10	Guidelines for monitoring of AAQM	NAAQMS/36/2012-13	CPCB
11	Guidelines For National Green Highways Policy 2015 for Plantation, Transplantation, Landscaping, Beautification and Maintenance Activities Along National Highways	Policy-2015	NHAI, MoRTH
12	Guidelines for Pedestrian Facilities	IRC: 103-1988	IRC
13	Guidelines for Surface and Water Sampling and Analysis	IS 10500 : 2012	BIS/APHA
14	Guidelines for use of Fly Ash in Road Embankments	IRC: SP: 58-2001	IRC
15	Guidelines on bulk bitumen transportation and storage equipment	IRC: SP: 39	IRC
16	Guidelines on preparation and implementation of EMP	IRC: SP: 108-2015	IRC
17	Guidelines on Road Drainage	IRC: SP: 42-1994	IRC
18	Guidelines on Safety in Road Construction Zones	IRC: SP: 55:2001	IRC
19	Handbook on Environmental procedures and guidelines	1994	MoEF&CC
20	Highway Safety Code	IRC: SP: 44-1996	IRC
21	Manual on landscaping of roads	IRC: SP: 21 - 2009	IRC
22	Methodology for estimating carbon footprint of road projects	ISBN 978-92-9092-028-1	ADB
23	Proceedings of International Seminar on sustainable development in Road Transport	8.10.2001	IRC
24	Protocol for Ambient Level Noise Monitoring	July, 2015	CPCB
25	Recommended practice for Borrow pits for Road Embankments constructed by Manual operation	IRC: 10-1961	IRC
26	Recommended practice for treatment of embankment slopes for erosion control	IRC: 36 - 1974	IRC
27	Recommended practice for use and upkeep of equipment, tools and appliances for bituminous pavement construction	IRC: 72-1978	IRC
28	Report containing recommendations of the IRC regional workshops on Highway Safety	IRC: SP: 27-1984	IRC
29	Road accident Forms	IRC: 53-1982	IRC
30	Road safety for children	IRC: SP:32 - 1988	IRC

Chapter

7

ADDITIONAL STUDIES – SOCIO-ECONOMICS, RISK & HAZARDS

7.1 Socio-economic studies

The total land required for the construction of the proposed project is 1036.51 Ha and involves removal of 1,395 structures. Hence, Socio-economic studies have been conducted in this section as part of the EIA study.

7.2 Geographical Coverage

The geographical coverage for SE Studies of the project extends to 100m ROW of the impact zone of study area along 73.5 km stretch for construction of eight lane configuration road. It comprises as many as 77 villages in 4 Taluks of the impact zone as detailed in Table 7.1.

7.3 Approach and Methodology

7.3.1 Objectives

- Understanding the baseline socio-economic environment prevailing in the impact zone.
- Evaluation of the effects of proposed project on the land losers, Project affected households etc in the impact zone.
- Predicting the positive and negative impacts of the project on the socio-economic environment in the area.
- Suggesting mitigation measures to minimize the adverse impacts, if any.

7.3.2 Methodology

The social impact assessment would be based on a judicious mix of secondary and primary data collected from various sources. Participatory Rural Appraisal (PRA) Technique and Focal Group Discussions tools were used in the present study. PRA is useful technique helps to share, analyze the knowledge of rural people on life and conditions for further plan and act¹¹¹, ¹¹². The work was carried out through Desk Research, Field Survey, Data Processing and Analysis and Report Preparation. The methodology adopted at each stage is explained as follows.

7.3.2.1 Desk research

This is vital to understand the socio-economic settings in and around urban local bodies of Bangalore. Published information available on the subject was referred, reviewed and critical information gaps were identified. The major documents and information sources extensively referred are the books, articles, newspapers columns, Handbooks of statistics- Karnataka, Census Population- 2011 series etc. Besides, the information from the Departments of Education, Health, Agriculture and Social Welfare was also referred, to gain deeper insights into the socio-economic setting of the project.

Socio-economic survey (100%) was carried out by visiting all the villages areas falling within the proposed PRR alignment. However, due to the conversion of several villages to towns over a period of time, identifying the land losers in the towns was an obstacle. A team was constituted to conduct the social impact survey studies with considerable exposure and experience in the past, who are familiar with the socio-economic settings of the area and understood the local

¹¹¹Karen Schoonmaker Freudenberger. Rapid Rural Appraisal and Participatory Rural Appraisal – A manual for CRS field workers and partners. Baltimore, Maryland. www.crs.org

¹¹²MoRD, GOI Notification dt: 08.08.2014

dialect. The demographic details of the affected villages/ land acquisition villages are presented below;

Table 7.1 Geographical coverage and demographic details of Affected Villages

SL.No	Name	TRU	No_HH	TOT_P	TOT_M	TOT_F	P_SC	P_ST
Bengaluru North Taluk, Bengaluru Urban District of Karnataka								
1	Madanayakanahalli	Urban	3452	12563	6565	5998	1062	350
2	Hanumanthasagara	Urban	176	649	334	315	31	24
3	Kuduregere	Urban	589	2425	1194	1231	520	59
4	Tammenahalli	Urban	308	1256	645	611	397	32
5	Chikkabanavara	Urban	3562	14409	7514	6895	1005	249
6	Soldevanahalli	Urban	812	2940	1877	1063	759	67
7	Kempapura	Urban	134	566	297	269	130	0
8	Kalathammanahalli	Urban	151	670	336	334	265	5
9	Kasaghattapura	Urban	655	2660	1380	1280	27	10
10	Byalakere	Urban	660	2722	1403	1319	532	54
11	Mavallipura	Urban	218	1000	526	474	259	8
12	Lingarajpur	Urban	59	224	122	102	58	5
13	Jarakabandekavalu	Urban	15	74	42	32	8	0
14	Ramagondanahalli	Urban	670	2685	1427	1258	565	75
15	Avalahalli	Urban	547	2283	1210	1073	560	83
16	Harohalli	Urban	107	501	236	238	129	0
17	Kenchenahalli - Chowdeshwari Ward	Urban	9506	36602	19060	17542	3941	810
18	Kempegowda Ward- Vasudevapura, Manchenahalli, Venkata	Urban	8647	34783	18197	16586	2816	1097
19	Vaderapura	Urban	-	3460	2253	937	239	25
20	Jakkur- Agrahara, Kattigenahalli, Kogilu	Urban	12387	52025	27269	24756	6423	973
21	Tirumenahalli	Urban	112	555	274	281	222	6
22	Chokkanahalli	Urban	85	379	188	191	28	5
23	Srikantapura Anchepalya (OG) WARD NO.-0201	Urban	1552	6218	3280	2938	481	142
24	Totadaguddadahalli (OG) WARD NO.-0200	Urban	1202	4606	2432	2174	651	149
25	Madavara	Urban	2307	8742	4644	4098	854	202
Bengaluru South Taluk, Bengaluru Urban District of Karnataka								
26	Doddanagamangala	Urban	1259	5017	2730	2287	1047	53
27	Doddathoguru (OG) WARD NO.-0204	Urban	4254	14700	8310	6390	1260	365
28	Konappana Agrahara	Urban	5929	20622	11711	8911	2189	621
29	Beretana Agrahara	Urban	Data not found					
Bengaluru East Taluk, Bengaluru Urban District of Karnataka								
30	Horamavu- NagareshwaraNagenahalli, Kothanur	Urban	23999	95368	49512	45856	12171	1699

SL.No	Name	TRU	No_HH	TOT_P	TOT_M	TOT_F	P_SC	P_ST
31	Hagadur Ward- Nagondanahalli, Hagadur	Urban	13419	50556	26388	24168	5614	901
32	Hoodi- Bairati, Bileshivale, KumbenaAgrahara	Urban	12579	50191	28201	21990	6964	1132
33	Chikkagubbi	Urban	-	813	416	397	695	112
34	Doddagubbi	Urban	-	2476	1277	1199	1779	684
35	Vaderahalli	Urban	176	759	388	371	30	16
36	Rampura	Urban	598	2680	1358	1322	514	11
37	Aduru	Urban	219	931	463	468	409	5
38	Biderahalli	Urban	624	2621	1385	1236	498	20
39	Hirandahalli	Urban	801	3547	1908	1639	721	27
40	Chimasandra	Urban	925	3631	2007	1624	525	136
41	Avalahalli (Bandapura)	Urban	263	1081	537	544	44	14
42	BidarenaAgrahara	Urban	440	1869	967	902	319	89
43	Doddabanahalli	Urban	310	1224	639	585	439	54
44	Kannamangala	Urban	1146	4381	2399	1982	513	112
45	Chikkabanahalli	Urban	299	1275	627	648	199	13
46	Sigehalli	Urban	1012	3858	2069	1789	720	86
47	Kadugodi	Urban	11423	43942	23604	20338	8138	784
Anekal Taluk, Bengaluru Urban District of Karnataka								
48	Channasandra	Urban	38	167	75	92	117	0
49	Varthur, Khanekandaya, Gunjur, Sorahunse, BelandurAmmanikere	Urban	14256	54625	28959	25666	8734	782
50	Valepura	Urban	315	1213	617	596	163	4
51	Kachamaranahalli	Urban	254	1056	523	533	319	26
52	Sulikunte	Urban	538	2295	1151	1144	1011	27
53	Kodati	Urban	707	2911	1523	1388	1020	28
54	Chokkasandra	Urban	99	432	212	220	197	0
55	Avalahalli	Urban	106	551	291	260	431	2
56	Gattahalli	Urban	181	756	390	366	245	16
57	Huskur	Urban	612	2598	1317	1281	747	74
58	Gulimangala	Urban	194	849	446	403	278	28
59	Chikkanagamangala	Urban	192	827	418	409	321	11
60	SingenaAgrahara	Urban	318	1513	776	737	239	15
61	Kammasandra	Urban	2749	9912	5685	4227	891	162
62	Hebbagodi	Urban	9623	34827	20771	14056	4134	894
Total			157770	621071	332755	288019	85597	13433
TRU- Total Rural/Urban, No_HH-Households, TOT_P-Total Population, TOT_M-Total Male, TOT_F-Total Female, P_SC- Population Schedule Caste, P_ST- Population Schedule Tribe								
Source: Primary Census Abstract, Census of India, 2011								

Table 7.2: Villages which are fall under BBMP Wards

Sl.No.	Villages	Ward Name
1	Harohalli	Chowdeswari Ward
2	Vasudevapura	Kempegowda ward
3	Manchenahalli	
4	Venkatala	
5	Agrahara	Jakkur ward
6	Kattigenahalli	
7	Kogilu	
8	Nagareshwara Nagenahalli	Horamavu ward
9	Kothanur	
10	Nagondanahalli	Hagadur Ward
11	Hagadur	
12	Bairati	Hoodi ward
13	Bileshivale	
14	Kumbena Agrahara	
15	Varthur	Varthur ward
16	Khanekandaya	
17	Gunjur	
18	Sorahunse	
19	Belandur Ammanikere	

The above mentioned are the villages for which population projection was not able to estimate due to the unavailability of Census data of previous decades.

7.3.2.2 Population projection in project affected villages

Population projection has been done for the study area using Arithmetic method by using following equation. Hence, $dP/dt = C$ i.e., rate of change of population with respect to time is constant. Therefore, Population after nth decade will be $P_n = P + n.C$. Where, P_n is the population after 'n' decades and 'P' is present population¹¹³.

¹¹³ NPTEL IIT Kharagpur

Table 7.3: Population projection for the project affected/land acquisition villages for 4 decades¹¹⁴

Sl. No	Villages	Population in 1991	Population in 2001	Population in 2011	1991-2001	2001-2011	Sum of 2 decades	Population Growth	Decade wise projection population			
									2021	2031	2041	2051
1	Madanayakanahalli	2728	5913	12563	3185	6650	9835	4917	17480	22398	27315	32233
2	Hanumanthasagara	219	287	649	68	362	430	215	864	1079	1294	1509
3	Kuduregere	1099	1369	2425	270	1056	1326	663	3088	3751	4414	5077
4	Tammenahalli	731	614	1256	-117	642	525	262	1518	1781	2043	2306
5	Soldevanahalli	1023	1179	2940	156	1761	1917	958	3898	4857	5815	6774
6	Kempapura	559	466	566	-93	100	7	3	569	573	576	580
7	Kalathammanahalli	454	468	670	14	202	216	108	778	886	994	1102
8	Kasaghattapura	1770	2161	2660	391	499	890	445	3105	3550	3995	4440
9	Byalakere	1286	1595	2722	309	1127	1436	718	3440	4158	4876	5594
10	Mavallipura	653	773	1000	120	227	347	173	1173	1347	1520	1694
11	Lingarajpur	85	125	224	40	99	139	69	293	363	432	502
12	Jarakabandekavalu	73	74	74	1	0	1	0	74	75	75	76
13	Ramagondanahalli	1008	1358	2685	350	1327	1677	838	3523	4362	5200	6039
14	Avalahalli	692	911	2283	219	1372	1591	795	3078	3874	4669	5465
15	Kenchenahalli	509	803	36602	294	35799	36093	18046	54648	72695	90741	108788
16	Vaderapura	*	2679	3460	*	781	0	0	3460	3460	3460	3460
17	Thirumenahalli	140	286	555	146	269	415	207	762	970	1177	1385
18	Chokkanahalli	241	582	379	341	-203	138	69	448	517	586	655
19	Kattigenahalli	2882	4628	52025	1746	47397	49143	24571	76596	101168	125739	150311
20	Chikkagubbi	268	312	813	44	501	545	272	1085	1358	1630	1903
21	Doddagubbi	1243	1861	2476	618	615	1233	616	3092	3709	4325	4942
22	Vaderahalli	0	0	0	0	0	0	0	0	0	0	0
23	Rampura	1660	1879	2680	219	801	1020	510	3190	3700	4210	4720
24	Aduru	710	770	931	60	161	221	110	1041	1152	1262	1373

¹¹⁴ "Census Digital Library- Primary Census Abstract 1991, 2001 and 2011"

Sl. No	Villages	Population in 1991	Population in 2001	Population in 2011	1991-2001	2001-2011	Sum of 2 decades	Population Growth	Decade wise projection population			
									2021	2031	2041	2051
25	Biderahalli	1170	1419	2621	249	1202	1451	725	3346	4072	4797	5523
26	Hirandahalli	1839	2271	3547	432	1276	1708	854	4401	5255	6109	6963
27	Cheemasandra	1010	1839	3631	829	1792	2621	1310	4941	6252	7562	8873
28	Bandapura	409	440	1081	31	641	672	336	1417	1753	2089	2425
29	Bidarena Agrahara	719	1004	1869	285	865	1150	575	2444	3019	3594	4169
30	Doddabanahalli	584	888	1224	304	336	640	320	1544	1864	2184	2504
31	Kannamangala	2088	2580	4381	492	1801	2293	1146	5527	6674	7820	8967
32	Chikkabanahalli	494	502	1275	8	773	781	390	1665	2056	2446	2837
33	Seegehalli	1313	1838	3858	525	2020	2545	1272	5130	6403	7675	8948
34	Kadugodi	1666	3080	43942	1414	40862	42276	21138	65080	86218	107356	128494
35	Channasandra	158	145	167	-13	22	9	4	171	176	180	185
36	Valepura	792	893	1213	101	320	421	210	1423	1634	1844	2055
37	Kachamaranahalli	658	716	1056	58	340	398	199	1255	1454	1653	1852
38	Sulikunte	974	1605	2295	631	690	1321	660	2955	3616	4276	4937
39	Kodathi	1007	1353	2911	346	1558	1904	952	3863	4815	5767	6719
40	Chokkasandra	393	395	432	2	37	39	19	451	471	490	510
41	Avalahalli	393	497	551	104	54	158	79	630	709	788	867
42	Gattihalli	1079	634	756	-445	122	-323	-161	594	433	271	110
43	Huskur	1794	2095	2598	301	503	804	402	3000	3402	3804	4206
44	Gulimangala	374	480	849	106	369	475	237	1086	1324	1561	1799
45	Chikkanagamangala	1104	653	827	-451	174	-277	-138	688	550	411	273
46	Singena agrahara	833	979	1513	146	534	680	340	1853	2193	2533	2873
47	Kammasandra	1184	2549	9912	1365	7363	8728	4364	14276	18640	23004	27368
48	Hebbagodi	5768	12296	34827	6528	22531	29059	14529	49356	63886	78415	92945
49	Doddanagamangala	Data not available	1360	5017	*	3657	-	-	-	-	-	-
50	Doddathoguru		4087	14700	*	10613	-	-	-	-	-	-
51	Srikantapura		3285	6218	*	2933	-	-	-	-	-	-
52	Madavara		3544	4606	*	1062	-	-	-	-	-	-
53	Totadaguddadahalli		1703	4606	*	2903	-	-	-	-	-	-

7.3.2.3 Field Survey

Field survey planned during January, 2020 and March, 2022 for the primary data collection which constituted the most important element of the methodology. Field survey was carried out along the corridor stretch containing a total of about 145 households using standard questionnaire. The potential respondents in the sample households were contacted personally by the field investigators who explain the purpose of the visit and seek their participation by sharing relevant information impartially. The field investigators also clarified the doubts and apprehensions expressed by the respondents.

In addition to household survey, rapid participatory rural appraisal tools, focused group discussions, interview with the stakeholders were used in collecting the qualitative information. As per the directions of Hon'ble NGT in its order dt: 08.02.2019, the survey team also visited the appellant Shri. Sudhakar Hegde house at Asha Township, Bileshivale on 17.01.2020. However, at his house informed that Shri. Sudhakar Hegde was passed away recently and his wife (also an applicant) Smt. Ranjita Hegde was contacted through telephone seeking her advice on EIA studies. She informed that she does not have any suggestions.

7.3.2.4 Limitations faced during field survey

- Firstly, most of the land owners wanted to meet the BDA authorities in presence of Chief Minister regarding finalization of the Compensation price before sharing the information
- Objection from localities' who does not want to cooperate as the project was delayed for very long period of time
- Actual Land owners have settled in other places
- Non availability of actual land owner's information at certain places
- In some places, survey team has been threatened and sent away from the villages

7.3.2.5 Data analysis

The data collected during the field survey and desk research phases was tabulated, analysed and validated with the help of secondary data.

7.4 Socio Economic Characteristics of the PIZ

Road construction activities will have significant impacts on community. The objective of the socio-economic assessment is to minimize the negative impacts and suggest mitigation measures. Hence, baseline socio-economic scenario in the study area is important. The basic socio-economic profile of the study area is presented as follows;

7.4.1 Demographic Profile

Demographic profile of the study area includes human settlements, Scheduled Castes and Scheduled Tribes and literacy levels. The profile comprises of the study area corridor stretch consisting of 77 villages in 4 Taluks are present below;

Table 7.4: Salient features of Demography in Study Area

Sl. No.	Demographic Parameter	Data as per Census 2011	Salient Features
1	Total Population (No.) - Males - Females	620520 332464 287759	<ul style="list-style-type: none"> • The projected population for 2021 is 7.4 lakhs. • The Sex Ratio in the area is 871 females per 1000 males in the study area as per census 2011. • Almost 100% of the population in the study area is categorized as urban population.
2	SCs (No.)	85166	<ul style="list-style-type: none"> • 14 % schedule caste population

Sl. No.	Demographic Parameter	Data as per Census 2011	Salient Features
3	STs (No.)	13431	• 2% Schedule tribe population in the studies area.
4	Average Literacy (%)	72.90%	• Higher than the district average of 60.33%
5	Households (No.)	157664	• Average 3.9 persons per household.

Source: Provisional Census Abstract 2011, Karnataka

7.4.2 Occupational Distribution

Among the total population, 50.12% are non-workers and the remaining constitutes the working population i.e. 49.88%. The overall workforce participation rate is nearly equal to the state workforce about 42.68%. Among the working population, 94.35% (250129) are main workers and 10.0% (26514) are marginal workers. The village wise occupational structure of proposed influence zone, as per 2011 census is placed in Annexure-24.

7.5 Profile of the Likely Project Affected Households (Survey Results)

7.5.1 Demographics

The survey sample households of 145 have a total population of 666 persons. 80.57% of the population comprises of males and 19.42% females; 48.0% of active adults, 6.28% of children and 45.71% of aged. Backward Castes with a share of 82.51% are predominant followed by General/higher (14.68%), Schedule Tribe (2.79%), Schedule Caste (0%).

Average literacy among the surveyed households is 86.85% with Male literacy higher at 80.57% than female literacy of 19.42%. Of the total literacy, 35.42% of the household population pursued primary education, while 20.0% pursued secondary education, followed by 15.42% are PUC holders, 5.71% are graduates and 10.28% is post graduates. 2.85% of the household population pursued vocational education.

7.5.2 Lifestyle

No reliable information/data are available, either at the district or Block levels, on the lifestyles of people. As such it will be very difficult to assess the lifestyles in the area with reasonable accuracy. However, based on an impressionistic assessment during the field surveys, it is felt that a majority of the population in the area owns a tenement to live in. They have access to basic amenities such as protected drinking water, electric power, education and healthcare. A majority of the people in the area also have access to a mobile phone and a cable TV connection.

7.5.3 Sources of livelihood

The work participation rate is 43.66 per cent in the study area is higher than the national work force participation of 39.1 per cent. Distribution of Occupation wise details, Agricultural/Farming sector employment is the sole source of livelihood for the survey households. 72.0% of the households earn their livelihood as farming, 16.0% earn from the agriculture allied activities and 4.0% earn their livelihood from un-organized sector in the region with private sector establishments as daily wage labor in the area. While 1.12% of the households pursue self-employment and small businesses as a source of livelihood, 2.28% of government services employees were found as results of the socio-economic survey. All the interviewed persons (100%) are aware of the PRR planning and whereas this awareness was 68% in 2016 survey.

7.5.4 Agriculture and plantation practices

Most of the land owners along the proposed alignment are involved in agriculture and plantation practices like growing of Ragi, Vegetable crops (Beans, Field beans, Ridge gourd,

Bitter gourd, Bottle gourd, Radish, Carrot, Ivy gourd, Snake gourd, Ladies finger), Leafy vegetable (Spinach, Amaranthus, Coriander, Chenopodium, Malabar spinach), Horticulture crops (Banana, Jamun, Sapota, Jackfruit, Mango, Butter fruit, Fig, Chakota), Commercial crops (Coconut & Areca nut), Plantation crops (Eucalyptus & Teak) and floriculture crops (Rose, Jasmine, Crossandra, Marigold, Sevanthi).

7.5.5 Cultural activities

The people in the study area are involved in various cultural and traditional practices such as local Jattras worshipping deity, celebrating harvest festivals, worshipping cultural species (Bevu, Tulasi, Arali, Bilvapatre, etc) and all local festivals pertaining to different religion.

7.5.6 Status of women

Participation of women in economic activity and decision-making process at house and community level is a sign of general socio-economic development of the women in particular and society in general. The survey tried to collect information about various activities in which the women members of family are participating. The analysis of data revealed that women in the surveyed families engaged in activities such as cultivation, Allied Activities (Dairy, Poultry, Sheep rearing, etc.), trade & business, household work, and agriculture labour. There are families in which women members are involved in more than one activity.

7.6 Archaeological monuments/ socially sensitive receptors

There are two archaeological monuments notified by Archaeological Survey of India (ASI) in Bengaluru Urban district namely Tippu Sultan's Palace and Old Dungeon Fort & Gates both were located at Chamarajpet.

The proposed project does not have any impact on these archaeological monuments neither directly nor indirectly from the proposed project activities. The distance between these monuments and PRR project activities is about 20-25 Kms. The study found that some of the socially sensitive receptors in the study area such as school, temples and other religious institutions; comes within the alignment of the road and also within the vicinity of the project activities. The list of sensitive receptors is given below.

Table 7.5: List of social sensitive receptors along the PRR

Sl.No.	Chainage	Name of the sensitive receptor	Village Name	Distance from RoW (m)	Type
1	03+600	Acharya Institution	Soladevanahalli	130	School
2	11+800	IAIM Healthcare centre	Ramagondanahalli	170	Hospital
3	16+200	NITTE Menakshi Institution and Technology	Yelahanka	270	school
4	17+900	Ryan International School	Vederapura	430	School
5	17+200	All People Church	Vederapura	420	Religious
6	17+500	Canadian International School	Manchenahalli	Adjacent	School
7	20+500	Aditya Institutions	Kogilu	80	School
8	21+700	Masjid Al Quba	Thirumenahalli	390	Religious
9	23+100	Ambigara Chowdaiah college of Nursing	Chokkanahalli	80	School
10	23+200	Manipal University Media and Entertainment Dept	Yelahanka	Adjacent	School
11	23+400	Akshaya P U and Degree College	Chokkanahalli	40	School
12	23+600	Masjid - Usman Ghani	Thirumenahalli	Adjacent	Religious
13	23+600	Khadar Nawaz Sharif Institution of Technology	Thirumenahalli	330	School
14	23+600	Karnataka college of Pharmacy	Thirumenahalli	120	School
15	23+700	Trinity Nursing Home	N. Nagenahalli	60	Hospital
16	23+700	Diana College	N. Nagenahalli	200	School
17	23+700	Masjid e- Noor	N. Nagenahalli	420	Religious
18	23+800	Diana Public School	N. Nagenahalli	Adjacent	School
19	23+800	Manipal Academy of Banking	Yelahanka	90	School
20	24+800	AIHM and CT	N Nagenahalli	160	School
21	25+600	Faran College of Nursing	Kannur	440	School
22	26+500	Accept Care Home	Byrathi	150	Hospital
23	27+000	Alpha College of Nursing	Hennur	340	School
24	27+500	Bishop House, Malankara Orthodox Syrian Church	Dodda Gubbi	10	Religious
25	28+200	Sri Vidhyanekata School and College	Bileshivale	50	School
26	33+500	East Point College of Engineering and Technology	Avalahalli	160	School
27	40+100	Eurokids - Seegehalli Kadugudi	Seegehalli	170	School
28	56+100	Delhi Public School	Kodathi	260	School

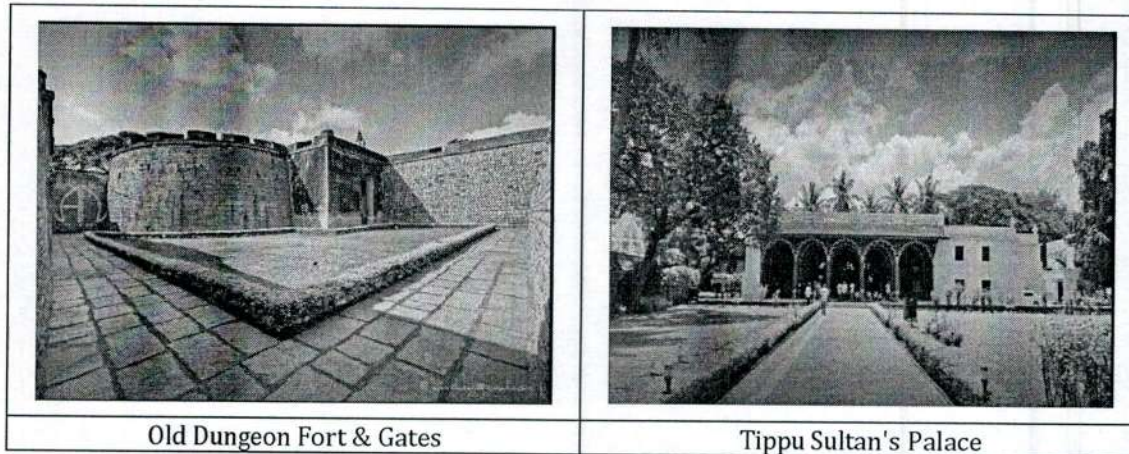


Fig 7.1: Archaeological monuments

7.7 Aspirations and Apprehensions

As revealed during field survey, all the respondents are aware of the infrastructural project in the area and are of the opinion that it is essential to ease the traffic movements. The perceptions of the respondents as regards to construction to eight lane road in the area could be summarized as follows;

- The land losers demand the compensation to be paid as per present market value by following RFCT LARR Act 2013.
- Delay's for about nearly 15 years for construction of the project has left people in misery and no hope for future development/activities.
- Project affected peoples were unable to either transact or build on their own land for over a period of 15 years, which has led in delaying marriages of their children.
- The land losers also demanded additional compensation for delays in the proposed project.
- People request for the NOC (No Objection Certificate) from BDA as they are not able to sell their lands due to PRR land acquisition notification.
- Psychological stress has developed among the PAPs due to delay in providing compensation led to animosity against the project and hence non involvement during surveys / studies.
- Many PAPs loose full land to PRR and becomes landless.
- Most of the titleholders have said that they have already sold their lands and asked us why their names are still mentioned in the Land acquisition notification.
- Many of the landowners have developed their lands to sites and layouts and also which some are already sold Hence, they are demanding compensation for the developed sites, layouts, and other immovable structures in the land.

7.8 Land Acquisition & Resettlement impacts

Land acquisition is proposed for a width of 100 mts ROW, except at locations of toll plaza and interchanges as per the orders of Hon'ble High Court of Karnataka in Writ Appeal Nos. 17005-07 of 2011 dt: 15.07.2013. The total land to be acquired is from 67 villages. Total of 1036.51 ha of land is required for the project. Of the total land notified, government land consists about 114.20 ha, Kharab land consist 43.43 ha and remaining private land is 555.57 ha. Land acquisition Notification dt: 29.06.2007 along with details of Chainage, Gram Panchayat and associated KSPCB Regional Offices are enclosed as Annexure-24.

Table 7.6: Village wise extent proposed for Land acquisition

Sl. No.	Villages	Acres (A)	Guntas (G)	Sl. No.	Villages	Acres (A)	Guntas (G)
Anekal				Bangalore North			
1	Channasandra	38	65	44	Agrahara	24	61
2	Chikkanagamangala	63	63	45	Avalahalli (North)	129	152.5
3	Chokkasandra	5	39	46	Byalakere	40	67
4	Gattihalli	19	51	47	Chikkabanavara	13	59
5	Gulimangala	47	80.75	48	Chikkabidarakallu	0	5.75
6	Gunjuru	44	73	49	Chokkanahalli	34	26
7	Hebbagodi	32	24	50	Hanumanthasagara	13	72
8	Huskuru	49	57	51	Harohalli	46	47.25
9	Kachamaranahalli (Anekal)	77	6	52	Jarakabandekavalu	35	23
10	Kammasandra	1	17	53	Kalathammanahalli	37	18
11	Khane kandaya	3	15.25	54	Kasaghattapura	12	21
12	Kodati	3	2	55	Kattigenahalli	10	89.75
13	Singena Agrahara	2	25	56	Kempapura	47	81.5
14	Valepura	2	26.25	57	Kenchenahalli	8	47.5
Bangalore East				58	Kogilu	64	58
15	Aduru	27	56.75	59	Kuduregere	58	55
16	Avalahalli (East)	40	1.5	60	Lingarajpur	0	1
17	Bellandur Amanikere	11	58.25	61	Madanayakanahalli	28	54
18	Bidarahalli	22	55	62	Madavara	8	30
19	Bidarena Agrahara	39	39	63	Manchenahalli	21	39
20	Bileshivale	54	39.25	64	Mavalipura	49	21
21	Byrathi	23	14	65	Ramagondanahalli	9	26
22	Cheemasandra	33	42	66	Soladevanahalli	20	29
23	Chikkabanahalli	51	36	67	Sreekantapura	14	27.5
24	Chikkagubbi	7	35	68	Thammenahalli	48	46.5
25	Doddabanahalli	15	97	69	Thirumenahalli	27	81
26	Doddagubbi	70	84.5	70	Thotadaguddadahalli	36	34
27	Hagaduru	17	47	71	Vaderapura	22	44
28	Hirandahalli	85	89	72	Vasudevapura	15	39
29	Hoskote Dodda Amanikere	5	33	73	Venkatala	50	54.5
30	Kachamaranahalli (East)	2	31.5	Bangalore South			
31	Kadugodi	120	61.5	74	Beretana Agrahara	2	6
32	Kannamangala	81	34.25	75	Doddanagamangala	33	6
33	Khajisonnenahalli	13	31	76	Doddathogur	11	22
34	Kothanur	8	20	77	Konappana Agrahara	28	5
35	Kumbena Agrahara	7	42	Grand Total			
36	Nagareshwara Nagenahalli	14	38.5				
37	Nagondanahalli	29	43				
38	Rampura	98	79.25				
39	Sheegehalli	39	92.25				
40	Sorahunase	50	59				
41	Sulikunte	89	37.25				
42	Vaderahalli	27	64.75				
43	Varthur	32	56				

The basic objective of the project is to improve the connectivity. The project will have both positive and adverse social impacts on the project road population. Since the project involves the construction of the eight lane roads, the project impacts are mostly limited to the existing right-of-way. The construction and improvements of the 73.5 Km of road of PRR project will have direct impact on the communities and other neighbouring villages. Structure of public interest, residential structures, home stead land and commercial structures will be affected. This accounts for the most critical areas for the social assessment. The shops, hotels, restaurants, small eating joints, motel and other commercial and residential establishments have direct access to the roads.

7.8.1 Likely impacts on the project

The total numbers of structures likely to be affected fully/partially are 1,395 under the proposed impact zone within the corridor. It can be seen from the following table that the project will likely to be impacted upon 1,377 on residential/commercial structures and 18 agricultural lands and assets. Details are given below;

7.8.2 Potential impacts

The proposed project would have impact on the people living along the corridor as well as the assets, belonging to individual or/ and the community. The project would have both the positive and the negative impacts on the people and their environs. The positive impact of the project would be in terms of the better road network with increased potential for economic development and the improved road safety considerations. The negative impact would primarily be in the form of loss of livelihood, housing, access to common property resources and disturbance in the existing social fabric of the people living and working along the corridor. An effort has been made to minimize the negative impacts.

7.8.3 Negative impacts

- Construction of road involves land acquisition and loss of agricultural lands.
- Loss of livelihood (Temporary / permanent) due to lands acquisition.
- Likely impacts due to the noise and vibrations in the surrounding areas during construction phase.
- Failure of communication system due to construction activities.
- It has been observed that the proposed project requires land and there is a shift in the land use patterns in the project area and its vicinity. The acquisition of such an area will change the land use by affecting in terms of their place of residence, loss of access to agriculture fields and plantations, loss of common proprieties such as temples, community halls, school, bore wells etc.

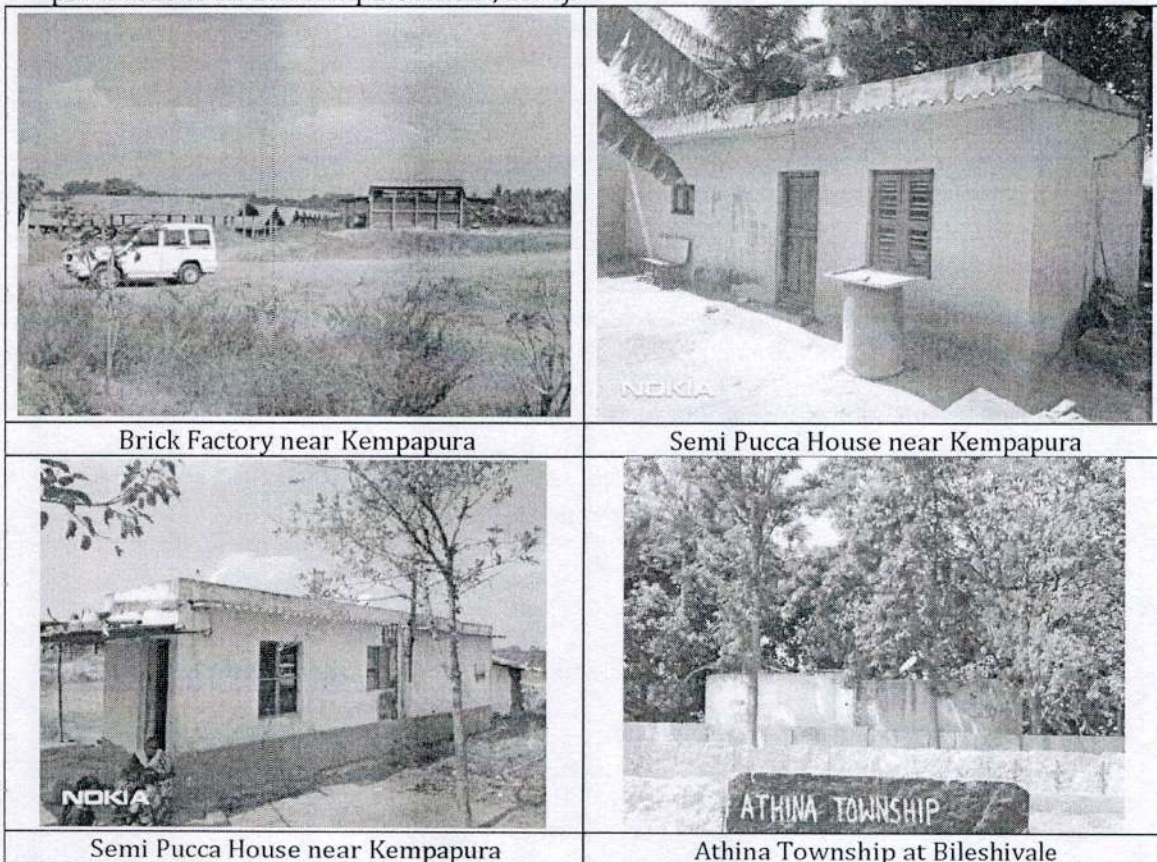
7.8.4 Positive impacts

- The project will improve access to markets, jobs, education and health services & connecting remote areas.
- The proposed ring road enhances connectivity to the National Highways and other state Highways. Any vehicle can access point to point connectivity cross to the other end without passing through the cities, which can even chock the city traffics.
- Infrastructure facilities will be developed in the project area.
- Project road during operation phase reduces travel time and operation costs with minimum pollution risks.
- The link road connecting the project road may have barriers to access good health care, medical assistance and education facilities. Provided better roads can improves health and educational services and transportation.
- Enhancement in the well-being, women become more independent and lessen the risks associated with their vulnerabilities, promoting gender and social equality.

- There will be considerable decrease in road accidents.
- Industrial, business and commercial activities will be improved.
- Direct or indirect employment opportunities will be created.

7.8.5 Mitigation measures

- The acquisition of land and private properties shall be carried out in accordance with the Resettlement Action Plan and entitlement framework of the Project. BDA has to ascertain that acquisition of land in the post design phase are addressed and integrated into the Environmental Management Plan and relevant contract documents.
- Owners will be informed in advance to shift the utilities in coordination with the project proponents before construction starts to avoid failure of services.
- To resolve issues of encroachments or infringement if any, local self – governments as well as communities will be involved in developing a consensus in decision-making.
- During construction & excavation, soil erosion and loss of topsoil is expected at the construction site, which is unavoidable but can be minimized. The excavated soil will be used for levelling and filling of low-lying areas. Compensation shall be paid as per BDA Act, 1976 (as per the provisions of the Land Acquisition Act, 1894).



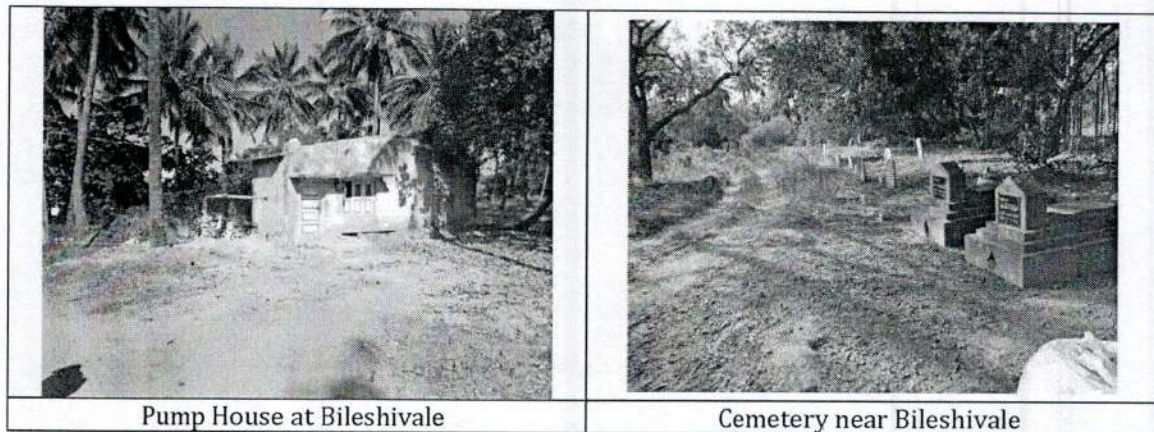


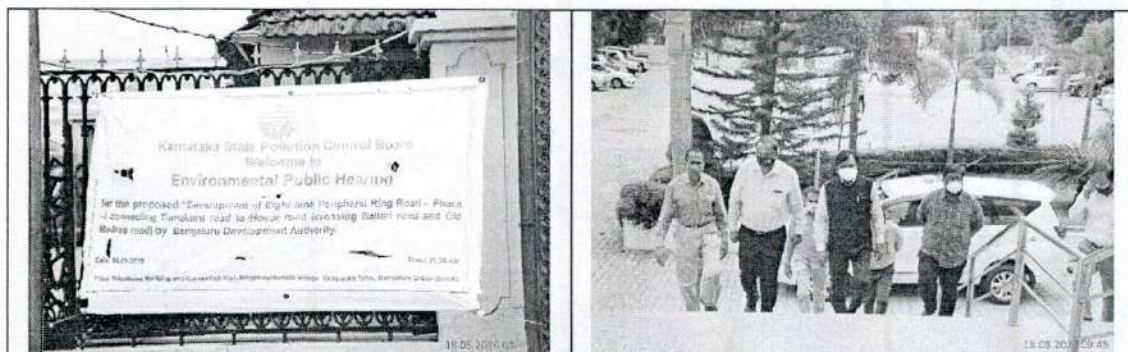
Fig 7.2: Structures along the alignment

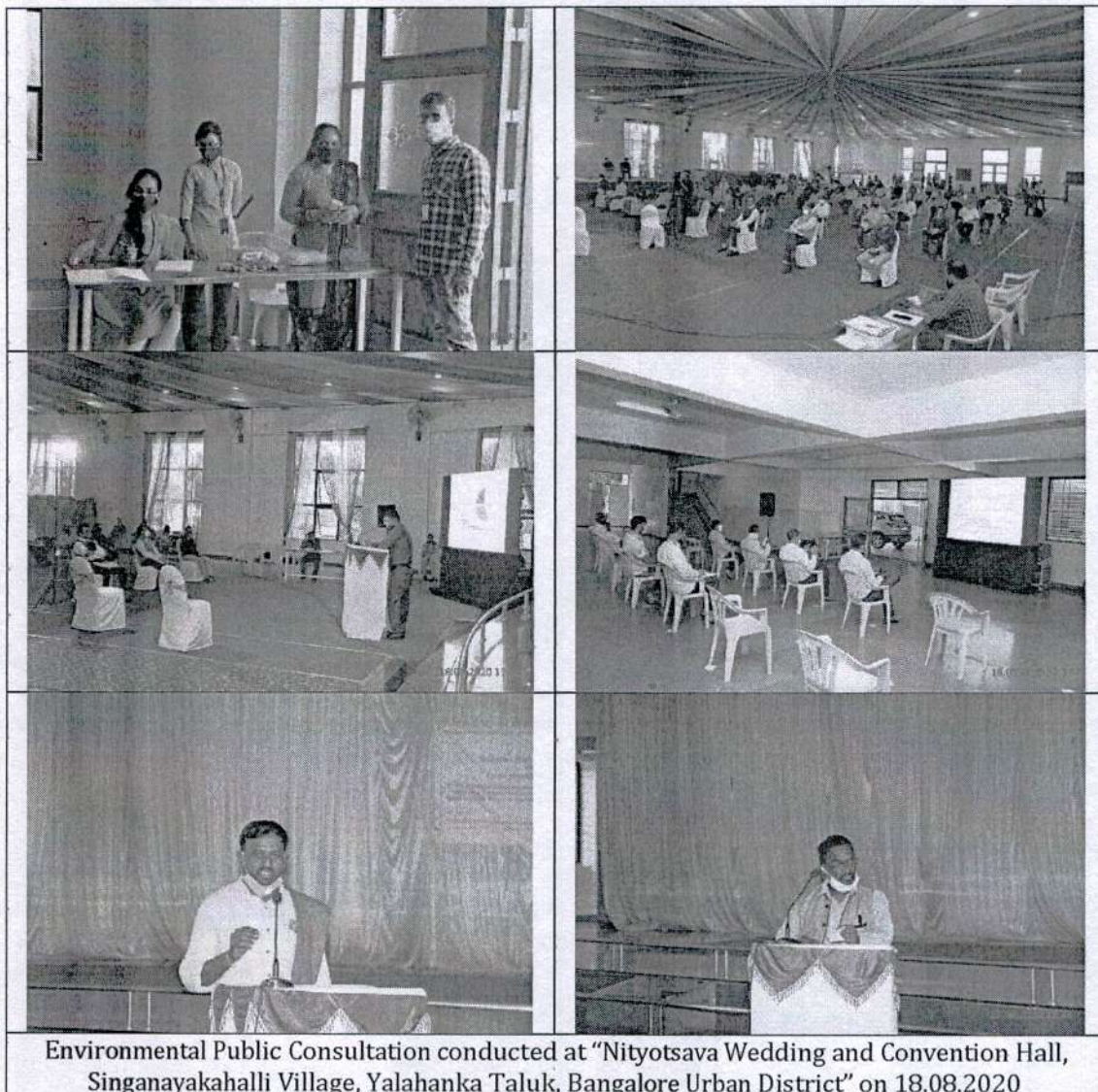
7.9 Environmental Public Hearing

The Draft EIAEMP Report was prepared and submitted to KSPCB on 22.06.2020. Further, all the requisite project documents were circulated to all the stakeholders on 24.07.2020. The KSPCB further published about the Environmental Public Hearing (physical) and Virtual Public Hearing in the Kannada Daily newspaper "Kannada Prabha" and English Daily newspaper "Deccan Herald" on 17.07.2020 and 01.09.2020 respectively by inviting the responses orally/writing/e-mail to KSPCB/Chairman, District Environmental Public Hearing Committee, Bengaluru Urban District from the concerned persons having plausible stake in the environmental aspects of the project or activity within 30 days from the date of publication of the paper notification.

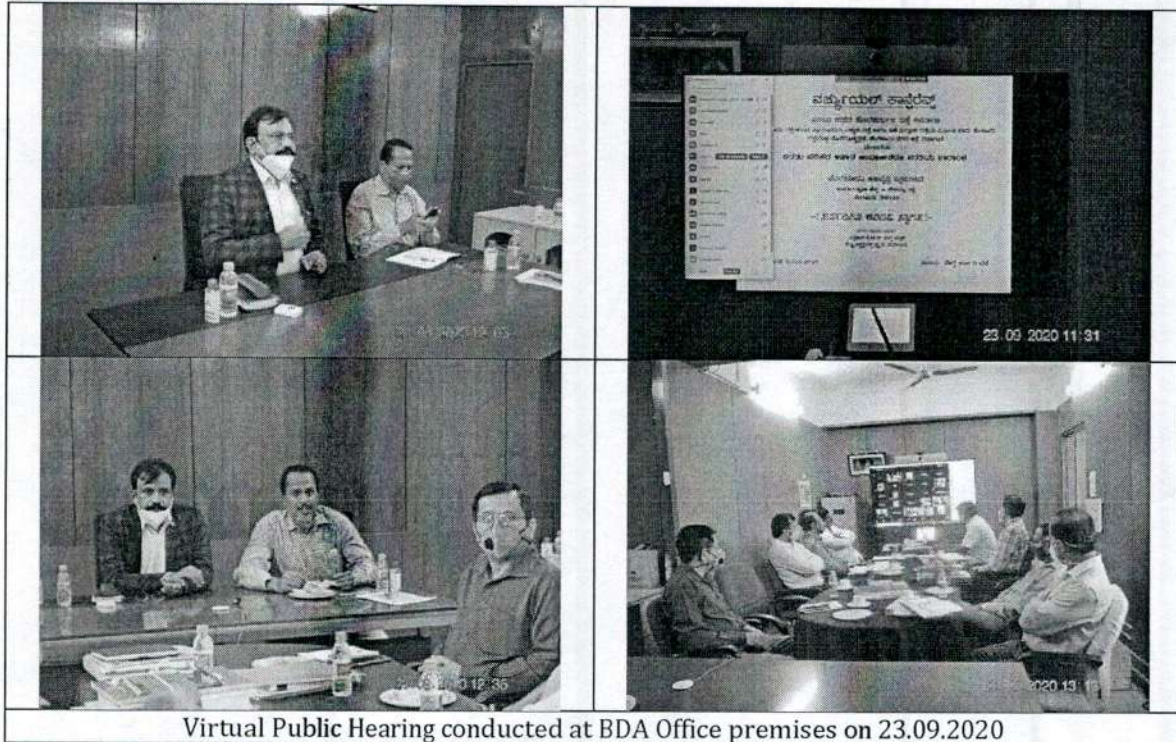
Subsequently, the Environmental Public Hearing (Physical & virtual) was conducted on 18.08.2020 and 23.09.2020 respectively under the chairmanship of the Deputy Commissioner, Bengaluru Urban District.

The Environmental Public Consultation was conducted at "Nityotsava Wedding and Convention Hall, Singanayakahalli Village, Yalahanka Taluk, Bangalore Urban District" on 18.08.2020 as per the provisions of the EIA Notifications, 2006 and its subsequent amendments. Keeping in view of the present pandemic COVID-19 situation, the Environmental Public Hearing was conducted as per the guidelines issued by the BBMP with necessary precautionary measures such as thermal screening, distribution of masks, face shields, gloves, utilization of hand sanitizers, seating arrangements with not more than 50 seats at two separate platforms with social distancing.





Considering the pandemic situation, a Virtual Public Hearing was also conducted on 23.09.2020 through Zoom platform, so that the public can participate in the meeting and give their submissions from their homes. The virtual Environmental Public Hearing was also successfully conducted with more than 300 participants. The proceedings of the same is enclosed in Volume II of the Final EIA/EMP Report.



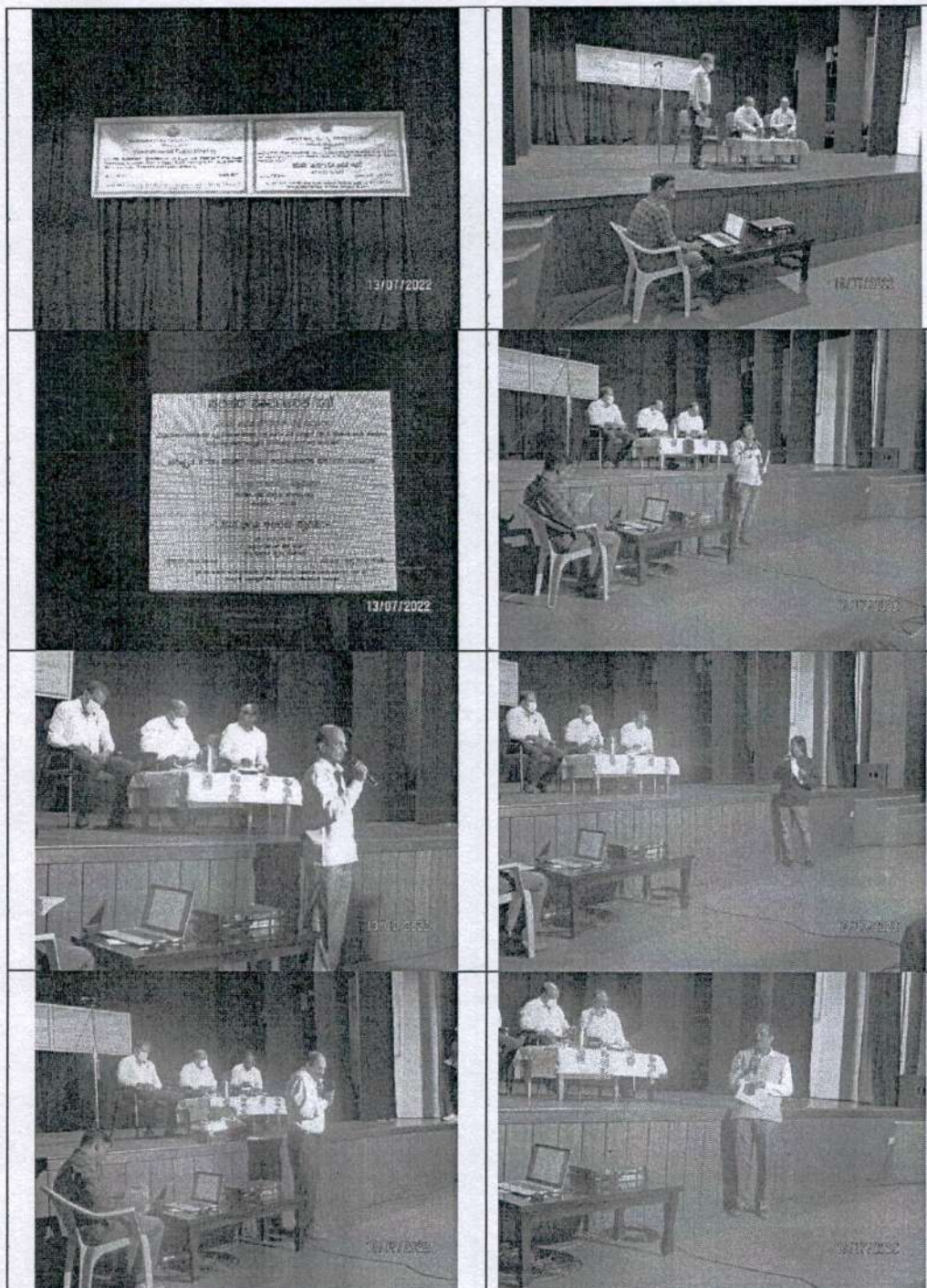
Virtual Public Hearing conducted at BDA Office premises on 23.09.2020

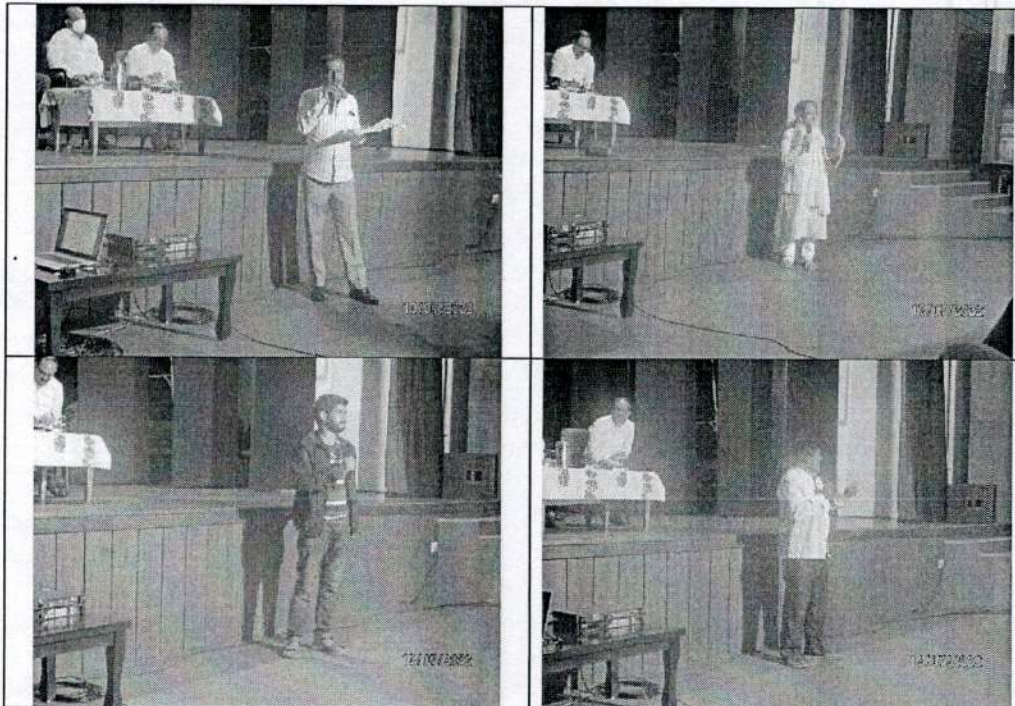
The validity of the Virtual Public Hearing conducted through ZOOM platform on 23.09.2020 was challenged by the public at the Hon'ble High Court of Karnataka. After detailed deliberations, the Hon'ble High Court of Karnataka vide its Judgement dt:23.02.2021 disposed off the case with a direction to conduct a fresh public hearing in the physical form.

Meanwhile, there is a change in total land requirement for the project from 733 Ha to 1036.51 Ha due to change in length of the project from 65.5 km to 73.5 km due to realignment and inclusion of cloverleaf structures at chainages CH 0+000 km to CH 3+400 km (NICE integration at Tumkur Road), 28+843.36 km to CH 31+896.76 km (Near Bilishivale), CH 37+996.76 km to CH 44+400 km (Near Sigehalli) and CH 60+619.92 km to CH 64+700 km (NICE integration at Hosur Road). Hence, the Draft EIA/EMP Report has been revised upon obtaining requisite corrigendum to ToRs from KSEIAA on 25.02.2022 and the same will be submitted to the KSPCB once again to conduct a fresh Environmental Public Consultation in physical form following due protocol and publicity as directed by the Hon'ble High Court in its judgement dt: 23.02.2021.

Therefore, a fresh Environmental Public Hearing (EPH) was conducted on 13.07.2022 at Dr. B.R. Ambedkar Bhavan, Bruhat Bengaluru Mahanagara Palike, No.757, 16th 'A' Main Road, Satellite Town, Yelahanka Taluk in Bangalore Urban District where the people are affected from the project. EPH was conducted by Karnataka State Pollution Control Board (KSPCB) in the presence of Deputy Commissioner, BDA and Environmental Consultants.

Prior to the conduction of EPH, the Draft EIA/EMP along with Executive Summary was submitted to the KSPCB on 29.04.2022 which was displayed in the KSPCB website for a month. The KSPCB further published about the fresh Environmental Public Hearing (physical) in the Kannada Daily newspaper "Hosa Digantha" and English Daily newspaper "The Hindu" on 12.06.2022 respectively by inviting the responses orally/writing/e-mail to KSPCB/Chairman, District Environmental Public Hearing Committee, Bengaluru Urban District from the concerned persons having plausible stake in the environmental aspects of the project or activity within 30 days from the date of publication of the paper notification.





Fresh Public Hearing conducted at Dr. B.R. Ambedkar Bhavan, Bruhat Bengaluru Mahanagara Palike, Satellite Town, Yelahanka Taluk in Bangalore Urban District on 13.07.2022

During the EPH, all the issues raised by the public were recorded in the form proceedings along with Photos and videos by the KSPCB. Further, all the issues raised by the public has been considered by BDA for implementation of the project. The compliance to the issues raised during EPH has been enclosed as Volume II of the Final EIA/EMP Report.

7.10 Natural Resource Conservation and Optimization

Natural resource conservation and optimization will be adopted during construction phase by following the below measures;

- Utilization of fly ash
- Pre-cast structures
- Utilization of LED lightings and solar energy for lightings
- Borrowing construction materials from nearby authorized borrow areas, quarries and crushers
- Asphalted roads along toll plazas for reducing the emissions of carbon, etc.

Further, other possibilities for utilization of natural resources and its conservation will be explored and adopted during construction phase.

7.11 Risks and Hazards associated with the project

This section involves studying the risk and hazards associated with the various aspects of the proposed project such as excavations, accidental falls, occupational hazards, vehicular transportation of chemicals and hazardous materials, blasting, presence of petroleum pipeline along the proposed alignment, emergency preparedness, road safety (Chapter-2), accident prone zones, etc. during its construction and operation phases.

7.11.1 Risks and hazards during construction phase

7.11.1.1 Accidents

Accidents during construction phase includes in the activities of handling heavy equipments, fall from heights, hazardous chemical spills, fire hazards, electric shocks etc which may occur due to the practice of unsafe procedures. The details of accidents which may occur during the construction phase of the project are discussed below;

Accidents during movement of vehicles within the construction or maintenance activity area may be anticipated due to improper traffic control in Road Construction Zones. Safety Standards will be maintained during construction phase to provide safe travel to the drivers of vehicles plying on the road at all time and provide protection to the project workers when they are at work.

To control the accidents during the construction period, the area of construction or maintenance activity in the road will be classified in to four zones from traffic safety point of view and also to avoid the traffic management

- Advance Warning Sub-Zone: This zone will advance or prepare the driver for an alert behavior on warning sub-zone. This will be done by warning the road user clearly and sufficiently in advance in the form of displaying signages.
- Transition Sub-Zone: The transition sub-zone is the area in which the traffic is steered and guided in and out of the diverted path around the work sub-zone. This is considered to be the most crucial sub-zone from safety point of view since most of the movements are turning movements and hence provision of safe and clearly marked lanes will be made to guide the drivers.
- Work Sub-Zone: This sub-zone involves construction or maintenance activities and the main concern is the safety of the workers at the site from the plying traffic. Therefore, the path of the traffic must be clearly delineated in order to avoid intrusion of vehicles moving towards the work area.
- Termination Sub-Zone: This sub-zone involves erection of signboard informing the road users about the end of construction Zone.

As per the IRC 67-2010 guidelines, traffic control devices such as road signs, delineators, barricades, safety cones, flags, pylons and flashing lights will be used to regulate the traffic in road construction zones. In addition to this, flagmen will be positioned at an interval of 20 m to 50 m to maintain the flow of traffic around a work zone by suitably regulating the traffic.

7.11.1.2 Blasting activities

Since the area of the PRR alignment is flat terrain, the project doesn't require the activity of blasting. If any hard-rocky exposure encounter during the construction phase, the requirement of blasting activity is needed. The PRR alignment is passing along the boundary of urban landscapes, where the intervention of wildlife habitat is negligible and no eco sensitive areas are present in the alignment. However, two eco sensitive areas namely, Bannerghatta National Park, located at distance of 7.75 km and Puttenahalli Bird Conservation Reserve, located at the distance of 1.49 Km is present around the boundary of proposed PRR alignment.

7.11.1.3 Petroleum pipeline alignment

In the proposed PRR alignment, part of the area at chainage from 28+000 km to 31+700 km to near Bileshivale, Vaderahalli, Rampura and Aduru villages has an underground petroleum pipeline running parallelly along the proposed PRR corridor. This petroleum pipeline is operated by an Organisation Petronet MHB Limited. Petronet MHB is a joint venture promoted by M/s Hindustan Petroleum Corporation Limited & Oil & natural Gas Corporation Limited. This pipeline carries a petroleum product, takes off from Mangalore Refinery located in Dakshina Kannada District,

Karnataka State. The pipeline passes through 237 villages & 17 Taluks under administrative jurisdiction of Dakshina Kannada, Chikkamagalur, Hassan, Mandya, Tumakuru and Bangalore rural & Bangalore urban Districts of Karnataka State.

Among the identified 4 villages, Rampur village at the chainage 30+700 km to 31+000 km is the nearest village coming close to the underground petroleum pipeline at the distance of 6 metres. The Rampur village belongs to Doddagubbi Panchayat of Bangalore East Taluk. As per 2011 census, this village has a total population of 3,190 people. The village is inhabited with residential settlements with a majority of RCC type structures and agriculture is being the predominant occupation.

The pipeline intersects the proposed PRR alignment in two areas near Chikkabanahalli village belonging to Bangalore East Taluk and at Kasaghattapura village belonging to Bangalore North Taluk. The pipeline intersecting at Chikkabanahalli village is surrounded by plantations of Eucalyptus and Coconut. The nearest villages located at this point is Chikkabanahalli, located at 650m and Kannamangala, located at around 450m distance away from the intersecting area.

At Kasaghattapura, the pipeline intersecting area consists of the plantations of Coconut and Banana. Nearest villages present at this intersecting area is Kasaghattapura located at 470m and Pakegowdana palya located at 630 m away from the intersecting area. The drawings showing the MHB Petronet alignment along with proposed PRR alignment are enclosed as Annexure-25.

7.11.2 Mitigation measures to be adopted during construction phase

7.11.2.1 Tool box meeting

Toolbox safety meetings keep the employees alert to work related accidents and illness. It helps to alert employees to workplace hazards by preventing accidents and illness on the job injuries. The meeting involves groups of people who work together and are prone to such injury risks. Toolbox meeting improve workplace safety and health, provides information and instructions, identification of hazards and deciding the action to be taken to reduce the risks. Following practices will be followed to ensure that:

- Toolbox meetings and trainings will be conducted on site on a weekly basis by safety managers and supervisors about safety, do's and don't during construction.
- On spot practical skill development training on safety including scaffold safety, crane safety, welding safety, electrical safety and traffic safety will be conducted for all foremen/ workmen prone to such risks.
- All vehicle drivers including Hydra operators will be trained on defensive driving.
- Efforts will be made to promote awareness towards safe work practices. Display of various safety communication posters/signages will be made to create safety awareness among the workforce.
- Contractor shall ensure that all workers use of personal protective equipments in the workplace and have undergone safety practices training.
- The contractor will ensure availability of safe corridors and safe crossings of pedestrian and bicyclists where paving activities are located in inhabited areas. The contractor will ensure installation of barriers, traffic calming devices, signs, signals and markings to avoid pedestrian from crossing hazardous sections.

7.11.2.2 Prevention of accidents

- Heavy equipments are handled by using certified lifting equipments like cranes.
- Manpower employed to handle heavy materials shall be trained to handle heavy material lifting activities and safe practices to be following during the operation of heavy metal lifting.
- Workers shall be communicated with the information of hazards and safety precautions to be followed during the lifting activity.

- Use of personal protective equipment such as gloves, safety shoes, hard hats will be ensured
- Lifting capacity of the vehicle shall be inspected and driver competency to handle the lifting equipment's shall be checked before initiating the activity.
- Heavy object lifting permit shall be followed prior initiating the work.
- Workers engaged in overhead works will ensure that work place is barricaded for unauthorized access.
- Proper training on hoisting/lifting equipment, its maintenance, equipment lifting procedures and proper use of ladders will be ensured.

7.11.2.3 Prevention of fall hazards

The contractor will ensure that proper working platform is provided to worker carrying work at height during the construction phase of the project. The working platform will be erected and used that its components do not get accidentally displaced so as to endanger any person. Also, the platforms should be able to be dismantled easily in such a manner that no accidental displacements take place. A working platform shall be of sufficient dimensions to permit the safe passage of persons and the safe use of any plant or materials required to be used and to provide a safe working area. Following measures shall be ensured during construction;

- The contractor shall ensure that Scaffoldings are assembled, dismantled or significantly altered only under the supervision of a competent person and by persons who have received appropriate and specific training.
- Every scaffold will be braced by means of longitudinal and transverse bracing systems so as to form a rigid and stable structure.
- Where heavy wind or gale force are expected, it would be necessary to take special precaution and install additional ties to the scaffold to prevent overturning and collapse.
- Guide rails and toe boards will be provided for all working platforms to ensure safety for workmen.
- Falling materials and injuries to the workers and passerby will be avoided by fully covering the working platforms. Safety nets will be provided to cease any falling materials.
- The use of barrels, boxes, loose earth pads or other unsuitable objects as supports for uprights and working platforms will be avoided.
- Scaffolds on thoroughfares will be provided with warning light to make it clearly visible.
- Scaffold platforms will be frequently maintained by removing grease, paint, mud, gravel or plaster or any such material.
- Either sand or saw dust or other suitable material shall be spread on platforms to prevent slipping.
- During dismantling of scaffolds necessary precautions will be taken to avoid danger of collapse.
- When scaffolds are to be used to a great extent and for long period of time, they will be inspected frequently to ensure its soundness.

7.11.2.4 Prevention of accidents from hazardous chemicals spill during construction phase

- Use of epoxy strippers, solvents can cause skin irritation and harm the respiratory organs of the person handling these chemicals frequently. Hence, PPE's such as nitrile gloves, rubber gloves, with a cloth liner, and protective clothing will be used during the chemical handling. Splash proof goggles shall be used to prevent the chemical splash hazard to eyes during its usage.
- All the chemical storage containers are identified with hazard symbols/pictograms.
- Good ventilation shall be ensured to avoid the inhalation of vapors.
- Suitable respiratory protection equipment's will be used while handing chemicals
- Eye wash showers will be placed at the location of hazardous chemical handling to flush immediately with plenty of water in case of chemical contact.

- Accident Safety and Hazardous Chemical Spill Management Plan will be prepared by the contractor and implemented.

7.11.2.5 Blasting activities

It is necessary to undertake the following mitigation measures to avoid the impact of blasting in the surrounding areas;

- Controlled blasting will be employed to avoid noise and vibration.
- Blasting will be scheduled to avoid sensitive wildlife areas and comply with seasonal restrictions.
- Proper maintenance of the noise generating parts of the machines will be carried out.
- The periodical monitoring of noise levels and blast vibrations will be practiced.
- Proper blast design will be made to control ground vibration and fly rocks
- During blasting, other activities in the immediate vicinity will be temporarily stopped;
- Blasting activity will not be carried out during high wind speed and unfavorable atmospheric conditions.
- Blasting will be carried out only in daytime.
- Use of NONEL (Nonelectric Detonating System) will be preferred to use for blasting to reduce the vibration of the ground and disturbance to human and surrounding wildlife.

During blasting activity:

Trapping inside the excavation, fall inside the pit and side of foundation trench are some of the major risks to cause fatal accidents besides the work getting suspended for a considerable time which resulted in time over-run in the completion of the construction activities and the consequent cost over-run due to price escalation. Hence it is necessary that project executing contractors shall take the responsibility of the safety of the labourers to avoid such accidents during the event of blasting activities.

- Whenever the requirement of blasting operation arises, necessary safety measures and precautions as specified in IS: 4081-1967 on Safety Code for Blasting and Related Drilling Operation shall always be strictly enforced.
- All purchase, manufacture, handling, transport, storage and use of explosives shall be in accordance with Explosive Rules 2008 and IS standard: 4081-1967
- The Contractor shall keep and maintain all necessary records of blasting as required by the relevant acts, regulations and by-laws. These records shall be made available to the Superintendent on request. The Contractor shall conduct a survey of all structures within the region of influence of the proposed site of blasting to determine their pre-blast condition.

During handling and use of explosives:

- Handling of explosives will be avoided during thunderstorms.
- Any package containing explosives shall not be dragged, dropped or handled roughly and the packages will be opened at a safe distance and at a shielded location.
- Sparking metal tools will be avoided to open kegs of explosives.
- Smoking or utilization of matches, open lights, fire, flame, or any other device capable of producing sparks or flame will be avoided while handling explosives.
- Explosives will be placed away from places with exposure to flame, excessive heat and sparks.
- No person shall strike, tamper with, or attempt to remove or investigate the contents of a blasting cap or an electric blasting cap or attempt to pull out the crimped safety fuse out of a blasting cap.
- Children and unauthorized or unnecessary persons will not be allowed where explosives are being handled or used.

- The blasting powder, explosives, detonators, fuses, etc, shall be inspected before use and damaged articles shall be discarded with necessary precautionary measures.
- No attempt shall be made to reclaim or use the contents of explosives which have been water soaked, even if these have been dried out.

During drilling and loading:

- Blasting shall be carried out only, with the permission of the engineer-in-charge or experienced supervisor and workmen who are thoroughly acquainted in handling explosives and blasting operations.
- No drilling shall be started until previous holes in the blasted area are flushed with air and water.
- The blaster shall be competent and qualified by reason of his training, knowledge or experience in the field of transporting, storing, handling, and using of explosives and having a working knowledge of Rules and Regulations pertaining to explosives.
- While planning drilling operations for blasting purposes, consideration must be given with a view to avoiding the possibilities of land-slides after blasting.
- The bore hole shall be carefully checked for length, presence of water, dust, etc, with a wooden tamping pole or a measuring tape before loading. It shall be cleared of all debris before explosives are inserted.
- The face of rock shall be carefully examined before drilling, to determine the possible presence of unfired explosive. No attempt shall be made to drill at a site if undenoted explosives are suspected.
- The position of all holes to be drilled shall be marked out with white paint.
- The diameter of the bore of each hole shall be greater than the outside diameter of the cartridges of explosive. The line of detonating fuse extending into a bore hole shall be cut from the spool before loading the remainder of the charge. Use of short pieces of fuse shall be prohibited for detonation purposes.
- Surplus explosives shall not be stacked near working areas during loading.
- Loading and drilling shall not be carried out at the same time in the same area.
- A bore hole shall not be loaded with explosives after springing (enlarging the hole with explosives) or upon completion of drilling without making sure that it is cool and that it does not contain any hot metal, burning or smoldering materials.

Safety precautions followed in blasting activities:

All precautions necessary to prevent injury to persons and / or damage to property occurring as a result of explosive works shall be taken with particular regard to:

- a) Ensuring that all persons working within or entering the blasting site shall wear safety helmets and high visibility safety clothing, and are fully informed as to what other safety precautions are necessary and the extent of the possible fly rock zone.
- b) Ensuring that firing does not take place until all persons other than the shot firer have retired from within the fly rock zone to a place of safety, and an approved sequence of warning siren signals has been sounded.
- c) Having in place a system of communication between the shot fired and other personnel including the Site supervisor and traffic controllers, which system shall be effective during the period from the sounding of the first firing warning siren signal to the sounding of the all clear signal.
- d) Providing an approved shot firer's shelter which is safely positioned in relation to the blasting site, and ensuring that such shelter is used by the shot fired at all times when testing electric circuits and when firing.

e) Where the fly rock zone is accessible to the general public, ensuring that job personnel are stationed outside the fly rock zone, at all accesses, to warn persons of the impending blast and to prevent them from approaching closer than safety permits.

f) Advising all persons on adjacent lands of impending blasting operations well in advance of each blast (which advice shall include the signals to be used during blasting operations), and ensuring that such persons shall not be exposed to any danger or their property damaged as a result of the blasting operations.

g) Ensuring that buildings located adjacent to the blasting site are not subjected to excessive vibrations.

h) No person shall:

- Smoke while handling explosives, or within eight (8) m of a place where explosives are stored or being handled;
- Take or make an open flame in a magazine or within eight (8) m of a place where explosives are stored or being handled;
- Abandon or leave any explosive unattended except in a magazine or designated storage place;
- Commit a dangerous or careless act with an explosive or where explosives are stored or being handled; or
- Store explosives within eight (8) m of flammable liquids or compressed gas.

7.11.2.6 Measures to guard the pipeline from accidental damage at intersecting area

For pipelines crossing under the proposed PRR alignment, the concurrence from the pipeline operating organization will be obtained to ensure the proper protection is provided to the pipeline to avoid accidental damage during construction activities. Flyovers are proposed at intersecting locations to avoid impact on pipelines.

In addition to this, special precautions are necessary at such locations to safeguard the carrier pipe by passing it through an additional oversize pipe termed a "Casing Pipe". This casing pipe will avoid any mechanical damage to pipeline present in the proposed PRR alignment, casing installation is carried out with the support from pipeline operating organization Petronet MHB. For the case of pipelines crossing in a busy road or highway, metallic casing is preferred as per API RP 1102 protocol.

The basic purpose of providing a casing is to relieve the carrier pipe from external load due traffic movement, to provide a path for leaky products to escape from road crossings and also to enable the leaky pipe to be replaced beneath the road surface. The casing pipe shall be designed to capable of withstanding the pressure equal to that of carrier pipe. The casing pipe shall be of steel, cast iron or reinforced cement concrete and have adequate strength and be large enough to permit ready withdrawal of the carrier pipe. Ends of the casing shall be sealed from the outside, so that it does not act as a drainage path.

Also, the concrete culvert of suitable size designed to accommodate the suitable load at both construction and operation phase of the PRR project shall be used to protect existing pipeline from the vulnerable to damage.

7.11.2.7 Risk assessment and Hazard management for petroleum pipeline

Hazard identification and Risk assessment is carried out to identify the potential modes in which the accidental leakage of petroleum pipeline may occur in case of system failure and to estimate the risk of the damage to the public living in the vicinity of the identified villages.

- Pipeline design

The entire pipeline along the project boundary is laid underground. The diameter of the pipeline is 20 inch made up of carbon steel as material of construction. The pipeline is designed to transport High Speed Diesel (HSD) and Motor spirit (MS)/superior Kerosene oil (SKO). At present, the pipeline is carrying only an HSD petroleum product. The pipeline passing along the PRR boundary is going to end at Transmix Reclamation Unit present at Devangonhi Terminal, located at Hoskote Taluk of Bengaluru Rural Dist.

The underground pipeline is designed as per ASME – B – 31.4 & OISD - 141 Guidelines. The design pressure of the underground pipeline is 70.6 Kg/cm². The entire pipeline has a protection system with 3 LPE external Coating & impressed current cathodic protection system.

SCADA (Supervisor Control and Data Acquisition), a computerized system is incorporated in the process to ensure smooth and safe operation of the system. Through this system, any leakage in the pipeline shall be immediately detected by the Computer system and product pumping shall be immediately cut off for safe shutdown in case of any emergency.

- Risk and hazards due to accidental contact

The Petronet MHB pipeline is located 6 m away from the proposed PRR project boundary in a location Rampura. The pipeline will pass along the PRR parallelly and only at 2 locations, the pipeline intersects the proposed PRR alignment. Hence, the risk and hazard assessment are carried out, by considering the worst-case situations to ascertain the nature of impact to the public present in the vicinity of the PRR project area.

At present, the Petronet MHB pipeline is carrying only an HSD petroleum product. The High-Speed Diesel is a flammable category of hazard which is ignited by sparks, its vapors are heavier than air and will collect in low areas, its runoff may lead to pollution and its vapors may form an explosive mixture with air. In order to effectively respond to a pipeline leak, spill or fire, it is essential that the emergency responders are aware of the hazards and risks associated with the incident. Following are the type of hazards associated with it;

Table 7.8: Identification of types of hazards near petroleum pipeline area from the PRR

Activity	Risk	Impact	Control measures
Soil excavation activity near to pipeline area, Burrowing of earth, Movement of Heavy machineries, Blasting activity.	Accidental damage to petroleum pipeline causing, spillage of petroleum products namely High Speed Diesel,	Expose to flammable petroleum products	Consultation with Petronet MHB authorities shall be done strictly before initiating the excavating activity near to the pipeline area.
	fire hazard due to presence of ignition sources nearby,	Fatal accidents due to the explosion.	Mechanical excavation will not be carried out
	flow of petroleum products into nearby drainage system,	Burn injuries to the inhabitants of surrounding area.	Blasting shall be strictly prohibited surrounding the pipeline area.
	Contamination of nearby surface water bodies lakes,	Fire hazard due to vapor cloud explosion Contamination of lake	Emergency preparedness plan shall be implemented and followed. Onsite emergency mock drill shall be done periodically with all workers and sub-contractors considering the events of Emergency spill response and containment actions.

Following necessary precautionary measures shall be taken to avoid the accidental contact to the petroleum pipeline from the various activities being carried out during the construction phase of the project

1. Consultation with Petronet MHB authorities shall be done before initiating the construction activities to seek the necessary precautionary measures to be followed to avoid the accidental contact of petroleum pipeline.
 2. During the construction phase, entire PRR boundary passing along the petroleum pipeline will be walked periodically for routine inspection to ensure that no unauthorized activities are taking place that could damage or otherwise affect the pipeline. Sensitive sections will be patrolled with the highest frequency. Some of the important aspects to be checked during the inspection are:
 - Any breaches and soil erosion along the route of the pipeline especially earth washouts from the pipe supports.
 - Any leakages
 - If there is any digging or ploughing in the vicinity of the pipeline which may result damage to the pipeline supports due to mechanical interference.
 3. Prior to any work on site, the Contractor will examine the site and identify any existing structures, pipelines, cables etc., particularly buried facilities, by using metal detectors or alternative techniques approved by the Company. Daily patrolling in the area of petroleum pipeline shall be carried out.
 4. Mechanical excavation will not be allowed near to pipelines
 5. The area adjacent to petroleum pipeline shall be always kept clear and free from unwanted materials and debris.
 6. Safety consciousness among the PRR contractors and workers will be enhanced about the hazards of petroleum pipeline running in the vicinity of the PRR project area. Trainings will be carried out to be taken up to educate and sensitize the staff on risk and hazard management of petroleum pipeline.
 7. The Project will maintain liaison with all landowners along the pipeline route and with Petronet MHB authorities to track the pipeline area along the PRR boundary. Any changes in PRR alignment during the course of construction here, the same shall be informed to Petronet MHB authorities for the required facility and protection of pipelines.
 8. Nearest landowners will be kept informed about any restrictions that apply to the land during the construction phase of the PRR near to the pipeline.
 9. Appropriate signs, night warning lights, reflectors etc. shall be installed to advise traffic and to maintain a safe working environment for the performance of the work.
 10. The ROW of the pipeline shall always be free from permanent structures, trees and identified with a marker sign.
 11. Toll free number provided as an emergency helpline from the Petronet MHB 1800-425-33-000 shall be communicated and displayed at the prominent locations in the project site.
- Steps to respond in case of accidental leakage

A. Secure the scene:

- Isolating the hazard area and denying entry to unauthorized persons, including other responders shall be ensured. It may be necessary to evacuate everyone in the danger area to a safe location upwind of the incident area.
- Stay clear of vapors, fumes, smoke and spills
- Avoid walking or driving into a vapor cloud or puddle of liquid.
- Avoid standing near manholes or storm drains.

- Prohibition of vehicles or mechanized equipment not approaching the scene until the isolation zones has been established. Vehicle engines are considered a potential ignition source.
- Utilization of appropriate air-monitoring equipment to establish the extent of vapor travel

B. Establish isolation zones and set up barricades

Isolation zones and barricades prevent unauthorized people and unprotected emergency responders from entering the hazard area and becoming injured. Emergency controller will be contacted immediately to activate the local emergency response plan. The 24-hour emergency phone number of the Petronet MHB pipeline station listed on a marker sign located on the ROW of pipeline present along the road will be called. The control center will immediately act to isolate the emergency. Control center personnel may provide additional information about the pipeline product and its hazards. Also, other local emergency response departments like Fire tender, District administration, Police department will be notified.

It is necessary to provide pipeline control center personnel with the following information:

- Call-back number, contact name (usually the Incident Controller from PRR contractor)
- Detailed location, including street or road, village name, nearest landmark)
- Type of emergency: fire, leak, vapor
- When incident was reported
- Any known injuries
- Other officials on site: police, fire, medical, etc.
- Surrounding exposures/sensitive areas
- Any special conditions: nearby school, hospital, etc.
- Local conditions: weather, terrain

C. Respond to protect people, property and the environment

The protection of people is always the highest priority. Protective actions involve the steps taken to preserve the health and safety of emergency responders and the public during a pipeline incident. While the pipeline operator concentrates on the pipeline, the responders concentrate on isolating and removing ignition sources and moving the public out of harm's way.

D. Rescue and evacuate people

- Evacuate or shelter-in-place as necessary, providing instruction and frequent updates to the public while evacuated or sheltered-in-place.
- Administer first aid and medical treatment, as needed.
- Enter the area only when wearing appropriate protective gear, Fire Fighters Protective Clothing, helmet, coat, pants, boots, gloves and hood and a Positive Pressure Self-Contained Breathing Apparatus (SCBA).

E. Eliminate ignition sources

Elimination of ignition sources such as electrical motors, firearms, vehicles, mobile phones, emergency radios, cigarettes, construction equipment, personal electronic devices, static electricity, open flames or sparks which causes additional exposure or great risk. Other precautionary measures include shutting down the power in the area of incident, parking all the emergency vehicles at a safe distance beyond the isolation zone (upwind), avoiding the utilization of sources causing ignition or sparks.

F. Fire control

In case of evidence of fire from the leaked pipeline, extinguishing a primary fire can result in explosive re-ignition. Unless it is necessary to save human life, flammable fires line operator advises to take the following actions;

- If the fuel source is not shut off and the fire is extinguished, leaking oil can migrate away from the pipeline and find an ignition source. Let the primary fire burn, eliminate potential ignition sources. Cool surrounding structures, equipment and vessels.
- Do not inhale fumes, smoke or vapors.
- Once the primary fire is out, beware of hot spot re-ignition.
- Ensure, the pipeline equipment is not operated until the fire is controlled and leakage is repaired

G. Leak control

In addition to the hazards such as flammability, toxicity and oxygen deficiency, liquid pipeline leaks and ruptures can create major problems with spill confinement and containment. Establishing barriers to prevent leaks from spreading to water sources, storm drains or other sensitive areas may minimize the impact. Basic containment devices such as sandbags, sorbents rolls etc. can be used to prevent the migration of petroleum products on land or on small streams. If a leak is accidentally ignited, firefighting should focus on limiting the spread of fire damage, but in no circumstances should efforts be made to extinguish the fire until the source of supply has been cut off or controlled.

H. Co-ordination with Petronet MHB Authority

Protection of life is always the highest priority. Pipeline operators will work with local emergency responders to eliminate possible sources of ignition for a leak or vapor cloud and to limit or contain the spill. Communication and coordination are the key elements of every response effort. Information on oil leakage will be disseminated to other Organizations.

- Emergency Response Plan

The Emergency Response Plan, include detailed communications arrangements, for dealing with the emergency that could affect the site. This include where applicable, injury, sickness, evacuation, fire and spillage.

The Emergency Response Plan is prepared to deal with emergencies arising out of spillage of petroleum pipeline caused from accidental contact during the construction phase of the project.

All personnel are required to understand their roles and responsibilities described in the Environmental Management Cell (Chapter-9) and undertake training and instruction necessary such that they are competent to carry out their roles and responsibilities. Mock drills shall be conducted periodically to check the effectiveness of the EMC members in rendering their performance in the event of real emergency. The Emergency respond measures will be followed under the command and control of the Engineering Member.

Table 7.9: Emergency contact details in case of accidental damage to petroleum pipeline

Sl.No.	Emergency contact details	Contact number
1	Petronet MHB Limited, Toll free number	1800-425-33-000
2	Petronet MHB Limited, Devangunthi station, Hoskote, Bengaluru	080 - 27904234/ 27945069 / 27902361

3	Police control room	100
4	Banaswadi Fire station	080 2297 1540
5	Hoskote Bangalore rural Fire station	080 2793 4470
6	Whitefield Fire station	080 2841 110
7	Sarjapura road Fire station	080 2574 6166

7.11.3 Safety measures during construction phase

- Washroom areas will be maintained clean with an access to proper sanitation facilities, conveniently located and sufficient latrines and urinals which are accessible to workers at all times.
- Accommodation facilities provided will be adequately lighted and ventilated.
- All walkways will be kept clear and unobstructed at all times
- Measures will be taken to ensure that no spillages of oil and grease occurs in the construction camp
- Proper drainage system will be maintained to prevent stagnant water.
- Metal bins will be used to store oily and greasy rags.
- Storage of flammable materials in appropriate bins, racks or cabinets. Metal bins used to store oily and grease rags will be covered with lids.
- Hazardous/dangerous chemicals kept in the stores are provided with the appropriate labeling, display of the material-safety-data-sheet (MSDS)
- "No smoking" signs will be displayed in areas with high fire risks such as paint stores, wood working areas, etc. The provision of a potable water supply, cooking fuel and toilet facilities shall be made as per the stipulated guidelines of the Indian labor Act.
- All the workers have to be supplied with potable drinking water at all times without affecting the water availability and supply to nearby communities
- Provision of first aid facility will be provided in the construction camp
- Periodical health check-up of the workers will be arranged by the contactors to ensure good health. Especially for those involved in working at hot mix plants and with bitumen pavers, health checkups for monitoring benzene content in their blood, especially before and after the construction will be ensured.
- Provision of day crèche shall be made at construction sites,

7.11.4 Emergency preparedness during construction phase

The Contractor shall prepare an Emergency Response Plan for all work sites. The plan shall integrate the emergency response plans of the Contractor and all other subcontractors. The Emergency Response Plan shall detail the Contractor's procedures, including detailed communications arrangements, for dealing with all emergencies that could affect the Site. This include where applicable, injury, sickness, evacuation, fire, chemical spillage, severe weather and rescue. The contractor shall ensure that an Emergency Response Plan is prepared to deal with emergencies arising out of:

- Fire and explosion
- Bomb threatening, Criminal or Terrorist attack
- Collapse of lifting appliances and transport equipment
- Collapse of building, sheds or structure etc.
- Drowning of workers
- Gas leakage or spillage of dangerous goods or chemicals
- Landslides getting workers buried floods, earthquake, storms and other natural calamities.

Arrangements will be made for emergency medical treatment and evacuation of the victim in the event of an accident or dangerous incident occurring, the chain of command and the responsible

persons of the contractor with their telephone numbers and addresses for quick communication will be adequately publicized and conspicuously displayed in the workplace. Measures will be taken from the contractors to tie-up with the hospitals and identify the fire stations located in the neighborhood for attending to the casualties promptly and emergency vehicle kept on standby duty during the working hours for the purpose. Onsite emergency mock drill will be conducted periodically for all workers and sub-contractor's workers. It shall be the responsibility of the contractor to keep the Local Law & Order Authorities informed and seek urgent help, as the case may be, so as to mitigate the consequences of an emergency.

7.11.5 Anticipated impacts during operation phase

7.11.5.1 Accident prone Zone

Accidents on the roads resulting in serious injuries and fatal casualties are attributed to the poor geometry of the roads, negotiating sharp curves and bends without adequate signage. The main cause of the accidents is mainly due to the negligence of drivers. The proposed "Peripheral Ring Road" is 65 km long pass through plain terrain for most length.

The various causes of road accidents are:

- Road users - Excessive speed and rash driving, violation of traffic rules, failure to perceive traffic situation or sign or signal in adequate time, carelessness, fatigue, alcohol, sleep etc.
- Vehicle - Defects such as failure of brakes, steering system, tyre burst, lighting system.
- Road Condition - Skidding road surface, pot holes, ruts.
- Road design - Defective geometric design like inadequate sight distance, inadequate width of shoulders, improper curve design, improper traffic control devices and improper lighting.
- Environmental factors - unfavorable weather conditions like mist, snow, smoke and heavy rainfall which restrict normal visibility and makes driving unsafe.
- Other causes -improper location of advertisement boards, gate of level crossing not closed when required etc.

7.11.5.2 Hazardous chemical spillage during the operation phase

Releases of hazardous materials and other emergencies such as fires that pose a significant threat to health, safety and environment by their nature require an emergency response or the mitigating factors to fight with the situations. Examples include:

- Fire, suspected fire, explosion, or other imminent danger.
- Conditions that are immediately dangerous or have the potential to become immediately dangerous to life or health.
- High levels of exposure to toxic substances.

Severity of hazard is such that the person(s) in the work area is uncertain they can handle the emergency with the personal protective equipment (PPE) and response equipment that has been provided and/or the exposure limit for the PPE could easily be exceeded.

7.11.6 Mitigation measures to be adopted during operation phase

7.11.6.1 Accident prone zone

Various methods of accident mitigation will be followed in the proposed PRR project as below

- **Design improvement at curves and to road geometry:** Provision of adequate sight distance at curves and road junctions will be maintained
- **Street lighting:** Street lighting facility will be provided at frequent intervals in the express road and also in-service road having an illumination range up to 40 lux. Besides improving the safety

- Sign boards - "Accident ahead" - 3 nos., "Lane merging" - 3 nos., "Direction Arrows" - 3 nos., "Speed Limit" boards- 3 nos., "Keep left/right" - 2 nos.(all signs 1200 mm size and of retro-reflective type (micro prismatic cubecomer).
- Sign Stand set (one for triangular and other for circular sign)-6 sets.
- Flags, whistle, reflective hand signal.
- Traffic cones 500 mm size with solar bulb mounted on top.
- Barricades-4 nos. reflective type, tape, stands, flags of 600 mm by 600 mm made of good red cloth secured to a staff at 1m length, paddles all east 600 mm wide and provided with rigid handle with markings SLOW, STOP.
- Reflective Jackets

As a minimum, each patrol vehicle should carry sufficient communication equipment to render its staff capable of direct communication with the Control Room.

The team deployed in each patrol vehicle, shall provided with adequate training for their tasks, especially in first aid, vehicle maintenance and minor repairs.

Table 7.10: List of hospital identified along the PRR for post-accident emergency care

Sl.No	Name of the hospital	Contact number
1	Police Control Room	100
2	Yelahanka fire station, Bengaluru, Karnataka	080 22796680
3	Banaswadi Fire station	080 2297 1540
4	Hoskote Bangalore rural Fire station	080 2793 4470
5	Whitefield Fire station	080 2841 110
6	Sarjapura road Fire station	080 2574 6166
7	Sapthagiri Hospital, Hesarghatta Main Rd, Navy Layout, Chikkasandra, Chikkabanavara, Bengaluru	080 2839 3392
8	Navachethana Hospital, Opp. Rail wheel Factory, 3rd B Cross Road, Yelahanka New Town, Bengaluru,	080 4248 0000
9	Sai Hospital, R.K. Hegde Nagar, Bengaluru Hennur road	080 2844 3062
10	Chris Super Specialty Hospital, Hennur Junction, Grace town, Kalyan Nagar, Bengaluru	080 4558 5558
11	Geetha Hospital, Old Madras Rd, Muneshwara Layout, Virgonagar, Aavalahalli, Bengaluru, Karnataka 560049	080 2847 3042
12	Silicon city Hospitals, M V Extension, Hoskote, Karnataka 562114	080 2971 6659
13	Columbia Asia Hospital Whitefield Main Rd, Varthur Kodi, Ramagondanahalli, Bengaluru	063668 14477
14	Baba Vims Specialty Hospital, Vijaya Lakshmi Colony, Kadugodi, Whitefield, Bengaluru, Karnataka 560067	080 2845 1119
15	Columbia Asia Hospital Sarjapur Road, Sarjapur Main Rd, opposite Iblur, Amblipura, PWD Quarters, Ambalipura, Bellandur, Bengaluru	080667 56565
16	Ramakrishna Smart Hospitals, Konappana Agrahara Village Begur Hubli, Electronic City, Bengaluru, Karnataka 560100	080678 00300
17	Springleaf Hospital, Konappana Agrahara, Electronic City, Opp. Infosys Convention Centre, Hosur Main Road, Bengaluru, Karnataka 560100	074111 22555

7.11.7 Hazardous chemical spillage during the operation phase

Any emergency situation with respect to vehicular accidents causing, spillage of oil or other hazardous materials is required to develop 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.

Transport emergencies can occur anywhere and at any time. Therefore, it is critical to the success of any transport emergency response that an appropriate emergency Organisation structure is set up by the PRR operating agency. All personnel who are members of the emergency response team must be well trained and competent to handle the situation in as professional a manner as possible. The areas to be covered include:

- Planning and understanding the lines of communication, both internally and externally.
- Equipment preparedness.
- Stabilization of the emergency at the scene
- Recovery of the vehicle and equipment.
- Dealing with the media.
- How to quickly return to normal operation.

During the event of an accidental spill occur, the applicable emergency spill procedure such as stopping the flow; removing ignition source; initiating emergency response; cleanup and safe disposal will be followed. It is very important that all members clearly understand their duties, responsibilities, and chain of command.

A chart identifying the team members should be made available at the scene of the incident. It is very important that all team members be well trained and back-up members are clearly identified. There should be regular emergency drills with different scenarios so that the team can gain experience in dealing with different emergency situations and the usage of emergency equipment. Team members should be selected on the following criteria:

- Medically certified where required.
- Live within short distance from the plant so that they can be called up quickly.
- Can be easily contacted both on and off duty.
- Ability and willingness to attend drills and training.

An overview of the emergency response activities flow is shown below.

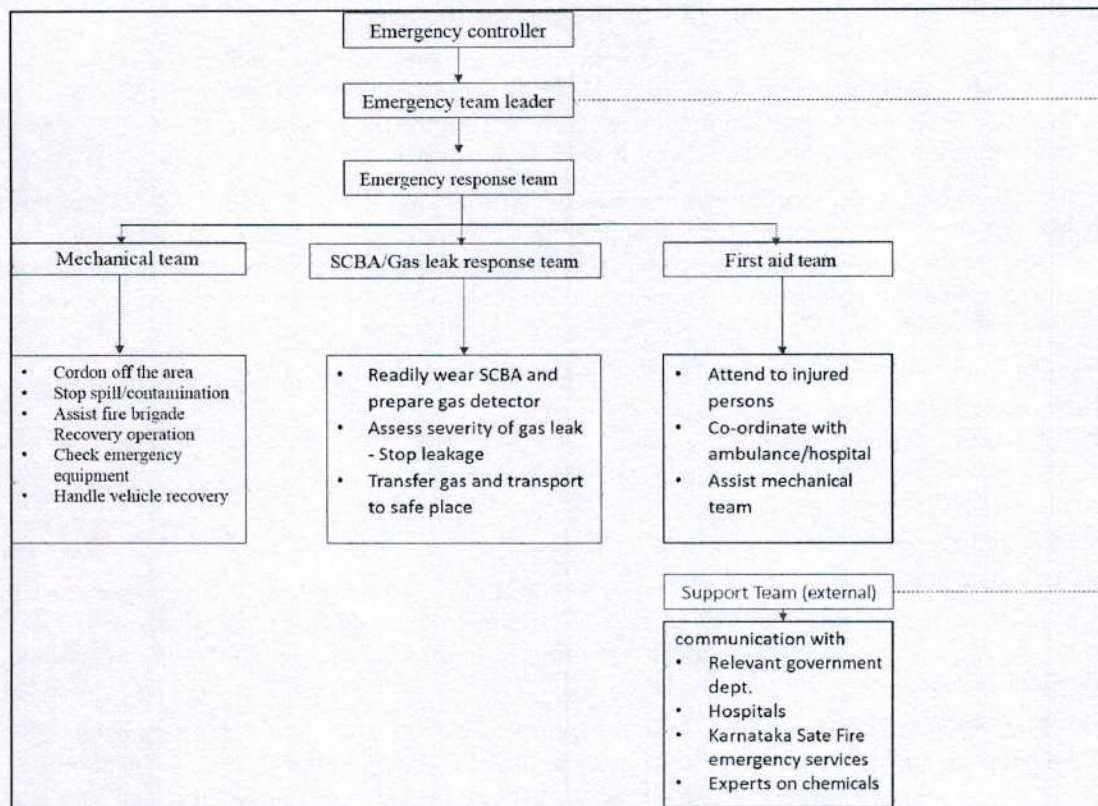


Fig 7.3: Emergency Response Activities flow chart

In the event of an incident the crew shall

- Ensure all preventive measures to curb product spillage/leakage
- Inform local police, fire Brigade, and concerned administrative department of spillage location.
- Alert passers-by and cordon off the area
- Communicate to the concerned oil/chemical company & the transporter
- Upon receipt of information from the concerned oil/chemical company, mobilize emergency plan and resources to the site, contacts local administration / mutual aid members (Fire Brigade) for necessary support

A. Responsibility of Emergency controller

The emergency controller is the sole person in charge of an emergency situation, to whom all other emergency team members report. The controller's main duties are:

- Upon receiving a serious incident report, assessing whether the situation calls for deployment of the emergency team to the scene of incident.
- Informs key management personnel and company spokesperson of current situation and reports periodically if the situation escalates.
- Decide whether the situation calls for assistance from public emergency services such as the fire brigade, highway police, ambulance and transport safety centre.
- Goes to the scene of the incident, identifies himself/herself as the emergency controller, and sets up an "Emergency Control Centre" (at a safe distance and up wind from the incident scene).
- Instructs public emergency team on what assistance is required from them. Public services must be briefed on the hazards associated with the transported gas or chemical.

- Handling the media if the company spokesperson is not at the scene.
- Making the announcement ending the emergency upon dealing/controlling the emergency situation.
- Ensuring a proper clean-up operation in the area to declare it is safe and environmentally stable to return to normal.
- Gathers data for full incident investigation.

B. Responsibility of Emergency team leader

- Assembling the emergency team members and briefing them on the situation.
- Assesses the situation and plan how best to tackle the emergency situation.
- Directs the emergency response team and co-ordinates with the public emergency teams.
- Continuously reporting to the emergency controller until the situation is under control.
- Takes control of the clean up operation; gets additional assistance or equipment from the plant or from public services if required.

C. Emergency response team

The emergency response team can be organized as a single team, but it is recommended that it be divided into Mechanical team, SCBA/Gas leak response team (SCBA: Self-Contained Breathing Apparatus) and first aid team.

D. Emergency equipments

Appropriate transport emergency equipment will be made available to be transported to the scene of emergency at the earliest. The equipment required varies depending on the hazards associated with the type of dangerous goods transported, however, the minimum equipments required includes; two sets of SCBA and spare oxygen tank, appropriate type of gas detector and spare sensors, chemical suits, spill control kit, portable fire extinguishers, safety vests, walkie talkies, tools such as hammer, crowbar, axe etc, safety cones and triangles, personal protective equipments, first aid kit.

In addition, each member of the emergency team should carry a small transport emergency response kit containing hard hat, cryogenic gloves, safety goggles, spark-proof torch, safety shoes, reflective vest and emergency contact list.

E. Procedure to clean the spills

In case of any accidental spillage, the emergency response team must follow the applicable emergency spill procedure which is practical and safely possible to control the situation and then get help.

F. Stop the flow

Ceasing the flow involves avoiding its entry into the water body, shutting down the equipment, closing valves and plugging hoses.

G. Remove ignition sources

- Shutting off the vehicles and other engines
- Not allowing tiger torches, vehicles, smoking or other sources of ignition near the area.
- Keeping a fire extinguisher at an accessible distance in case of potential ignition.

H. Contain the spill

- Identify the chemical spilled by referring the labeling mentioned on the tank. If there is no evidence, contact the transporter/ sender to ask for MSDS of the chemical spilled and emergency spill handling plan.
- Wear proper personnel protective equipment
- Spread absorbent or place a spill blanket on the spill to contain

I. Clean-up and disposal

The emergency respond team shall ensure that a proper cleanup and disposal method is carried out. Absorbent pads will soak up the spilled material, storage of absorbent pads in a contained manner and removal from site for disposal to a licensed (authorized) facility. Further, the cost estimate for adopting the above-mentioned mitigation measures and EMP are given in Chapter -9.

7.11.8 Pedestrian safety

7.11.8.1 Along intersections, subways and flyovers

Pedestrian facilities will be planned, designed, operated and maintained so it is usable by everyone, including those disabilities or using mobility aids. IRC: 103-2012 guideline will be followed to design the pedestrian facility. Care will be taken to provide the facilities to pedestrian to not only along the roads and intersections, but also at the areas like workplaces, access to transit areas, markets, schools etc.

The pedestrian facilities provided shall comply with the following physical characteristics

- Foot path surface: An even surface without cracks or bumps for comfortable walking. All surfaces will be stable, firm and slip resistant.
- Footpath width: The footpath will be wide enough to accommodate pedestrian flow at any given point of time.
- Obstructions: The location of garbage bin, electric pole and any other features like signage etc., will be on one side of the footpath so as to give a clear walkway to the pedestrian.
- Potential for vehicle contact: The foot path will be segregated from roads, where fast moving vehicles plu. Raised footpaths and the guard rails will be considered to protect the pedestrian from vehicle conflicts.
- Continuity: The continuity of the pedestrian facility is important for the disability and old age. Provision of Kerb ramp will be considered for continuity of the footpath.

The pedestrian facility will be provided on both sides of the road and above level of the carriageway separated by kerbs. Height of the kerb at the edge will not exceed the standard public riser i.e. 150mm. The width of the kerb ramp will not be less than 1200mm. Width of footpaths will be determined based on the street hierarchy and ROW, land use and pedestrian traffic and as per the universal accessibility design. Generally, the minimum width of 1.8m width walking zone with clear from obstructions will be followed considering the nature of area. No utility ducts, utility poles, electric, water or telecom boxes, signage or any other obstruction will be placed in the walking zone.

The guard rails will be provided with the proper height and the obstruction to visibility. The visibility of approaching vehicles by the pedestrian as well as the visibility of the pedestrian by the drivers of the approaching vehicles should be adequate. Pedestrian guard rails will be either the reinforced cement concrete/steel channeled sections/iron tubes/polymer fiber railings. Guard rails will be provided on sides of the carriage way and service road so as to channelize the pedestrian on to the planned crossing locations.

7.11.8.2 Pedestrian safety at intersections

- At intersections, the curve portion of the footpath will be widened to reduce the distance of crossing. This helps in creating extra space, avoids vehicles halting at intersections, and improves visibility of vehicle drivers and pedestrians. Where curb extension not possible, smaller turning radius should be provided to slow down vehicles taking the turn. This would provide safety for pedestrians crossing the road
- At intersections, railing barriers will be provided to prevent people from crossing the junctions diagonally. The barrier must open only at planned crossing facility (at ZEBRA crossing). A signalized junction will be provided for sufficient length to guide the pedestrian to the nearest planned pedestrian crossing.
- To clearly detect the guard rail, guard rail should be 1100mm high from the median level and painted to contrast for easily detectable by persons with low vision. The guard rails on the footpath will have rounded top to prevent injuries.
- Pedestrian Refuge islands of adequate size will be provided at intermediate locations for separate road segments and where length of crossing is two lanes or more, to protect pedestrians from the traffic flow and vehicles taking U-turn at the junction.
- Crossings will have proper signage and illumination. Reflective paint markings will be used for high visibility.
- The shortest possible direct route will be considered to cross the roads.
- Guide strips will be constructed to indicate the position of pedestrian crossings for the benefit of people with visual disabilities.
- Pedestrian traffic lights will be provided with clearly audible signals for the benefit of visually impaired pedestrians.
- Pedestrian signals will be provided at some intermediate crossings between junctions
- Pedestrian signal should be at such location and height that it is clearly visible to pedestrians waiting at the beginning of the crossing and while they are walking on the designated crossing path
- The zebra crossing will be provided with a clearly specified track with the help of alternate black and white stripes. The ZEBRA crossing will be accompanied by STOP line as per IRC: 35-1970 guidelines.

7.11.8.3 Pedestrian safety at flyovers and subways

- Adequate lighting will be provided on footpaths for visibility and safety of pedestrians especially in subways with emergency lighting.
- Footpath will be wide enough to ensure clear walkway of minimum 1500mm or as per the IRC 2012 guideline.
- Footpath on flyovers will be maintained with free from obstacles/hazards like broken poles, improper drain covers, signage boards and uneven surface posing a hazard to pedestrian traffic.
- Guardrails with suitable material of construction will be provided with the proper height on the flyovers as per the IRC standard
- Water drainage arrangement will be provided and floor always maintained in a dry state.
- Subway should have necessary provision for dewatering in case of heavy water ingress.
- Cleanliness should be maintained on a regular basis.
- Prominent signages will be provided to direct pedestrians to the subway.
- Proper waterproofing will be done to prevent water seepage

7.11.9 Training on Management System

Training is one of the most important components within company's safety management system. It gives employees an opportunity to learn their jobs properly, bring new ideas into the workplace, reinforce existing ideas and practices, and it helps to put our Safety and Health Program into action.

The management leadership will direct the organization to establish, implement, and maintain the health and safety management system in its occupational process. All necessary funds and time will provide to ensure effective safety and health training is provided to the management team and subordinates. Both management and employees will be involved in developing the safety program in the project. To most effectively carry out their safety responsibilities, all team members must understand

- Their role in the program,
- The hazards and potential hazards that need to be prevented or controlled, and
- The ways to protect themselves and others.

The above goals will be achieved by including the following contents in the training, which will be received from the competent training organization on periodic basis.

- Educating everyone on the natural and system consequences of their actions;
- Educating all managers, supervisors and employees on delegating their safety management system responsibilities, roles, accountability and to establish health and safety policy at the workplace
- Educating all employees about the specific hazards and control measures in the project; training all employees on hazard identification, analysis, reporting and control procedures; and training all employees on safe work procedures and practices.
- Developing the programs to integrate the safety in the design stage itself and throughout the processes by implementing the Management of Change procedure (MoC). This improves the safety and quality of changes by ensuring that a standard methodology is used to handle all changes and control the impact upon the day-to-day operations, also to reduce the potential for change induced incidents by providing a standard, formal, approach to handling a change i.e. in selection of equipment design, selection of facilities, adopting best practices and technology resources.

7.11.10 Hazard identification and risk assessment

Assessment of the potential for unplanned consequence of events leading to an accident during construction phase is assessed through Hazard Identification and Risk Assessment (HIRA) tool. Risk is rated based on likelihood of various consequences. A risk matrix is prepared based on findings of likelihood of an event with various consequences involved is given below:

Risk Rating = Probability x Severity			Consequence / Severity				
			Insignificant / Negligible	Minor/ marginal	Moderate	Major/ critical	Severe/ catastrophic
Likelihood/ probability			1	2	3	4	5
	Highly Unlikely	1	1	2	3	4	5
	Unlikely	2	2	4	6	8	10
	possible	3	3	6	9	12	15
	Likely	4	4	8	12	16	20
	certain	5	5	10	15	20	25

Based on calculated risk rating, level of a risk and emergency can be defined in the event of accident. Risk rating from 1 – 4 indicates low; 5 – 12 indicates medium; 15 – 25 indicates high risk category.

Hazard Identification and Risk Analysis is carried out for the various steps involved in the construction phase of the project and is shown in below table;

Table 7.11: Hazard Identification and Risk Analysis during construction stage

Sl. No.	Risk	Impact	Mitigation measure	Probability	Severity	Risk level
1	Fall of trees on the pedestrians, commuters during tree removal activities	Fatal accidents	Surrounding area of the tree cutting area shall be barricaded	3	5	H
2	Use of electrical equipment's like temporary lightings, electrical tools and equipment's	Electric shock hazard to the public	Electric wires shall be regularly checked for insulation of wires especially placed near steel items & damp areas. Good quality wire with joints free will is used in all electrical equipments. Fencing around the electrical equipments shall be made. Caution signage boards will be displayed to keep the public away. Regular inspection and maintenance of electrical equipments will be carried out.	3	5	H
3	Operation of cranes	Electric shock hazard due to contact with high tension lines and live electric pole contact	Job safety analysis shall be carried out before heavy object lifting works to mitigate the risk of energized electric lines. Competent person shall be allowed to operate the crane in presence of signal men.	3	5	H
4	Traffic congestion due to movement of vehicles	Respiratory diseases due to dust generation	Temporary asphaltation of roads will be carried out. Frequent water sprinkling activity will be carried out to avoid dust generation. Provision for temporary traffic diversions shall	3	3	M

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Sl. No.	Risk	Impact	Mitigation measure	Probability	Severity	Risk level
			be made on the paved and well compacted surfaces to avoid the interruptions to the flow of traffic and minimize the dust generation			
		Risk of accidents due to traffic congestion	Following safety standards such as erection of barricades, including signs, marking, flags, lights and flagmen for the formation and protection of traffic approaching or passing through the section of the road under construction. Ensuring the availability of safe corridors and crossings of pedestrian and bicyclists.	3	5	H
5	Activities of debris transportation	Respiratory diseases to surrounding communities due to dust generation	The debris shall be secured with tarpaulin covering during transportation. Overload of debris into vehicle shall not be allowed	3	3	M
6	Excavation of surface area	Fall of pedestrians, commuters in the excavated area	Excavation area will be provided with steps of minimum 500mm offsets and also planking and strutting will be done. The area will be well barricaded & a red lamp provided at night. A watchman should be deputed to prevent any movement of persons or vehicles	3	5	H
		Electric shock due to contact with underground high voltage power lines	Before taking up the work all available drawings, available signages will be studied, local enquiry will be made to know the	3	5	H

Sl. No.	Risk	Impact	Mitigation measure	Probability	Severity	Risk level
			position of cables and work in such area will be executed under strict supervision of an experienced supervisor.			
7	Handling and lifting of heavy materials	Injury to body parts	Heavy materials are handled by using certified lifting equipments. Use of proper personal protective equipments, gum boots, Helmet, Ear plugs, air mask and goggles. Tool box talk will be provided to the labours periodically by the contractor agency.	4	3	M
		Generation of noise due to heavy vehicle operation, working with jack hammer, joint cutting machines, vibrators etc	Practice of work rotation system, use of ear muffs to workers exposed to loud noise.	3	3	M
8	Preparation of cement mortar for concreting,	Injury to body parts	Protective footwear, goggles and clothing to all workers engaged in concreting activities	2	3	M
9 ^r	Painting activities in the road lanes	Damage to skin due to solvents handling. Fire hazard in painting materials storage area	Hand gloves, respiratory mask, goggles will be used. Painting chemical will be stored in dedicated container with authorized person access. Material safety data sheets will be displayed and hazardous information will be communicated to the workers handling painting activities. No hot work activities will be carried out near to painting material storage area.	3	4	M

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Sl. No.	Risk	Impact	Mitigation measure	Probability	Severity	Risk level
10	Welding activities	Injury to eyes and body parts due to welding.	Welders will be provided with protective eye shields to workers who are engaged in welding works	2	3	M
11	Storage of oils, bitumen, diesel and any other form of chemicals	Fire hazard	Use of protective clothing, hand gloves, goggles, gum boots when working with mixture of asphalt and solvents. Material safety data sheets will be displayed at storage sites. Good ventilation shall be ensured and inhalation of vapours avoided. The storage area shall be provided with secondary containment to contain the spillage.	3	4	M
12	Working at height during overhead works	Fall hazard	Work place is barricaded for unauthorized access. Provision of fall arrest measures such as use of safety belts, helmets and proper use of ladders.	3	5	H
13	Dismantling activities of heavy materials, scaffolding, barricading sheets etc during demolition work etc	Fall hazard, hit hazard	Area will be barricaded for the restricted entry. Screens made up GI sheets shall be placed wherever necessary to prevent the flying pieces from injuring the workers. Safety Helmets conforming to IS 2925 to all the workmen engaged in dismantling work. Leather or rubber gloves will be used during demolition of RCC work.	3	4	M
14	Movement of vehicle carrying hazardous chemicals, hazardous	Exposure of commuters to Hazardous chemical due to accidental	Emergency preparedness plan addressing the situations like vehicular accidents, causing	3	4	M

Sl. No.	Risk	Impact	Mitigation measure	Probability	Severity	Risk level
	waste	spillage. Fire hazard due to chemical spillage	release of oil and chemical spills will be prepared and followed			
15	Presence of labor camps in the project site	Spread of epidemic disease due to waste water stagnation	Septic tank and soak pit will be provided to handle the waste water	3	5	H
		Fire hazard from the solid waste generated from the camp	Waste segregation shall be done and handed over to recycler.	2	4	M
16	Gas cutting operations	Fire hazard and explosion hazard	Ensure the non-return valve, flash back arrestor, and pressure gauges. The gas cylinders shall be transported in trolleys	3	5	H
17	Column form work, Pier and Pier Cap Formwork, Formwork for Edge beam/Parapet for flyovers and bridges	Fall hazard	Safe access arrangement from the ground will be provided, working platform will be provided throughout the perimeter. 'Work at height' warning signage will be displayed. Surrounding area will be barricaded in the ground	3	5	H
18	Handling of bituminous during surface works	Burn hazard, Asphalt fumes may cause fatigue, poor appetite, throat and eye irritation, carcinogen	Mandatory use of PPEs such as Gumboots, respirators, helmets, hand gloves, Goggles, apron. Accidental spill control measures will be taken. Affected area will be cleaned immediately after spill	3	4	M
19	Pedestrians crossing the road at intersections, subways and on flyovers	Moving vehicles may not to pedestrians causing fatal accidents	Signal system will be followed in the busy areas to give way for pedestrians with the sound alarm, Guide rails will be provided in congested locations to guide the pedestrians to ZEBRA cross	2	5	M

Sl. No.	Risk	Impact	Mitigation measure	Probability	Severity	Risk level
			Pedestrian refuge island will be provided in intersection area to slow down the vehicles during turn. ZEBRA crossings will be provided with a clear marking			
20	Fall of tree branches on pedestrians and vehicle commuters on service road	Physical injuries to body parts, fatal accidents	Periodic trimming of trees to remove the dried branches will be planned in co-ordination with local municipal authority. Area will be barricaded during the tree trimming activities. The activity will be carried during the non-peak hours	3	5	H
21	Road repair and maintenance activity	Vehicle hit hazard to the workers engaged in road maintenance activity	The area of road maintenance will be barricaded guarded by the flag men. The vehicle commuters shall be warned in advance at sufficient distance with a clear marked lane. Workers will be trained for the risk associated in road maintenance activity. Use of personal protective equipments like reflective jackets, helmets, safety shoes will be provided	2	4	M
22	Presence of potholes on roads	Vehicle accidents	Periodic inspection will be conducted to check for the potholes or any damage in the roads. Maintaining the adequate materials in stock to repair the damaged potholes.	2	5	M

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Sl. No.	Risk	Impact	Mitigation measure	Probability	Severity	Risk level
23	Providing Bus bays in service roads	Accidents to bus commuters/passengers from the other vehicles	Separate lay bye will be provided for bus stands to facilitate segregation and improve visibility. Road separators guiding the bus to the bus bay will be provided	2	4	M
24	Accidents of hazardous vehicles	Spillage of hazardous chemicals posing risk and health hazard to the commuters	Deployment of trained emergency respond team to handle the hazardous material got spilled in safe manner. Emergency equipment's (refer section 7.11.7) will be provided to handle the spillage.	3	5	H

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Chapter

8

PROJECT BENEFITS

The primary objective of the PRR is to provide better access to city commuters and thereby decongesting the city traffic. Further, the project also helpful in various means which are as follows;

Improvements in the physical infrastructure:

- Project will boost economic development activities viz., industries, educational institutions, hospitals, information technology development, housing and other infrastructure projects, etc.

Improvements in the social infrastructure:

- Enhanced connectivity between rural and urban area of north and east parts of Bangalore Many villages where PRR alignment is passing through doesn't have proper road network and access to city. The project will bring substantial socio-economic development in the region.
- Better access to various places reduces travel time of commuters and thus quality of life will be improved.
- Improved access to higher education facilities & modern health facilities.
- The project provides linkage to internal arterial roads and new urban roads will be developed due to the project.

Employment potential:

- Direct and Indirect employment opportunities during construction and operation phase will be increasing.
- The project will generate 300 employment (50 Skilled, 100 semiskilled and 150 unskilled) during construction phase and 300 employment (120 Skilled, 100 semiskilled and 80 unskilled) during operation phase. Further, due to the road development many indirect jobs will be created.

Other tangible benefits:

- Construction of PRR will provide better connectivity for the commuters accessing various national and state highways including BIAL.
- The project is planned as a requirement for the future of Bangalore city traffic beyond ORR.
- Traffic congestion inside the Bangalore city will be reduced and thus helps in reduced heat highland effects.
- The project acts have a bypass for long distance traffic moving interstate.
- Decrease in travel time reduces pollution levels.
- Accidents will be considerably reduced due to proper road safety aspects.
- Vehicle operation and maintenance cost will be considerably reduced.

Sl.No	Attribute	Action Plan	Reference Document	Implementation	Concurrent responsibility
		<ul style="list-style-type: none"> 500 m away from waterbodies / nala / streams RO purified drinking water shall be supplied LPG for cooking shall be provided Mobile STP shall be established to treat the sewage generated from labor camps Proper sanitation facilities such as latrines, urinals, bath rooms shall be provided separately for both men and women First aid facilities, canteen, health care, day care facilities for children shall be provided as per the guidelines. 	Workers (Regulation of Employment and Conditions of Service) Act, 1996		
8.	Sourcing of fly ash	<ul style="list-style-type: none"> While transportation of fly ash, adequate conditioning shall be done with water to avoid escapes to air borne and becomes fugitive dust. Provision of free board shall be made in the truck sufficiently to ensure spillage / overflow The speed limit of vehicles carrying fly ash shall be 40 Kmph. Transportation of fly ash in thickly populated area shall be avoided as much as possible. It should be stored in covered and designated place to avoid getting air borne. 	<p>IRC: SP-58-2001 Guidelines for Use of Fly ash in Road Embankments.</p> <p>Guidelines for disposal/utilization of Fly Ash for reclamation of Low-Lying Areas and in stowing of Abandoned mines/Quarries, CPCB, 2019.</p>	BDA & Contractors	Energy Dept., GoK
9.	Storage of construction materials	<ul style="list-style-type: none"> Provision of barricade Provision of sand flooring for storage of lubricants, oil, petrol, diesel, etc 500 m away from labor camps Provision of Damp-proof flooring for 	IS 4082: 1996 Stacking and Storage of Construction Materials and	Contractors	BDA

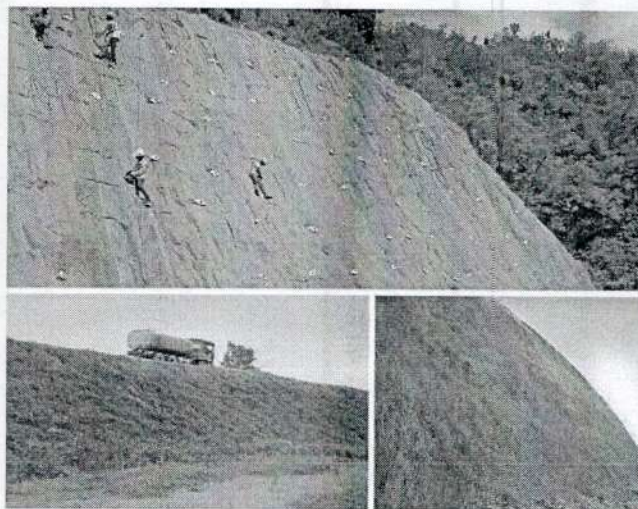
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Sl.No	Attribute	Action Plan	Reference Document	Implementation	Concurrent responsibility
		cement storage	Components at site - Recommendations		
r 10.	Traffic management	<ul style="list-style-type: none"> Provision of safe route shall be ensured for livestock's, farmers, pedestrians, etc connecting to project corridor Temporary Traffic control plan shall be prepared by contractor in consultation with Bangalore city police and inform the local public for its implementation. The construction activities shall be planned phase wise to make full utilization of plant and machinery. Site clearing and excavation shall not be done on either side of the cross roads until making provision for re-routing of existing traffic. Sourcing of construction materials to the working sub sections shall be done during night time so that day traffic shall not be altered. Proper traffic signages, markings, flags, lights and flagmen shall be ensured while re-routing the traffic. 	IRC:SP-55-2001 Guidelines on safety in Road Construction Zones	Contractors & BDA	Bangalore City Traffic Police

10.2 Construction phase management

10.2.1 Top soil management

The road projects start with site clearing and during this stage, soil is vulnerable to erosion. Contractor shall in consultation with identify a designated place for top soil storage. This area shall preferably away from drainage paths. The slope of the stockpiles shall be kept at 1:2 with a height restriction of 2 m. These stockpiles shall be stabilized within 2-4 days with geotextile mats¹¹⁶ and grass seeds to avoid erosion. To avoid any further erosion, temporary drainage facility shall be provided around the stockpile which is connected to a pit. As and when requires, top soil shall be used for redevelopment of borrow areas, embankment and turfing, plantation activities, restoration of labor camps, etc. The other soil erosion control measures for slope stability and embankment include;



- During slope stability heavy cuts shall be avoided as much as possible. The height of the embankment shall be kept minimum to achieve the ruling grade such that use of earth work is minimum.
- The embankment slope shall be kept at 3:1 ratio
- Provision of interceptor ditches shall be provided to avoid surface run off during rainy season.
- When fly ash is used for embankment or for slope stabilization, it is necessary to ensure the provisions of filter bed and top cap.
- Use of geo textile mats and vegetative cover with grass shall be ensured.
- Regular maintenance shall be ensured when dislodging of anchorage or stones.

10.2.2 Borrow area management

Borrow areas are integral part of any highway development project. Borrow areas will be identified by the contractors and BDA by following the due procedure as detailed below;

- Borrow area shall be 1 Km away from habitations / villages and 500 m away from water bodies.
- Waste lands shall be identified and cultivable lands shall not be considered for borrow area.
- Project authorities shall ensure that there is no vegetation in the borrow area.
- The identified borrow area shall at least 50 away from approach road.
- Complete fencing of the borrow area shall be ensured either with iron mesh or any other means to avoid entry of livestock, children, etc.
- Depth of soil cut in the borrow area should not exceed 2 m in any case and not steeper than 1:4 ratio.
- Provision of ridges of 8 m width shall be provided and there will be exit for every 300 m.
- Water shall not be stagnant in any case and by water shall be drained out every day during monsoon.
- Vehicles carrying earth to project shall have sufficient free board to avoid spillage and covered with tarpaulins to avoid spreading to air.
- Blasting shall not be encouraged.

¹¹⁶Photo source: www.terrearmeeindia.com

- Natural drains shall not be altered by any means.
- A berm shall be provided from the boundary of adjoining field having width equal to at least half of the depth proposed for excavation.
- In case if it involves cluster of borrow areas, there should be distance of 500 m from one to other.
- Temporary roads connecting to borrow area shall be watered every day (3 times a day) to avoid fugitive dust emissions affecting adjacent area.
- Restoration of borrow area will be undertaken soon after construction work complete by using the fill material available and or by using desilting of lakes nearby.
- MOEF&CC OM dt: 18.12.2012 and 24.03.2013 shall be ensured while implementation.

(Ref: IRC 10: 1961 Rev 1989 Recommended practice for borrow pits for road embankments constructed by manual operations, Clause 305.2.2.2 of MoRTH specification for roads and bridge works).

10.2.3 Land Acquisition, Resettlement and Rehabilitation Action plan

PRR project was under planning since 2004 and BDA in exercise of the powers conferred under sub section (1) of Section 19 of the BDA Act, 1976 and in exercise of the powers conferred in clause (c) of section 3 and 7 of the Land Acquisition Act, 1894, Government of Karnataka vide Government order no. UDD 399 MNX 2006, Bangalore dt: 29.06.2007 issued Final Notification for Land acquisition of 1036.51 ha in 77 villages.

The Hon'ble Supreme Court vide its Judgement dt:20.01.2022 clarified that since LA Act has been incorporated into the BDA Act so far as they are applicable, the provisions of 2013 Act are not applicable for the acquisitions made under the BDA Act. Therefore, the Land acquisition will be carried out as per the BDA Act, 1976 (as per the provisions of Land Acquisition Act, 1894)

BDA vide Government Order no. UDD 214 MNJ 2018 Bangalore dt: 21.02.2022, the land acquisition activities and compensation process will be carried out as per the Judgement of the Hon'ble Supreme Court or as decided by the Cabinet Ministry during Land Acquisition process.

10.2.3.1 Preparation of SIA

BDA has to submit the LAQ, R&R proposal to DC, Bangalore (Urban) District & Commissioner, R&R. Upon receiving the project documents, DC will constitute a team of experts to make field visit to verify the correctness of the proposal. Based on the report, DC will calculate the estimated expenses for acquisition, R&R including administrative charges. The DC will inform the BDA to deposit the cost of acquisition, R&R.

Within thirty days upon the deposits by BDA, the DC, Bangalore (Urban) District will notify the SIA. The SIA study will be conducted in consultation with the local authority and stakeholders in the affected areas, ascertain and record the views of affected families through public hearings; duly giving adequate publicity of the date and venue of the public hearings. SIA team will collect and analyses a range of quantitative and qualitative data, undertake detailed site visits, use participatory methods such as focused group discussions, anticipatory rural appraisal techniques and informant interviews in preparing the SIA report.

It includes detailed land assessment, based on a thorough analysis of all relevant land records and data, field verification and review and comparison with similar projects. Based on the land assessment, land records and field verification, the SIA will provide an accurate estimate of the number of PAF's and the number of PDF's among them and enumerate all affected families. A socio-economic and cultural profile of the affected area will be prepared, based on available data and consultations and where resettlement is required, the identified resettlement site/s will be visited and a brief socio-economic profile of the land and its currently resident population will be included. The SIA will identify and assess the nature, extent and intensity of the positive and negative social impacts associated with the proposed land acquisition.

Further, Social Impact Management Plan (SIMP) which will present the ameliorative measures to be undertaken to address the social impacts identified in the course of the assessment. It

should assess the viability of the impact mitigation and management strategies with clear with clear indication of the costs, timelines and capacities. SIA and SIMP are the outputs of the SIA process. It will be publicly disclosed, formally appraised, and widely read and reviewed before a decision is taken on whether or not to proceed with the proposed acquisition. SIA and SIMP documents must be available in the local language. Public review and feedback are mandatory before the finalization of the SIA Report and SIMP. Formal public hearing/s will be held in the affected areas with the specific purpose of presenting the main findings of the SIA, seeking feedback on its contents, and making sure that any omissions or additional information and views are incorporated into the final documents.

Public hearings will be conducted in all Gram Panchayats where at least twenty-five per cent of the members are directly affected by the acquisition. Date and venue of the public hearing will be announced and publicized three weeks in advance through public notifications, advertisements in local newspapers, radio, and through direct communication with Gram Panchayat or Municipal Ward representatives.

A member of the SIA team can facilitate the public hearing; designated Government officers like Gram Panchayat or Municipal Ward representatives will be included. Representatives from the BDA and designated land acquisition and R&R functionaries will attend the public hearing and address the questions and concerns raised by the affected communities. Political representatives, local NGOs/CBOs and media persons will also be invited to attend. The proceedings of the public hearing will be video recorded and transcribed. This recording and transcript will be submitted along with final SIA report SIMP.

After the required public hearing/s have been conducted, the SIA team will review all the feedback and information gathered, incorporate this into their analysis, and revise the SIA report accordingly. The final submission will be in local language and made available to all stakeholders and local authority officials. SIA conducted will be formally appraised by an Expert Group constituted as per the provisions of the Act, which will then make a written recommendation to the Government on whether or not the proposed land acquisition will proceed. Expert Group's recommendation will be made available in the local language to the all stakeholders. Then, Govt. will examine the SIA and expert committee recommendation if any, and take a decision on whether or not to proceed with the acquisition which would ensure minimum impacts directly or indirectly by the proposed project.

10.2.3.2 Process of Obtaining Consent

The prior consent provisions will not apply for acquisition in respect of the public projects for public purpose. Hence, this clause is not applicable to PRR.

10.2.3.3 Preliminary Notification for Acquisition

The Preliminary notification will be issued under the 11(1) and the DC will direct the revenue authorities to update the land records, delete the names of the dead persons, enter the legal heirs of the deceased families, etc. The DC after hearing objections and making enquiry under section 15(2) of the act, will submit the report along with recommendations to State Government for final decision.

10.2.3.4 Preparation of R&R scheme

Up on publication of 11(1) notification, the DC will authorize any officer or engage the service consultant or agency to conduct a survey and undertake a census of the affected families within the period of three months to list of likely PAF's land holdings and vulnerable communities etc. The data collected through SIA and Gram Panchayats or Municipalities and government records are put to verify through the site visits and door to door surveys to prepare a draft R&R scheme. A comprehensive draft scheme prepared by the administrator in addition to the particulars mentioned in the 16(2) of the Act, which should be make known in the affected areas through public notices and circulars about the scheme. The administrator will conduct the public hearing not earlier than the fifteen days of publication of the draft R&R scheme and not prior to

three weeks of published draft SIA & SIMP in Kannada. All the stakeholders will also be submitted a copy including the Commissioner R&R.

The powers, duties and responsibility of the administrator is to co-ordinate with all stakeholders and help agency to bring out a comprehensive reports, prepare a R&R scheme, publish the reports and conduct public hearing smoothly to monitor and supervise the studies and refer the matter to the Commissioner R&R for satisfactory fulfilment of the relevant provisions under the Acts related to R&R. On receipt of the R&R scheme within four weeks, the DC will convene a meeting with R&R committee at the project level, discuss the scheme and submit the scheme to the Commissioner along with the suggestions. After the scrutiny, the commissioner R&R will accord the approval and by the way of notice publish in the local daily newspaper of the affected areas to bring it to the knowledge of the people.

The DC or the authorized officer after the due enquiry into the claims and objections raised by the interested parties in pursuance of the public notice published under Act, make the land acquisition awards and R&R awards. The valuation of land, trees structure will be valued as on date of the Preliminary notification. The compensation will be calculated in accordance with the provision of the first schedule and second schedule of the R&R Act and rules.

If the amount of the award compensation includes less than five crores, the DC will declare the award and if its more than five and less than ten crore, DC will declare the award with previous approval of Regional Commissioner of Bangalore Revenue Division and if it is more than ten crore its awarded after getting approval of the State government, through Commissioner R&R. The DC will also recover any excess amount paid to the land owners due to the correction of the ward, after due notice. Lastly any difficulties arise in the interpretation of any provision of these rules or implementations of the rules, the state government will have the power to issue clarifications or remove necessary difficulties.

10.2.3.5 Present status

As a requiring body, BDA submitted the land acquisition, R&R proposal to DC (Land Acquisition) in February, 2020. The preliminary cost worked out for the proposal would be Rs. 9,318 Crores. However, during the process of SIA and preparation of R&R scheme and discussion with various stakeholders, the cost may be reviewed again.

10.2.4 Catchment area treatment plan

T.G Halli catchment area is under threat due to urbanization and developmental activities¹¹⁷. Hence, augmentation of catchment in the study area will be taken up by constructing water recharge structures for improvement of ground water level and soil moisture content. Further, extensive plantation activities will be taken up in the catchment as part of biological measures towards protecting the catchment (*Ref Doc. -Sujala-I and II, Watershed Development Dept., GoK*). Farm pond, check dams and percolation ponds are proposed as part of CAT. Further, the selection criteria for farm pond, check dams and percolation ponds are as given below;

Farm ponds:

- Farmers willingness for pond construction and to share harvested water with neighbours.
- Optimum catchment size for considerable storage and ensuring long period.
- Well-protected (treated) catchment for arresting rapid siltation.
- The command area near the pond should be free from salinity/alkalinity
- The site should require little land shaping around the pond.

¹¹⁷Comprehensive Assessment of T.G Halli Reservoir Catchment Area and its Preservation Zone, EMPRI, GoK, 2015

Chapter
9

ENVIRONMENTAL COST BENEFIT ANALYSIS

The Environmental cost benefit analysis was not included during scoping stage and hence, is not included in the EIA/EMP report.

Chapter
10

ENVIRONMENTAL MANAGEMENT PLAN

EMP provides a mechanism to address the adverse environmental impacts of a project during its execution, to enhance project benefits and to introduce standards of good practice to be adopted for all project related work¹¹⁵. The EMP measures include mitigation or enhancement measures as appropriate to the nature of impacts and are explained in the following sections.

10.1 Pre-construction activities management

Sl.No	Attribute	Action Plan	Reference Document	Implementation	Concurrent responsibility
1.	Finalization of RoW/ alignment	Width of the RoW was already finalized as per DPR. However, in order to avoid social or culturally important structures, a joint inspection will be convened by engineering and land acquisition team. At unavoidable situations, possibility of slight re-alignment may be verified.	DPR	BDA	Urban Development Dept., GoK
2.	Land Acquisition, R&R including CPR	Land acquisition will be planned in consultation with PAFs. R&R activities will be initiated by giving sufficient time to PAFs to relocate and to make alternate arrangements. NGOs will be involved in R&R activities to acts as bridge between BDA and PAFs. Shifting of CPRs will be undertaken in consultation with villagers / community harmoniously.	BDA Act, 1976 (as per the provisions of Land Acquisition Act, 1894)	BDA & NGOs	Revenue Dept., GoK
3.	Demarcation / Numbering of Trees	In consultation with DFO, Bangalore Urban District, KFD, joint tree marking within the RoW will be undertaken. An expert committee will be	Tree enumeration list and EIA report	BDA	Forest Dept., GoK

¹¹⁵<https://www.adb.org/sites/default/files/institutional-document/33739/files/environment-safeguards-goodpractices-sourcebook-draft.pdf>

Sl.No	Attribute	Action Plan	Reference Document	Implementation	Concurrent responsibility
		constituted for identification of trees for Trans plantation and their further monitoring.			
4.	Identification of borrow areas and quarries	<p>Sourcing of construction materials is from the Government approved quarries. However, following conditions are ensured while selecting the site;</p> <ul style="list-style-type: none"> ▪ Regular water sprinkling at site ▪ Trucks carrying stone/gravel/aggregate shall be covered with tarpaulins ▪ Dust suppression system is in place ▪ Use of sharp teeth for shovels ▪ Dust extraction system for drill machines ▪ Wet drilling and use of sharp drill bits ▪ Provision of Hoods / Chutes at transfer points ▪ Use of PPEs by workers ▪ Rubber pads / mats to reduce noise and vibrations ▪ Provision of Garland drains ▪ Safety precautions while handling blasting, explosives, magazine, etc ▪ Availability of mine closure plan <p>Further, borrow areas will be identified as per MoEF&CC guidelines. The environmental management at and around quarries and borrow areas will be detailed in Section 9.2.2 below.</p>	Karnataka Minor Mineral Concession Rules, 1994 and 2016	BDA & Contractors	Mines and Geology Dept, GoK
5.	Finalization of locations for erecting hot mix plants, crushers and batching	<p>While selecting the locations for erection of hot mix plants, crushers and batching plants following siting guidelines shall be ensured;</p> <ul style="list-style-type: none"> ▪ Two Km away from NH, habitats, temples, schools and river ▪ One and a half Km from SH 	Karnataka Regulation of Stone Crushers Act, 2011	BDA & Contractors	KSPCB & District Administration

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Sl.No	Attribute	Action Plan	Reference Document	Implementation	Concurrent responsibility
	plants	<ul style="list-style-type: none"> 500 m away from link roads Eight Km away from the limits of Municipal corporations Four Km away from the limits of District Head quarters Two Km away from the boundary limits of Taluk Head quarters One Km away from the limits of inhabited village or any land recorded as Forest in Government records or any private land which is shown as cultivable land in the revenue records <p>It is also necessary to ensure;</p> <ul style="list-style-type: none"> Complete barricading (30-40 ft) of hot mix plants, crushers and batching plants Regular Water sprinkling (2 hourly once in winter and summer season & thrice a day in rainy season depending upon precipitation) 3 tier plantations of fast-growing species like Gliricidia sepium, Leucaena leucocephala, Tecoma stans, etc Temporary garland drains 			
6.	Water for construction activities	20 KLD of Secondary treated water will be used for dust suppression activities and thus reduce the dependency on fresh water. Further, 30KLD/km of water required for construction activities will be sourced from BWSSB. An MoU will be entered with BWSSB to provide fresh as well as treated water for construction activities. The treated water quality shall comply with IS 456: 2000.	IS 456: 2000 Plain and Reinforced Concrete - Code of practice	BDA	BWSSB
7.	Labor camps	<ul style="list-style-type: none"> Labor camp shall be planned 1 K m away from human habitations 	Building and Other Construction	BDA & Contractors	Labor Dept, GoK

Check dams:

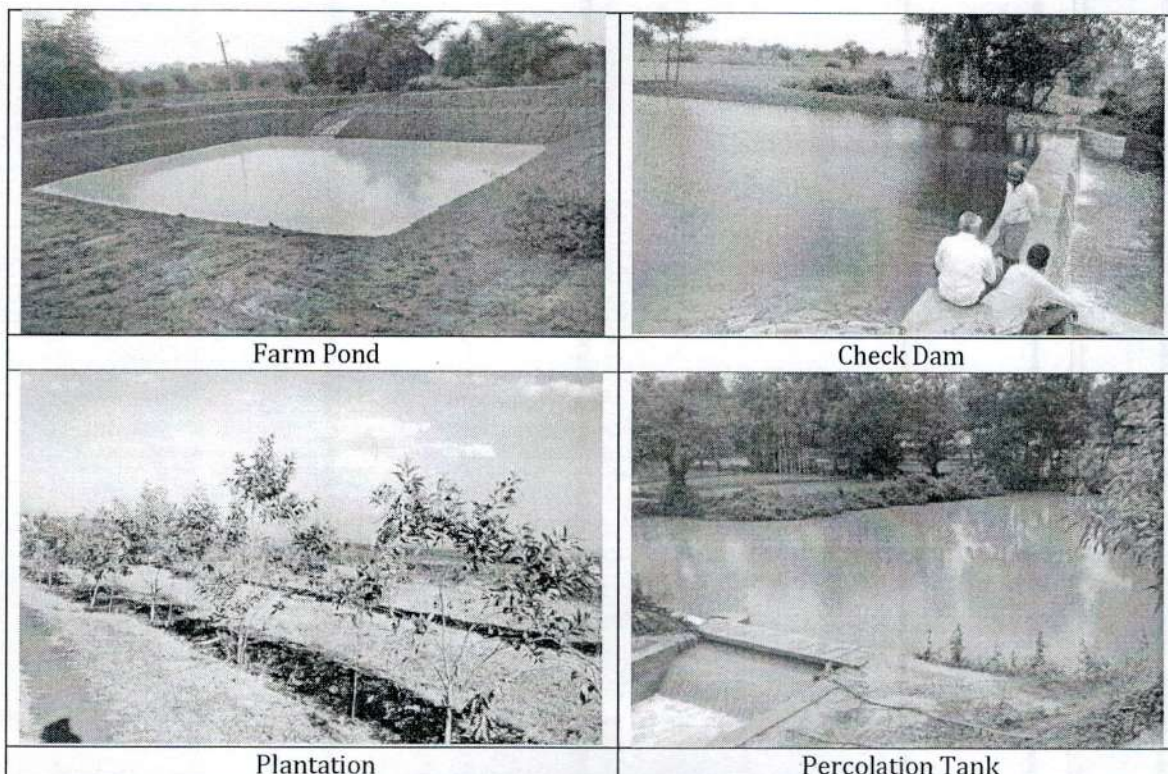
- Areas where farmers are using traditional irrigation by constructing temporary cross bunds on streams.
- Where the farmers are willing to take up operation & maintenance of the structure.
- The structure should be able to store a high volume of rainwater
- The check dam should provide a long length of stored water.
- There should be a high percentage of cropped area, or potential crop area, on either side of the length of the stored water.
- Risk of submergence of cropped lands during flash floods should be minimal.
- It should have a high cost-benefit ratio.

Percolation ponds:

- Should be constructed across natural stream.
- Impound water for a long time.
- Should be located upstream

Table 10.1: T. G Halli Catchment Area Treatment Plan

Sl.No	Particulars	No.	Unit Cost in Rs.	Total Cost in Rs.	Responsibility
1	Farm Pond	25	75,000/-	18,75,000/-	BDA & Watershed Development Dept., GoK
2	Check dam	10	1,50,000/-	15,00,000/-	
3	Percolation Tank	25	75,000/-	18,75,000/-	
4	Afforestation activities around Hesaraghatta, Byrathi lakes & government lands in the catchment	12,038 trees x 10 = 1,20,380	300/-	3,61,14,000/-	BDA & Forest Dept. GoK
Total				4,13,64,000/-	



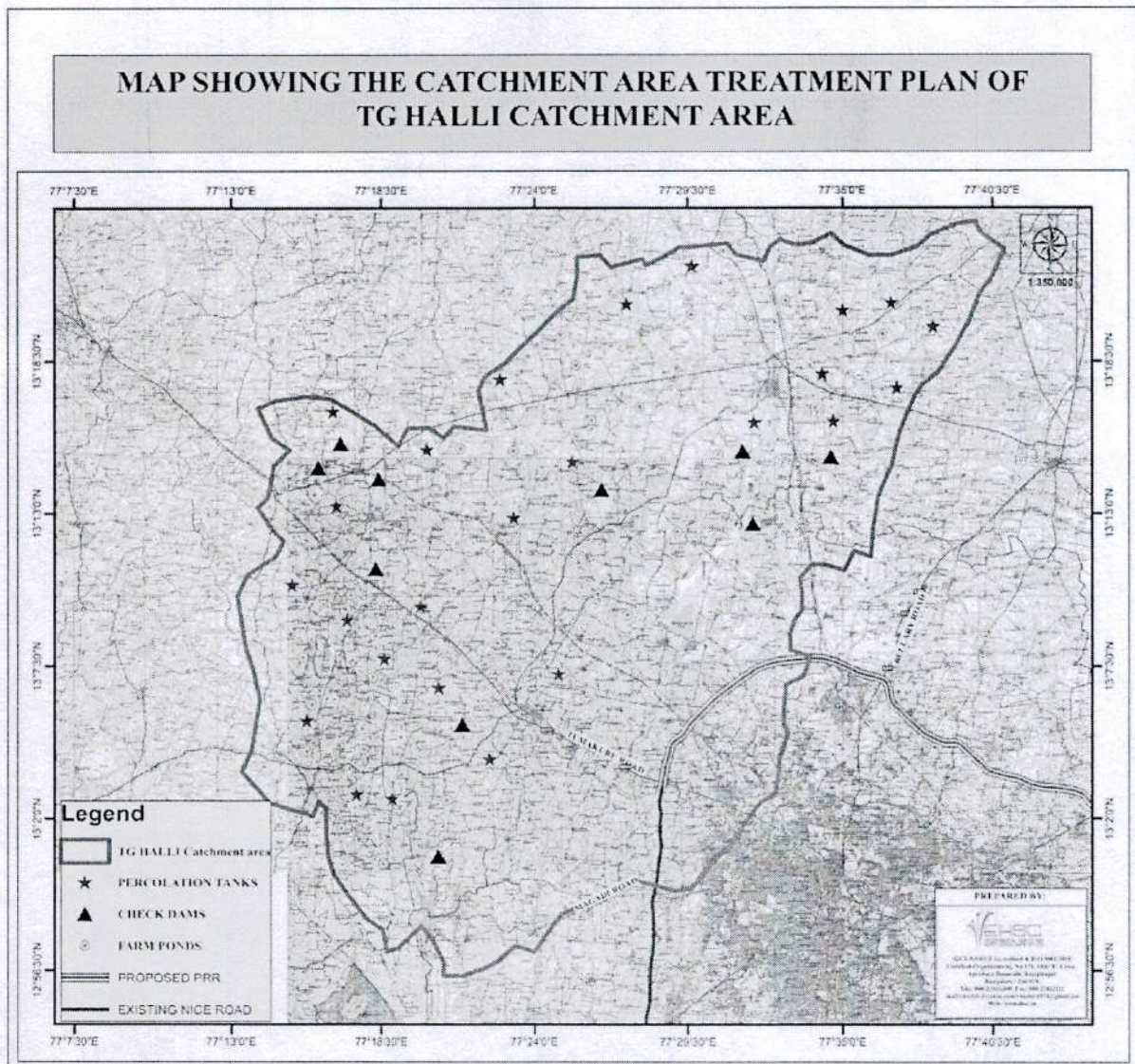


Fig 10.1: Typical catchment area treatment¹¹⁸

10.2.5 Ecological restoration plan

10.2.5.1 Green belt development

As part of green belt development program, reducing pollution, improving the local biodiversity and aesthetic values all along the project alignment, the plantation of several native trees will be carried out. The project alignment has recorded 36824 trees and requires removal of 32,175 trees. Out of which, 13,355 trees falls in T.G Halli Catchment area (20.9 Km). The ecological services provided by these trees are invaluable. As per Guidelines for National Green Highways Policy, 2015, IRC SP 21: 2009 and based on judicial orders of various courts in the country (S M Anantha Murugan v/s NHAI at Madras High Court, T.N. Godavarman Thirumalpad Vs. Union of India & Ors. and Cauvery Sene (Regd.), Medikeri Vs. The State of Karnataka at Principal Bench of NGT) and as a precautionary principle towards maintaining greenery around Bangalore city (WP No. 7288/2011 Suo moto v/s Government of Karnataka at High Court of Karnataka), 10 trees are proposed for plantation for each tree removal. Thus, it is required to plant, 3,21,750

¹¹⁸Photos Source: Watershed Development Dept., GoK

trees for the project. Out of 73.50 Km, 48+380 Km is available for plantation after deducting concrete structures. The details of plantation plan are as follows;

Table 10.2: Tree plantation plan

Sl.No	Designated area for plantation	Nos.	Cost in INR	Responsibility
1	On either side of the project alignment falling in T.G Halli Catchment (20.9 Km)	14,958	Considered above in Table-9.1	BDA
2	Outside the project alignment and within T.G Halli Catchment	1,05,422		BDA & Forest Dept. GoK
3	On either side of the project alignment (52.6 Km excluding 20.9 Km of the alignment falling within TG Halli Catchment)	39,270	1,17,81,000/-	BDA
4	Plantation in the designated places as suggested by KFD	1,59,503	4,78,50,900/-	MoU will be entered with KFD as per GNGH, 2015 (Annexure-26)
5	Transplantation proposed for 2597 trees and at 70% success rate	2,597	2,59,70,000/-	BDA & KFD
Total		3,21,750	8,56,01,900/-	

The planting techniques to be followed, criteria for selection of species for plantation and procedure for tree plantation and tree transplantation are given below and the list of species proposed for plantation is enclosed in Annexure-22.

Planting Techniques:

- The pit size for planting trees will be maintained at 60 cm x 60 cm x 60 cm.
- Top soil removed from the project area shall be re-used for filling the pit.
- The filling of soil will be completed at least 7 days prior to the plantation.
- 2 years old plants with good condition shall be opted for plantation.
- Two rows of green belt will be developed and shrubs will be planted at the median of the Road.
- The distance from embankment to Row I will be 1m and distance between the trees will be 3 m.
- The distance from embankment to Row II will be 4m and the distance between the trees in the Row II will be 6 m and the same will be maintained on the other side of the Road.
- The plantation needs to be monitored regularly by watering, weeding, application of manure and impart proper protection.
- Dead species will be replaced immediately.

Criteria for selection of species for Plantation:

- Catchment area Treatment : Fruit bearing, NTFPs,
- Project Alignment: Suitable to Agro climatic zone, Pollution attenuation, higher growth rate, Tolerant to extreme conditions
- Outside the project alignment: Agro forestry, Timber yielding, NTFPs, Fruiting, social and economic values
- For Transplantation: Cultural and social significance, higher success rate
- Around crushers / hot mix plant / batching plant: Pollution attenuation, higher growth rate, Tolerant to extreme conditions

Procedure for Tree Transplantation¹¹⁹:

1. Tools and Equipment's: Digging and root pruning tools shall be sharp and clean in order to cut without breaking, crushing or tearing roots. Mechanical digging and root pruning equipment shall be operated according to manufacturers' recommendations to minimize root damage. Lifting cables, chains, straps, and/or slings shall be inspected and used according to manufacturers' instructions and specifications.
2. Time for transplanting: Monsoon and winter are preferred. Very hot months i.e. April, May, and June should be avoided.
3. Pit Digging/ Tree Lifting: The tree transplanter works on hydraulic pressure generated by truck engine. Conical shaped 4 blades are arranged in such a way that it penetrates up to 5' m deep in soil with top dia - 9' & bottom dia 4". Once all the blades penetrate inside soil, then the earth ball is lifted above ground level, there by a pit is dug or a tree with root stock is lifted. The Tree transplanter comes in two models: 90D - Trees with basal girth 90 cm. can be lifted and 100D - Trees with basal girth 100 cm. can be lifted.
 - Trees above 100 cm basal girth cannot be lifted. Such trees can be transplanted with orthodox method.
 - Silviculturally, it is considered that trees having basal girth above 100 cm are mature or over mature. The vigour for survival in over mature trees is less compared to the younger tree.
 - It is advisable to water the area thoroughly two days in advance to facilitate easy working. Both the sides (up lifting the tree and transplanting site). During monsoon this may not become necessary.
 - Before working ensure that no underground development facilities are coming in the working zone.
 - To reduce the rate of evaporation, minimizing moisture requirement, facilitating transplanting mechanically it is advised that 1/3 of the crown height from ground level may be lopped during cold season. During hot period 1/2 of crown height may be lopped. The forester after considering the local condition may take appropriate decision. All the sites should not have any underground facilities like drinking water / drainage / gas lines, cables, RCC construction or hard rock.
 - While operation, all the precautions like, wearing helmet, not applying extra pressure beyond limit to the blades while penetrating, ensure stabilizing pad are placed at required position during operation and after operation.
 - Forked trees should not be allowed.
4. Tree Transport: Once the tree is lifted, then the entire bowl with tree is tilted to rest on the truck chassis. The branches should be either tide or trimmed properly to avoid any hindrance during transportation. Heavy traffic areas may require special assistance for road clearing.
5. Tree Transplanting: After reaching the destination the pit digging process is reversed and a tree is transplanted. The pit be treated with, Antitermite, antibacterial, antifungal treatment. (1/3 of the pit be filled with water, 50 grams of phorate powder, 30 ml. of antibacterial liquid, 30 ml. of antifungal liquid, 20 ml. root promoter (IBA solution), may be pre dissolved and poured in the pit). Add 10-15 kg. of organic manure (vermicompost/compost). After transplanting a ring bund of 2 m. radius be made manually and it should be watered thoroughly.
6. Post Transplanting Care: After transplanting it should be watered thoroughly. 2-3 watering per week during first month and then after 1 watering per week for 1 month is found suitable. It also observed at the leaves shed off in 1 month. New leaves sprout thereafter. In case of termite attack necessary treatment may be given.

¹¹⁹ Yashpal Kshirsagar, B. Palanikumar, T.V. Manjunatha, Sonal Vrishini and Kiranangadi. 2018. Tree Transplanting: Success Stories of Trees Transplanting at Karnataka, India. Int.J.Curr.Microbiol.App.Sci. 7(10): 2709-2716. doi: <https://doi.org/10.20546/ijemas.2018.710.315>

10.2.5.2 Compensatory afforestation

The project requires diversion of 7.73 Ha of forest land belonging to Jarakabandekaval RF which attracts the provisions of Forest (Conservation) Act, 1980. To compensate the forest diversion, 14.60 ha (36.10 acres) of land has been identified in Sy. No 156 of Mantapa Village, Jigani Hobli, Anekal Taluk, Bangalore Urban District which is adjacent to Bannerghatta National Park and found suitable for compensatory afforestation and management point of view. As per the prevailing guidelines of MoEF&CC and KFD, BDA has to pay NPV and cost for compensatory afforestation which is as follows;

Table 10.3: Cost estimate for forest diversion

Sl. No	Item	Cost in Rs.
1	NPV towards Diversion of 7.73 Ha of Forest Land (Eco Class IV- Tropical Thorn Forests, Open Forest - Rs. 4,38,000/- x 7.73 Ha)	33,85,740/-
2	Cost of Compensatory Afforestation (Rs. 3,00,000/- x 7.73 Ha)	23,19,000/-
Total		57,04,740/-

10.2.5.3 Schedule – I birds' conservation

As per the baseline survey Black kite, Brahminy kite and common buzzard were found in the project site. Similarly, Indian peafowl, Black shouldered kite, Black kite and Brahminy kite were found in the study area, belongs to Schedule I of Wildlife (Protection) Act, 1972. Except, Indian peafowl, all the species belong to kite family. It is impractical to prepare management plan for birds especially in urban landscape and difficult for Forest Department to implement also since avifaunal habitat is not confined to any particular area. However, as mandated conservation measures applicable to project site and possible by BDA is given below;

- BDA or its appointed contractors shall bind by the provisions of Wildlife (Protection) Act, 1972 towards conservation of wild animals and birds.
- Raising awareness about the importance of scheduled species birds of prey, their current plight and the threats that they face, and the measures that need to be taken to conserve them to project authorities and labors by experts in the relevant field.
- Every year, BDA shall provide financial assistance to at least 10 schools for undergoing site visit to Zoos, Wildlife Sanctuaries, Bird Sanctuaries, etc as part of environmental education.

Table 10.4: Cost estimate for conservation of schedule I species

Sl. No	Item	Cost in Rs.
1	Environment education & awareness to 20 schools in the study area (2 schools per year)	5,00,000/-
2	Financial assistance to schools (2 schools per year) for visiting Zoos, Wildlife Sanctuaries, Bird Sanctuaries	1,00,000/-
3	Financial Assistance to KFD for habitat improvement in Puttenahalli Lake Bird Conservation Reserve	10,00,000/-
Total		16,00,000/-

10.2.5.4 Aquatic life conservation

Herbivorous fish for the control of aquatic vegetation:

- Chinese grass carp- *Ctenopharyngodon idella* Valenciennes, a fast growing fish that feeds voraciously on many species of aquatic plants such as *Vallisneria*, *Hydrilla*, *Potamogeton*, *Apronogeton*, *Ceratophyllum*, *Chara*, *Elodea*, and other soft weeds grows to a size of 32 kg.
- African and Middle East Tilapia- *Tilapia zilli*, *T. rendali*, *T. guineensis*, South America's *Oreochromis mossambica* and Egypt's *Sarotherodon niloticus* can control varieties of aquatic weeds.

- Chinese's silver carp- *Hypophthalmichthys molitrix* Valenciennes consumes microscopic algae. Grows to a size of 15 kg; can thrive in eutrophic waters and the Big head-*Aristichthys nobilis* Valenciennes also displays these desirable characteristics.
- The Sandkhol, *Thynnichthys sandkhol* Sykes is often cultured in Malaysia. This species is available in India only in the Krishna-Godavari Rivers, also in Tungabhadra reservoir, Telangana, Andhra Pradesh and Karnataka.
- Indigenous herbivorous fish *Puntius pulchellus* (Day), present only in the Krishna-Godavari, Tungabhadra and Kumudavathi Rivers; also in the Madaga tank, and Anjanapur reservoir in Shivmogga District of Karnataka State. The species, in addition to soft aquatic weeds such as *Vallisneria*, *Hydrilla*, *Potamogeton*, *Cerateophyllum*, terrestrial submerged grass *Agrostis* spp., its roots, bark or submerged trees (Anjanapur reservoir) and on the roots of water hyacinth, *Eichhornia crassipes* also.
- For the supply of the fish species listed above, the Department of Fisheries in Karnataka (Nos. 1, 3 & 5) could be approached; for the first three Tilapia fish, letters may be addressed to the Director, National Bureau of Fish Genetic Resources, ICAR, Lucknow (UP); *O. mossambica* and *A. nilotica* are the only species in all the tanks of the State, some rivers and even in reservoirs. For *T. sandkhol*, the Director of Fisheries, Telangana could be contacted. The fish forms a good fishery in the Nizamsagar reservoir, Telangana.

Threatened fish species from the tanks needing rehabilitation:

Following fish species which were inhabiting the seasonal, long-seasonal and perennial tanks which were found in large numbers in good many situations few decades back, desires rehabilitation since these have disappeared to a very large biotopes in the district and elsewhere too. A nominal number of each of the species detailed below need only be introduced in order to stabilize their productive potentialities to increase their respective populations.

MINNOWS: *Puntius* amphibious, *P. chola*, *P. dorsalis*, *P. puckelli*, *P. sophore*, *Pethia ticto*, *Chela cachius*, *Amblypharyngodon mola*, *Esomus danricus*, *Rasbora daniconius*, *Osphromenus cupanus*.

CAT-FISHES: *Mystus vittatus*, *Clarias batrachus*, *Heteropneustes fossilis*, *Glossogobius girius*, *Channa marulius*, *C. Orientalis*, *S. striatus*, *C. punctatus* and *Mastacembelus armatus*.

All the fish species listed above, save *Puntius puckelli* are available in majority of lotic and lentic water bodies of the State, their young and adult sizes can be collected from tanks and other lotic water bodies located in the districts, Mysore, Hassa, Shivamogga, Chikmagalur, Kolar, Ballari, as also in such avenues located elsewhere. *P. buckelli* is one fish which till recently reported to be present only within the perimeters of Bengaluru district (Day, Francis, 1877-78). This is a very important fish species. Any time of the year, it can be arranged to be collected for rehabilitating in the tanks located, to begin with, Sankey tanks, Yelhanka tank and Hebbal tank.

Enrichment of tank fisheries:

The richness of wide spectrum of native (soft macrophytes) and fauna (fish species, in particular), insects and molluscan representatives in fresh water bodies is governed by their zoogeographical locations. Majority of these eco-resources are inter-connected and prevalence of fish species, in particular, is a common feature. Other than certain tanks which bore connections, during monsoon seasons, with the lotic water bodies located close-by, also harbour certain riverine, medium and minor piscine forms; also each of these had the distinction of nurturing and propagating the species, medium and minor carps, minnows, minor catfishes and certain predatory fish too. These had their own compatible coexistence and also propagating norms based on their self-practiced coexisting complimentary strategies. Since these biotopes never had the distinction of harboring fast growing Gangetic carp, also certain river fishes of economic importance, ideas flourished in a few technically based knowledgeable scholars who put into practice their vision by undertaking culture of the fish species acclaimed to be fast growing, together with certain river fish of economic importance also. Incidentally, the carp

fishes introduced in few smaller water bodies-tanks to be precise-had similar feeding habits as that of already existing minnows and weed fishes. Then, in order to enrich the fishery of the tanks, compatible and complimentary fish species, indigenous were transplanted. Farm grown fish fingerlings of the Indian major carp CATLA (*Gibelion catla*), ROHU (*Labeo rohita*), MRIGAL (*Cirrhinus mrigala*), as also exotic COMMON CARP (*Cyprinus carpio*) and GRASS CARP (*Ctenopharyngodon idella*) were introduced in few selected water bodies. These efforts produced encouraging results on augmenting considerable fish production strategies. The fish species, indigenous to these water areas since decades had a setback in the over-all population dynamics. Since, the Gangetic carp were unable in self-perpetuating their stock in these water sheets, the Exotic common carp enriched its stock by breeding, successful recruitment established itself quite well. Because of the competition for food and space, the introduced species had their major share and the species native to these habitats faced a severe set back in their respective populations and recruitments too. Later the intentional or inadvertent introduction of Exotic Tilapia species, *Oreochromis mossambica*, Nile Tilapia- *Oreochromis nilotica* and the highly predaceous catfish *Clarius gariepinus* made their presence felt influencing the food-spectrum and breeding/recruitment success in the areas these were there. The last three species, along with the Common carp, has already compounded the problems, not only in the lentic water bodies, also in majority of the lotic environments on account of their food habits and breeding /recruitment success.

Now in order to replenish the fish stock comprised of minnows/weed fishes, larvicidal fish, minor carps, minor and air breathing Channa species, efforts be made to introduce their stock by collecting then from riverine/reservoir stretches and also from tanks located in the adjoining districts, additionally, as an important developmental strategy to augment considerable fish production from good many perennial tanks and long seasonal tanks present in the districts of Bengaluru, efforts be made to introduce fast growing *Gangetic carp* -Catla, Rohu and Mrigal, as also herbivorous fish *Puntius pulchellus* (present in the Krishna-Godavari river systems and the exotic carp, *Ctenopharyngodon idella* so as to improve the stock, better utilization of fish food available and to retard the extinction/annihilation of native fish species. To a large extent, it is quite possible to enhance the productivity of a water mass by introducing and acclimatization processes through supplanting a more compatible and valuable fish into the biotopes which utilizes the same food web as the less valuable members of the fauna indigenous to the system. Additionally, where certain tanks hold good distribution of Molluscan fauna, stocking molluscicidal *Pangasius pangasius* will be an added advantage since the species feeds on this food web. This leads to establishment of new food niches resulting in high fish yield.

As a recourse to this objective, depending upon the 'per hectare water area of each tank studied (as also elsewhere), fish fingerlings at the rate of 500 fingerlings/ha of Catla (*Gibelion catla*)-40%, Rohu (*Labeo rohita*)-30% and Mrigal (*Cirrhinus mrigala*)-30% need to be introduced annually. The fish fingerlings should be of above 75 mm in size only, and, under no circumstances or excuse, fry or advanced fry are to be introduced anywhere. The fish seed is available in all the Departmental Fish Farms, also in the farms from private entrepreneurs. Every fishermen/fisherwomen society, lease holders, village Panchayats are to strictly advised not to stock even one small number of Tilapia or African catfish in the water bodies under their control.

Fishermen/fisherwomen cooperative societies:

In the state of Karnataka, in all, around 633 primary Fishermen/fisherwomen Cooperative Societies (508 inland +125 marine) are functioning. In the twin districts of Bengaluru (Bengaluru North and South), 22 Fishermen/fisherwomen Cooperative Societies are functioning with a total active membership strength of 4273. Yelhanka tank, the Krishna Fishermen Cooperative Society is based, is actually involved in the development of fisheries-cum-marketing facilities since around more than 25 years. The society has active membership of 755. Till date, as reported, around 25 lakhs of fish seed comprised of Indian major carp, exotic

common carp have been stocked; additionally, Nile Tilapia- *Oreochromis nilotica* and South America's-*Oreochromis mossambica* have been clandestinely, introduced and are being the major part of the daily fish catch from the said tank.

Fishermen/Fisherwomen Cooperative Societies in Bengaluru Urban District

No.	Name of the society	Tank	Total no. of shareholders
1	Krishna Fishermen Cooperative Society Ltd., Yeshwanthpur, Bengaluru North	Yelhanka	755
2	Pragathi Fishermen Cooperative Society Ltd., Dodda Bommasandra, Yelhanka Hubli, Bengaluru North Taluk	Nagavara	62
3	Bengaluru District Fish Production, Processing & Marketing Fishermen Cooperative Society Ltd., No. 12, Muni-Nanajappa Building, BEML Road, Bengaluru-560008	Bongaiyanakere	53
4	Anekal Tank Fishermen Cooperative Society Ltd., Sippai Galli, Anekal, Bengaluru	Jigani kere	370
5	Ganga Fishermen Cooperative Society Ltd., Belekahalli, Bengaluru South Taluk.	Hulimavu kere	50
6	Vrishabavathi Fishermen Cooperative Society, Byramangala	Byramangala reservoir	350

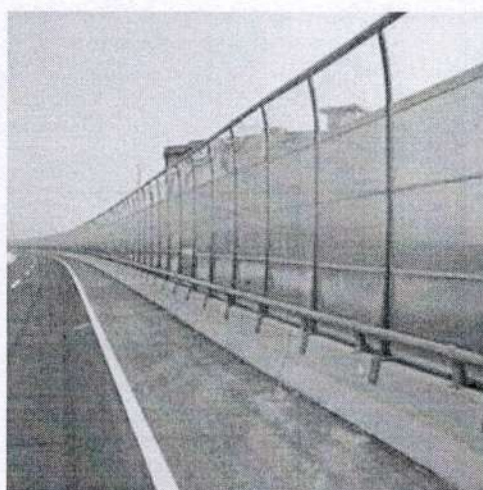
Table 10.5: Cost estimate for introduction of herbivorous fishes and rehabilitation of fish species

Sl. No	Item	Cost in Rs.
1	Herbivorous fish for control of aquatic vegetation	3,00,000/-
2	Rehabilitation of fish species	5,00,000/-
3	Release of fish fingerlings in the selected lakes along PRR	10,00,000/-
Total		18,00,000/-

10.3 Operation phase management

10.3.1 Noise reduction management plan

The project is proposed around the urban agglomeration of Bangalore city. Hence, noise generated from road traffic is a matter of concern. As per the noise model results, during operation phase, the expected noise from traffic would be >90 dBA. Hence, poly carbonate noise barriers¹²⁰ shall be installed and this would reduce noise level up to 36 dBA. The details of sensitive receptors and locations proposed for installation of noise barriers is as follows;



¹²⁰Photo source: <https://www.hsengineers.in/noise-barriers.html>

Table 10.6: Details of sensitive receptors and locations proposed for installation of noise barriers

Sl.No.	Chainage		m	Name of the sensitive receptor	Village Name	Distance from RoW (m)	Cost (Rs./-)
1	12+100	12+600	500	Jarakabandekaval RF	Jarakabandekaval	Adjacent	1,05,00,000/-*
2	17+000	17+700	700	Canadian International School	Manchenahalli	Adjacent	73,50,000/-
3	20+450	20+550	100	Aditya Institutions	Kogilu	80	10,50,000/-
4	23+000	23+200	200	Ambigara Chowdaiah college of Nursing	Chokkanahalli	80	21,00,000/-
5	23+200	23+300	100	Manipal University Media and Entertainment Dept	Yelahanka	Adjacent	10,50,000/-
6	23+300	23+500	200	Akshaya P U and Degree College	Chokkanahalli	40	21,00,000/-
7	23+600	23+800	200	Masjid - Usman Ghani	Thirumenahalli	Adjacent	21,00,000/-
8	23+650	23+750	100	Trinity Nursing Home	N. Nagenahalli	60	10,50,000/-
9	23+750	23+850	100	Diana Public School	N. Nagenahalli	Adjacent	10,50,000/-
10	23+800	24+100	300	Manipal Academy of Banking	Yelahanka	90	31,50,000/-
11	27+450	27+550	100	Bishop House & Malankara Orthodox Syrian Church	Dodda Gubbi	10	10,50,000/-
12	28+000	28+300	300	Sri Vidhyanekatana School and College	Bilishivale	50	31,50,000/-
Total			2900				3,57,00,000/-

Note-*/- cost inclusive of barriers proposed on either sides

10.3.2 Road safety, traffic management and risk management plan

As per the CTTS report published by BMRDA, vehicle population in the city will be approximately 17.81 million by 2031. This may result estimated 16.5 million daily vehicle trips by 2031, which will be approximately two times the current traffic volume. Road safety and its effective management is a matter of concern. Hence, Intelligent Transport System (ITS) will be adopted for PRR with an objective of providing dynamic traffic information to users and guide the traffic. The components of ITS development is provided in section 2.21.14 of Chapter-2. Rs. 252 Crores has been earmarked for ITS development.

Accidents of vehicles and spillage of chemicals while transportation are the most critical risks anticipated during the operation phase of the project. Accident emergency medical care, crane services, crash rescue vehicles, patrol vehicles and an emergency response team will be in place. The details of the same are provided in section 7.11.6.2 of Chapter-7.

10.3.3 Transmission of diseases and its prevention

Truck drivers and helpers will travel in highways for lengthy distances for longer periods and spend away from families lead to sexual activity with commercial sex workers. Hence, these workers are prone to Sexually Transmitted Infections and HIVs¹²¹. Following measures are ensured in PRR project to prevent the STI and HIV.

Table 10.7: STI and HIV prevention plan

Sl.No	Action Plan	Cost in Rs.	Implementation	Concurrent responsibility
1.	Creating awareness on STI and HIV by way of erecting sign boards, hoardings, etc.	5,00,000/-	BDA or its contractors	Dept. of Health and Family Welfare, GoK
2.	Counselling of truck drivers and cleaners will be undertaken with the help of NGOs.	10,00,000/-	BDA or its NGOs	Dept. of Health and Family Welfare, GoK
3.	Medical facility upgradation will be undertaking at Kodathi PHC hospital to test STI and HIV. Every year 10-20% of the truck drivers and cleaners will be subjected to these tests.	10,00,000/-	Dept. of Health and Family Welfare, GoK	BDA
Total		25,00,000/-		

10.4 Institutional arrangements

Government of Karnataka through BDA has established Bangalore PRR Development Corporation Ltd, an SPV for implementation of the project. BDA/BPRRDCL and its appointed contractors are responsible for implementation of EIA/EMP at site by obtaining necessary statutory approvals. The technical aspects / monitoring and approval of the project will be dealing with already existing Technical Advisory Committee (TAC) at BDA.

To address the environmental, social, risk, and health aspects, an Environmental Management Cell will be established at BDA. This cell is also working on acquiring ISO 9001: 2015 and 14001:2004 EMS certifications for the project by following international best practices while project implementation. The institutional structure of Environmental Cell is given below and the roles and responsibilities of each member of the cell are given in Table 9.8. The roles and responsibilities of each member of the cell during emergencies are given below.

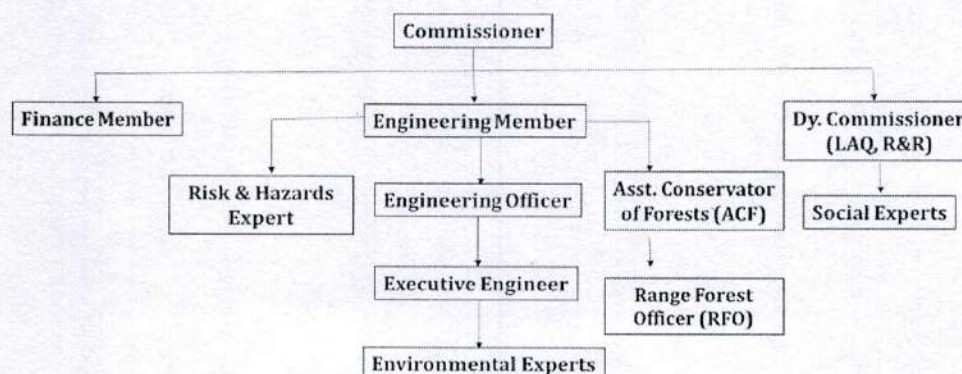


Fig 10.2: Organization Structure of Environment Cell

¹²¹ Arvind Pandey, Ram Manohar Mishra, Damodar Sahu, Sudhir Kumar Benara, Uttpal Sengupta, Ramesh S Paranjape, Abhishek Gautam, Satya Ranjan Lenka, and Rajatshurva Adhikary. 2011. Heading towards the Safer Highways: an assessment of the Avahan prevention programme among long distance truck drivers in India. BMC Public Health. 11(6):S15. 1-12.

Table 10.8: Roles and responsibilities of members of Environmental Cell

Sl.No.	Designation	Roles and Responsibility
1	Commissioner	Overall administration, monitoring, guidance of all the activities
2	Engineering Member	Administrative approvals, monitoring and guidance to all the activities pertaining to Mitigation Measures to avoid impact, EMoP and implementation of EMP.
3	Finance Member	Financial approvals pertaining to all the activities involved in EMoP and EMP.
4	Dy. Commissioner (LAQ, R&R)	Approvals and monitoring of activities pertaining to land acquisition, removal of structures along the alignment, coordination with land losers, compensation, etc
5	Engineering Officer	Approval & Monitoring of all the activities involved to mitigate impacts, EMoP and EMP under the guidance of EM.
6	Asst. Conservator of Forests	Tree Transplantation activities, Green belt development activities and entering into MoU with KFD for plantation activities, frequent monitoring and maintenance connected to Trees and vegetation.
7	Executive Engineer	Supervising all construction activities and advising Contractor to ensure Environmental and social mitigation measures, EMoP and EMP are in place.
8	Environmental Experts (3 Nos. of minimum 10 years of Experience in similar work)	Overall monitoring of the project during its pre-construction, construction and operation phase and implementation of mitigation measures, EMoP and EMP, coordinating meetings, addressing public grievances, obtaining statutory approvals, preparation of Compliance reports, etc
9	Social Experts (3 Nos. of minimum 10 years of Experience in similar work)	Overall monitoring of land acquisition, compensation, social engineering, coordination with local, NGOs, etc. R&R activities, proper guidance to community, implementation of CER, conflict resolution, preparation of compliance, etc.
10	Risk and Hazards Expert	Overall monitoring of risk and hazards arising out of project, Health and safety of workers, critical monitoring of project alignment and pipeline alignment to ensure safety, etc, preparation of compliance to standards, etc.

10.4.1 Roles and Responsibilities of EMC during emergencies

10.4.1.1 Engineering Member (EM)

The Engineering Member shall co-ordinate the activities of the emergency response teams and ensures that the emergency response effort observes the following priorities

- Preserve life of people,
- Protect the environment
- Protect assets,
- Preserve damage to the reputation of owner and contractor

10.4.1.2 Engineering Officer-3

The Engineering Officer-3 acts as emergency controller. The controller's main duties are:

- Informs EM and Commissioner about the situation and reports periodically if the situation escalates.
- Decides whether the situation calls for assistance from public emergency services such as the fire brigade, highway police, ambulance and transport safety centre.

- Assessing the situation and considering the magnitude of emergency. He will give direction to stop all operations.
- Coordinate public information needs for the affected area to ensure relevant information is disseminated to the public/media.
- Public services must be briefed on the hazards associated.
- Handles the media if the authorized spokesperson is not at the scene.
- Once the emergency situation has been dealt with and is under control, makes the announcement ending the emergency.
- Ensures a proper clean-up operation is done and that the area is safely and environmentally stable to return to normal.
- Gathers data for full incident investigation

10.4.1.3 Executive Engineer (EE)

- The EE acts as incident controller and shall instructs public emergency team on what assistance is required from them.
- As soon as possible, contact the pipeline station about the event of emergency to immediately act to isolate the emergency by shutting off the pumping operation.
- Assesses the situation with the HSE officer and emergency patrol team
- EE will require to tie-up with the hospitals and fire stations located in the neighborhood for attending to the casualties promptly and emergency vehicle kept on standby duty during the working hours for the purpose.
- Arrangements shall be made for emergency medical treatment and evacuation of the victim in the event of an accident or dangerous incident occurring.
- Co-ordinates with the public emergency teams.
- Reports progress to the emergency controller continuously until the situation is under control.
- Takes control of the recovery (clean up) operation; gets additional assistance or equipment from the plant or from public services (such as tow trucks and cranes) if required.

10.4.1.4 Environmental Officer

Environmental officer shall ensure that provisions for adequate emergency response are in place, which will include but is not limited to:

- Establishing assembly points
- Identify the emergency response teams and training them.
- Set up drills and exercises.
- Keep arrange to procure firefighting and medical equipment, evaluate and decide whether additional resources may be required to deal with possible, future incidents are in place.
- The Environmental officer shall co-ordinate with the emergency assistance patrolling teams
- Onsite emergency mock drill will be conducted once in every month for all his workers and his sub-contractors' workers.

10.4.1.5 Risk Expert and his patrolling team

- Should be familiar with the alignment of PRR project and petroleum.
- Wear appropriate breathing apparatus as well as full structural firefighter protective clothing.
- Monitor the construction activities near petroleum pipeline.
- Establish barriers to prevent leaks from spreading to water sources, storm drains or other sensitive areas.
- Cool surrounding structures, equipment and vessels and assist the fire brigade team.

10.4 EMP Cost

Sl.No.	Attribute	Action Plan	Particulars	Cost in INR	Implementation	Concurrent responsibility
CONSTRUCTION PHASE						
1	Air Pollution & SHW Management	Water sprinkling 3 times a day during non-monsoon month (6 months) at haul roads and disturbed areas	(Rs. 600/- x 5 tractors x 3 trips per day x 18 months x 25 days)	40,50,000/-	Contractors	BDA
2		Water sprinkling 2 hourly once during non-monsoon month (6 months) and 3 times a day during monsoon season at crushers, hot mix plant and batching plant.	(Rs. 600/- x 5 tractors x 3 trips per day x 18 months x 25 days)	40,50,000/-	Contractors	BDA
3	Air pollution	Provision of LPG at labor camps	4 cylinders per unit x 25 units @950 per Cylinder x 3 years	3,42,000/-	Contractors	BDA
4		Adequate stack arrangements for DG sets	-	50,000/-	Contractors	BDA
5	Air and soil pollution	Green mesh to cover debris	-	1,50,000/-	Contractors	BDA
6	Air & Noise Pollution	Erection of barricade on either side of the RoW	-	20,00,000/-	Contractors	BDA
7		Erection of barricade around crushers, hot mix plant and batching plant	-	10,00,000/-	Contractors	BDA
8		Use of PPEs	-	1,00,000/-	Contractors	BDA
9	Noise pollution	Installation of signage boards	-	2,50,000/-	Contractors	BDA
10	Water Pollution	Silt/sediment fencing	-	10,00,000/-	Contractors	BDA
11		Provision of RO Drinking Water facility at labor camp	-	3,00,000/-	Contractors	BDA
12	Water & soil pollution	Provision of Garland drains at crushers, hot mix plant and batching plant	-	3,00,000/-	Contractors	BDA
13		Installation of Oil interceptors	(3 nos x Rs. 50,000/- each)	1,50,000/-	Contractors	BDA
14	Muck disposal	Excavated earth disposal plan	-	50,00,000/-	Contractors	BDA

Sl.No.	Attribute	Action Plan	Particulars	Cost in INR	Implementation	Concurrent responsibility
	plan	and borrow area management				
15	Soil pollution	Soil conservation structures	-	4,00,000/-	Contractors	BDA
16	Water & SHW management	Provision of Mobile STP at labor camp	-	15,00,000/-	Contractors	BDA
17		Proper sanitation facilities such as latrines, urinals, bath rooms at labor camp	-	18,00,000/-	Contractors	BDA
18	Hydrology	Maintenance of drainage by clearing debris	-	10,00,000/-	Contractors	BDA
19		Desiltation of tanks	-	8,00,000/-	Contractors	BDA
20		Installation of Rainwater harvesting structures and formation of percolation pits	-	2,31,75,000/-	Contractors	BDA
21	Risk assessment	Training to workers on fire fighting, use of PPE's, Chemical safety and first aid	-	2,00,000/-	Contractors	BDA
22		Day crèches at labour camps	-	5,00,000/-	Contractors	BDA
23	Fisheries Management Plan	Introduction of herbivorous fishes and rehabilitation of fish species	-	8,00,000/-	Contractors	BDA
24	Ecological restoration plan	NPV and Compensatory afforestation	-	57,04,740/-	Contractors	BDA
25	Environmental Monitoring	Detailed in Chapter-6	Detailed in Chapter-6	8,68,55,280/-	Contractors	BDA
Sub-total (A)				14,14,77,020/-		
OPERATION PHASE						
1	Air pollution	Road Patrolling/Repair& maintenance	Lump sum	30,00,000/-	Contractors	BDA
2	Soil pollution	Stabilization of slope	-	5,00,000/-	Contractors	BDA
3	SHW Management	Separate colored bins for disposal of solid and plastic waste during operation phase	-	7,00,000/-	Contractors	BDA
4	Ecological	Green belt development plan	-	8,56,01,900/-	Contractors	BDA

Table 10.9: Summary of EMP Cost

Sl. No.	Management Plan	Cost
CONSTRUCTION PHASE (CAPITAL COST)		
1	Air pollution control measures	44,42,000/-
2	Noise pollution control measures	33,50,000/-
3	Water pollution control measures	13,00,000/-
4	Soil pollution control measures	10,00,000/-
5	Hydrology measures	2,49,75,000/-
6	Waste management	73,50,000/-
7	Muck disposal plan	50,00,000/-
8	Risk & Hazard Management	7,00,000/-
9	Fisheries Management Plan	8,00,000/-
10	Ecological restoration plan	57,04,740/-
11	Environmental Monitoring Plan	8,68,55,280/-
12	Corporate Environmental Responsibility @0.25%	37,33,00,000/-
	Total	51,47,77,020/-
OPERATION PHASE (CAPITAL COST)		
1	Air pollution	30,00,000/-
2	Soil pollution	5,00,000/-
3	SHW Management	7,00,000/-
4	Risk assessment	4,58,800/-
5	Noise reduction management plan	3,57,00,000/-
6	Transmission of diseases and its prevention	25,00,000/-
	Total	4,28,58,800/-
OPERATION PHASE (RECURRING COST)		
1	Catchment Area Treatment Plan	1,37,88,000/-
2	Green belt development plan	2,85,33,967/-
3	Conservation plan for Schedule I species	5,33,334/-
4	Biological environment management	8,33,334/-
5	Fisheries management plan	3,33,334/-
6	Environmental Monitoring	37,67,520/-
	Total	4,77,89,489/-

The total amount estimated for implementation of Environmental Management Plan (EMP) for construction phase is 51.47 Crores (Capital Cost) and operation phase is 4.28 Crores (Capital Cost) along with a recurring cost of 4.77 Crores during Operation Phase.

Sl.No.	Attribute	Action Plan	Particulars	Cost in INR	Implementation	Concurrent responsibility
5	restoration plan	Conservation of Schedule-I species	-	16,00,000/-	Contractors	BDA
6	Biological environment management	Green belt maintenance, Road signage boards along ecological sensitive areas	-	25,00,000/-	Contractors	BDA
7	Risk assessment	Maintenance of Fire extinguishers in emergency rescue vehicles, toll plaza's etc	-	1,20,000/-	Contractors	BDA
8		Procurement of PPE's, SCBA apparatus, Spill kits, chemical suits, eats for emergency respond team	-	2,18,800/-	Contractors	BDA
9		Maintenance of first aid equipments in emergency rescue vehicle and medical aid centre	-	1,20,000/-	Contractors	BDA
10	Noise reduction management plan	Implementation of noise barriers	Lumpsum	3,57,00,000/-	Contractors	BDA
11	Transmission of diseases and its prevention	STI and HIV prevention plan	-	25,00,000/-	Contractors	BDA
12	Fisheries management plan	Introduction of fingerlings into lakes	-	10,00,000/-	Contractors	BDA
13	Catchment Area Treatment Plan	Farm ponds, check dams, percolation tanks, afforestation activities in TG Halli Catchment Area	-	4,13,64,000/-	Contractors	BDA
14	Environmental Monitoring	Detailed in Chapter-6	Detailed in Chapter-6	1,13,02,560/-	Contractors	BDA
Sub-total (B)				18,62,27,260/-		
Total (A+B)				32,77,04,280/-		

Sl. No.	Particulars	Locations	Units	Total Cost (Lakhs)	Timeline Criteria	FY 2023-24 (Lakhs)	FY 2024-25 (Lakhs)	FY 2025-26 (Lakhs)
		5. Bidarahalli Government High School			Target			
3	Rejuvenation of lakes	1. Jarakabande tank	6 Nos.	1500.00	Physical Target	3 Nos.	2 Nos.	1 No.
		2. Gunjur lake						
		3. Chikkabanahalli lake			Financial Target	750.00	500.00	250.00
		4. Chinnaganahalli lake						
		5. Chikkatogur lake						
		6. Thirumenahlli lake						
Total				3733.00				

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Chapter
11

CORPORATE ENVIRONMENTAL RESPONSIBILITY

Corporate Environmental Responsibility (CER) has been mandated as per the office memorandum No. F.No.22-65/2017-IA.III dt 01.05.2018 issued by MoEF&CC, New Delhi. The proposed PRR Project is considered as a green field project with capital investment of 14,934 Crores which falls between > 10,000 crores. Therefore, about 0.25% of the total project cost (37.33 Crores) has been allocated for Corporate Environmental Responsibility.

Keeping in view of COVID-19 situation and other epidemic diseases, upgradation of infrastructure facilities at the existing hospitals is need of the hour. Based on their demand and discussion with the local Medical officers, upgradation activities will be taken up. List of hospitals and budget allocation is as follows. Further, based on the demands of public during public hearing, the activities will be modified at the later stages. In addition to this, rejuvenation of 6 lakes (Gunjur lake, Chikkabanahalli lake, Chinnaganahalli lake, Thirumenahalli lake, Chikkatogur lake and Jarakabande tank) falling along the proposed PRR alignment will be carried out. Further, as suggested during the Public Consultation the timber from the trees removed for the project will be utilized for making furnitures for schools and anganwadis in the villages along the project alignment.

Sl. No.	Particulars	Locations	Units	Total Cost (Lakhs)	Timeline Criteria	FY 2023-24 (Lakhs)	FY 2024-25 (Lakhs)	FY 2025-26 (Lakhs)
1	Upgradation of infrastructure facilities at the existing hospitals	1. Hebbagodi UPHC, Anekal Taluk 2. Sarjapura UPHC, Anekal Taluk 3. Bidarahalli PHC, Bangalore East Taluk 4. Gunjur UPHC, Bangalore East Taluk 5. Kodathi PHC, Bangalore East Taluk 6. Hagadur UPHC, Bangalore East Taluk 7. Chikkabanavara, Bangalore North Taluk 8. Hesaraghatta UPHC, Bangalore North Taluk	8 Nos.	2183.00	Physical Target	3 Nos.	3 Nos.	2 Nos.
					Financial Target	818.63	818.63	545.75
2	Utilization of timber from the trees removed for making furnitures for Schools	1. Chikkabanavara Government School 2. Anganwadi Kendra at Hesaraghatta 3. Hebbagodi Government School 4. Gunjur Government High School	5 Nos.	50.00	Physical Target	2 Nos.	2 Nos.	1 No.
					Financial	20.00	20.00	10.00

Sl.No.	Description	Quantity
8	Population of the villages through which alignment passes	6,06,975
9	Length of the alignment proposed in forest area (m)	773
10	Width of the alignment proposed in forest area (m)	100

12.2 Preamble

- The Environmental Clearance for the project was earlier accorded by the Karnataka State Environment Impact Assessment Authority (KSEIAA) vide letter No.: SEIAA 32 IND 2009 dt: 20.11.2014. Further, the Environmental Clearance was challenged at the Hon'ble NGT and after detailed deliberation, Hon'ble NGT in its order dt: 08.02.2019 directed the BDA to prepare the fresh EIA report.
- Further, BDA approached Hon'ble Supreme Court challenging the orders of Hon'ble NGT. Meanwhile, as per the directions of Hon'ble NGT and without prejudice to the orders of the Hon'ble Supreme Court, fresh application was submitted to SEIAA for issue of ToRs for the project. The project was considered in the 235th SEAC meeting held on 02.12.2019 and ToRs has been issued by SEIAA vide letter No. SEIAA 40 IND 2019 dt: 21.01.2020. However, the Supreme Court in its judgment dt: 17.03.2020 upheld the orders of the Hon'ble NGT and directed to prepare fresh EIA studies for the project.

12.3 Significant features of the proposed PRR alignment

- In the proposed PRR alignment, part of the area at chainage from 28+000 km to 31+700 km to near Bilishivale, Vaderahalli, Rampura and Adhuru villages has an underground petroleum pipeline running parallelly along the proposed PRR corridor and intersects at two places near Bilishivale village. The pipeline intersects the proposed PRR alignment in two areas near Chikkabanahalli village belonging to Bangalore East Taluk and at Kasaghattapura village belonging to Bangalore North Taluk. Flyovers are proposed at the intersecting points to avoid impact on petroleum pipelines.
- Project alignment is passing near 6 lakes viz., Tank at Jarakabande Forest, Chinnaganahalli lake, Chikkabanahalli lake, Gunjur lake, Thirumenahalli lake and Chikkatogur lake.
- About 20.9 km of the proposed alignment passes through the Thippagondanahalli Reservoir catchment area notification where Kumudavathy and Arkavathy river sub catchment exists.
- The total land required for the construction of the proposed project is 1036.51Ha with removal of 1,395 structures. The land will be acquired as per BDA Act, 1976 (as per the provisions of Land Acquisition Act, 1894).
- The project involves diversion of 7.73 Ha of forest land in Sy. No. 59 belonging to Jarakabandekaval RF.
- The project requires removal of 36,824 trees which will be compensated by planting trees in the ratio 1:10 along with transplantation activities.
- Boundary of Bannerghatta National Park and Puttenahalli Bird Conservation Reserve are at a distance of 7.75 Km and 1.49 Km respectively.
- The interstate boundary of Tamil Nadu is at a distance of 8.27 Km from the proposed alignment of PRR.
- Peenya Industrial Area and Jigani-Bommasandra Industrial Area are notified as severely polluted area and critically polluted areas by CPCB and is located at a distance of 3.4 Km and 4 km respectively from the proposed PRR alignment respectively.

Chapter
12

SUMMARY AND CONCLUSION

12.1 Project description & Justification for implementation of the project

- The proposed project involves development of 73.5 km long Peripheral Ring Road (PRR) between Tumakuru Road on West and Hosur Road on East via Ballari Road and Old Madras Road. It integrates with the existing NICE Road.
- The RoW of the project is 100 m. The proposed alignment of PRR will be located at an approximate radial distance of 17 km - 25 km from city centre and acts as a bypass to the city for the long-distance personalized vehicles (cars and cabs) and commercial vehicles (trucks and LCVs).
- The proposed "Peripheral Ring Road" connects major Highways namely Tumakuru Road (NH-4), Hesaraghatta Road (SH-39), Doddaballapura Road (SH-09), Ballari Road (NH-7), Hennur- Baglur Road (SH-104), OMR (NH-4), Hoskote-Anekal Road (SH-35), Sarjapur Road and Hosur Road (NH-7).
- PRR project is proposed for implementation to make the road network as 'circle' with the existing NICE road on the other part of Bangalore city. Existing city internal road networks are already crowded with traffic and development on either side of the road and further expansion of these roads are techno-economically and socially not feasible.
- The project cost is estimated to be Rs. 14,934 crores, out of which, Rs. 9,318 Crores will be earmarked for land acquisition and R&R aspects.

Typical cross section for 100 m RoW of PRR

Sl.No	Particulars	RoW utilization	Sl.No	Particulars	RoW utilization
1	Median	13 m	9	Shyness-1	0.25 x 2 (0.5 m)
A	Open drain	5 m	10	Service road	10.5 x 2 (21 m)
B	Granular shoulder	4.0 x 2 (8.0 m)	11	Shyness -2	0.25 x 2 (0.5 m)
2	Gantry -1	0.75 x 2 (1.5 m)	12	Drain	1.0 x 2 (2.0 m)
3	Edge strip	0.50 x 2 (1.0 m)	13	Cycle track	2.0 x 2 (4.0 m)
4	Left Carriageway	14 m	14	Foot path	2.0 x 2 (4.0 m)
5	Right Carriageway	14 m	15	Space for U/G Cable	1.0 x 2 (2.0 m)
6	Paved shoulder	1.5 x 2 (3 m)	16	Space for other utilities	2.0 x 2 (4.0 m)
7	Gantry-2	0.75 x 2 (1.5 m)	17	Green space	5.0 x 2 (10.0 m)
8	Covered drain	2.0 x 2 (4 m)			

Project features

Sl.No.	Description	Quantity
1	Length of the alignment (Km)	73.50
2	Width of the alignment (m)	100
3	No. of bridges a. Major b. Minor	a. Nil, b. 12
4	No. of Culverts	51
5	No. of intersections	10
6	No. of Railway crossings	5
7	No. of villages through which alignment is passes	77

12.4 Baseline Environmental Scenario

The EIA report presents baseline data collected for one season viz., December 2019 to February 2020 and February 2022 to March 2022 for physical, biological and socio-economic components of environment, identification, prediction and evaluation of impacts based on the project activities and to prepare Environmental Monitoring Programme, Environmental Management Plan (EMP) along with budgetary aspects for mitigation of adverse impacts due to the proposed project.

Ambient Air Quality: A network of 12 Ambient Air Quality Monitoring Stations has been selected for assessment of the existing status of air environment within the study zone. The average minimum and average maximum concentrations of PM₁₀: 63.6 µg/ m³ and 84.78 µg/m³; PM_{2.5}: 16.35 µg/ m³ and 28.40 µg/m³; SO₂: 6.77 µg/ m³ and 7.80 µg/m³; NO_x: 17.91 µg/ m³ and 26.72 µg/m³; CO: 0.66 mg/ m³ and 1.42 mg/m³; Pb: 0.01 µg/m³ to 0.40 µg/m³; Ni: 5.27 ng/ m³ and 7.90 ng/m³; O₃: 1.25 µg/m³ to 5.73 µg/m³ and NH₃: 1.07 µg/m³ to 6.06 µg/m³ were recorded. As per Air Quality Index (AQI), Good and satisfactory ambient air quality was observed in the study area. The air quality w.r.t SO₂, PM_{2.5} and NO₂ is good.

Ambient noise levels: Ambient noise levels were measured at 20 locations (13 commercial, 4 residential, 2 sensitive and 1 industrial area). As per the monitoring results, out of 13 commercial area locations, noise levels are exceeded the standards in 11 locations except at 2 locations (N12 and N18) during day time. The noise levels are in the range between 62.15 to 79.77 db(A). Similarly, during night time 6 locations are exceeded and remaining 7 locations are within the standards. The noise levels are in the range between 36.82 to 63.58 db(A). Vehicular movement is the major contributor of noise in the commercial area.

Surface water: Surface water sampling was carried out at 9 lakes and the results shows that the pH of the 9 lakes ranges from 7.32 to 8.31, EC - 477 µs/cm to 2080 µs/cm, Total Hardness - 92 mg/L to 452 mg/L, Chloride - 52.6 mg/L to 283.82 mg/L, DO - 4.6 mg/L to 5.2 mg/L and total coliform - 2100 MPN/100 ml to 540 x 10⁴ MPN/100 ml. Water quality criteria as per CPCB guidelines shows that, out of 9 samples, 1 sample belongs to criteria 'D' (11.11%) and 8 samples belongs to criteria 'E' (88.89%). Therefore, all the water from the above locations is suitable for irrigation purposes only. Similarly, the Water Quality Index of all 9 surface found to be "unsatisfactory" as per KSPCB Guidelines.

Ground water: Ground water sampling was carried out at 10 locations and the results shows that the pH ranges from 6.66 to 7.68, Alkalinity - 94 mg/L to 420 mg/L, Electrical conductivity - 658 µs/cm to 2900 µs/cm, TDS 480 mg/L to 1918 mg/L, Calcium - 34.4 mg/L to 192 mg/L and Bicarbonate values ranges from 94 mg/L to 420 mg/L. All the values are well within the standards except for TH at Kadugodi (668 mg/L), Varthur (660 mg/L) and Jigani Bommasandra Industrial Area (888 mg/L); Total Chromium at Jigani Bommasandra Industrial area (0.127 mg/L) and Iron at Yelahanka New Town (0.38 mg/L), Rampura Village (0.721 mg/L) & Jigani Bommasandra Industrial area (0.575 mg/L).

Soil: The soil samples were collected from 15 locations and the texture of soil in the study area varied all along the alignment. The soil analysis results indicate that, soil texture varied from sandy loam to loam. Sandy loam soils are capable of quickly draining excess water. Loamy soils have good water retention, porosity and permeability this will helps in the drainage of water during construction phase. Organic carbon falls in medium category indicating the setting of cement by adsorbing calcium ions liberated during hydration will be more and thereby favouring road construction activities. Overall results of soil quality analysis were found to be supportive to road construction activities.

Land use: Land use land cover of the study area of 2,572.32 Sq. Km indicate that, area predominantly covered with Fallow land (27%) followed by agricultural land (22%) and built up area (20%). Plantation activities in the study area mainly includes banana, coconut, areca

nut, teak, eucalyptus, etc and floriculture is also observed in the study area. Waterbodies comprising of 3 % of the study area.

Biological environment: Total tree enumeration all along the alignment was carried out and a total of 122 trees species (n=36,824) belonging to 41 families were found within the alignment. The project requires removal of 32,175 trees. The predominant tree species recorded were *Eucalyptus globulus* Labill (n=11053), *Cocos nucifera* L. (n=5976), *Mangifera indica* L. (n=4254), *Eucalyptus tereticornis* L. (n=2488), *Tectona grandis* L.f. (n=3038), *Grevillea robusta* A. Cunn. ex R. Br. (n=1712), *Pongamia pinnata* (L.) Pierre (n=1615), *Azadirachta indica* A. Juss. (n=1065) and *Manilkara zapota* (L.) Van Royen (n=945). All the recorded species are common to region and no RET species were recorded. Out of 36,824 trees, 13,355 trees were falling in TG Halli Catchment area and 631 trees falling in Jarakabandekaval RF where forest diversion of 7.73 Ha is proposed. All the recorded tree species are commonly found, some of them were medicinal, edible and timber yielding; they have economic and social values in the region. *Ficus spp.* is the keystone species found within the project alignment. Tree of 30 cm GBH were dominant throughout the alignment, totaling to 22,341 individuals. Analysis of carbon sequestration potential of tree species reveals that the trees species (n=36,824) of >30 cm GBH have sequestered 3728.69 tonnes of carbon.

As per the baseline survey, Schedule I species such as Black kite, Brahminy kite and common buzzard were found in the project site. Similarly, Indian peafowl, Black shouldered kite, Black kite and Brahminy kite were found in the study area, belongs to Schedule I of Wildlife (Protection) Act, 1972. No RET species were recorded during the study.

Socio-economic studies: Field survey was carried out along the corridor stretch containing a total of about 145 households using standard questionnaire. The potential respondents in the sample households were contacted personally by the field investigators and clarified the doubts and apprehensions expressed by the respondents. As revealed during field survey, all the respondents are aware of the infrastructural project in the area and is of the opinion that it is essential to ease the traffic movements. The perceptions of the respondents as regards to construction to eight lane road in the area could be summarized as follows;

- The land losers demand the compensation to be paid as per present market value by following RFCT LARR Act 2013.
- Delay's for about nearly 15 years for construction of the project has left people in misery and no hope for future development/activities.
- Project affected peoples were unable to either transact or build on their own land for over a period of 15 years, which has led in delaying marriages of their children.
- The land losers also demanded additional compensation for delays in the proposed project.
- People request for the NOC (No Objection Certificate) from BDA as they are not able to sell their lands due to PRR land acquisition notification.
- Psychological stress has developed among the PAPs due to delay in providing compensation led to animosity against the project and hence non involvement during surveys / studies.
- Many PAPs loose full land to PRR and becomes landless.
- Most of the titleholders have said that they have already sold their lands and asked us why their names are still mentioned in the Land acquisition notification.
- Many of the landowners have developed their lands to sites and layouts and also which some are already sold Hence, they are demanding compensation for the developed sites, layouts, and other immovable structures in the land.

Land acquisition is proposed for a width of 100 mts ROW, except at locations of toll plaza and interchanges. The total land required for the construction of the proposed project is 1036.51 Ha (2567 A 22.25 G) and involves removal of 1,395 structures. The total numbers of structures likely to be affected fully/partially are 1,395 under the proposed impact zone within the corridor.

12.5 Anticipated impacts & Mitigation measures

Sl.No.	Environmental Attribute	Activity	Impact	Mitigation Measures
1	Air Pollution	Site preparation, construction activities, transportation of raw materials, earthwork, quarrying, labour camps, etc	<ul style="list-style-type: none"> Emission of dust due to site clearance and excavation activities. Operation of hot mix plants, concrete batching plants and asphalt mixing plants. Dust emissions may cause reduction in growth rate, deposition of dust on leaves, photosynthetic activity, necrosis, leaf curling, abscission, etc in the plants. Continuous exposure to dust emissions may cause respiratory disorders, eye irritation, cough, chest pain, infections, etc in human. The typical day model output reveals that maximum GLC observed in the core construction area up to 109.45 $\mu\text{g}/\text{m}^3$ and impact observed till 2 kms from the core construction zone. 	<ul style="list-style-type: none"> Barricading the project site on either side of the of the RoW to reduce dispersion of dust As per KSPCB Guidelines, the hot-mix plants with dust extraction unit will be installed in downwind direction from nearby settlement and located at least 500 m from the nearest habitation. Use of Personal Protective Equipment's (PPE) for all the labor. Water will be sprinkled 3 times a day in the line and earth mixing sites, asphalt mixing site and service roads. In filling subgrade, water spraying is needed to solidity the material. After the impacting, water will be sprayed regularly to prevent dust. With the implementation of EMP, the dust load will be reduced to 76.814 $\mu\text{g}/\text{m}^3$ will fall in the satisfactory range of AQL.
2	Noise Pollution	Site preparation, construction activities & transportation of raw materials	<ul style="list-style-type: none"> Movement of vehicles and heavy machineries Construction activities including blasting, hot mix plants, batching plants, operation of machineries devices for breaking concrete), earth-moving machines, pile drivers, 	<ul style="list-style-type: none"> Machinery and vehicles will be maintained regularly Noise barriers in the form of barricade and proper signages (no horn zones) will be used to minimize the noise pollution. Controlled blasting method will be

Sl.No.	Environmental Attribute	Activity	Impact	Mitigation Measures
			<p>pneumatically driven devices and combustion engines.</p> <ul style="list-style-type: none"> Construction activities are expected to produce noise levels in the range of 80 – 95 dB (A). The increasing noise levels due to drilling, blasting and allied construction activities will disturb the avi-fauna and faunal burrow animal habitats like reptiles. 	<p>deployed which reduces increased noise levels and also reduces vibrations effect, including erection of tall barricades (40ft height) around construction spots.</p>
3	Water Pollution	Improper management of sewage and waste, earthworks, construction activities, labor camps, tree removal, runoff, etc	<ul style="list-style-type: none"> Removal of 4925 trees affects the hydrological regime and water quality in the TG Halli catchment area. Improper handling and disposal of muck will change the natural flow pattern of the surface runoff in the natural drains/nalacriss-crossing the alignment neighborhood flooding and moderate loss of crops/plantation. Deposition of dust on nearby lakes may be anticipated due to construction activities which affects the penetration of sunlight thereby increasing BOD and phytoplankton productivity threatening the survival of aquatic biota. Improper collection, handling & disposal of solid wastes (organic solid waste:45Kgs/day) from labor camps will result in formation of leachate under precipitation/rainy days and thereby indirectly affects the ground 	<ul style="list-style-type: none"> Plantation of trees to the number of trees removed in the catchment area in the ratio 1:10 will be carried out in the catchment area. Muck will not be stored / filed near nala / streams to ensure natural flow of water in the drain / nala across the proposed alignment. Erection of barricades and water sprinkling shall minimize the deposition of dust on the waterbodies thereby reducing the impact on avifauna and aquatic biota. Solid wastes (75Kgs/day) from the labor camps will be segregated into organic (45Kgs/day) & inorganic wastes (30Kgs/day) through different colored bins located at different places within the camps. Organic solid wastes will be handed over to nearby piggeries and Inorganic wastes will be disposed to

Sl.No.	Environmental Attribute	Activity	Impact	Mitigation Measures
			water quality of the region through infiltration factors.	BBMP authorized scrap dealers/waste recyclers.
4	Hydrology & geology	Construction activities, water extraction, etc	<ul style="list-style-type: none"> The foundations require excavation of pits and blasting of rock which has a negligible impact as the pits shall be filled back with stony waste & gravel that shall be stabilized. However, likely impact on the geological resources will occur from the extraction of materials (borrow of earth, granular sub base and aggregates for base courses and bridges) which is insignificant. As such there is no threat to Geologic environment. The litho unit is massive and hard which is stable. The proposed project corridor length crosses about 63 minor & major drainages and also few tanks. Construction activities such as excavation, storage of debris, muck, etc may affect the streams which are seasonal that carry huge volume of storm water and contribute to recharge of groundwater as such these needs to be protected. This may also cause flooding during monsoon season. 	<ul style="list-style-type: none"> The collapse can be avoided by formation of benches of 1.5 m to 3.0 m height for working conveniently and making access to sub surface levels for pit formation. The safety buffer zone of 30.0 m to be left to protect the natural stream course and maintained periodically with desilting and cleaning. The safety buffer zones specifically pronounced in the orders of the Hon'ble National Green Tribunal, Principal Bench, New Delhi shall be strictly adhered to. Maintenance of streams by removing debris periodically may minimize the impact on drainage pattern.

Sl.No.	Environmental Attribute	Activity	Impact	Mitigation Measures
5	Soil Quality	Land acquisition, agriculture and removal of vegetation, Storage and use of top soil, construction activities, labor camps, etc	<ul style="list-style-type: none"> Removal of structures leads to generation of construction debris. About 20.93 MT of construction debris will create confined augmented absorptions of toxic heavy metals in the soil, which may reach toxic levels through the food chain. Removal of trees and vegetation & earth works including quarrying leads to erosion and loss of top soil. About 32,175 number of trees will be removed thereby erosion of soil is anticipated. Top soil from the borrow area will lose its fertility if not handled properly. Also the borrow area become potential breeding ground for mosquitoes and other bacterial infection disease. The transportation of borrow and quarry materials also cause dust nuisance. 	<ul style="list-style-type: none"> Reuse of the construction debris for scientific disposal of construction debris to avoid contamination. Selection of the disposal sites will be carried out in consultation with the State Pollution Control Board, Revenue Department and Forest Department in order to ensure that no natural drainage, productive lands or natural habitat is adversely impacted due to disposal. Turfing of road embankment slopes and compensatory afforestation activities. Borrow areas situated less than 0.8 km (if unavoidable) from villages and settlements should not be dug for more than 30 cm after removing 15cm of topsoil and should be drained.
6	Solid & Hazardous Waste	Earth works, labour camps, utilization of hazardous materials for construction.	<ul style="list-style-type: none"> The project requires demolition of 1,395 Nos. of structures which generates demolition waste and debris (20.93 MT) due to dismantling of existing cross drainage structures and roadside residential and commercial structures may lead to entry of toxic heavy metals into the soil and nearby waterbodies. Improper disposal of sewage 	<ul style="list-style-type: none"> Demolition wastes and debris shall be stored separately in dumping yards located 1000 m away from the sensitive locations such as settlements, forest areas, schools, etc and lined with impermeable membrane/concrete. These wastes shall be reused for construction and filling purposes as per the C&D Waste Management Rules, 2016.

Sl.No.	Environmental Attribute	Activity	Impact	Mitigation Measures
			<p>(18KLD) and solid wastes (45Kgs/day) from labor camps area leads to the formation of leachate thereby causing soil pollution, surface and ground water pollution.</p> <ul style="list-style-type: none"> Improper handling of hazardous materials such as bituminous material-asphalt waste and tar during transportation and construction activities may enter into waterbodies thereby increasing the turbidity. 	<ul style="list-style-type: none"> Mobile STPs are used to treat the sewage generated from labor camps and solid waste generated shall be segregated, stored in separate bins and disposed off to KSPCB authorized disposal sites. Hazardous and other wastes (Bituminous material-asphalt waste, tar) will be stored in stockyards with paved bases and handled as per Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016
7	Land use	Construction of PRR, excavation activities, vehicular movements, residential and commercial development, demand for infrastructure, etc	<ul style="list-style-type: none"> Utilization of local land resources for the project is one of the major impact on land use. Land acquisition of 1036.51 Ha along 73.5 Km with RoW of 100 m leads to loss of productive agricultural land, forest land and water bodies. The project also envisages removal of trees (32,175 trees) and roadside structures (1,395 structures) which also leads to permanent changes in the existing land use pattern. Road construction activities involve alterations in the local physiography and drainage patterns. The impacts on physiography may include destabilization of slopes due to cut and fill operations. 	<ul style="list-style-type: none"> Compensatory afforestation will be carried out in the ratio 1:10 to balance the number of trees removed. Parallel cross drainage structures will be added to improve local physiography and drainage.
8	Ecology & Biodiversity	Removal of trees, construction	<ul style="list-style-type: none"> Removal of 32,175 trees and clearance of vegetation cause 	<ul style="list-style-type: none"> Green belt development plan and avenue plantation along with

Sl.No.	Environmental Attribute	Activity	Impact	Mitigation Measures
		activities, loss of agricultural lands, etc	<p>disturbance in Microclimate, habitat loss and disturbance of vegetation and sensitive plant communities. Removal of these trees can make alteration and physical disturbance, increased risk of Soil erosion and release of CO₂.</p> <ul style="list-style-type: none"> Deposition of dust on surface water of downwind lakes may affect photosynthetic plants and threatens survival of aquatic life. As per the Noise and Vibration report the noise levels ranges from 57.82 dB(A) to 80.78 dB(A) in day time and 33.9 dB(A) to 63.58 dB(A) at night time. Construction activities and vehicular movement during construction phase generate noise, which directly impact on behavioral changes of faunal species. 	<p>transplantation activities will be carried out in 1:10 ratio as per NHAI guidelines.</p> <ul style="list-style-type: none"> Erection of barriers along construction sites may reduce the deposition of dust on plants and water bodies. Construction period will be restricted only during day time, noise will be mitigated by providing acoustic enclosure, wildlife signs, Traffic signs and speed limits may decrease the impact of noise on animal behavior and movements.
9	Social	Land acquisition, R&R activities	<ul style="list-style-type: none"> Construction of road requires acquisition of agriculture lands and landed assets. Temporary or permanent loss of livelihood due to acquisition of lands and involuntary relocation of the project affected families. A variety of utilities serving in the regional needs like electricity poles, transformers, telephones towers/poles, water pipelines, and drainage and sewage systems which 	<ul style="list-style-type: none"> The acquisition of land and private properties shall be carried out in accordance with the Resettlement Action Plan and entitlement framework of the Project. BDA has to ascertain that acquisition of land in the post design phase is addressed and compensation shall be paid as per BDA Act, 1976 (as per the provisions of the Land Acquisition Act, 1894). Regarding utilities concerned

Sl.No.	Environmental Attribute	Activity	Impact	Mitigation Measures
			<p>are within the impact zone shall be impacted.</p> <ul style="list-style-type: none"> The acquisition of such an area will change the land use by affecting in terms of their place of residence, loss of access to agriculture fields and plantations, loss of common properties such as temples, community halls, school, bore wells etc. 	<p>owners will be informed in advance to shift the utilities in coordination with the project proponents before construction starts to avoid disruption of regional services.</p> <ul style="list-style-type: none"> Participatory Approach taken up for discussions with the various stakeholders for building community consensus to secure land, where required, for ensuring constructions of link road and for relocation or shifting of cultural properties.
10	Risks & Hazards	Soil excavation activity near to pipeline area, Burrowing of earth, Movement of Heavy machineries, Blasting activity.	<ul style="list-style-type: none"> Accidental damage to petroleum pipeline causing, Spillage of petroleum products namely High Speed Diesel, Fire hazard due to presence of ignition sources nearby, Flow of petroleum products into nearby drainage system, Contamination of nearby surface water bodies lakes, 	<ul style="list-style-type: none"> Consultation with Petronet MHB authorities shall be done strictly before initiating the excavating activity near to the pipeline area. Mechanical excavation will not be carried out Blasting shall be strictly prohibited surrounding the pipeline area. Emergency preparedness plan shall be implemented and followed. Onsite emergency mock drill shall be done periodically with all workers and sub-contractors considering the events of Emergency spill response and containment actions.

Based on the evaluation of impacts, the project score is -668 and categorized under 'Significant adverse impacts, most of the impacts are reversible. Mitigation measures are crucial (600-900)'.

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12.6 Alternative analysis

- Project Alignment: PRR project is proposed for implementation to make the road network as 'circle' with the existing NICE road on the other part of Bangalore city. Existing city internal road networks are already crowded with traffic and development on either side of the road and further expansion of these roads are techno-economically and socially not feasible. Hence, any road planning alternative to PRR inside the city (within ORR) is not viable.
- Petronet MHB pipeline alignment: PRR alignment is passing adjacent to Petronet MHB petroleum pipeline at CH 28+350 km to CH 31+615 km and crossing the petroleum alignment at CH 38+824 km and CH 6+875 km. Wherever, it is passing adjacent sufficient RoW of 6 m (left side) and 12 m (right side) from the Petronet pipeline has been provided. At crossing locations, flyover is proposed to avoid the impact on pipelines. Further, all precautionary measures will be considered while implementation of project road in this section.
- Construction of project alignment near Lakes: BDA being owning several lakes in the city and undertaken restoration and rejuvenation of lakes, while designing the project alignment, utmost care has been considered to avoid lake and its areas. Considering the topographical features, design specifications and land acquisition notification on PRR alignment and at unavoidable situations, project alignment is passing near 6 lakes viz., Tank at Jarakabande Forest, Chinnaganahalli lake, Chikkabanahalli lake, Gunjur lake, Thirumenahalli lake and Chikkatogur lake. In order to minimize the impact on wetlands and as part of engineering measures flyovers are proposed near these lakes with precast construction and as part of biological measures, BDA will take up restoration and rejuvenation of these lakes as part of CER at the later stages.

12.7 Environmental Monitoring Programme

- Environmental Monitoring Programme will be carried out during both construction and operation phase for 3 years each which involves Ambient Air Quality Monitoring, ambient noise level monitoring, soil quality analysis, surface water quality analysis, ground water quality analysis, aquatic life studies and periodic health check-ups for labors as per the CPCB guidelines through MoEF&CC recognized laboratories under the supervision of BDA.
- Environmental Monitoring is proposed during the construction and operation phase of the project. Rs. 8,68,55,280/- was estimated for environmental monitoring during construction phase (36 months) and Rs. 1,13,02,560/- is estimated for operation phase (36 months) of the project. Other activities includes, monitoring of green belt/tree plantation, labor camps, risks and hazards associated with gas pipelines, land acquisition, sourcing of construction materials, borrow areas, etc.

12.8 Environmental Public Consultation

- The Environmental Public Hearing (Physical & virtual) was conducted on 18.08.2020 and 23.09.2020 respectively under the chairmanship of the Deputy Commissioner, Bengaluru Urban District.
- The Environmental Public Consultation was initially conducted at "Nityotsava Wedding and Convention Hall, Singanayakahalli Village, Yalahanka Taluk, Bangalore Urban District" on 18.08.2020 as per the provisions of the EIA Notifications, 2006 and its subsequent amendments. Keeping in view of the ongoing pandemic COVID-19 situation, the

Environmental Public Hearing was conducted as per the guidelines issued by the BBMP with necessary precautionary measures such as thermal screening, distribution of masks, face shields, gloves, utilization of hand sanitizers, seating arrangements with not more than 50 seats at two separate platforms with social distancing.

- Further, considering the pandemic situation, a Virtual Public Hearing was also conducted on 23.09.2020 through Zoom platform, so that the public can participate in the meeting and give their submissions from their homes. The virtual Environmental Public Hearing was also successfully conducted with more than 300 participants.
- The validity of the Virtual Public Hearing conducted through ZOOM platform on 23.09.2020 was challenged by the public at the Hon'ble High Court of Karnataka. After detailed deliberations, the Hon'ble High Court of Karnataka vide its Judgement dt:23.02.2021 disposed off the case with a direction to conduct a fresh public hearing in the physical form.
- Therefore, a fresh Environmental Public Hearing (EPH) was conducted on 13.07.2022 at Dr: B.R. Ambedkar Bhavan, Bruhat Bengaluru Mahanagara Palike, No.757, 16th 'A' Main Road, Satellite Town, Yelahanka Taluk in Bangalore Urban District where the people are affected from the project. EPH was conducted by Karnataka State Pollution Control Board (KSPCB) in the presence of Deputy Commissioner, Bengaluru Urban District.

12.9 Environmental Management Plan

Effective EMP is proposed to mitigate the impacts during construction and operation phase of the project on various environmental components such as air, water, noise, soil, biological, social environment, risk assessment measures and emergency preparedness.

The total amount estimated for implementation of Environmental Management Plan (EMP) for construction phase is 51.47 Crores (Capital Cost) and operation phase is 4.28 Crores (Capital Cost) along with a recurring cost of 4.77 Crores during Operation Phase. This EMP cost is exclusive of the land acquisition and R&R cost amounting to Rs. 9,318 Cr.

Chapter
13

DISCLOSURE OF CONSULTANTS

M/s Environmental Health and Safety Consultants Pvt. Ltd is located at Rajajinagar, Bengaluru have been involved in obtaining environment clearances for various developmental projects from the Ministry of Environment, Forests & Climate Change (MoEF), New Delhi since 2002.

In accordance with the orders and notifications of the MoEF, Govt. of India, the organization is ISO 9001:2015 certified and accredited as 'A' category organization from National Accreditation Board for Education and Training (NABET) in ten sectors viz., Mining of minerals- opencast only, River valley, Hydel, Drainage and Irrigation projects, Thermal Power plant, Metallurgical industries, Distilleries, Sugar industry, Highways, Synthetic organic chemicals and Pharmaceuticals, Building and large construction projects and Townships and area development projects.

The company comprises of highly dynamic and well qualified team of Environmental Engineers and subject experts, both in-house and empanelled in various fields such as Ecology and Biodiversity, Socio-economics, Soil Conservation, Land Use studies, Hydrology, Geology, Risk Assessments, etc.

The organization has tied with state of art external environmental laboratories at Bengaluru and Belagavi capable of conducting all types of sampling and analysis related to Air, Water, Noise and Soil. Bengaluru laboratory namely Environmental Health & Safety Research & Development Center (EHSRDC) is accredited from National Accreditation Board for Testing and Calibration Laboratories (NABL) for 1522 parameters and recognized from MoEF&CC under the E(P) Act, 1986 and also certified for ISO 9001:2015, 14001:2015 and OHSAS 18001:2007. Whereas, the Belagavi Laboratory namely Environmental Health & Safety Research & Development Center, Unit-II (EHSRDC) is recognized from MoEF&CC under the E(P) Act, 1986 and also certified for ISO 9001:2015 and 18001:2007. For the present project baseline data collection, services of EHSRDC, Bangalore has been utilized and their MoEF&CC recognition is valid from 09.02.2017 to 22.09.2022.

COMPLIANCE TO OBSERVATIONS OF HON'BLE SUPREME COURT JUDGEMENT AND NGT

14.1 Compliance to deficiencies noted in the Hon'ble Supreme Court judgment dt: 17.03.2020

Sl.No	Deficiency	Compliance
G. Deficiencies in the EIA report		
G1.	Accreditation of the EIA consultant 56. The Committee noted the deficiencies in the performance of M/s Ramky Enviro Engineers Pvt. Ltd. as an EIA consultant and indicated a scope for improvement. The Committee then proceeded to record the sectors for which M/s Ramky is granted accreditation. Conspicuous in its absence is the grant of accreditation for serving as an EIA consultant for highway projects. When the final EIA report for the PRR project was prepared in August/October 2014, M/s Ramky lacked accreditation to serve as an EIA consultant for highway projects. This aspect shall be borne in mind in deciding the eventual directions which this Court seeks to issue.	M/s Environmental Health and Safety Consultants Pvt. Ltd, Bengaluru is accredited as 'A' category organization from National Accreditation Board for Education and Training (NABET) in ten sectors including Highways projects. The NABET certificate No.: NABET/EIA/2124/RA 0241; dt 07.06.2022 (Valid till 22.08.2024) is enclosed in the EIA/EMP report.
G2.	Forest Land 65. Project proponents are duly bound to disclose the existence of forest land and inform the SEAC of the status of their application for forest clearance at the time of submitting the EIA report for the grant of the EC. Where the competent authority has granted the EC for a project, the project proponent is then duty bound to obtain and submit to the competent authority the requisite stage I forest clearance for the proposed project within 12 months or 18 months, as the case may be. Where the project proponent fails to submit the requisite forest clearance within the prescribed time, the EAC or the SEAC are authorized to re-examine the project and decide whether there is a need for the reappraisal of the project. The process envisaged for the disclosure of the forest clearance procedure as well as the	The project involves diversion of 7.73 Ha of forest land in Sy. No. 59 belonging to Jarakabandekaval RF and attracts the provisions of Forest (Conservation) Act, 1980. In view of this, an online application to MoEF&CC for forest land diversion has been submitted on 09.06.2020 (Annexure-13). To compensate the forest diversion, 14.60 ha (36.10 acres) of land has been identified in Sy. No 156 of Mantapa Village, Jigani Hobli, Anekal Taluk, Bangalore Urban District which is adjacent to Bannerghatta National Park and found suitable for compensatory afforestation and management point of view.

Sl.No	Deficiency	Compliance
G. Deficiencies in the EIA report		
	submission of the grant of forest clearance sub-serves the purpose of ensuring timely and adequate protection of forest land. Where the EAC or the SEAC is of the opinion that additional documents are required upon the failure of the project proponent to submit the requisite forest clearance within the prescribed time, it may direct that a fresh public hearing be conducted.	
G3.	<p>Trees</p> <p>68. The EIA report prevaricated by recording that the area required for the proposed PRR project has only a few trees. Though the development of infrastructure may necessitate the felling of trees, the process stipulated under the 2006 Notification must be transparent, candid and robust. Hiding significant components of the environment from scrutiny cannot be an acceptable method of securing project approvals. There was a serious lacuna in regard to disclosures and appraisal on this aspect of the controversy</p>	A total of 36,824 no. of trees falling within the 100 m RoW of the alignment is proposed to be removed. The details such as Chainage wise tree species, number, IUCN Conservation status-2020, RET status, Girth class distribution, Basal Area, Volume and Carbon sequestration capacity of trees proposed to be removed are given in Section-3.4.3.1 of Chapter-3. In order to compensate the number of trees removed green belt development in the ratio 1:10 along with transplantation activities has been proposed in Section 9.2.5.1 of Chapter-9.
G4.	<p>Pipelines</p> <p>70. In view of this matter, the appellant sought to take adequate precautions to ensure that the proposed PRR project did not cross a pipeline and where it did, it was at a sufficient height without the use of support pillars. The respondent contended that that the appellant was constrained to revert to the proposed alignment prior to the meeting by virtue of various orders passed by the High Court of Karnataka. This shall be dealt with in the directions which this Court seeks to issue</p>	In the proposed PRR alignment, part of the area at chainage from 28+000 km to 31+700 km to near Bilishivale, Vaderahalli, Rampura and Adhuru villages has an underground petroleum pipeline running parallelly along the proposed PRR corridor. The pipeline intersects the proposed PRR alignment in two areas near Chikkabanahalli village belonging to Bangalore East Taluk and at Kasaghattapura village belonging to Bangalore North Taluk. Flyovers are proposed at these two intersecting points to avoid impact on pipeline. Further details along with precautionary measures to be adopted during construction phase are given in Section-7.11.1.3 and 7.11.2.6 of Chapter-7 respectively.

Sl.No	Observation	Compliance
		<p>Bengaluru is accredited as 'A' category organization from National Accreditation Board for Education and Training (NABET) in ten sectors including Highways projects.</p> <ul style="list-style-type: none"> Public hearing will be conducted as per the guidelines of EIA Notification, 2006 and its subsequent amendments in consultation with KSPCB and DC respectively. <p>All the details w.r.t TG Halli Catchment area, tree removal, forest land diversion, impacts, mitigation measures and management plan has been covered in respective sections (as mentioned above) of EIA/EMP report.</p>
4.	<p>It is not necessary to adjudicate on the contentions raised, having regard to the patent fact that there was substantial delay in EIA and a period of almost five years has been passed even thereafter. This Tribunal, vide order dated 15.04.2015, considered the issue. In view of the fact that there was an error in noting the number of trees cut and that the impact of potential leakage of the pipeline was not considered and that it was assumed that the Forest Clearance was not necessary, stayed the Environmental Clearance which order been operative for the last four years.</p> <p>It will, thus, be in the interest of justice that as fresh rapid EIA is conducted. If the project is found viable, after incorporating due abatement measures, including the suggestions of the appellant, the same can be taken up without further delay. It is made clear that the project proponent will not proceed on the basis of impugned Environmental Clearance.</p>	<p>All the necessary details of tree removal forest land diversion and pipeline alignment with necessary abatement measures are studied in detail and presented in EIA/EMP report.</p>

Chapter
15

COMPLIANCE TO TERMS OF REFERENCES

Sl. No.	Terms of References (ToRs)	Compliance w.r.t Final EIA Report
Standard Terms of Reference for conducting Environment Impact Assessment Study for Highways and information to be included in EIA/EMP Report		
1.	Examine and submit a brief description of the project, project name, nature, size, its importance to the regions/state and the country.	Details of the project are given in Section 1.3 of Chapter 1
2.	In case the project involves diversions of forests land, guidelines under OM dated 20.03.2013 may be followed and necessary action taken accordingly.	The project involves diversion of 7.73 Ha of forest land belonging to Jarakabandekaval RF. The details of FC application are given in Section 1.4 and Section 3.4.1.4 of Chapter-1 and Chapter -3.
3.	Details of any litigation(s) pending against the project and/ or any directions or orders passed by any court of law/any statutory authority against the project to be detailed out.	The litigation details are presented in Section 1.4 of Chapet-1 and Chapter-12.
4.	Submit detailed alignment plan, with details such as nature of terrain (plain, rolling, hilly), land use pattern, habitation, cropping pattern, forest area, environmentally sensitive places, mangroves, notified industrial areas, sand dunes, sea, river, lake, details of villages, tehsils, districts and states, latitude and longitude for important locations falling on the alignment by employing remote sensing techniques followed by ground truthing and also through secondary data sources.	Details along with maps are given in Fig 3.30, 3.31, 3.32 of Section-3.3 and Fig 3.3 of Section 3.4.1 of Chapter-3.
5.	Describe various alternatives considered, procedures and criteria adopted for selection of the final alternative with reasons.	Details of alternatives are given of Chapter-5.
6.	Submit Land use map of the study area to a scale of 1:25,000 based on recent satellite imagery delineating the crop lands (both single and double crop), agricultural plantations, fallow lands, waste water bodies, built-up areas, forest area and other surface features such as railway tracks, ports, airports, roads, and 1:2000 scale showing the existing features falling within the right of way namely trees, structures including archeological and religious, monuments etc. if any.	Land use map of the study area is given as Fig 3.30 in Section 3.3.3 of Chapter-3.
7.	If the proposed route is passing through any hilly	The proposed project alignment does

Sl. No.	Terms of References (ToRs)	Compliance w.r.t Final EIA Report
	area, examine and submit the stability of slopes, if the proposed road is to pass through cutting or embankment/ control of soil erosion from embankment. Landslide, rock fall protection measures to be indicated.	not pass through any hilly areas.
8.	If the proposed route involves tunneling, the details of the tunnel and locations of tunneling with geological structural fraction should be provided. In case the road passes through a flood plain of the river, the details of micro drainage, flood passages and information on high levels flood periodicity at least of last 50 years in the area should be examined.	The proposed project does not involve any tunneling activities.
9.	The projects is located within 10 Km. of the sanctuary a map duly authenticated by Chief Wildlife Warden showing these features vis-a-vis the project location and the recommendations or comments of the Chief Wildlife Warden thereon should be furnished at the stage of EC.	The project location is within the 10 Km radius of Bannerghatta NP and Puttenahalli Conservation Reserve. In this regard, request submitted to PCCF (Wildlife) and Chief Wildlife Warden along with concerned DCF, ACF and RFOs on 17.06.2020.
10.	Study regarding the Animal bypasses/underpasses etc. across the habitation areas shall be carried out. Adequate cattle passes for the movement of agriculture materials shall be provided at the stretches passing through habitation areas.	The details of animal underpasses are given in Section 2.14 of Chapter-2.
11.	The information should be provided about the details of the trees to be cut including their species and whether it also involves any protected or endangered species. Measures taken to reduce the number of the trees to be removed should be explained in detail. Submit the details of compensatory plantation. Explore the possibilities of relocating the existing trees. Animal and wildlife crossings to be provided in areas inhabited by wild life.	The details of trees to be removed are given in Table 3.14 of Section 3.4.3.1.1, Chapter-3. The details of measures taken during tree removal, transplantation and compensatory plantation are given in Section-9.2.5 of Chapter-9. No notified animal or wildlife crossings are recorded in the project site.
12.	Necessary green belt shall be provided on both sides of the highway with proper central verge and cost provision should be made for regular maintenance.	Details of green belt on either sides of the highway are given in Section-9.2.5.1 of Chapter-9.
13.	If the proposed route is passing through a city or town, with houses and human habitation on the either side of the road, the necessity for provision of bypasses/diversions/under passes shall be examined and submitted. The proposal should also indicate the location of wayside amenities, which should include petrol station/service Centre, rest areas including public conveyance, etc. Noise reduction measures should also be indicated.	Details of underpasses are given in Section 2.13 and 2.14 of Chapter-2. Details of wayside amenities are given in Section 2.20 of Chapter-2. Noise reduction measures are given in Chapter-4 and Chapter-9.
14.	Submit details about measures taken for the	The details of pedestrian underpasses

Sl. No.	Terms of References (ToRs)	Compliance w.r.t Final EIA Report
	pedestrian safety and construction of underpasses and foot-over bridges along with flyovers and interchanges. If any.	are given in Section 2.14 of Chapter-3 and pedestrian safety measures are given in Section 7.11.8 of Chapter-7.
15.	Assess whether there is a possibility that the proposed project will adversely affect road traffic in the surrounding areas (e.g. by causing increases in traffic congestion and traffic accidents). Specific care be also taken to ensure that by passes have a sufficient buffer to prevent unwanted obstructions defying the purpose of the by pass	The details of road traffic management are given in Section 9.3.2 of Chapter-9.
16.	Examine and submit the details of use of fly ash in the road construction, if the project road is located within the 100 Km from the Thermal Power Plant.	The details are given in Section 2.21.10 of Chapter-2.
17.	Examine and submit the details of sand quarry, borrow area and rehabilitation.	The details are enclosed in Section-2.21.9.2 of Chapter-2.
18.	Explore the possibilities of utilizing the debris/waste materials available in and around the project area.	The details are provided in Chapter-4 in.
19.	Submit the details on compliance with respect to Research Track Notification of MoRTH	IRC guidelines will be followed.
20.	Examine and submit the details of sand quarry and borrow area as per OM and latest amendment on Rationalization of procedure for Environmental Clearance for Highway Projects involving borrow areas for soil and earth"	The details are enclosed in Section-2.21.9.2 of Chapter-2.
21.	Climate and meteorology (max and min temperature, relative humidity, rainfall, frequency of tropical cyclone and snow fall); the nearest IMD meteorological station from which climatological data have been obtained to be indicated.	The details are enclosed in Section-3.2.2 of Chapter-3.
22.	The air quality monitoring should be carried out as per the new notification	The AAQM has been carried out as per the CPCB guidelines and the details are enclosed in Section-3.2.3 of Chapter-3.
23.	Identify project activities during construction and operation phases, which will affect the noise levels and the potential for increased noise resulting from this project. Discuss the effect of noise levels on nearby habitation during the construction and operational phases of the proposed highway. Identify noise reduction measures and traffic management strategies to be deployed for reduction measures and traffic management strategies to be deployed for reducing the negative impact if any. Prediction of noise levels should be done by using mathematical modeling at different representative location.	The details of project activities affecting noise levels, its effects on nearby habitations are given of Chapter-4. The details of noise reduction measures and traffic management strategies are given in Chapter-9. Prediction of noise levels using dhvaniPRO model are given in Chapter-4.
24.	Examine the impact during construction activities due to generation fugitive dust from crusher units,	The details are enclosed in Section 4.1.1 of Chapter-4.

14.2 Compliance to directions of the Hon'ble Supreme Court judgment dt: 17.03.2020

Sl.No	Deficiency	Compliance
(i)	The appellant is directed to conduct a fresh rapid EIA for the proposed PRR project	A fresh EIA/EMP report has been prepared by conducting fresh baseline data studies from December, 2019 to February, 2020.
(ii)	The appellant shall, for the purpose of conducting the rapid EIA, hire a sector-specific accredited EIA consultant.	M/s Environmental Health and Safety Consultants Pvt. Ltd, Bengaluru is accredited as 'A' category organization from National Accreditation Board for Education and Training (NABET) in ten sectors including Highways projects.
(iii)	The appellant shall have due regard to the various deficiencies noted in the present judgment as well as ensure that additional precautions are taken to account for the prevailing state of the environment.	All deficiencies noted in the present judgment along with necessary precautionary measures are studied in detail and presented in the EIA/EMP report.
(iv)	The appellant shall ensure that the requisite clearances under various enactments have been obtained and submitted to the SEAC prior to the consideration by it of the information submitted by the appellant in accordance with the OMs issued by the MoEF-CC from time to time.	The project involves diversion of 7.73 Ha of forest land in Sy. No. 59 belonging to Jarakabandekaval RF and attracts the provisions of Forest (Conservation) Act, 1980. In view of this, an online application to MoEF&CC for forest land diversion has been submitted on 09.06.2020. Further, all necessary clearances will be obtained and submitted to the SEAC prior to the consideration.
(v)	The SEAC shall thereafter assess the rapid EIA report and other information submitted to it by the appellant in accordance with the role assigned to it under the 2006 Notification. If it is of the opinion that the appellant has complied with the 2006 Notification as well as the directions issued by this Court, only then shall it recommend to the SEIAA the grant of EC for the proposed project. The SEAC and the SEIAA would lay down appropriate conditions concerning air, water, noise, land, biological and socioeconomic environment and other conditions it deems fit; and	All the conditions concerning air, water, noise, land, biological and socioeconomic environment and other conditions laid by SEAC and SEIAA, Karnataka will be complied.
(vi)	The appellant shall consult the requisite authority to ensure that no potential damage is caused by the project to the petroleum pipelines over which the proposed road may be constructed.	The petroleum pipeline passes parallel to the proposed PRR alignment near 4 villages and intersects the alignment at 2 places. Flyovers are proposed at these two intersecting points to avoid impact on

Sl.No	Deficiency	Compliance
		pipeline. Further, necessary precautionary measures (Section 7.11.2.6 of Chapter-7) will be adopted during construction phase upon necessary consultation and approvals from requisite authority.

14.3 Compliance to observations of Hon'ble National Green Tribunal, principal bench in its order dt: 08.02.2019

Sl.No	Observation	Compliance
2.	Principal grounds on which the Environmental Clearance is being questioned are that there is inordinate delay in furnishing of the Environmental impact assessment (EIA) Report with reference to the date of study of data. The application was filed before the state Environment Impact Assessment Authority (SEIAA) on the 10.09.2009. Terms of Reference (ToR) were prepared on 21.11.2009. Primary data was collected in December 2009 and February 2010. EIA was placed before SEIAA in June 2104. The Environmental Clearance was granted on 21.11.2014. Thus, the primary data was more than three years prior to the EIA Report. There are omissions in the EIA Report with regard to data of forest land as well as the provision of revised Master Plan, 2015 prepared by the BDA. Thippagondanahalli Reservoir (TGR) catchment area has been suppressed in the EIA report. Green cover particulars have been overlooked. Further objection is that there is proximity of the area to the petroleum pipelines and land earmarked for petroleum pipelines overlaps the project. According to the appellant, Stage - I Forest Clearance was not obtained as required. The EIA consultant was non-accredited. Public hearing was not proper which vitiated the decision by the State Expert Appraisal Committee (SEAC).	<ul style="list-style-type: none"> The baseline data studies have been carried out during December, 2019 to February, 2020 for preparation of fresh EIA/EMP report. About 20.9 km of the proposed alignment passes through the Thippagondanahalli Reservoir catchment area with a removal of 13,355 trees in the TG Halli catchment area. Necessary precautionary measures will be adopted to minimize the impact on TG Halli Catchment Area. A total of 36,824 no. of trees falling within the 100 m RoW of the alignment is proposed to be removed. Compensatory tree plantation in the ratio 1:10 will be carried out. The petroleum pipeline passes parallel to the proposed PRR alignment near 4 villages and intersects the alignment at 2 places. Further, necessary precautionary measures will be adopted during construction phase upon necessary consultation and approvals from requisite authority. The project involves diversion of 7.73 Ha of forest land in Sy. No. 59 belonging to Jarakabandekaval RF and attracts the provisions of Forest (Conservation) Act, 1980. Hence obtaining Stage-I Forest Clearance is essential. M/s Environmental Health and Safety Consultants Pvt. Ltd,

Sl. No.	Terms of References (ToRs)	Compliance w.r.t Final EIA Report
	air emissions from hot mix plants and vehicles used for transportation of materials and prediction of impacts on ambient air quality using appropriate mathematical model, description of model, input requirement and reference of derivation, distribution of major pollutants and presentation in tabular form for easy interpretation shall be carried out.	
25.	Also examine and submit the details about the protection to existing habitations from dust, noise, odour etc. during construction stage. IRC guidelines to be followed for traffic safety while passing through the habitat.	The details are given as mitigation measures in Section-4.1.1.2 & 4.1.2.2 of Chapter-4.
26.	If the proposed route involves cutting of earth, the details of area to be cut, depth of cut, locations, soil type, volume and quantity of area to be cut, depth of cut, locations, soil type, volume and quantity of earth and other materials to be removed with location of disposal/ dump site along with necessary permission.	The details are given in Table -2.18 of Section-2.21.9 of Chapter-2.
27.	If the proposed route is passing through low lying areas, details of fill materials and initial and final levels after filling above MSL, should be examined and submit.	The details are given in Table -2.20 of Section-2.21.9 of Chapter-2.
28.	Examine and submit the water bodies including the seasonal ones within the corridor of impacts along with their status, volumetric capacity, quality likely impacts on them due to the project.	Details are given in Table-3.9 and 3.10 of Section 3.2.6 of Chapter-3.
29.	Examine and submit details of water quantity required and source of water including water requirement during the construction stage with supporting data and also categorization of ground water on the CGWB classification.	The details are given in Section-3.2.5.8.5 of Chapter-3.
30.	Examine and submit the details of measures taken during construction of bridges across river/canal/major or minor drains keeping in view the flooding of the rivers and the life span of the existing bridges. Provision of speed breakers, safety signals, service lanes and foot paths should be examined at appropriate locations throughout the proposed road to avoid the accidents.	The Details of Cross drainage structures are given in Section 3.2.5.8.3 of Chapter-3. Details of traffic control devices to avoid accidents are given in Section-7.11.1.1 of Chapter-7.
31.	If there will be any changes in the drainage pattern after the proposed activity, details of changes shall be examined and submitted.	The details are given in Chapter-4.
32.	Rain water harvesting pit should be at least 3-5 m. above the highest ground water table. Provision shall be made for oil and grease removal from surface	Details are given in Section-2.21.8 of Chapter-2.

Sl. No.	Terms of References (ToRs)	Compliance w.r.t Final EIA Report
	runoff.	
33.	If there is a possibility that the construction/widening of road will cause impacts such as destruction of forest, poaching, reductions in wetland areas, if so, examine the impact and submit details.	Details of impacts are given in Chapter-4.
34.	Submit the details of road safety, signage, service roads, vehicular under passes, accident prone zone and the mitigation measures.	Details are given in Section 7.11.5.1 and 7.11.6.1 of Chapter-7.
35.	IRC guidelines shall be followed for widening and upgradation of road.	Complied.
36.	Submit details of Social Impact Assessment due to the proposed construction of road.	Details are given in Section 7.1 to 7.10 of Chapter-7.
37.	Examine road design standards, safety equipment specifications and Management System training to ensure that design details take account of safety concerns and submit the traffic management plan.	The details of provision of ITS as traffic management is given in Section-2.21.14 of Chapter-2. Traffic management plan is given in Section 9.3.2 of Chapter-9.
38.	Accident data and geographic distribution should be reviewed and analyzed to predict and identify trends- in case of expansion of the existing highway and provide post-accident emergency assistance and medical care to accident victims.	The details are given in Section 7.11.6.2 of Chapter-7.
39.	If the proposed project involves any land reclamation, details to be provided for which activity land to reclaim and the area of land to be reclaimed.	The details of land requirement are given as Annexure-24.
40.	Details of the properties, houses, businesses religious and social place etc. activities likely to be effected by land acquisition and their financial losses annually.	The details of land requirement are given as Annexure-24. The details of no. of structures affected are given in Section 7.8.1 of Chapter-7.
41.	Detailed R&R plan with data on the existing socio-economic status of the population in the study area and broad plan for resettlement of the displaced population, site for the resettlement colony, alternative livelihood concerns/employment and rehabilitation of the displaced people, civil and housing amenities being offered, etc and the schedule of the implementation of the project specific	The details are given in Section-9.2.3.4 of Chapter-9.
42.	Submit details of Corporate Social Responsibility. Necessary provisions should be made in the budget.	The details of Corporate Environmental Responsibility are given in Chapter-10.
43.	Estimated cost of the project including Environmental Monitoring Cost and funding agencies, whether governmental or on the basis of BOT etc and provide details of budget provisions (capital & recurring) for the project specific R & R Plan.	The details of Environmental Monitoring Cost are given in Chapter-6, Page-6-6.1 and other capital and recurring costs are given in Chapter-9.
44.	Submit environmental management and monitoring	The details of Environmental

Sl. No.	Terms of References (ToRs)	Compliance w.r.t Final EIA Report
	plan for all phases of the project viz. construction and operation.	Monitoring program are given in Chapter-6.
45.	Details of blasting if any, methodology/technique adopted, applicable regulations/ permission, timing of blasting, mitigation measures proposed. Keeping in view mating season of wild life.	The details of blasting activities and its effects are given in Sections- 7.11.1.2 and 7.11.2.5 of Chapter-7 respectively.
46.	In case of river/ creek crossing, details of the proposed bridges connecting on either banks, the design and traffic circulation at this junction with simulation studies.	The project is not crossing any rivers / creeks. Wherever the project road is crossing the nalas / streams, minor bridges / culverts are proposed. The details of the same are provided in Chapter-2 and 3.
47.	Details to ensure free flow of water in case the alignment passes through water bodies/river/streams etc.	The details of Cross drainage structures are given in Table-3.7 of Section-3.2.5.8.3, Chapter-3.
48.	In case of bye passes, the details of access control from the nearby habitation/habitation which may come up after the establishment of road.	Not applicable.
49.	Bridge design in eco sensitive area/mountains be examined keeping in view the rock classification hydrology etc.	Not applicable.
50.	Details of litigation pending against the project, if any, with direction/ order passed by any court of law against the project should be given.	The litigation details are presented in Section 1.4 of Chapter-1 and Chapter-12.
51.	The cost of the project (capital cost and recurring cost) as well as the cost towards implementation of EMP should be clearly spelt out.	The cost details are given in Chapter-9.
52.	In case of alignment passing through coastal zones a) HTL/LTL map prepared by authorized agencies superimposed with alignment and recommendation of Coastal Zone Management Authority b) Details of CRZ-I(I) areas, mangroves required to be removed for the project along with the compensatory afforestation, area and location with budget c) Details of road on stilt in CRZ-I areas, design details to ensure free tidal flow d) Details of Labour camps, machinery location	Not applicable.
53.	Any further clarification on carrying out the above studies including anticipated impacts due to the project and mitigative measure, project proponent can refer to the model ToR available on Ministry website " http://noef.nic.in/Manual/Highways ".	Complied.
Additional ToRs		
1.	Details of the Kharab land and its position on the village survey map may be detailed and submitted.	The details of Kharab land are provided in Chapter-7 and also sy.no details are

Sl. No.	Terms of References (ToRs)	Compliance w.r.t Final EIA Report
		available in Annexure-24.
2.	Surface hydrological study of surrounding area may be carried out and the carrying capacity of the natural nalas may be worked out in order to ascertain the adequacy in the carrying capacity of the nalas.	The details of hydrological studies are given in Section 3.2.5 of Chapter-3. The details on carrying capacities of nalas are given in Section-3.2.5.8.3 of Chapter-3.
3.	The applicability of the recent Hon'ble Supreme court on buffer zone for water bodies and nalas may be studied and submitted.	The applicability of recent Hon'ble Supreme court on buffer zone for water bodies and nalas is discussed in Section-1.4 of Chapter-1.
4.	Documents related to possession of land to be incorporated in the EIA.	Documents related to possession of land are given as Annexure-24.
5.	The Proponent should carry out Social Impact Assessment that the project as per OM Dated: 21-8-2014 issued by the Ministry regarding guidelines on Environment Sustainability & Enterprise Social Commitment (ESC) related issued. The social impact assessment studies so carried out should form part of EIA & EMP report.	The details of socio-economic studies as part of EIA/EMP report is discussed in Section 7.1 to 7.10 of Chapter-7. Procedure for conducting SIA studies are given in Section-9.2.3 of Chapter-9.
6.	The details to balance cutting and filling earthwork quantities all along the alignment in order to avoid import and export of earthwork from the project site.	The details of cutting and filling of earthwork all along the alignment is given in Section 2.21.9.2 of Chapter-2.

Chapter
16

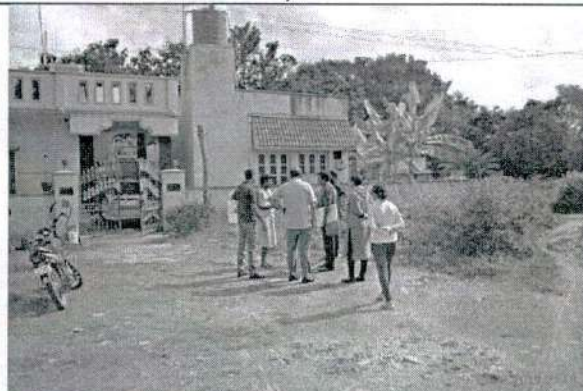
PHOTOGRAPHS



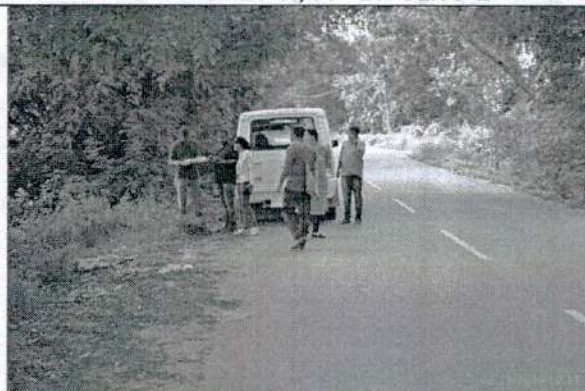
Tumakuru Road-NICE Junction
13° 3'23.79"N, 77°28'36.14"E



Near Hesaraghatta Road
13° 05' 22.26"N, 77° 29' 31.03"E



Near Hesaraghatta Road
13° 5'31.49"N, 77°29'30.28"E









Jalahalli West Road, Bylakere
13° 7'6.50"N, 77°31'22.84"E



Doddaballapur Road
13° 07' 45.74"N, 77° 34' 18.15"E



Kogilu Road
13° 6'14.14"N, 77°36'51.06"E

	
<p>Hennur Road (Bharatiya City) 13° 4'52.10"N, 77°38'35.67"E</p>	<p>Doddaballapur Road 13° 7'45.18"N, 77°34'18.29"E</p>
	
<p>Doddaballapur Road 13° 7'45.48"N, 77°34'18.76"E</p>	<p>Yelhanka Lake 13° 6'56.79"N, 77°35'48.25"E</p>
	
<p>Doddagubbi Main Road 13° 3'51.67"N, 77°40'14.32"E</p>	<p>Ballari Road (AAQM random check) 13° 07' 15.1"N, 77° 36' 36.2"E</p>



Near Bilishivale (Petronet MHB pipeline alignment)
13° 3' 39.82"N, 77° 40' 21.77"E

Expert site visit









Tumakuru Road- Near Madavara
13° 3' 17.8"N, 77° 28' 22.9"E


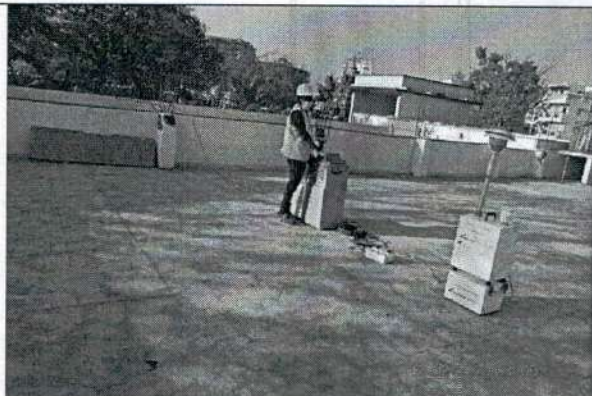




Near Indian Institute of Horticultural Research
Centre
13° 7' 49.9"N, 77° 32' 29.2"E









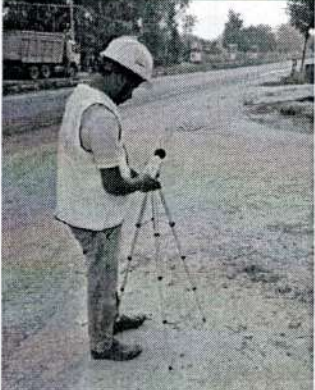





Old Madras Road-Near Avalahalli
13° 02' 11.06"N, 77° 44' 8.69"E






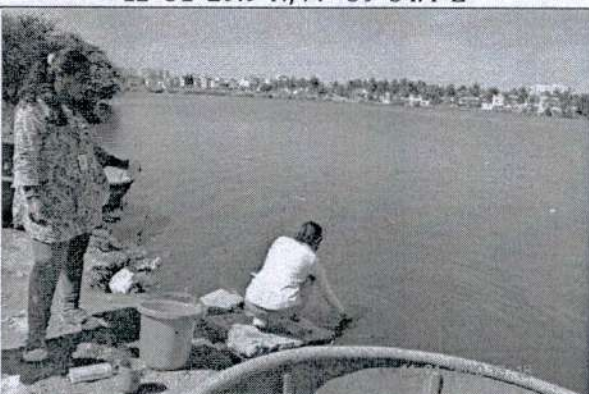
Sarjapur Road- Near Sulikunte Village
12° 53' 30.13"N, 77° 43' 44.54"E






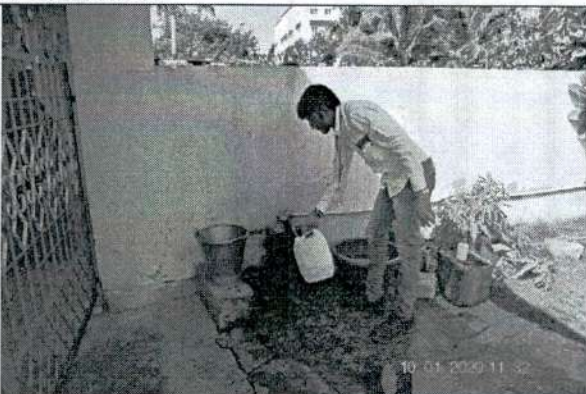
	
Near Channasandra Main Road 12° 59' 2.55"N, 77° 46' 24.50"E	Jigani Bommasandra Industrial Area 12° 49' 5.10"N, 77° 40' 55.43"E
Ambient Air Quality Monitoring (December 2019)	
	
Old Madras Road-Near Avalahalli 13° 02' 11.06"N, 77° 44' 8.69"E	Sarjapur Road- Near Sulikunte Village 12° 53' 30.13"N, 77° 43' 44.54"E
	
Near Hennur Road-Bharatiya City 13° 5' 0.29"N, 77° 38' 31.07"E	Old Madras Road-Near Avalahalli 13° 02' 11.06"N, 77° 44' 8.69"E
Ambient Air Quality Monitoring (January 2020)	







	
Tumakuru Road- Near Madavara 13° 3' 17.8"N, 77° 28' 22.9"E	Old Madras Road-Near Avalahalli 13° 02' 11.06"N, 77° 44' 8.69"E
Ambient Air Quality Monitoring (February 2020)	
	
Tumakuru Road Near Madavara Junction 13° 3' 22.9" N, 77° 28' 27.6"E	Near Kuduregere 13° 04' 06.9" N, 77° 28' 35.1"E
	
SH 39 Near SBM Layout 13° 05' 25.7" N, 77° 29' 33.7"E	Jigani Bommasandra Industrial Area 12° 49' 5.19" N, 77° 40' 55.01"E







	
<p>Bangalore-Hyderabad Highway (NH7)- Near Venkata (Ballari Road) 13° 06' 42.7" N, 77° 36' 17.2"E</p>	<p>Jarakabande RF 13° 07' 50.0" N, 77° 32' 29.4"E</p>
	
<p>Hennur Main Road Near Chikkagubbi 13° 04' 38.7" N, 77° 39' 11.2"E</p>	<p>Channasandra Main Road Near Channasandra 12° 59' 02.3" N, 77° 46' 24.4"E</p>
	
<p>Whitefield - Hoskote Road Near Chikkabanahalli Lake 13° 00' 49.3" N, 77° 45' 40.2"E</p>	<p>Thanisandra Main Road Near Chokkanahalli 13° 05' 05.0" N, 77° 38' 05.1"E</p>







	
Sarjapur Road Near Sulikunte 12° 53' 29.99" N, 77° 43' 44.36" E	Kanyakumari Road Near Chikkatogur lake (Hosur Road) 12° 50' 56.96" N, 77° 40' 6.09" E
Ambient Noise Level Monitoring	
	
Anchepalya Lake 13° 03' 07.2"N, 77° 28' 40.0"E	Jakkur Lake 13° 04' 56.1"N, 77° 36' 49.9"E
	
Rampura Lake 13° 02' 59.0"N, 77° 41' 45.7"E	Yellamma Lake 13° 01' 30.9"N, 77° 43' 26.2"E

	
Chikkabanahalli Lake 13° 01' 21.9"N, 77° 45' 14.7"E	Lake near Koralur Village 12° 59' 06.5"N, 77° 46' 36.7"E
	
Varthur Lake 12° 56' 43.4"N, 77° 44' 47.1"E	Chikkatogur Lake 12° 51' 29.9"N, 77° 39' 34.4"E
	
Rayasandra Lake 12° 52' 02.4"N, 77° 40' 34.0"E Surface water sampling	

	
Soladevanahalli Village 13° 05' 04.9" N, 77° 28' 42.6"E	Yelhanka New Town 13° 06' 02.3" N, 77° 35' 00.7"E
	
Doddabyalakere village 13° 06' 27.1" N, 77° 31' 27.6"E	
	
Chikkagubbi village 13° 04' 49.9" N, 77° 39' 59.3"E	Rampura village 13° 03' 09.3" N, 77° 41' 46.2"E

	
Huskur village 12° 51' 41.0" N, 77° 42' 14.5"E	Varthur 12° 56' 22.6" N, 77° 44' 58.6"E
	
Sulikunte village 12° 52' 54.3" N, 77° 44' 10.7"E	Jigani Bommasandra Industrial Area 12° 48' 46.9" N, 77° 40' 48.8"E
Ground water sampling	
	
Anchepalya Village 13° 03' 24.1"N, 77° 29' 01.9"E	Near Kasghattapura 13° 06' 21.0"N, 77° 30' 31.2"E

	
Near Jarakabande RF 13° 07' 49.2"N, 77° 32' 29.1"E	Near Maruti Nagar 13° 06' 26.57"N, 77° 36' 46.10"E
	
Near Thirumenahalli 13° 05' 14.0"N, 77° 38' 08.0"E	Near Rampura 13° 03' 07.2"N, 77° 41' 35.9"E
	
Near Virgonagar 13° 01' 34.4"N, 77° 44' 11.8"E	Near Seeghihalli 13° 00' 38.5"N, 77° 46' 02.1"E

	
Near Channasandra 12° 59' 11.0"N, 77° 46' 18.1"E	Near Nagondanahalli 12° 58' 08.01"N, 77° 46' 00.5"E
	
Near Valepura 12° 57' 23.0"N, 77° 45' 56.07"E	Near Varthur 12° 56' 19.2"N, 77° 45' 13.8"E
	
Near Kachamaranahalli 12° 54' 32.5"N, 77° 44' 46.2"E	Near Sulikunte 12° 52' 53.2"N, 77° 44' 10.7"E

<p>Near Doddanagamangala 12° 52' 09.0"N, 77° 40' 58.10"E</p>	
<p>Soil sampling</p>	
<p>Granite gneiss exposed as pediment Just after crossing the railway line 13° 05' 14" N 77° 29' 15.3" E</p>	<p>Granite Gneiss Section (Sheet Rock) in abandoned quarry near Bande Bommasandra 13° 04' 42.4" N 77° 41' 34.9" E</p>
<p>Well inventoried at Kogilu 13° 06' 15.2" N, 77° 37' 01.1" E</p>	<p>Well inventoried at Gunjur 12° 55' 12.1" N, 77° 44' 11.3" E</p>

Well inventoried at Kasaghattapura 13° 06' 39.3" N, 77° 30' 07.8" E	Well inventoried at Venkatapura 13° 06' 45.7" N, 77° 36' 19.2" E
Hydrology and Geology studies	
Anchepalya lake 13° 3' 9.00"N, 77° 28' 41.53"E	
Yelhanka lake 13° 6' 59.30"N, 77° 35' 38.25"E	









Agrahara lake
13° 5'23.76"N, 77°37'26.68"E















Chikkabanahalli lake
13° 1'21.77"N, 77°45'17.91"E





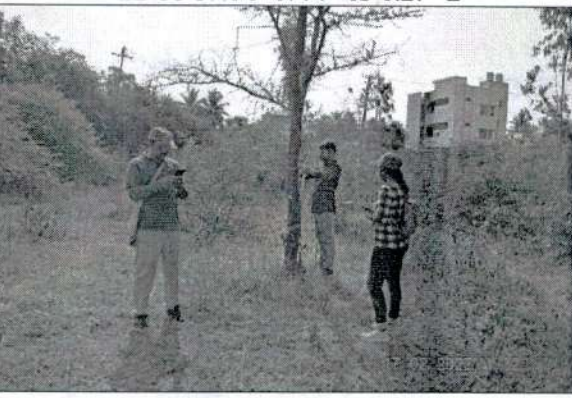









Chinnaganahalli Lake
13° 1'56.66"N, 77°44'48.09"E







	
Cheemasandra lake 13° 2'39.45"N, 77°44'24.67"E	Chikkatogur Lake 12°51'27.53"N, 77°39'30.69"E
	
Varthur Kere 12°56'47.75"N, 77°44'45.47"E	Koralur Lake 12°59'41.25"N, 77°46'27.63"E
Aquatic Ecology and Biodiversity studies	
	
CH@0+100 13°3'43" N 77°28'43" E	CH@0+300 13°3'51" N 77°28'44" E

	
CH@0+300 13°3'51" N 77°28'44" E	CH@0+400 13°3'40" N 77°28'43" E
	
CH@1+200 13°3'48" N 77°28'43" E	CH@1+300 13°3'51" N 77°28'44" E
	
CH@2+300 13°04'26.2" N 77°28'58.8" E	CH@9+100 13°07'06.12" N 77°31'23.45" E

	
CH@15+500 13°7'38" N 77°34'45" E	CH@24+900 13°4'46" N 77°38'48" E
	
CH@34+200 13°03'01.55" N 77°43'24.07" E	CH@35+300 13°02'51.9" N 77°43'57.6" E
	
CH@35+300 13°02'51.9" N 77°43'57.6" E	CH@42+400 13°3'40.36" N 77°35'24.10" E

	
CH@48+700 12°56'38.42" N 77°48'21.62" E	CH@50+000 12°55'57.10" N 77°45'0.55" E
	
CH@50+000 12°55'57.84" N 77°45'0.27" E	CH@50+700 12°55'38.38" N 77°44'48.40" E
	
Measuring of GBH Chainage -0+900-1+000	Measuring of GBH Chainage -1+300-1+400

	
Measuring of GBH Chainage -1+700-1+800	Measuring of GBH Chainage -38+800-38+900
	
Recording of species Chainage -41+300-41+400	Recording GPS Co-ordinates Chainage -41+700-41+800
	
Measuring of GBH Chainage -43+600-43+700	Measuring of GBH Chainage -43+700-43+800

	
Measuring of GBH Chainage -44+300-44+400	Measuring of GBH Chainage -44+700-44+800
Tree enumeration along the proposed PRR alignment	
	
Chikkabanavara Lake Bird watching 13°3'35.40"N 77°28'39.94"E	Chikkabanavara Lake Primary data collection 13°3'32.76"N 77°28'43.34"E
	
Chikkabanavara Lake Bird Watching 13° 3'36.46"N 77°28'40.05"E	Puttenahalli Lake Recording tree species 13° 6'45.16"N 77°34'34.83"E



Near Huskur
Recording GPS readings
12°51'58.98"N 77°42'30.19"E



Jarakabande Kavalu
Collection of sample
13° 7'30.51"N 77°32'42.86"E

Ecology and Biodiversity studies



Chikka Byalakere
13° 7'10.56"N, 77°31'16.10"E




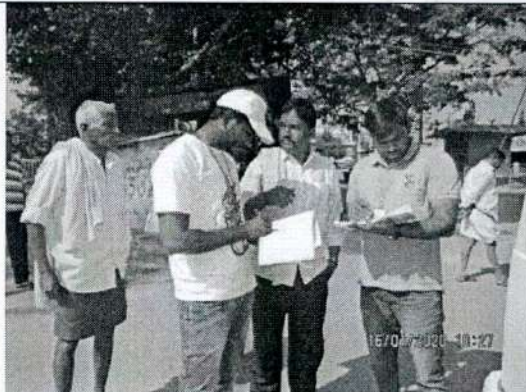

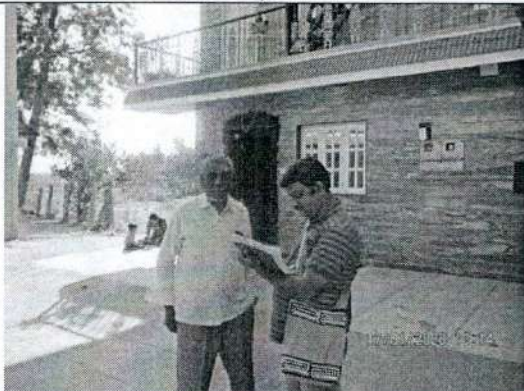
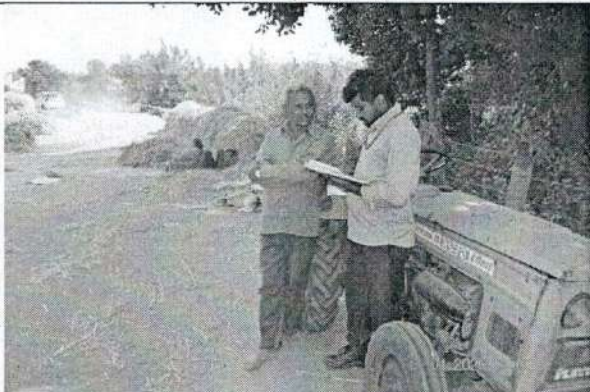

Kempapura
13° 3'10.39"N, 77°36'5.33"E











Chikkabanahalli
13° 1'24.99"N, 77°45'17.93"E

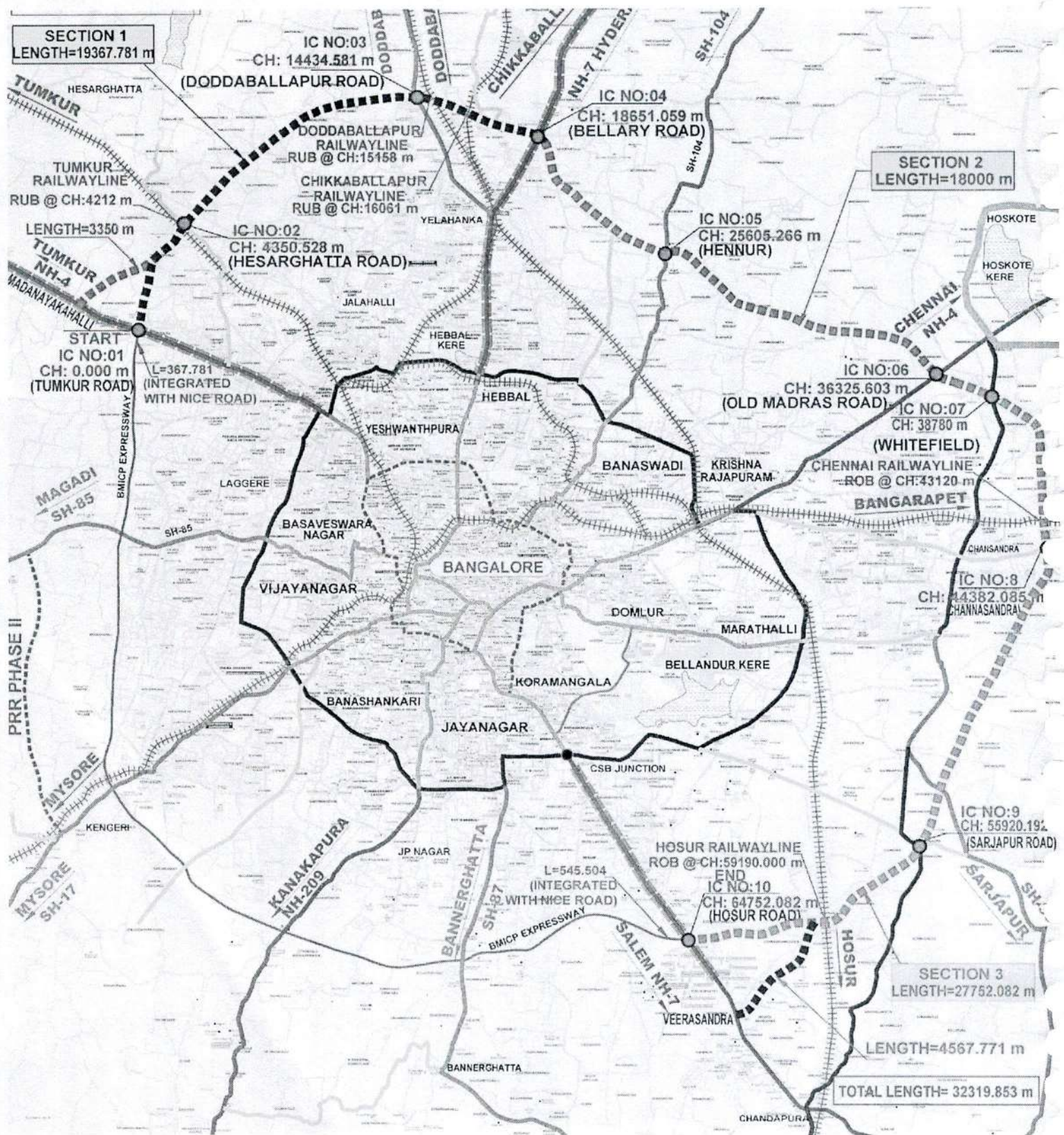


Bidarahalli
13° 3'40.77"N, 77°42'56.54"E

	
Mavallipura 13° 7'10.11"N, 77°31'16.78"E	Harohalli 13° 7'51.65"N, 77°34'50.01"E
	
Kenchenahalli 13° 7'8.11"N, 77°35'3.63"E	Bairathi 13° 4'39.24"N, 77°39'11.43"E
	
Harohalli 13° 7'49.86"N, 77°34'51.14"E	Doddabanahalli 13° 1'36.74"N, 77°44'16.10"E

	
Jarakabande Kavalu 13° 3'46.52"N, 77°32'3.65"E	Bileshivale 13° 3'12.22"N, 77°40'16.67"E
	
Soladevanahalli 13° 5'0.64"N, 77°29'3.59"E	Avalahalli 13° 2'6.71"N, 77°44'13.49"E
	
Doddanagamangala 12°51'17.28"N, 77°40'26.60"E	Doddanagamangala 12°51'14.13"N, 77°40'10.54"E

	
<p>Dodda Toguru 12°51'17.35"N, 77°39'36.02"E</p>	<p>Haripriya Layout (Doddanagamangala) 12°51'49.17"N, 77°40'49.86"E</p>
<p>Socio-economic survey with PAP's</p>	



Consultants

Environmental Health & Safety Consultants Pvt. Ltd.,

[QCI-NABET ACCREDITED & ISO 9001:2015 Certified Organization]

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