

# Volume – I Draft Environment Impact Assessment Report

**Development of Vadodara Mumbai Expressway  
(Phase-II) from km.26.320 to km.104.700  
(km.390.864 of NH-8) of Main Expressway in  
the State of Maharashtra  
(MoEFCC F. No. No.10-80/2016-IA-III)**



*Project Proponent*

**NATIONAL HIGHWAYS AUTHORITY OF INDIA**  
Ministry of Road Transport and Highways, Government of India



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Consultant (15<sup>th</sup> October 2019) : 90**

**NOVEMBER 2019**

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(MoEFCC F. No. No.10-80/2016-IA-III)

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Period of Baseline Monitoring

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## LIST OF ABBREVIATION

AADT	: Annual Average Daily Traffic
AASHTO	: The American Association of State Highway Officials
ADT	: Average Daily Traffic
AE	: Authority Engineer
AH	: Affected Households
AM	: Arithmetic Mean
AP	: Affected Person
AQ	: Air Quality
ARAI	: The Automotive Research Association of India
ASI	: Archaeological Survey of India
ATMS	: Advanced Traffic Management System
BC	: Bituminous Concrete
BDL	: Below Detection Limit
BOD	: Biological Oxygen Demand
C/L	: Centre Line
Ca	: Calcium
CA	: Compensatory Afforestation
CALINE 4	: California Line Source Dispersion Model Version 4
CBR	: California Bearing Ratio
CD	: Cross Drainage
CEF	: Composite Emission Factor
CER	: Corporate Environmental Responsibility
CGWA	: Central Ground Water Authority
CGWB	: Central Ground Water Board
Cl	: Chlorine
CO	: Carbon Monoxide
CoI	: Corridor of Impact
CPCB	: Central Pollution Control Board
CPR	: Common Property Resources
CRTN	: Calculation of Road Traffic Noise
CRZ	: Coastal Regulation Zone
Cu	: Copper
CWC	: Central Water Commission
CZMP	: Coastal Zone Management Plan
dB	: Decibel
DC	: District Collector
DFO	: Divisional Forest Officer
DNH	: Dadra and Nagar Haveli
DO	: Dissolved Oxygen
DPR	: Detailed Project Report

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DTEPA	:	Dahanu Taluka Environment Protection Authority
DTESA	:	Dahanu Taluka as Ecologically Sensitive Area
EA	:	Executive Agency
EAC	:	Expert Appraisal Committee
EC	:	Electrical Conductivity
EHS	:	Environment Health and Safety
EIA	:	Environmental Impact Assessment
EMP	:	Environment Management plan
EO	:	Environmental Officer
EPA	:	Environment (Protection) Act
ES	:	Environmental Specialist
ESZ	:	Eco-sensitive Zone
Fe	:	Iron
FLS	:	Finite Line Source
G.I. Sheet	:	Galvanized Iron Sheet
GIS	:	Geographical Information System
GLC	:	Ground Level Concentration
Gol	:	Government of India
GSB	:	Granular Sub Base
GSDA	:	Groundwater Surveys and Development Agency
GW	:	Ground Water
HAM	:	Hybrid Annuity Mode
HDPE	:	High Density Polyethylene
HFL	:	High Flood Level
Hg	:	Mercury
HS	:	Homogeneous Section
ICAP	:	Indian Clean Air Program
ICAP	:	Indian Clean Air Program
IMD	:	India Meteorological Department
IRC	:	Indian Road Congress
IS	:	Indian Standards
IUCN	:	International Union for Conservation of Nature
IVI	:	Important Value Index
JMR	:	Joint Measurement Record
JMS	:	Joint Measurement Survey
JNPT	:	Jawaharlal Nehru Port Trust
LA	:	Land Acquisition
LAP	:	Land Acquisition Plan
LHS	:	Left hand Side
LPG	:	Liquid Petroleum Gas
MCZMA	:	Maharashtra Coastal Zone Management Authority
M.S. Sheet	:	Mild Steel Sheets



MDR	: Major District Road
Mg	: Magnesium
MI	: Monitoring Indicators
Mn	: Manganese
MO	: Medical Officer
MOEF&CC	: Ministry of Environment, Forest and Climate Change
MoRT&H	: Ministry of Road Transport and highways
MPCB	: Maharashtra Pollution Control Board
MPN	: Most Probable Number
MSL	: Mean Sea Level
NAAQS	: National Ambient Air Quality Standards
NABL	: National Accreditation Board for Testing and Calibration Laboratories
NBWL	: National Board for Wildlife
NE	: Not Evaluated
NGO	: Non-Government Organization
NH	: National Highway
NHAI	: National Highways Authority of India
NHDP	: National Highway Development Program
NO <sub>2</sub>	: Nitrogen Dioxide
NOC	: No Objection Certificate
NPV	: Net Present Value
NQ	: Noise Quality
NTU	: Nephelometric Turbidity Unit
NWMP	: National Water Quality Monitoring Program
OBC	: Other Backward Caste
Pb	: Lead
PCU	: Passenger Car Unit
PD	: Project Director
PIA	: Project Influence Area
PIU	: Project Implementation Unit
PM	: Particulate Matter
POL	: Petroleum, Oil & Lubricants.
PP	: Project Proponent
PPE	: Personal Protective Equipment
PT	: Performance Target
PTV	: Percent Time Violation
PUC	: Pollution under Control
RAP	: Reclaimed Asphalt Pavement
RCC	: Roller Compacted Concrete
RHS	: Right Hand Side
RoW	: Right of Way
SAR	: Sodium Absorption Ratio

SC	: Schedule Caste
SCZMA	: State Coastal Zone Management Authority
SD	: Standard Deviation
SEIAA	: State Environment Impact Assessment Authority
SH	: State Highway
SIA	: Social Impact Assessment
SO	: Safety Officer
SO <sub>2</sub>	: Sulphur Dioxide
SPL	: Sound Pressure Level
ST	: Schedule Tribes
SW	: Surface Water
SWM	: Solid Waste Management
TCS	: Typical Cross Section
TDS	: Total Dissolved Solids
ToR	: Terms of Reference
TWLS	: Tungreshwar Wildlife Sanctuary
VDF	: Vehicle Damage Factor
VME	: Vadodara Mumbai Expressway
VOC	: Vehicle Operating Costs
WQI	: Water Quality Index

## **WEIGHTS AND MEASURES**

Cum	: Cubic Meter
dB(A)	: A Weighted Decibel
gm/cm <sup>3</sup>	: Gram per Centimeter Cube
g/km	: Gram Per Kilometer
ha	: Hectare
ham	: Hectare meter
km	: Kilometer
Km/l	: Kilometer Per Liter
Km <sup>2</sup>	: Square Kilometer
L <sub>eq</sub>	: Equivalent Continuous Noise Level
µg	: Microgram
µg/m <sup>3</sup>	: Microgram Per Cubic Meter
m	: Meter
mg/kg	: Milligram per Kilogram
mg/l	: Milligram per Liter
mg/m <sup>3</sup>	: Milligram Per Cubic Meter
mbgl	: Meter Below Ground Level
PM <sub>2.5</sub>	: Particulate Matter of 2.5 Micron size
PM <sub>10</sub>	: Particulate Matter of 10 Micron size
ppm	: Parts Per Million
Sq. m.	: Square Meter

### Compliance of TOR issued by the MoEFCC dated 09 December 2016

S. N.	ToR	Compliance
1	Examine and submit a brief description of the project, project name, nature, size, its importance to the region / state and the country.	Please refer to Chapter-1 of Draft EIA Report
2	In case the project involves diversion of forests land, guidelines under OM dated 20.03.2013 may be followed and necessary action taken accordingly.	The proposed project involves diversion of approx. 191.5894 ha of forest land. Proposal has been uploaded on 15 <sup>th</sup> October 2018 (FC Proposal No. FP/MH/ROAD/36560/2018) and it is under examination with the State Government.
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.	Following petitions are under hearing on Hon'ble High Court Bombay 1. WP 13561/ 2018 and 2. WP 13544/ 2018 which are filed by the project affected persons regarding land acquisition activities
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, teshils, 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.	The alignment passes through plain and rolling terrain of Vasai, Palghar, Dahanu and Talasari Taluka of Palghar district. The land use pattern within the study area and along the proposed expressway has been given in Section 3.7 of Chapter 3 of Draft EIA Report (Page-38).
5	Describe various alternatives considered, procedures and criteria adopted for selection of the final alternative with reasons.	The details of the alternatives considered have been presented in Chapter 5 of Draft EIA Report ((Page-182 to 186).
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 lands, water bodies, built-up areas, forest area and other surface features such as railway tracks, ports, airports, roads, and major industries etc. and submit a detailed ground surveyed map on 1:2000 scale showing the existing features falling within the right of way namely trees, structures including archaeological & religious, monuments etc. if any.	The land use map of the study area covering 15 km on either side of the expressway in 1:25,000 scale is provided in Annex 3.3 of Draft EIA Report (Volume-II)  Ground surveyed map on 1:2000 scale showing the existing features falling within the right of way is provided in Annex 3.4 Draft EIA Report (Volume-II)

S. N.	ToR	Compliance
7	If the proposed route is passing through any hilly 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.	The proposed expressway lies in rolling terrain and coastal plain. The details of the measures for ensuring stability of slopes and to control soil erosion from embankment have been presented in Section-4.2 of Chapter 4 of Draft EIA Report (Page 114 to 123)
8	If the proposed route involves tunnelling, the details of the tunnel and locations of tunnelling 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.	There is no provision of tunnel in the proposed expressway.  133 nos. of culverts, 8 nos. of major bridges and 29 nos. minor bridges are proposed for maintaining the existing drainage pattern. Details are provided in Section 2.4.3 and Section 2.4.4 of Chapter-2 of Draft EIA Report.  All bridges have been designed for a return period of 100 years and culverts have been designed for a return period of 50 years.
9	The projects is located within 10km. of the sanctuary a map duly authenticated by Chief Wildlife Warden showing these features vis-à-vis the project location and the recommendations or comments of the Chief Wildlife Warden thereon should be furnished at the stage of EC.	The proposed expressway does not pass through any Wildlife Sanctuary and is located at a distance of 1.28 km from the boundary of the Tungeshwar Wildlife Sanctuary.  Final ESZ Notification of Tungeshwar Wildlife Sanctuary has been published on [S.O.3250 (E) dated 11 <sup>th</sup> September 2019. The proposed expressway is located at a distance of is 0.456 km from the ESZ boundary i.e. <b>outside ESZ</b> .  As per MoEFCC Office Memorandum dater 8 <sup>th</sup> August 2019 (F. No. 22-43/2018-IA.III), <i>“Proposal involving developmental activity / project located outside the stipulated boundary limit of notified ESZ and located within 10km of National Park / Wildlife Sanctuary, <b>prior clearance</b> from Standing Committee of the National Board for Wildlife <b>may not be applicable</b>. However, such proposal .....would be examined by the sector specific Expert Appraisal Committee and appropriate conservation measures ..... shall be made.”</i>  Hence, <b>Not Applicable</b>
10	Study regarding the Animal bypasses / underpasses etc. across the habitation areas shall be carried out. Adequate cattle passes	8 Vehicular Underpasses, 3 Vehicular Overpasses, 21 pedestrian underpasses and

S. N.	ToR	Compliance
	for the movement of agriculture material shall be provided at the stretches passing through habitation areas.	51 cattle underpasses have been proposed. The details are provided in Section 2.4.6, 2.4.7 and 2.4.8 of Chapter-2 of Draft EIA Report.
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 wild life crossings to be provided in areas inhabited by wild life.	Tentative number of trees proposed to be felled in forest and non-forest land is 69,095.  Details are provided in Section 4.6.1 of Chapter-4 of Draft EIA Report (Page 162 to 169)
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.	The Green Belt Development Plan has been presented in Section 9.3 of Chapter 9 of Draft EIA Report (Page 254)  The cost of Green Belt Development has been included in EMP budget.
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.	It is a greenfield expressway and major land use (73%) within RoW of the expressway is agricultural and allied uses. human habitations are away from the alignment.  Details of wayside amenities are provided in Section 2.4.11 of Chapter-2 of Draft EIA Report (Page 20)
14	Submit details about measures taken for the pedestrian safety and construction of underpasses and foot-over bridges along with flyovers and interchanges. If any.	The expressway is a greenfield alignment and is access controlled therefore it will be bifurcating the communities on either side. Since it is passing mainly through rural belt the farming communities on either side need to be provided with suitable connection. To serve this purpose, 21 light vehicular cum pedestrian underpasses, 50 cattle underpasses and connecting roads have been proposed.  Details are provided in Section 2.4.9 & 2.4.10 of Chapter-2 of Draft EIA Report (Page 19)
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	The project will enhance traffic movement and the design of the proposed expressway shall address safety concerns and reduce accidents.



S. N.	ToR	Compliance
	buffer to prevent unwanted obstructions defying the purpose of the by pass	
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.	1,09,32,287 cum fly ash will be required for construction of the expressway. Fly ash samples have been collected from two sources namely Nani Naroli (GIPCL, Surat) and Ukai (GETPC, Ukai). Fly ash sample from Nani Naroli exhibits a CBR of 175% and the other one from Ukai exhibits a CBR of 5 %. Tests were repeated to confirm the high CBR from Nani Naroli, which may be due to its chemical composition. Owing to the good CBR and reasonably low dry density and specific gravity, the fly ash can be considered as good embankment material.
17	Examine and submit the details of sand quarry, borrow area and rehabilitation.	Details of borrow and quarry area is given in Section 2.7.1 and 2.7.2 of chapter-2 of Draft EIA Report (Page 22 & 23)  Rehabilitation of Borrow Area and Quarry Area are given in Annex-9.3 and 9.4 respectively of Draft EIA Report (Volume-II).
18	Explore the possibilities of utilizing the debris/waste materials available in and around the project area.	The waste generated during the construction shall be used under subgrade as per its suitability.
19	Submit the details on compliance with respect to Research Track Notification of MoRTH	MoRTH guideline has been complied.
20	Examine and submit the details of sand quarry and borrow area as per OM no.2-30/2012-IA-III dated 18.12.2012 on 'Rationalization of procedure for Environmental Clearance for Highway Projects involving borrow areas for soil and earth" as modified vide OM of even no. dated March 19, 2013.	Details of existing borrow and quarry area is given in Section 2.7.1 and 2.7.2 of chapter-2 of Draft EIA Report (Page 22 & 23)  If, Contractor decides to open new borrow area, required permission shall be obtained from the competent authority as mentioned in Table 1-2 of Chapter-1 of Draft EIA Report (Page-9).
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 have been presented in Section 3.9 of Chapter 3 of Draft EIA Report (Page 47 to 53)
22	The air quality monitoring should be carried out as per the new notification issued on 16 <sup>th</sup> November, 2009.	The details have been presented in section 3.10 of Chapter 3 of Draft EIA Report (Page 54 to 60)

S. N.	ToR	Compliance
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 reducing the negative impact if any. Prediction of noise levels should be done by using mathematical modelling at different representative locations.	The impact on the noise levels during construction and operation phase has been presented in section 4.5 of Chapter 4 of Draft EIA Report (Page 151 to 161)
24	Examine the impact during construction activities due to generation of fugitive dust from crusher units, air emissions from hot mix plants and vehicles used for transportation of materials and prediction of impact 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.	The impact on the air quality during construction and operation phase including Air Quality Modeling has been presented in section 4.4 of Chapter 4 of Draft EIA Report (Page 133 to 150)
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.	Protection to existing habitations from dust and noise during construction stage has been examined and mitigation measures have been suggested. Details are given in Section 4.4 and 4.5 of Draft EIA Report. IRC guidelines have been followed for traffic safety while passing through the habitat.
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 earth and other materials to be removed with location of disposal/dump site along with necessary permission.	Details have been provided in Section 4.2 of Chapter-4 of Draft EIA Report (Page 114 to 118)
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 proposed expressway is passing through plain and rolling terrain. There is no stretches having level below MSL. However, the final FRL/ embankment height is designed based on the HFL as per IRC:SP:99-2013. The fill material for the embankment has been considered from selected quarry which confirm IS codes and MoRTH specification.

S. N.	ToR	Compliance
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.	2 Ponds shall be fully affected and 2 ponds are likely to be partially affected due to the proposed alignment. Details are provided in Section 4.3.1 of Chapter-4 of Draft EIA Report (Page 125)
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 based on the CGWB classification.	Details have been provided in Section 3.13 of Chapter-3 of Draft EIA Report (Page 69 to 74)
30	Examine and submit the details of measures taken during constructions 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.	08 major bridges and 29 minor bridges have been proposed. The details provision of safety signals, service lanes and foot paths to avoid accidents has been presented in chapter 2 of Draft EIA Report Provision of diversions with direction signs and other safety requirements followed as per IRC & MoRTH guidelines
31	If there will be any change in the drainage pattern after the proposed activity, details of changes shall be examined and submitted.	Details have been provided in Section 4.3.1 of Chapter-4 (Page 125)
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 runoff.	As per the CGWA classification, all the Talukas, through which the proposed expressway is passing, fall under <b>safe category</b> and mean water level range of 2 to 5 mbgl is observed in the Palghar, Dahanu and Talasari area. Therefore, rainwater harvesting structure has not been proposed along the expressway, except at toll plaza and wayside amenities as per MoRTH requirement.
33	If there is a possibility that the construction/widening of road will cause impact such as destruction of forest, poaching, reductions in wetland areas, if so, examine the impact and submit details.	The impact on the Flora, Fauna and Forest due to the construction of the expressway and its mitigation measures has been presented in Section 4.6, 4.7 and 4.8 of Chapter 4 of EIA Report.
34	Submit the details of road safety, signage, service roads, vehicular under passes, accident prone zone and the mitigation measures.	The details provision for road safety has been presented in Section 2.4.14 chapter 2 of Draft EIA Report (Page 21).
35	IRC guidelines shall be followed for widening & up-gradation of road.	Complied
36	Submit details of social impact assessment	The details of the Social Impact Assessment

S. N.	ToR	Compliance
	due to the proposed construction of road.	have been presented in Chapter 7 of Draft EIA Report
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.	All relevant guideline has been followed for designing the expressway as per traffic, pedestrian and accident safety.  The proposed project is a greenfield alignment and there is no normal operating traffic as in the case of existing highways. Therefore, there is no specific standard requirement for traffic management plan during construction phase. It is normally the construction vehicles, which will be plying on temporary roads for the constriction works. Wherever the proposed expressway is crossing any existing road, during construction phase, the Contractor shall provide and maintain a passage for traffic either along a part of the proposed RoW or along a temporary diversion constructed close to the crossing. The Contractor shall take prior approval of the Authority Engineer regarding traffic arrangements during construction. Guideline for Preparing of Traffic Management Plan is given in Annex-9.9 of Draft EIA Report (Volume-II)
38	Accident data and geographic distribution should be reviewed and analysed 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.	Proposed expressway is mostly green field. However, provision for accident emergency assistance and medical care to accident victims has been considered as road safety measures.
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 proposed project does not involve any land reclamation.
40	Details of the properties, houses, businesses religious and social places etc. activities likely to be effected by land acquisition and their financial loses annually.	Details are presented in Section 7.2 of Chapter 7 of Draft EIA Report
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	Details of the socio-economic profile of the study area have been presented in Section 3.18 of Chapter 3 of Draft EIA Report (Page 106 to 113)

S. N.	ToR	Compliance
	being offered etc., and the schedule of the implementation of the project specific	
42	Submit details of Corporate Social Responsibility. Necessary provisions should be made in the budget.	The cost for Fund allocation for Corporate Environment Responsibility (CER), has been presented in Section 9.8 of Chapter-9 of Draft EIA Report (Page 267 to 269)
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 Environment Management Plan Budget has been given in Section 9.7 of Chapter 9 (Page 264) and Total Project Cost is given in Section 2.8 of Chapter 2 (Page 24) of Draft EIA Report.
44	Submit environmental management and monitoring plan for all phases of the project viz. construction and operation.	Environmental Management Plan is given in Chapter-9 and Environmental Monitoring Plan is given in Chapter-6 of Draft EIA Report
45	Details of blasting if any, methodology/technique adopted, applicable regulations / permissions, timing of blasting, mitigation measures proposed keeping in view mating season of wild life.	There is no blasting required for this project
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.	There is no intersection at location where the bridge ends at the river banks. There are no at-grade junctions in the expressway and all entry and exits are through grade-separated interchanges with loops and ramps, which are designed for the traffic capacity based on traffic forecasts.
47	Details to ensure free flow of water in case the alignment passes through water bodies/river/streams etc.	It has been ensured that free flow of water is maintained wherever the expressway alignment crosses river / local streams / nallah etc., as detailed in Table 4-4 of Chapter-4 of Draft EIA Report (Page 126)
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.	Proposed expressway is access controlled and bypassing all major habitations
49	Bridge design in eco sensitive area / mountains be examined keeping in view the rock classification hydrology etc.	The proposed expressway neither passing through eco sensitive area nor mountains
50	In case of alignment passing through coastal zones	Details are provided in Section 3.15 of Chapter-3 of Draft EIA Report (Page 103)

S. N.	ToR	Compliance
	<p>a) HTL/LTL map prepared by authorized agencies superimposed with alignment and recommendation of Coastal Zone Management Authority</p> <p>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</p> <p>c) Details of road on stilt in CRZ-I areas, design details to ensure free tidal flow</p> <p>d) Details of Labour camps, machinery location</p>	



## EXECUTIVE SUMMARY

### E.1 INTRODUCTION

This EIA Report has been prepared in accordance with the Terms of Reference (ToR) issued by the Minister of Environment, Forest and Climate Change (MoEFCC) vide letter dated 9<sup>th</sup> December 2016.

### E.2 NEED OF THE PROJECT

The Mumbai–Ahmedabad Corridor is one of the important transport corridors of the country. On one side of this corridor is Mumbai which is the financial capital of the country and on the other side is Vadodara, an important commercial and business city. Many industries like, textile, gems & jewelries, petrochemical & fertilizer etc. have been established along this corridor. This corridor also serves SEZ areas and ports. NH-8 is of great significance for transportation in this corridor between Delhi to Mumbai.

NH48 (old NH-8) has been widened to 6 lane but many of the sections have already reached beyond the capacity volume of 6 lane with average journey speed of 50-60 km/hr with traffic more than 1 lakh PCUs.. Further widening of NH-48 is not feasible. With rapid economic development taking place in the States of Gujarat and Maharashtra, there is a need to develop an expressway wherein the movement of large volumes of passenger and goods vehicles can take place at a fast pace. Further, the Delhi – Vadodara Expressway is also connection the Vadodara – Mumbai Expressway (VME) which will complete the expressway corridor from Delhi to Mumbai.

Keeping in view of the importance of the National Highways for the economic development, the construction of about 379 km long proposed Vadodara Mumbai Expressway (VME) including SPUR is envisaged to fulfill this objective. The proposed VME has been divided into three phases for implementation. This EIA Report deals with development of VME Phase II from Km 26+582 to Km 104+700 of main expressway.

### E.3 PROJECT PROPONENT

National Highways Authority of India (NHAI), an autonomous agency of the Government of India is the project proponent.

### E.4 LOCATION OF THE PROJECT

The proposed project is the development of 8 lane access-controlled green-field Vadodara Mumbai Expressway (Phase-II). The expressway starts at proposed chainage 26+582 (at Koshimb village of Vasai Taluka) and ends at proposed chainage 104+700 [km 390+864 of new NH-48 (old NH-8)] at Ibhadpada village of Talasari Taluka in the state of Maharashtra. Total length of expressway (Phase-II) is **78.118 km**. The proposed alignment is passing through 4 talukas (Vasai, Palghar, Dahanu and Talasari) of Palghar district in the state of Maharashtra.

## E.5 STUDY METHODOLOGY

The study methodology for the EIA employs a simplistic approach in which the critical environmental issues have been identified before initiation of the baseline study. Based on the identification, baseline data was collected during the study period from March to May 2017. This data has analyzed to predict and quantify the impacts and suggest best suited mitigation measure to mitigate the identified impacts.

## E.6 POLICY AND LEGAL FRAMEWORK

Various statutory clearances required to be obtained by the Project Proponent before start of construction of the proposed expressway is:

Type of Clearance	Required (Yes / No)	Remarks
Environment Clearance	Yes	Green field expressway (category "A" project)
CRZ Clearance	Yes	Alignment passes through the intertidal zones of Vaitaran River
Forest Clearance	Yes	Involves diversion of 191.5894 ha forest land
DTEPA Clearance	Yes	Alignment passes through Dahanu Taluka Eco Fragile Area for a length of 27.745 km
Consent to Establish	Yes	NOC from MPCB under Air Act & Water Act
NBWL Clearance	No	Alignment does not passes through any Protected Area or Eco-Sensitive Zone
ASI Clearance	No	No Protected Monument within 300m of the proposed expressway alignment

Apart from the above clearances, the contractor before starting the construction work has to obtain the various Clearances / NOCs from concerned authorities.

## E.7 SALIENT FEATURES OF PROPOSED PROJECT

Proposed Project	Development of 8 lane access-controlled green-field Vadodara Mumbai Expressway (Phase-II).
Total length	78.118 km
Start Point	Proposed Km 26+582 at Koshimb village of Vasai Taluka
End Point	Proposed Km 104+700 at Ibhadpada village of Talasari Taluka
District and State	Palghar district in the State of Maharashtra
No. of affected villages	51
Proposed Right of Way	100 m / 120 m in general
No. of major bridges	8
No. of minor bridges	29

No. of culverts	133
Interchanges	2 (Km 50+594 & Km 78+648)
Fly-over	4 (Km 60+240, Km 73+054, Km 91+756 and Km 99+915)
Vehicular Underpass	8
Vehicular Overpass	3
Light Vehicular Underpasses	21
Small Vehicular / Cattle Underpasses	50
Way side Amenities	Type – A : 1 Type – B : 4
Toll Plaza	2 at chainage 50+594 and 78+638
Truck Parking	At 2 locations
Embankment	<ul style="list-style-type: none"> <li>▪ Total length of embankment - 70.617 km</li> <li>▪ Average height of embankment &gt; 3.5 m</li> </ul>
Drain	<ul style="list-style-type: none"> <li>▪ Lined drain has been proposed on both side</li> <li>▪ Total length of shoulder drain - 141.234 km</li> <li>▪ Total length of toe drain - 134.445 km</li> </ul>
Safety Measures	<ul style="list-style-type: none"> <li>▪ Thrie beam metal crash barriers</li> <li>▪ Advanced Traffic Management System (ATMS)</li> </ul>
Total Project Cost	Rs, 7,101 Cr.

## E.8 DESCRIPTION OF THE ENVIRONMENT

As per the EIA Guidance Manual for Highways (MoEF&CC, February 2010), a study area of 15 km radius from the proposed expressway was considered for secondary data collection. Primary data has been collected within 500 meters on either side of the proposed alignment. Baseline environment monitoring was carried out for the period of March to May, 2017.

### E.8.1 Physiography and Terrain

Geographically the proposed expressway lies between latitude 19°29'19.52"N, to 20° 9'2.46"N and between 72°52'58.81"E to 72°54'55.76"E longitude with elevation varies from about 3 m to 1113 m above MSL. The proposed expressway passes through mainly plain terrain except for a few stretches where it passes through rolling terrain.

### E.8.2 Seismicity

The project area is situated in the Zone III (having moderate seismic intensity) of the Seismic Map of India (as per IS: 1893, Part I, 2002) and therefore has a moderate risk of potential damage due to earthquake.

### E.8.3 Hydrology

The proposed alignment runs parallel to and / or very near to Rivers Vaitarna, Surya and Suseri between Km 30+000 and km 72+200. Vertical profile of the proposed expressway shall be governed by the HFL of these major rivers along the entire stretches. The river beds for the stretch between Km 26 to Km 45 seem to be made up of sandy / loamy soil whereas; rocks were visible in the beds of Surya river, Suseri river and Vadvali river. The proposed alignment crosses Vaitarna river at three locations. Vaitarna River experience tidal fluctuations in water levels at the proposed crossing points with the expressway. The maximum extent of tidal fluctuation generally observed was 3m, as informed by the local people. The Study area comes under Sub zone 5(a) for West Coast Region (Konkan Coasts) as per calcification of The Central Water Commission.

### E.8.4 Land Use

- **Land Use within PROW (100m-120m):** Agricultural and allied uses occupied largest part amounting 73.13% of the total area, followed by open scrub (13.41%), barren land (6.48%), reserved forest (2.71%), surface water bodies (2.12%), settlements (1.37%), mangrove forest (0.36%), open mixed forest (0.24%), mudflats (0.15%) and marshy land (0.04%)
- **Land Use within Study Area:** Total study area is 3027.325 ha. Agriculture land occupied major part (48.27%) of the total area, followed by reserved forest (31.39%), settlement (both urban and rural) (5.83%), surface water bodies (3.66%), marshy land (22.82%), open scrub (2.57%), open mixed jungle (1.83%), industrial (1.1%), mangrove forest (0.85%), salt pan (0.71%), barren land (0.64%), mudflats (0.34%).

### E.8.5 Soil Quality

M/s Anacon Laboratories Pvt. Ltd., Nagpur (A NABL Accredited laboratory) was engaged for collection and analysis of Soil samples. Four (4) sampling locations of different land use (riverbed, agricultural, forest & plantation) within 500 meters on either side of the proposed alignment were collected for studying soil characteristics.

Station Code & Place	Land Use	Soil Quality
SQ1 Ghatim Village	River bed & Mangrove	Electrical conductivity is very high. Very low quantities of nitrogen, phosphorus and poor organic matter content indicate that the soils are poor in soil fertility
SQ2 Maswan village	Agricultural	Favorable organic matter content accompanied by medium levels of nitrogen and phosphorus, high levels of potassium and electrical conductivity within the required limits make the soils quite fertile.
SQ3	Forest	The organic matter being quite low shows that it is a

Station Code & Place	Land Use	Soil Quality
Rankol Village		degraded forest soil where there is very little addition of organic matter from the perennial trees. It should be covered with better plantation so that there is an increase in organic matter proportion of the soil & porosity and as a consequence the water infiltration and water holding capacity of soil improves
SQ4 Talote Village	Plantation	With nitrogen, phosphorus and potassium being in medium range, the soil can be categorized as fertile one. The sodium absorption ratio being well within the range does not show the problem of salinity. The only problem is that of low organic matter which has resulted in higher bulk density and will therefore influence the rate of water infiltration into the soil adversely.

### E.8.6 Climate

Past climatic data show that May is the hottest month with the mean daily maximum temperature around 34.4°C and January is recorded to be the coldest month with the mean daily minimum temperature of 17.3°C. The normal annual rainfall in the study area ranges from 1900 mm to 2600 mm and mean annual rainfall during the year 1981 to 2010 is 1874.6 mm.

A maximum temperature of 46.1°C and minimum temperature of 21.6°C was observed during the monitoring period (March to May 2017). Maximum Relative humidity during the monitoring period is found to be 81.4% while the average relative humidity was about 32%. The period was mostly dry with occasional rains totaling 27.4 mm.

### E.8.7 Ambient Air Quality

Five sampling stations were set up for monitoring ambient air quality within the study area. Monitoring locations were selected following the CPCB guidelines for ambient air quality monitoring so as to accord an overall idea of the ambient air quality scenario in the study area. The ambient air quality at the monitored locations does not exceed National Standards and well within the limits. No industrial sources of air emission are observed along the proposed alignment of the expressway. Air quality data of the study area generated through manual monitoring network has been utilized to calculate the monitoring date wise AQI of the study area and it can be concluded that 60% time of the monitoring period air quality of the area was satisfactory while 40% time of the monitoring period air quality of the area was good

### E.8.8 Ambient Noise Level

To assess the background noise levels in the study area ambient noise monitoring was conducted at five locations. Highest equivalent noise level during day time [57.8 dB(A)] and during night time [48.7 dB(A)] is observed at Pargaon village. The measured and

calculated values of the study area indicate that ambient noise levels slightly exceed the threshold limits. As the proposed expressway is non-existent as on date; it can be inferred that such noise levels originate from local activities i.e. “without project scenario”, which may escalate during the operation stage i.e. “with project scenario”

### E.8.9 Surface Water

Surface water samples (grab samples) were collected once in the month of May 2017 from 8 locations covering river, canal & pond and analyzed for physical, chemical and bacteriological parameters as per established standard methods and procedures. It is observed that the water of Vaitaran river is slightly alkaline, high values of BOD signify presence of decomposable and oxidizable organic matter in the water resulting increase of oxygen demand. Electrical Conductivity (EC) and Total Dissolved Solids (TDS) found to be very high in all three samples collected from Vaitaran River at different locations. Such high values of EC and TDS in Vaitaran River water indicate that the water is highly mineralized and salinity level is very high. This water is not suitable for irrigation under ordinary condition. Values of EC and TDS of the samples collected from Surya River, Jogani Nadi, Vadvali River, canal etc. indicate that the salinity level is low to medium and plants with moderate salt tolerance can be grown without special practices for salinity control.

### E.8.10 Ground Water

- **Depth of Ground Water:** In the study area, pre monsoon depth to water level (May-2011) ranging between 2 to 5 mbgl and 5 to 10 mbgl while post-monsoon depth to water level (Nov- 2011) ranging between 2 to 5 mbgl in major part of the study area. Mean water level range of 2 to 5 mbgl is observed in the Palghar, Dahanu and Talasari area.
- **Ground Water Category:** As per the CGWA classification, all the Talukas, through which the proposed expressway is passing, fall under safe category.
- **Ground Water Quality:** Ground water samples were collected once in the month of May 2017 from 5 locations comprising hand operated tube wells (hand-pumps) and analyzed for physical, chemical and bacteriological parameters as per established standard methods and procedures. The physico-chemical qualities of the ground water satisfy the acceptable limit as stipulated in Drinking Water Standards of India (IS 10500 : 2012) and suitable for human consumption.

### E.8.11 Ecology and Biodiversity

- **Quadrat Study of Flora:** Quadrat study of flora was carried in the month of October, 2017 at 15 locations between Koshimbe village to Talasari village. Overall 144 floral species were recorded during quadrat study out of which, 72 were tree species, 20 shrubs and 52 herb species. The study revealed the predominance of tree species like *Tectona grandis* *Terminalia tomentosa* *Phoenix dactylifera*,



*Bombax ceiba* and *Butea monosperma*. Fruit bearing trees are present in large numbers. Shannon's diversity index was 3.57 for trees 2.55 for shrubs and 3.28 for herbs. The value of Simpson index for diversity ranges between 0 and 1, the greater the value, the greater the sample diversity. In the present study the value was highest for trees 0.95 followed by herbs 0.94 and lowest 0.90 for shrubs.

- **Diversion of Forest Land:** The proposed project involves diversion of 191.5894 ha of forest land, which includes reserved forest (13.1%), mangrove forest (2%), protected forest (70.5%) and private forest (14.4%).
- **Mangrove** forest is found in patches along the Vaitarni River in the project area. The proposed expressway alignment crosses the Vaitarni River at 3 (three) locations and passes through the intertidal zones of Vaitarni River. Tentatively 3.8623 ha area of mangrove will be affected for the project.
- **Faunal Composition:** The fauna of project area is based on direct sighting during field survey, stakeholder consultation, review of Forest working plan of Dahanu Division, Wildlife Management plan of Tungeshwar Wildlife Sanctuary, DNH Wildlife Sanctuary and published literature. The fauna of the project area comprised of Schedule-I and threatened species such as *Panthera pardus*, *Felis chaus*, *Tragulus meminna*, *Axis axis*, *Sus scrofa*, *Antelope cervicapra*, *Muntiacus muntjak*, *Accipiter badius*, *Gyps bengalensis*, *Haliaeetus leucogaster* etc.
- **Protected Areas:** The proposed expressway does not pass through any Wildlife Sanctuary, National Park etc. it is located at a distance of 1.28 km from the boundary of Tungeshwar Wildlife Sanctuary and at a distance of 0.456 km from the notified Eco-Sensitive Zone boundary of Tungeshwar Wildlife Sanctuary i.e. outside the Eco-Sensitive Zone. Approx. 27.745 km stretch of the proposed expressway is traversing through Dahanu Taluka Ecologically Sensitive Area (proposed km 68+455 to Km 96+200).

#### E.8.12 Coastal Regulation Zone (CRZ)

The proposed expressway passes through the intertidal zone of Vaitarna River. CRZ map and report was prepared by the National Centre for Earth Science Studies (NCESS), Thiruvananthapuram in October 2015. NCESS has revised the CRZ map and report (**draft available, final awaited**) based on the recently approved Coastal Zone Management Plan (CZMP) of Thane and Palghar district by MoEFCC on 28.02.2019. Based on the **Draft Map** prepared by the NCESS, location and length in CRZ along the expressway is given in **Table E-1** and classification of CRZ area is given in **Table E-2**.

**Table E-1 Length of Expressway in CRZ (Tentative)**

Proposed Ch. Km		Length (Km)	Village	River
From	To			
28+300	28+500	0.200	Doliv	Vaitarna River

Proposed Ch. Km		Length (Km)	Village	River
From	To			
29+991	30+374	0.383	Wadhiv & Navghar Penand & Sonave Sakhare & Khamloli	
30+540	30+854	0.314		
30+854	32+056	1.202		
35+325	36+020	0.695		
44+828	45+264	0.436		
<b>Total</b>		<b>3.230</b>		

Source: Draft CRZ Map prepared by NCESS

Note: to be updated after finalization of CRZ Map & Report

**Table E-2 Break-up CRZ area with Classification (Tentative)**

Description	CRZ IA	CRZ IB	CRZ II	CRZ III	CRZ IV B	Grand Total
Doliv Village	0.1563	1.8691	3.7068	-	-	5.7322
Wadhiv Village	1.0347	0.5688	-	1.0306	-	2.6341
Navghar Village	1.1634	0.9162	-	1.2813	-	3.3609
Penand Village	0.1506	0.7004	-	2.7783	-	3.6293
Sonave Village	0.0058	0.8291	-	2.1091	-	2.944
Sakhare Village	-	0.919	-	1.031	-	1.95
Khamloli Village	-	0.3796	-	1.2172	-	1.5968
Vaitrarna River	-	-	-	-	10.9942	10.9942
<b>Grand Total</b>	<b>2.5108</b>	<b>6.1822</b>	<b>3.7068</b>	<b>9.4475</b>	<b>10.9942</b>	<b>32.8415</b>

Source: Draft CRZ Map prepared by NCESS

Note: to be updated after finalization of CRZ Map & Report

This may be changed/ updated in the Final CRZ map and report, which will be incorporated in this report upon receipt of the same. CRZ application can be submitted after Final CRZ Map & Report are available.

### E.8.13 Archaeological Sites:

There are no archaeological sites within 300 m on either side of the proposed expressway.

### E.8.14 SOCIO-ECONOMIC PROFILE

The proposed expressway passes through 51 villages in Palghar district, in the State of Maharashtra.

- **Total Population:** population composition of the villages is important to anticipate the extent of project impact. Population details of the 51 villages have been derived from primary census abstract 2011 and total population is 85,476, out of which 42,390 are male and 43,086 are female.

- **Tribal Population:** Total tribal population of 51 villages is 66,819 (Scheduled Cast – 1,123 and Scheduled Tribes – 65,696), which is 78.2% of the total population. As per Census of India, 2011, 100% population of Chandwad village is Scheduled Tribes. Out of 51 villages, maximum tribal population is observed in Vadavali village (5375 nos.) and in 24 villages, tribal population is more than 90%.
- **Literacy Rate:** Among 51 villages, highest literacy rate is observed in Nagaze village of Palghar Taluka (male – 92.02%, female – 78.88%). Lowest literacy rate among male observed in Dhaniwari village (44.01%) of Dahanu Taluka and among female observed in Ganeshbag village (18.52%) of Dahanu Taluka. In Dhaniwari and Ganeshbag village, tribal population is more than 99%. Overall literacy levels among tribals are lower than that of the general population.
- **Category wise Distribution of Main Workforce:** Agriculture does play an important sector in engaging the workforce in the project area. Majority of main workers are cultivators (42.8%) followed by agricultural labours (33.2%), other workers (22.0%) and only 2.0% population are engaged in household industry such as handloom, weaving, biri rolling, papad making, toy making, etc.

## E.9 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A summary of the anticipated environmental impacts during construction and operation phase along with recommended mitigation measures is summarized in **Table-E.3**:

**Table - E.3 Summary of Anticipated Impacts and Recommended Mitigation Measures**

Area	Impacts	Mitigation Measures
<b>Construction Phase:</b>		
Topography and geology	<ul style="list-style-type: none"> <li>▪ Disfiguration &amp; change in existing profile of the land due to borrow pits &amp; construction of realignments.</li> <li>▪ Disturbance on geological setting due to quarrying.</li> <li>▪ Uncontrolled digging of borrow pits resulting in water accumulation &amp; breeding of vector disease.</li> <li>▪ Establishment of construction camp</li> </ul>	<ul style="list-style-type: none"> <li>▪ Borrow pits shall be allowed at only pre-identified locations.</li> <li>▪ Borrow pits shall be restricted to 1 m depth followed by resurfacing of pits.</li> <li>▪ Road building materials shall be procured from approved and licensed quarries.</li> <li>▪ Suitable seismic design of the structures shall be adopted to mitigate the earthquake impacts.</li> </ul>
Soil	<ul style="list-style-type: none"> <li>▪ Disruption &amp; loss of productive top soil from agricultural fields</li> <li>▪ Soil erosion and contamination</li> </ul>	<ul style="list-style-type: none"> <li>▪ Adequate measures like drainage, embankment consolidation &amp; slope stabilization shall be taken to avoid soil erosion.</li> <li>▪ Top soils (15 cm) of borrow pit sites shall be conserved and restored after excavation is over.</li> <li>▪ Accidental spills of lubricants/oil and molten asphalt shall be avoided by adherence to good practices.</li> </ul>

Area	Impacts	Mitigation Measures
		<ul style="list-style-type: none"> <li>▪ Oil Interceptor shall be provided for wash down, refueling areas</li> <li>▪ Vehicle parking area of the construction camp will be made impervious using 75 mm thick P.C.C. bed over 150 mm thick rammed brick bats.</li> </ul>
Land use	<ul style="list-style-type: none"> <li>▪ Changes in existing land use pattern of the PROW for construction of the expressway</li> <li>▪ Loss of agricultural land, forest land etc. due to land acquisition</li> </ul>	<ul style="list-style-type: none"> <li>▪ Earth material generated from excavation shall be reused during site development.</li> <li>▪ Construction debris will be disposed of in suitable pre-identified dumping areas.</li> <li>▪ Dumping areas will be biologically reclaimed.</li> <li>▪ Construction camp will be provided to avoid indiscriminate settlement of construction workers.</li> <li>▪ Construction activities shall be kept confined to PROW only</li> </ul>
Drainage & Hydrology	<ul style="list-style-type: none"> <li>▪ The drainage network along the expressway is subject to adverse impacts due to construction of embankment</li> <li>▪ 2 Ponds shall be fully affected and 2 ponds are likely to be partially affected due to the proposed alignment</li> </ul>	<ul style="list-style-type: none"> <li>▪ To minimize the impact drainage &amp; hydrological flow, 8 major bridges, 29 minor bridges, 133 culverts are proposed to be constructed along the expressway</li> <li>▪ Free flow of water in river / stream has been ensured in all bridge location</li> <li>▪ All bridges have been designed for a return period of 100 years and culverts have been designed for a return period of 50 years</li> <li>▪ Silt fencing shall be provided between expressway and water bodies to avoid any siltation due to runoff from construction area</li> <li>▪ Shoulder and toe drains has been proposed along the expressway on both side</li> </ul>
Water use	<ul style="list-style-type: none"> <li>▪ Impact on the local water sources due to use of construction water.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Minimum use of water from existing sources for construction purpose</li> <li>▪ The contractor shall arrange water required for construction in such a way that the water availability and supply to nearby communities remain unaffected.</li> <li>▪ If new tube-wells are to be bored, due to the non-availability of water required for construction, prior sanctions and approvals by the Ground Water Department has to be obtained by the Contractor</li> <li>▪ Wastage of water during the construction should be minimized</li> </ul>
Water quality	<ul style="list-style-type: none"> <li>▪ Increase of sediment load in the run off from construction sites and increase in turbidity in receiving water bodies.</li> <li>▪ Water pollution due to generation of wastewater from construction camps</li> <li>▪ Water pollution due to use of fly</li> </ul>	<ul style="list-style-type: none"> <li>▪ Silt fencing will be provided to reduce sediment load</li> <li>▪ Oil interceptor to stop and separate the floating oils</li> <li>▪ Packaged Wastewater Treatment Plant has been recommended for the construction camp</li> <li>▪ All the construction activities will be carried out during dry seasons only.</li> </ul>

Area	Impacts	Mitigation Measures
	<p>ash in the embankment</p>	<ul style="list-style-type: none"> <li>▪ In line with specifications of IRC:SP:58, method of construction of Fly Ash embankments is proposed by alternate layers of fly ash and soil i.e. Sandwich Type Construction</li> <li>▪ Rainwater Harvesting Structures has been proposed at toll plaza and way side amenities</li> <li>▪ The fuel storage and vehicle cleaning area shall be stationed at least 500m away from the nearest water body</li> <li>▪ Apart from provision of the mitigation measures, water quality shall be monitored during construction and operation phases as per environmental monitoring program to understand the effectiveness of mitigation measures suggested</li> </ul>
Air quality	<ul style="list-style-type: none"> <li>▪ Deterioration of air quality due to fugitive dusts emission from construction activities and vehicular movement along unpaved roads.</li> <li>▪ Deterioration of air quality due to gaseous emissions from construction equipment &amp; vehicular traffic.</li> <li>▪ Deterioration of air quality due to emission from hot mix plants and stone crusher.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Construction materials will be stored in enclosed spaces to prevent fugitive emissions.</li> <li>▪ Truck carrying soil, sand and stone will be duly covered to avoid spilling.</li> <li>▪ Dust suppression measures such as regular water sprinkling on haul &amp; unpaved roads particularly near habitation</li> <li>▪ Hot Mix Plant with Pollution Control Measures having Fabric Filter with multiple wet scrubber shall be installed and elevators at loading section shall be fully covered</li> <li>▪ A combination of dry and wet type control system is suggested for stone crusher to minimize the impact on air quality</li> <li>▪ Hot mix plants &amp; stone crusher shall be located at least 500 m away from inhabited areas &amp; sensitive receptors</li> <li>▪ Air quality shall be monitored during construction and operation phases as per environmental monitoring program to understand the effectiveness of mitigation measures suggested</li> </ul>
Noise level	<ul style="list-style-type: none"> <li>▪ Increase in noise level due to construction activities like operation of construction equipment &amp; vehicular traffic.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Construction camp and temporary labour sheds will be located away from the immediate vicinity of the construction sites and major road traffic.</li> <li>▪ PPEs will be provided to construction personnel exposed to high noise levels as preventive measure.</li> <li>▪ Low noise construction equipment will be used.</li> <li>▪ Stationary construction equipment will be placed 113 m away from inhabited areas.</li> <li>▪ Stationary construction equipment will be placed 200 m away from the silence zones</li> <li>▪ Construction activities carried out near residential area will be scheduled to the daytime only so that minimum disturbances are caused to people.</li> </ul>

Area	Impacts	Mitigation Measures
		<ul style="list-style-type: none"> <li>▪ Noise barrier will be constructed in silence zone, interchanges (300m on each side on outer edge), fly-overs (200m on each side on outer edge), truck parking (500m on one side on outer edge), way side amenity - type A (500m on one side on outer edge) and way side amenity - type B (150m on one side on outer edge)</li> <li>▪ Noise level shall be monitored during construction and operation phases as per environmental monitoring program to understand the effectiveness of mitigation measures suggested</li> </ul>
<p>Floral, Fauna and Forest</p>	<ul style="list-style-type: none"> <li>▪ As per joint measurement survey of 34 villages, approximately 43,392 trees are falling within the proposed ROW in non-forest land</li> <li>▪ Tentative number of trees to be felled in the forest area is 25,703.</li> <li>▪ Proposed project involves diversion of 191.5894 ha forest land</li> <li>▪ Loss of habitat of fauna due to felling of trees and diversion of forest land</li> </ul> <p><u>Note:</u> no. of trees to be felled will be updated after completion of Joint Survey with Forest Department in all ranges and completion of JMS in all villages and as per JMR</p>	<ul style="list-style-type: none"> <li>▪ 90,899 no. of trees and 49,408 no. of hedges have been proposed to be planted under greenbelt development plan</li> <li>▪ Plantation suggested under Compensatory afforestation for diversion of 191.5894 ha forestland shall be 1,91,589 plants. However, this shall be finalized by the Forest Department</li> <li>▪ To compensate the loss of horticultural trees in the area, budget of <b>Rs. 2.5 Crore</b> earmarked under Corporate Environmental Responsibility for fruit sapling distribution</li> <li>▪ To compensate the loss of medicinal plants, development of herbal garden is proposed. Total budget of <b>Rs. 60 Lakhs</b> proposed for development of herbal garden by Forest Department under CER.</li> <li>▪ Wildlife awareness &amp; environmental protection training shall be provided to the work force by the Contractor and a budget of <b>Rs. 12 lakh</b> has been proposed for training in the EMP Budget.</li> <li>▪ Cooking fuel (LPG) shall be provided to construction workers to avoid cutting / felling of trees for fuel wood.</li> <li>▪ Soil erosion shall be checked by adopting bio-engineering measures</li> <li>▪ The Contractor shall ensure that no open fire is done in construction camp as it may lead to fire to surrounding forest causing injury to wildlife</li> <li>▪ Noise will be kept under control by regular maintenance of equipment and vehicles.</li> <li>▪ Noisy activity shall be prohibited during night time</li> </ul>
<p>Protected Area</p>	<ul style="list-style-type: none"> <li>▪ The proposed expressway does not pass through any National Park, Wildlife Sanctuary, Conservation Reserve and Community Reserve; hence no direct impact is envisaged</li> <li>▪ Approx. 27.745 km stretch of the proposed expressway is</li> </ul>	<ul style="list-style-type: none"> <li>▪ The wildlife kills reported by Tungeshwar Wildlife Sanctuary shows that all the incidence of vehicle kill occurred towards south–east side from the start point of proposed expressway, which is about 1.8 km away from old NH-8. The Sanctuary is on further right side of old NH-8 and old NH-8 is acting as a barrier for the movement of wild animals. There is no report of wildlife killed in the</li> </ul>



Area	Impacts	Mitigation Measures
	<p>traversing through Dahanu Taluka Ecologically Sensitive Area</p> <ul style="list-style-type: none"> <li>▪ Proposed expressway may cause obstruction in movement of wildlife. hence bridges, culverts and wildlife / cattle underpass are important structures in the design of the expressway</li> </ul>	<p>stretch of old NH-8 parallel or closed to the proposed expressway.</p> <ul style="list-style-type: none"> <li>▪ Further, the density of forest is more towards western side of the proposed expressway in comparison to the eastern side. Therefore, the possibility of accident of wild animal in the proposed expressway is expected to be nominal. Further, fencing / wall has been proposed along the ROW boundary of the entire expressway.</li> <li>▪ 8 major bridges and 29 minor bridges, 133 culverts 51 cattle underpasses (size 7m x 4m) have been proposed along the expressway. In addition to above, the box culverts of size 6m x 4m and 5m x 4m will act as cattle underpass / animal crossings during summer season.</li> <li>▪ Monitoring of wild animals should be done during construction phase and any incidence of sighting should be immediately reported to Forest Department.</li> <li>▪ Measures recommended during Environment &amp; CRZ Clearance, DTEPA clearance and Forest Clearance shall be complied; progress report of implementation of EMP and recommendations by various authorities shall be submitted as per the schedule</li> </ul>
Solid Waste	<ul style="list-style-type: none"> <li>▪ Waste generated during construction may impact soil, agriculture and water quality</li> <li>▪ Waste generated from workers' camps may impact surface and ground water quality and agriculture</li> </ul>	<ul style="list-style-type: none"> <li>▪ Approx. 75 kg/day solid waste will be generated by the construction workers out of which estimated biodegradable waste is 30 kg/day and remaining 45 kg/day is non-biodegradable waste. There shall be "Refuse Containers" at site for the management of domestic waste generated by the construction workers and these containers shall be emptied at least once daily and shall be disposed of as per SWM Rules, 2016 in consultation with the local authority.</li> </ul>
Construction camp	<ul style="list-style-type: none"> <li>▪ Influx of construction work-force &amp; suppliers who are likely to construct temporary tents in the vicinity.</li> <li>▪ Likely sanitation &amp; health hazards &amp; other impacts on the surrounding environment due to inflow of construction labourers.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Temporary construction camps with adequate potable water supply, primary health facilities and fuel for cooking shall be provided</li> <li>▪ Packaged Wastewater Treatment Plant has been recommended for the construction camp</li> <li>▪ It will be ensured that the construction workers are provided fuel for cooking to avoid cutting of trees from the adjoining areas.</li> <li>▪ Contractor to provide a full-fledged dispensary. The number of beds shall be as per the requirement of the labour license</li> </ul>
Occupational health & safety	<ul style="list-style-type: none"> <li>▪ Health &amp; safety related problems to construction workers due to inadequate health &amp; safety measures.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Adequate safety measures complying to the occupational safety manuals will be adopted to prevent accidents / hazards to the construction workers</li> </ul>



Area	Impacts	Mitigation Measures
		<ul style="list-style-type: none"> <li>▪ Contractor shall conduct monthly health check-ups of all his laborers in his camps through registered medical practitioner</li> <li>▪ Contractor to conduct workshop on HIV / AIDS for all his laborers at all his camps at least once in a quarter</li> </ul>
Road safety	<ul style="list-style-type: none"> <li>▪ Increase on incidence of road accidents due to disruptions caused in existing traffic movements.</li> </ul>	<ul style="list-style-type: none"> <li>▪ The proposed project is a greenfield alignment and there is no normal operating traffic as in the case of existing highways. Therefore, there is no specific standard requirement for traffic management plan during construction phase. It is normally the construction vehicles, which will be plying on temporary roads for the construction works. Wherever the proposed expressway is crossing any existing road, during construction phase, the Contractor shall provide and maintain a passage for traffic either along a part of the proposed RoW or along a temporary diversion constructed close to the crossing. The Contractor shall take prior approval of the Authority Engineer (AE) regarding traffic arrangements during construction.</li> <li>▪ Reduction of speed through construction zones.</li> </ul>
<b>Operation Phase</b>		
Land use and Encroachment	<ul style="list-style-type: none"> <li>• Change of land use by squatter/ encroachment within ROW and induced development outside the ROW.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Fencing has been proposed along the ROW boundary of the entire expressway</li> <li>▪ Planning agencies and Collector / Revenue Officer will be made involved for controlled development and prohibiting squatter/ encroachment within ROW.</li> </ul>
Drainage	<ul style="list-style-type: none"> <li>• Filthy environment due to improper maintenance of drainage.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Shoulder drain &amp; toe drain of sufficient capacity has been provided on both sides of the expressway to accommodate increased run-off. The out fall for these drains will be the nearby culverts / bridges or natural drainage channel. Silt fencing will be provided to sediment entering into the water courses.</li> </ul>
Water quality	<ul style="list-style-type: none"> <li>• Chances of contamination of water bodies from road surface run off containing oil spills due to traffic movement &amp; accidents.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Adequate drains have been proposed to accommodate increased run-off. The out fall for these drains will be the nearby culverts / bridges or natural drainage channel.</li> <li>▪ Silt fencing will be provided to sediment entering into the water courses.</li> <li>▪ Contingent actions will be taken for speedy cleaning up of oil spills, fuel and toxic chemicals in the event of accidents.</li> <li>▪ Regular maintenance of rainwater harvesting structures shall be done during the operation stage to prevent choking of these structures</li> </ul>

Area	Impacts	Mitigation Measures
		<ul style="list-style-type: none"> <li>▪ Monitoring of water quality at specified locations will be conducted at fixed interval</li> </ul>
Air quality	<ul style="list-style-type: none"> <li>▪ Air pollution due to vehicular emission from road traffic.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Results of air quality modeling indicate that due to higher carriageway width, air turbulence and high design speed, emissions from traffic are low at receptor locations. With the introduction of BS-VI compliant fuels and vehicles in 2020 onwards, the vehicular emission is expected to further reduce and may offset the increased pollutant concentration due to increased traffic volume. Hence, the pollutant concentration is not expected to increase beyond stipulated limits in operation phase of the expressway.</li> <li>▪ Plantation along the expressway will act as sink of air pollutants</li> <li>▪ Monitoring of air quality at specified locations will be conducted at fixed interval</li> </ul>
Noise level	<ul style="list-style-type: none"> <li>▪ Noise pollution due to traffic noise.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Plantation along the expressway will act as a natural noise barrier.</li> <li>▪ Monitoring of noise level at specified representative locations will be conducted at fixed interval.</li> <li>▪ Maintenance of noise barrier</li> </ul>
Flora & fauna	<ul style="list-style-type: none"> <li>▪ Illegal felling of trees along the expressway</li> <li>▪ Effect on aquatic fauna in case of accidental spill of oil, fuel &amp; toxic chemicals into water bodies</li> </ul>	<ul style="list-style-type: none"> <li>▪ Monitoring of avenue plantation along the expressway to be done for 5 years as per Green Highway policy. Dead sapling shall be replaced and survival rate of 90% shall be maintained. Saplings shall be provided with tree guards to protect from cattle grazing.</li> <li>▪ Regular watering of plants to be done in dry season</li> <li>▪ Regular maintenance of the cattle underpass and culverts, which will act as animal crossing.</li> </ul>
Road safety	<ul style="list-style-type: none"> <li>• Impacts on human health due to accidents.</li> <li>• Damage of expressway due to wear &amp; tear.</li> </ul>	<ul style="list-style-type: none"> <li>▪ To improve the safety of such high speed corridor, Thrie beam metal crash barriers shall be provided in entire length on both sides of each main carriageway (i.e. on median and on earthen shoulder of both carriageway), Loops and Ramps excluding stretches covered by bridges and RE wall structures, where concrete barriers to be provided.</li> <li>▪ In addition to safety barrier, safety features like road marking, traffic sign, boundary stones, kilometer stones and hectometer stones, pavement marking and lighting has been proposed. Advanced Traffic Management System (ATMS) for entire expressway have been proposed to facilitate the road users, which will include mobile communication system,</li> </ul>

Area	Impacts	Mitigation Measures
		meteorological data system, automatic traffic counter and vehicle classification, video surveillance system, video incident detection system. To improve antiglare, hedge plantation on median have been proposed

## E.10 SOCIAL IMPACTS

**Table - E.4 Summary of Project Impacts (Phase-II of Main Alignment)**

Sl. No.	Impact Summary	Number / Area
1	Total private / government land acquisition requirement (in ha tentative)	710.3247
2	Total number of private land units / plots affected (No.)	2393
3	Fully displaced land owner (15% of affected land owners) (No.)	359
4	Total number of structures affected of all categories (Including Private, Government, and Religious)	895
5	Total number of affected private structures	717
6	Number of Fully displaced structure owner (15% of affected structure owners)	108
7	Total number of affected Households Including Land & Structures	3110
8	Total number of Govt. /Communities properties	175
9	Total number of religious properties	3

Source: Field Survey

## E.11 ANALYSIS OF ALTERNATIVES

The identification of the route alignment of Vadodara Mumbai Expressway was initially taken up in the early 1990s by the Ministry of Road Transport & Highways from a Technical Assistance Program of Asian Development Bank. The alignment was finalized by M/s Wilbur Smith. Based on this alignment the Government of Gujarat has frozen a corridor of 600m width. NHAI in the year 2008 awarded the task of finalization of VME alignment to M/s SECON through a desk study. As per the terms of the study SECON was to study Wilbur-Smith's alignment on satellite imagery and modify it based on the present site conditions by carrying out a desktop study.

In the current consultancy assignment, the Consultant was given the alignment as was finalized by M/s SECON to follow. It was stipulated that the consultant might review the alignment based on existing conditions at sit if it passes through problematic area and propose alternate solution. The consultant reviews the alignment and modifies it based on technical, environmental and social consideration and submitted to NHAI for approval. After a series of presentations in NHAI headquarters in front of senior NHAI officials, approval has been granted to the VME alignment vide letter No. NHAI/V-M Expressway/DM/2008/30 dated 8<sup>th</sup> February 2010.

## E.12 ENVIRONMENTAL MONITORING PROGRAM

Environmental monitoring involves regular checking of the environmental management issues detailed in the EMP and to ascertain whether the mitigation measures are achieving their objectives, according to the EMP, with the progress of the works.

To mitigate the potential negative impacts of proposed development and measurement the performance of mitigation measures, an Environmental Monitoring and Management Plan is developed. Contractor is the main executor of the implementation activities. The contractor will report to the Sr. Environmental Specialist of Authority Engineer (AE) who in turn shall report to the PIU. The Contractor will submit monthly and quarterly environmental compliance reports to the AE. The AE will submit separate quarterly environmental monitoring reports to Project Implementation Unit (PIU) of NHA and PIU will be responsible for preparation of the targets for non-compliances identified by the AE.

## E.13 ENVIRONMENTAL MANAGEMENT PLAN

EMP has been prepared addressing the following issues:

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

Environmental Budget: A capital cost provision of about **Rs. 66.42 Crore** has been kept towards implementation of environmental management plan.

Corporate Environment Responsibility (CER): A capital cost provision of about **Rs. 35.05 Crore** has been kept under Corporate Environment Responsibility (CER) for implementation of various activities for overall improvement of environmental and ecological conditions of the project area.

## E.14 CONCLUSIONS

Based on the EIA study and surveys conducted for the project, it can be concluded that associated potential adverse environmental impacts can be mitigated to an acceptable level by adequate implementation of the measures as stated in the EIA Report.

Adequate provisions shall be made in the project to cover the environmental mitigation and monitoring requirements, and their associated costs as suggested in environmental budget. The proposed expressway will provide fast connectivity between Ahmedabad to Pune for a length of about 650 km by providing link between Ahmedabad Vadodara Expressway and Mumbai Pune Expressway. The proposed expressway will reduce the travel time, vehicle operating cost, no. of accidents, increase employment opportunity and improve economic development of the region.

## **CHAPTER-1: INTRODUCTION**

### **1.1 PURPOSE OF THE REPORT**

Intercontinental Consultants and Technocrats Private limited (ICT) has been appointed as a Consultant by the National Highways Authority of India (NHAI) through agreement dated 29<sup>th</sup> January, 2009 for carrying out the consultancy services for "Preparation of Feasibility cum Preliminary Design Report for Vadodara Mumbai Expressway under NHDP Phase-VI".

This EIA & EMP Report has been prepared as a part of this consultancy services for "***Development of Vadodara Mumbai Expressway (Phase-II) from km.26.320 to km.104.700 [km.390.864 of new NH-48 (old NH-8)] of Main Expressway in the State of Maharashtra***". and purpose of the report are as follows:

- Establishment of present environmental conditions along the proposed corridor of the expressway through available data / information supported by field studies / monitoring, wherever necessary;
- Prediction of impacts on various environmental attributes due to the construction & operation of the proposed expressway;
- Recommendation of mitigation measures to minimize / reduce adverse impacts on the environment;
- Preparation of Environmental Monitoring Program;
- Preparation of an Environmental Management Plan (EMP) for timely implementation of the mitigation measures to make the project environmentally sound and sustainable.
- Obtaining statutory clearances from the concerned authorities

This EIA Report has been prepared in accordance with the Terms of Reference (ToR) issued by the Minister of Environment, Forest and Climate Change (MoEFCC) vide letter dated **9<sup>th</sup> December 2016**. Copy of the approved ToR is given as **Annex-1.1**

### **1.2 IDENTIFICATION OF PROJECT AND PROJECT PROPONENT**

**Identification of Project:** The Mumbai–Ahmedabad Corridor in the western part of the country is one of the important transport corridors of the country. On one side of this corridor is Mumbai which is the financial capital of the country and on the other side is Vadodara, an important commercial and business city. Many industries like, textile, gems & jewelries, petrochemical & fertilizer etc. have been established along this corridor. This corridor also serves SEZ areas and ports. New NH 48 (old NH 8) is of great significance for transportation in this corridor starting from the country's administrative capital of Delhi to financial capital of Mumbai. Present condition and steps taken to develop its speed and safety are as follows:

- The Vehicle Damage Factor (VDF) as assessed on NH8 varies from 2.04 to 5.86 for 2 axle vehicles and varies from 19.48 to 25.69 for 6 axle vehicles.

- The average journey speed in majority part of Mumbai-Vadodara section of NH 8 was found to be in the range of 50-60 km/hr. whereas the designed speed is 100km/hr.
- NH8 has been widened to 6 lane but many of the sections have already reached nearly the capacity volume (LOS E) of 6 lane NH (120,000 PCU) in the year 2015.

Even with six laning or further widening, segregation of long distance and local and / or slow traffic is hard to achieve. Further, NH-8 is not an access controlled highway and is passing through many settlements where land availability and displacement of people would be a major concern for further widening. With rapid economic development taking place in the States of Gujarat and Maharashtra, there is a need to develop an expressway wherein the movement of large volumes of passenger and goods vehicles can take place at a fast pace.

Keeping in view of the importance of the National Highways for the economic development, the Government of India has taken up an ambitious program of development of the National Highways under different phases of National Highway Development Program (NHDP). The construction of about 379 km long proposed Vadodara Mumbai Expressway along with SPUR of about 94 km is envisaged to fulfill this objective and decided to be implemented under NHDP (Phase-VI). The proposed Vadodra - Mumbai Expressway has been divided into **three phases** for implementation (**Figure 1-1**):

- Phase I:** From proposed chainage 104+700 to chainage 378+722 in the State of Gujarat, Maharashtra and Union Territory of Dadra and Nagar Haveli. Environmental Clearance has already obtained from MoEF&CC vide letter dated 11<sup>th</sup> February 2015 for Phase-I development.
- Phase II (Main Expressway):** This section starts from chainage 26+320 near Vasai (revised to chainage 26+582 in March 2019). It terminates at chainage 104+700 on the junction with new NH-48 [km.390.864 of new NH-48 (old NH-8)]. This **EIA Report deals with development of VME Phase II (Main Expressway)**.
- Phase II (SPUR):** Start point of SPUR (ch. 0+000) is chainage 26+320 of the main expressway (revised to Ch. 26+582 in March 2019). It ends at chainage 94+390 at km 24.476 of NH-4B near JNPT (length 94.390 km) in the state of Maharashtra.
- Phase III:** From proposed chainage 0+000 to 26+320 (26.320 km) in Thane District of Maharashtra.  
The consultant recommended deletion of this stretch to avoid large scale displacement of people & demolition of residential, commercial and industrial establishments at Mira-Bhaynder & Vasai-Virar Municipal area. This recommendation has been accepted by the PWD, Government of Maharashtra and gave **No Objection for exclusion of Phase-III** vide letter no. NHP 2014/CR171/N.H.1 dated May 22, 2018. Copy of the letter is given in **Annex 1.2**.



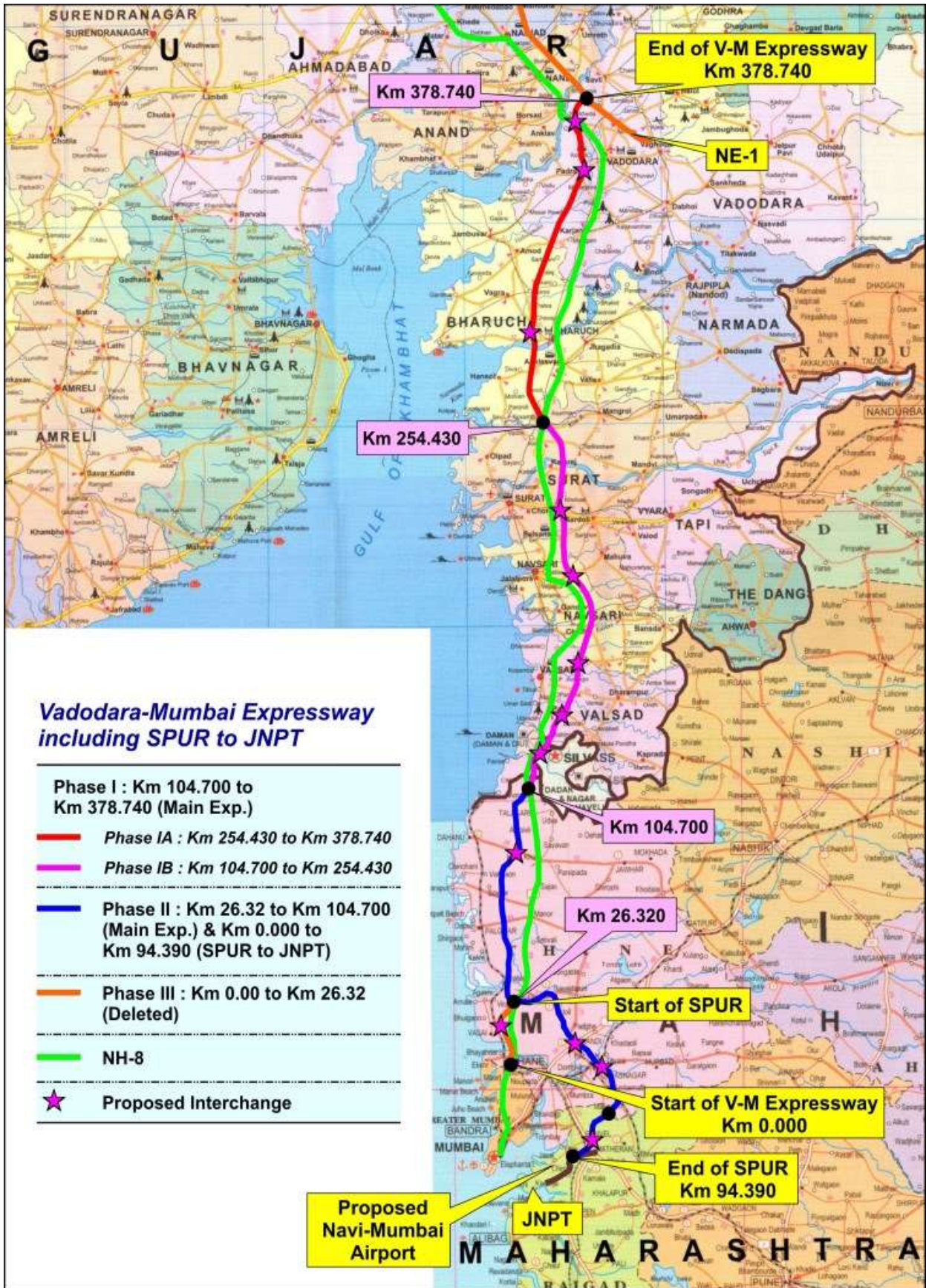


Figure 1-1 Index Map showing various phases of Proposed Vadodara Mumbai Expressway

**Project Proponent:** National Highways Authority of India (NHAI), an autonomous agency of the Government of India, is responsible for management of the network of national highways across the country. It is a nodal agency of the Ministry of Road Transport and Highways (MoRTH), Government of India. NHAI is the project proponent for the development of the proposed Vadodara Mumbai Expressway.

### 1.3 BRIEF DESCRIPTION OF NATURE, SIZE, LOCATION OF THE PROJECT

The Phase II of proposed VME is a **greenfield alignment**. The expressway starts at proposed chainage km 26+320 (at Vasai Taluka) and ends at proposed chainage km 104+700 (km 390+864 of new NH-48) at Talasari Taluka in the state of Maharashtra (**78.380 km**). Accordingly Form-1 was submitted to the MoEFCC in the year **2016**.

The proposed SPUR of VME was initially decided to start from Km 26+320 of main expressway. However, after the decision for deletion of Phase-III of VME (as discussed in Section-1.2) and finalization of development proposal of SPUR; a meeting was held on **22<sup>nd</sup> March 2019** in the office of Regional Officer (NHAI) Mumbai, where it is decided that the start point of SPUR will be at Km 26.582 of main expressway of VME. Therefore, **the start point of Phase-II main expressway is revised from km 26+320 to Km 26+582**, which eventually reduces the length of the main expressway by 262 m. **Revised length of the VME (Phase-II) main expressway is 78.118 km.**

The proposed alignment is passing through 4 talukas (Vasai, Palghar, Dahanu and Talasari) of Palghar district in the state of Maharashtra. The alignment is passing through plain and rolling terrain with cultivated, forest and barren areas. On its way, it crosses Palghar-Manor road, Boisar road, Tarapur, Masvan and Pulachapada Roads which connects these villages with NH-48 (old NH-8) and the alignment ends with a partial cloverleaf type interchange on NH-48 near Talasari. The proposed expressway crosses **51 villages** in Palghar district. The predominant land use along the alignment is agricultural followed by vegetation cover. An **Index Map** showing the location of the proposed expressway is presented in **Figure 1-2**.

### 1.4 SCOPE OF THE STUDY

The proposed project is a green field expressway. Applicability of various environmental laws, regulations and guidelines was reviewed for the proposed project and its allied activities. As per the EIA Notification, 2006 and its subsequent amendments, it falls in item. No 7 (f) of the Schedule to the Notification. Hence, it is a category **“A”** project and requires Prior Environment Clearance from the MoEFCC, GOI.

The proposed project was first time considered by the Expert Appraisal Committee of MoEFCC during its 127<sup>th</sup> meeting held during 28<sup>th</sup> to 29<sup>th</sup> October 2013 for grant of ToR. MoEFCC vide letter dated 14<sup>th</sup> November 2013 issued the ToR (MoEFCC File No. 10-59/2013-IA.III). The validity of ToR was for 2 years i.e. up to November 2015.



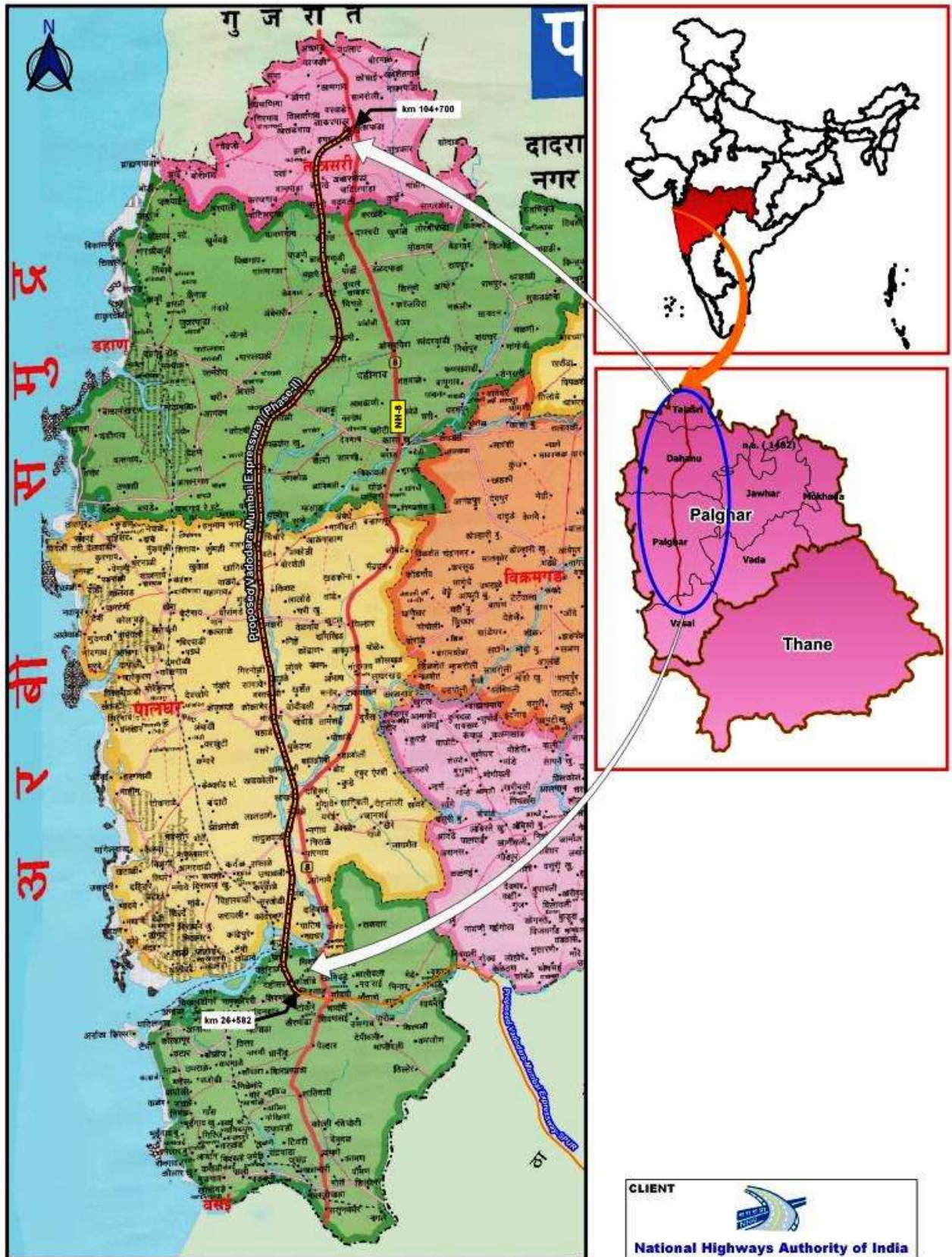


Figure 1-2 Index Map showing the location of the Proposed Expressway

This ToR was further extended for 1 year (up to November 2016) by the MoEFCC vide minutes of the 153rd meeting of EAC held during 18th to 20th November 2015. The Draft EIA Report was prepared as per the approved ToR but could not be submitted for public hearing due to various reasons beyond the control of the Consultant. Thereafter, NHAI requested MoEFCC to close this ToR file and issue a fresh ToR on the same project vide letter dated 25<sup>th</sup> October 2016.

Accordingly, a fresh proposal for obtaining ToR for EIA study was uploaded through online portal of MoEFCC on 26<sup>th</sup> October 2016 (Proposal No. IA/MH/MIS/59976/2016). **The Ministry issued the ToR vide letter no. dated 9<sup>th</sup> December 2016 (MoEFCC File No.10-80/2016-IA-III).** Copy of the approved ToR (scope of the study) is given as **Annex-1.1.**

This EIA Report has been prepared strictly as per the approved ToR and compliance of the ToR is given in the beginning of this EIA report.

## 1.5 REVIEW OF POLICY, REGULATIONS AND LEGAL FRAMEWORK

The relevant / applicable sections of following acts, policy guidelines, regulations and legislations framed by the Government of India / Government of Maharashtra for environmental safeguards are to be followed:

- Environment (Protection) Act and Rules, 1986
- EIA Notification, 14<sup>th</sup> September 2006 and its subsequent amendments
- The Water (Prevention and Control of Pollution) Act and Rules, 1974, 1975
- The Air (Prevention and Control of Pollution) Act, Rules and Amendment, 1981, 1982, 1983, 1987
- Noise Pollution (Regulation & Control) Rules, 2003 and amended in 2010
- Forest (Conservation) Act, 1980 and its amendments
- Forest (Conservation) Rules, 2003 and its amendments
- Forest (Conservation) Second Amendment Rules, 2014
- The Schedule Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006
- The Schedule Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Amendment Rules, 2012
- Maharashtra Felling of Trees (Regulation) Act, 1964 and its amendments
- Wildlife (Protection) Act, 1972 and its amendments
- Coastal Regulation Zone (CRZ) Notification, 2011
- MoEFCC approved Coastal Zone Management Plan of Palghar district, dated 28.02.2019
- Solid Waste Management Rules, 2016 and amendments
- Construction and Demolition Waste Management Rules, 2016
- The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016
- Maharashtra Plastic and Thermocol Products (Manufacture, Usage, Sale, Transport, Handling and Storage) Notification, 2018

- Chemical Accident (Emergency Planning, Preparedness and Response) Rules, 1996
- Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010
- Disposal of Fly Ash Notification 2009 and its amendments on 25<sup>th</sup> January 2016
- MoEFCC Office Memorandum (File No. 22-13/2019-IA.III) dated 28<sup>th</sup> August 2019 regarding Fly Ash Notification and subsequent amendments
- The Motor Vehicles Act, 1988
- The Motor Vehicles (Amendment) Bill, 2015
- The Explosive Act, 1984
- Public Liability Insurance Act, 1991
- The Mines Act. 1952
- Mines and Minerals (Development and Regulation) Amendment Act, 2015
- The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996
- Any other applicable Acts, Policies, Notification, Circulars, Guidelines etc.

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

**Table 1-1 Applicable IRC Codes**

IRC:SP:108-2015	Guidelines on Preparation and Implementation of EMP
IRC:119:2015	Guidelines for Traffic Safety Barriers
IRC:120:2015	Recommended Practice for Recycling of Bituminous Pavement
IRC:SP:98-2013	Guidelines for the use of Waste Plastic in Hot Bituminous Mixes
IRC:SP:99-2013	Manual of Specifications and Standards for Expressways
IRC:37	Guidelines for the Design of Flexible Pavements
IRC:SP:93-2011	Guidelines on Requirements for Environmental Clearance for Road Projects
IRC:SP:21:2009	Guidelines on Landscaping and Tree Plantation
IRC:SP:58-2001	Guidelines for Use of Fly Ash in Road Embankments
IRC: SP:55-2001	Guidelines for Safety in Construction Zones
IRC: SP: 44-1994	Highway Safety Code
IRC:103 1988	Guidelines for Pedestrian Facilities
IRC: SP: 32-1988	Road Safety for Children
IRC:56-1974	Recommended Practices for Treatment of Embankment Slopes for Erosion Control
IRC:10:1961	Recommended Practices for Borrow pits for Road Embankments Constructed by Manual Operation



### 1.5.1 Clearances Required

A summary of various statutory clearances required to be obtained by the Project Proponent before start of construction of the proposed expressway is discussed below:

- a) **Environment Clearance:** The proposed project is a green field expressway. As per the EIA Notification, 2006 and its subsequent amendments, it is a category “A” project and Environmental Clearance is **required** from the EAC of MoEF&CC.
- b) **CRZ Clearance:** The proposed expressway alignment passes through the intertidal zones of Vaitaran River. Therefore, CRZ Clearance is **required** from the MCZMA and MoEFCC.
- c) **Forest Clearance:** The proposed project involves diversion of Forest Land. Hence, Forest Clearance is **required**. Proposal has been uploaded on 15<sup>th</sup> October 2018 (FC Proposal No. FP/MH/ROAD/36560/2018) and it is under examination with the State Government.
- d) **NBWL Clearance:** The proposed expressway does **not pass through** any protected areas and is located at a distance of **1.28 km** from the boundary of the Tungeshwar Wildlife Sanctuary and **4.57 km** from the boundary of the Dadra and Nagar Haveli Wildlife Sanctuary.

Final ESZ Notification of Tungeshwar Wildlife Sanctuary has been published on [S.O.3250 (E)] 11<sup>th</sup> September 2019. The proposed expressway is located at a distance of **0.456 km** from the notified ESZ boundary i.e. outside ESZ.

As per MoEFCC Office Memorandum dater 8<sup>th</sup> August 2019 (F. No. 22-43/2018-IA.III), “*Proposal involving developmental activity / project located outside the stipulated boundary limit of notified ESZ and located within 10km of National Park / Wildlife Sanctuary, prior clearance from Standing Committee of the National Board for Wildlife may not be applicable. However, such proposal .....would be examined by the sector specific Expert Appraisal Committee and appropriate conservation measures ..... shall be made.*” Hence, clearance from Standing Committee of NBWL is **not required**.

- e) **DTEPA Clearance:** The proposed expressway passes through Dahanu Taluka Eco Fragile Zone for a length of 27.8 km from km 68+400 to km 96+200. Therefore, clearance from the Dahanu Taluka Environment Protection Authority (DTEPA) is **required** for the proposed project.
- f) **Consent to Establish:** As per the directions of Central Pollution Control Board, dated March 07, 2016, NOC from Maharashtra Pollution Control Board (MPCB) under Air Act & Water Act is **required** for the proposed greenfield expressway.
- g) **ASI Clearance:** No ASI Protected Monument or World Heritage Monument is



located within 300m of the proposed expressway alignment. Therefore, ASI Clearance is **not required**.

Apart from the clearances as mentioned above, the contractor before starting the construction work has to obtain the Clearances / NOCs as listed in **Table 1-2** for operating his equipment and starting construction activity.

**Table 1-2 Clearances required to be obtained by the Contractor**

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
1.	Consent for Establishment of Hot Mix Plant, WMM Plant, Stone Crushers and Batching Plant	<ul style="list-style-type: none"> <li>▪ Maharashtra Pollution Control Board</li> </ul>	<ul style="list-style-type: none"> <li>▪ Air (Prevention and Control of Pollution) Act, 1981</li> <li>▪ Water (Prevention and Control of Pollution) Act, 1974</li> <li>▪ The Noise Pollution (Regulation and Control) Rules, 2000</li> </ul>
2.	Consent for Operation of Hot Mix Plant, WMM Plant, Stone Crushers and Batching Plant		
3.	Permission for withdrawal of groundwater for construction	<ul style="list-style-type: none"> <li>▪ Central Ground Water Authority</li> <li>▪ State Ground Water Board</li> </ul>	<ul style="list-style-type: none"> <li>▪ Environment (Protection) Act, 1986</li> <li>▪ Ground Water Rules, 2002</li> </ul>
4.	Permission for extraction of sand from river bed	<ul style="list-style-type: none"> <li>▪ Department of Mines &amp; Geology, Government of Maharashtra</li> </ul>	<ul style="list-style-type: none"> <li>▪ Mines and Minerals (Development and Regulation) Amendment Act, 2015</li> </ul>
5.	Permission for extraction of sand from river bed	<ul style="list-style-type: none"> <li>▪ District Level Environment Impact Assessment Authority (DEIAA)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Environment (Protection) Act, 1986</li> </ul>
6.	Opening of new quarry area	<ul style="list-style-type: none"> <li>▪ Department of Mines &amp; Geology, Government of Maharashtra</li> <li>▪ Maharashtra Pollution Control Board</li> </ul>	<ul style="list-style-type: none"> <li>▪ Environment (Protection) Act, 1986</li> <li>▪ The Mines Act. 1952</li> <li>▪ Mines and Minerals (Development and Regulation) Amendment Act, 2015</li> <li>▪ The Explosive Act, 1984</li> <li>▪ Air (Prevention and Control of Pollution) Act, 1981</li> <li>▪ Water (Prevention and Control of Pollution) Act, 1974</li> </ul>
7.	Opening of new borrow area	<ul style="list-style-type: none"> <li>▪ MoEF&amp;CC / SEIAA / DEIAA</li> <li>▪ Maharashtra Pollution Control Board</li> <li>▪ District Collector</li> </ul>	<ul style="list-style-type: none"> <li>▪ Environment (Protection) Act, 1986</li> <li>▪ Air (Prevention and Control of Pollution) Act, 1981</li> <li>▪ Mines and Minerals (Development and Regulation) Amendment Act, 2015</li> </ul>
8.	Location and layout of workers camp, & equipment and storage yards	<ul style="list-style-type: none"> <li>▪ Maharashtra Pollution Control Board</li> </ul>	<ul style="list-style-type: none"> <li>▪ Environment (Protection) Act, 1986;</li> <li>▪ The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016</li> </ul>
9.	Discharges from labour	<ul style="list-style-type: none"> <li>▪ Maharashtra Pollution</li> </ul>	<ul style="list-style-type: none"> <li>▪ Water (Prevention and Control of</li> </ul>

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
	camp	Control Board	Pollution) Act, 1974
10.	Storage, handling and transport of hazardous materials	<ul style="list-style-type: none"> <li>▪ Maharashtra Pollution Control Board</li> </ul>	<ul style="list-style-type: none"> <li>▪ Hazardous and Other Waste (Management and Trans-boundary Movement) Rules, 2016</li> </ul>
11.	NOC for controlled blasting	<ul style="list-style-type: none"> <li>▪ Revenue Department / District Collector</li> <li>▪ Maharashtra Pollution Control Board</li> </ul>	<ul style="list-style-type: none"> <li>▪ Explosives Rules, 2008</li> </ul>
12.	Disposal of Bituminous Wastes (if any)	<ul style="list-style-type: none"> <li>▪ Intimate local civic body to use local solid waste disposal site</li> </ul>	<ul style="list-style-type: none"> <li>▪ Hazardous and Other Waste (Management and Trans-boundary Movement) Rules, 2016</li> </ul>
13.	PUC Certificate for all construction vehicles and all machineries	<ul style="list-style-type: none"> <li>▪ Transport Department of Govt. of Maharashtra</li> </ul>	<ul style="list-style-type: none"> <li>▪ The Motor Vehicle Act 1988</li> <li>▪ The Motor Vehicles (Amendment) Bill, 2015</li> <li>▪ The Central Motor Vehicles Rules, 1989</li> </ul>
14.	Installation of DG Set (Consent to Establish)	<ul style="list-style-type: none"> <li>▪ Maharashtra Pollution Control Board</li> </ul>	<ul style="list-style-type: none"> <li>▪ Air (Prevention and Control of Pollution) Act, 1981</li> <li>▪ The Noise Pollution (Regulation and Control) Rules, 2000</li> </ul>
15.	Operation of DG Set (Consent to Operate)		
16.	Engagement of Labour - Labour License	<ul style="list-style-type: none"> <li>▪ Labour Commissioner (Ministry of Labour and Employment)</li> </ul>	<ul style="list-style-type: none"> <li>▪ The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996</li> <li>▪ Contract Labour (Regulation and Abolition) Act 1970 along with Rules, 1971</li> </ul>
17.	Engagement of Labour - Social Security - Labour Welfare - Wages	<ul style="list-style-type: none"> <li>▪ Labour Commissioner (Ministry of Labour and Employment)</li> </ul>	<ul style="list-style-type: none"> <li>▪ The Employees' Provident Fund &amp; Miscellaneous Provisions (Amendment) Act, 1996</li> <li>▪ The Personal Injuries (Compensation Insurance) Act, 1963</li> <li>▪ The Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979</li> <li>▪ Equal Remuneration Act, 1976</li> <li>▪ The Payment of Wages (Amendment) Act, 2005</li> <li>▪ The Minimum Wages Act, 1948</li> <li>▪ The Minimum Wages (Central) Rules, 1950</li> </ul>

In addition to the above, Contractor has to obtain:

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

## 1.6 STRUCTURE OF THE REPORT

The structure of the Draft Environment Impact Assessment Report is given below:

### **Volume: I Draft Environment Impact Assessment Report**

	Compliance of ToR
	Executive Summary
Chapter-1	: Introduction
Chapter-2	: Project Description
Chapter-3	: Description of the Environment
Chapter-4	: Anticipated Environmental Impacts & Mitigation Measures
Chapter-5	: Analysis of Alternatives
Chapter-6	: Environmental Monitoring Program
Chapter-7	: Additional Studies
Chapter-8	: Project Benefits
Chapter-9	: Environmental Management Plan
Chapter-10	: Summary and Conclusion
Chapter-11	: Disclosure of Consultant

### **Volume: II Annexes to Draft Environment Impact Assessment Report**

Annex-1.1	: Approved ToR of MoEF&CC
Annex-1.2	: No Objection Letter of PWD, Maharashtra
Annex-3.1	: Alignment of proposed expressway on Survey of India Toposheet
Annex-3.2	: Map of Catchment Area and Drainage Network
Annex-3.3	: Land Use Map of the Study Area
Annex-3.4	: Ground Surveyed Map on 1:2000 Scale
Annex-3.5	: On-site Meteorological Monitoring Data
Annex-3.6	: Phyto-sociological Assessment of Flora
Annex-3.7	: Filled up questionnaire of Forest Range Officers
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Annex-9.12	: Guidelines for Storage, Handling, Use and Emergency Response for Hazardous Substances

## CHAPTER-2: PROJECT DESCRIPTION

### 2.1 PROJECT PROFILE

The proposed project is the development of 8 lane access-controlled green-field Vadodara Mumbai Expressway (Phase-II). The expressway starts at proposed chainage 26+582 (at Koshimb village of Vasai Taluka) and ends at proposed chainage 104+700 [km 390+864 of new NH-48 (old NH-8)] at Ibhadpada village of Talasari Taluka in the state of Maharashtra. Total length of expressway (Phase-II) is **78.118 km**. The proposed alignment is passing through 4 talukas of Palghar district in the state of Maharashtra. The Taluka wise length of proposed expressway is given in **Table 2.1**.

**Table 2-1 Taluka wise break-up of Length of Proposed Expressway**

District	Taluka	No. of Village	Start Chainage	End Chainage	Length (Km)
Palghar	Vasai	3	26+582	31+000	4.418
	Palghar	27	31+000	68+400	37.400
	Dahanu	15	68+400	96+200	27.800
	Talasari	6	96+200	104+700	8.500
<b>Total</b>		<b>51</b>			<b>78.118</b>

Source: DPR Prepared by the ICT Pvt. Ltd.

The Geo-graphical Coordinates of start and end points of the proposed expressway are given in **Table 1-2**.

**Table 2-2 Project Coordinates**

Description	Coordinates
Starting Point (Ch. 26+582)	19°29'19.5"N, 72°52'58.8"E
End Point (Ch. 104+700)	20° 9'2.4"N, 72°54'55.7"E

Source: DPR Prepared by the ICT Pvt. Ltd.



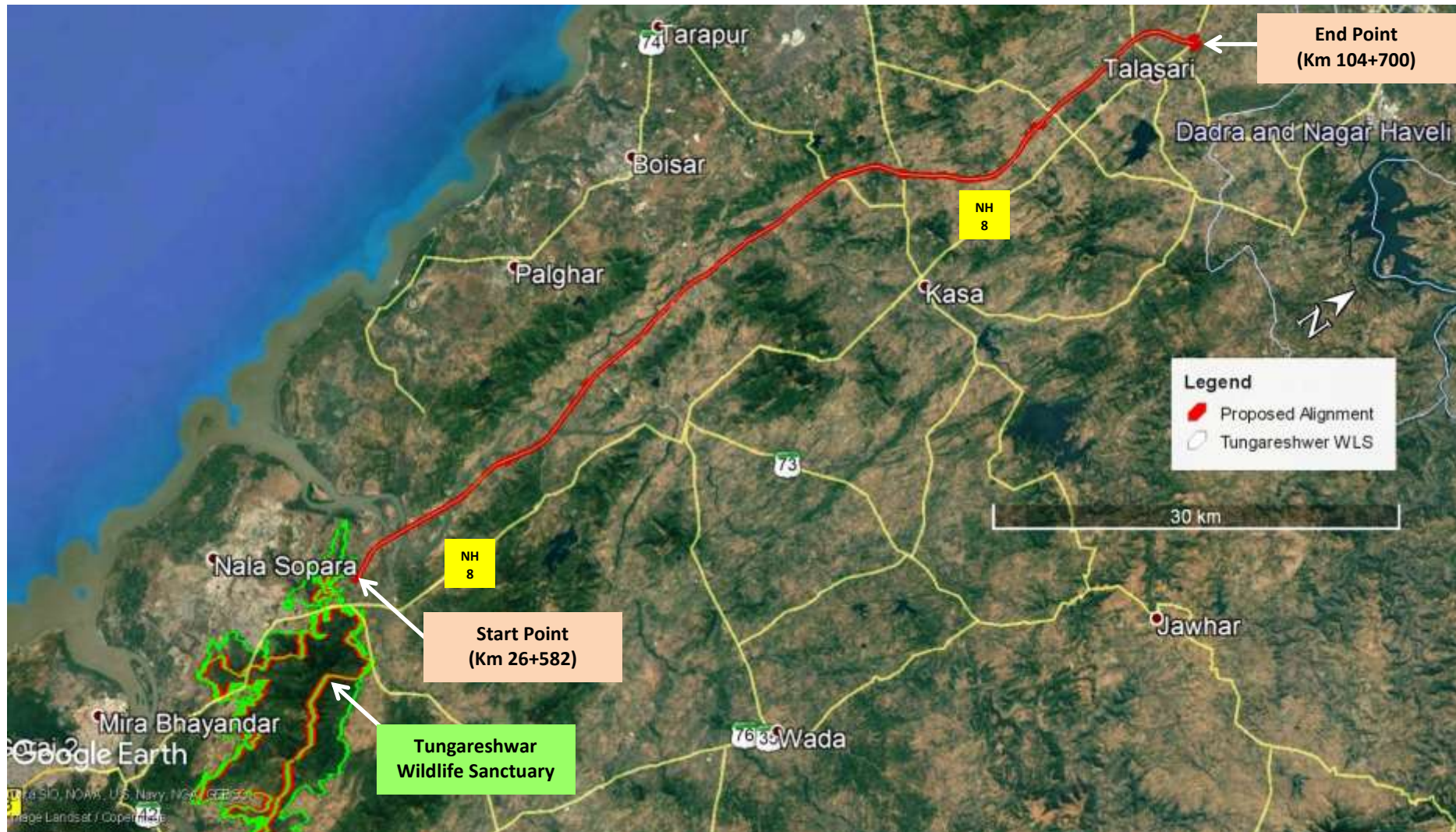
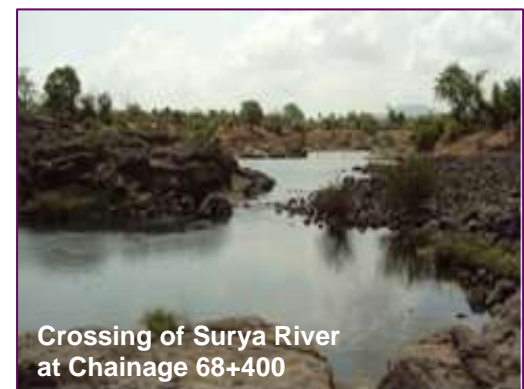


Figure 2-1 Proposed Expressway alignment marked on Satellite Imagery (Google Earth)

## 2.2 DESCRIPTION OF THE ALIGNMENT

### Section from start point (chainage 26+582) to Dahanu-Charoti Road (chainage 78+650):

In this section the alignment is to the west (left) of NH-48 (old NH-8) and diverges from it. It starts 300 m away from NH-48 and moves away to about 11.6 km at chainage 66+000 before narrowing the distance to 10.0 km along Dahanu – Kasa Khurd Road (SH 30). The terrain is generally plain/ rolling. This section initially runs through Vaitarna River valley and then starts rising. The Section is thinly populated, under developed and where subsistence agriculture is common occupation. The alignment crosses Vaitarna River thrice - at chainage 31+300, chainage 35+725 and chainage 45+040. The crossing at chainage 31+300 is 2.2 km upstream (east side) of the existing railway bridge located near Vaitarna Railway Station of Western Railway mainline. The alignment from chainage 45+000 to 68+420 runs parallel to Surya River on the eastern side of the river. The alignment crosses River Surya at chainage 68+420 and Suseri Nala at chainage 72+190. The section ends with diamond interchange on SH-30.



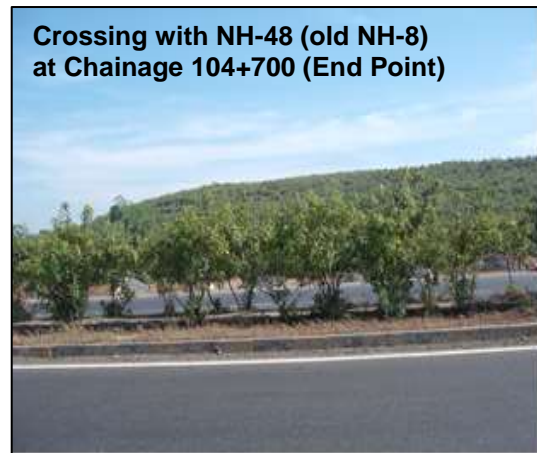
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There are no railway crossings in this section. The alignment crosses Palghar- Manor road, Boisar road, Tarapur, Masvan and Pulachapada Roads which connects these villages with NH48. The alignment passes through Reserved Forest in parts aggregating to a total length of about 1.75 km. Some parts of this section cross Coastal Regulation Zone (CRZ) area.

### Section from Dahanu-Charoti Road (chainage 78+650) to NH-48 (old NH-8) Crossing (chainage 104+700):

In this section the alignment moves close to NH-48 up to chainage 85+200 (2 km away) and then runs parallel to it before crossing at chainage 104+700 near Talasari. The alignment is in plain and rolling terrain and passes through very sparsely populated area without any major obstructions. The alignment crosses River Jogani at chainage 89+604 and River Vadavali at chainage 96+ 208. Agriculture is the main occupations of the people living along the alignment. At chainage 99+840, the alignment crosses SH-29 to Umergoun and the crossing is 3.4 km west of NH-48 and at chainage 91+756 the alignment crosses SH-31. The alignment crosses existing NH-48 (km 390+864) near Talasari.





### 2.3 ESTIMATED TRAFFIC

To estimate the expected traffic movement on V-M Expressway and the spur, traffic surveys were planned to be conducted on the important roads in the vicinity of the proposed alignment. These are: NH-8, NH-6, NH4, NH4B, Mumbai Pune expressway and state highways cutting across the proposed V-M Expressway and the spur alignments.

Traffic surveys on NH-8 and surrounding road network were conducted in year 2009, and the DPR for VME was submitted in 2012. Further, traffic surveys on selected locations were conducted in 2016 to update the traffic analysis and forecast.

In 2009, traffic surveys were conducted at 25 mid-block locations and 27 intersections, whereas in 2016 the traffic surveys have been conducted at 11 mid-block locations and 10 intersections for updation.

There were two Homogeneous Traffic Sections in VME- Phase II (**Table 2-3**). The homogeneous section wise estimated Annual Average Daily Traffic (PCU and Vehicle) and peak hour traffic (PCU & Vehicle) are presented in **Table 2-4**.

**Table 2-3 Homogeneous Traffic Sections**

Section No	Name	Chainage		Length (km)
		Start	End	
2-1 (HS-01)	Khanivade - Dahanu Road	26+582	78+650	52.33
3 (HS-02)	Dahanu Road - Talasari	78+650	104+700	26.05

Source: DPR Prepared by the ICT Pvt. Ltd.

**Table 2-4 Section wise Estimated AADT in PCU/day**

Year	Section	Car	LGV	Bus & Mini bus	2-Axle Truck	3-Axle Truck	MAV	Container	Total
2021	HS-01	7,374	3,150	828	4,227	4,649	1,982	3,072	<b>25,282</b>
2021	HS-02	4,766	2,794	673	5,900	5,566	1,838	2,524	<b>24,062</b>

Year	Section	Car	LGV	Bus & Mini bus	2-Axle Truck	3-Axle Truck	MAV	Container	Total
2025	HS-01	10,077	4,050	986	5,004	5,962	2,630	4,288	<b>32,997</b>
2025	HS-02	6,924	3,617	805	6,905	7,070	2,455	3,618	<b>31,394</b>
2030	HS-01	13,080	5,129	1,514	6,284	7,956	3,908	6,271	<b>44,143</b>
2030	HS-02	9,272	4,602	1,295	8,398	9,256	3,680	5,457	<b>41,961</b>
2035	HS-01	15,098	5,779	1,722	7,015	9,181	4,540	7,592	<b>50,927</b>
2035	HS-02	10,723	5,190	1,473	9,353	10,674	4,279	6,655	<b>48,346</b>
2045	HS-01	20,252	7,092	2,117	8,395	11,544	6,141	10,238	<b>65,780</b>
2045	HS-02	14,482	6,379	1,813	11,114	13,367	5,814	9,108	<b>62,077</b>

Source: DPR Prepared by the ICT Pvt. Ltd.

For capacity and service volume of expressway, IRC SP: 99-2013 has been referred. The code specifies design service volume (at LOS-B) for plain and rolling terrain is 1300PCU/Hr./Lane. For high speed highways and expressways, it is desirable to maintain LOS 'B'. The Highway Capacity Manual-2010 (AASHTO) also suggests that, the ancillary infrastructure facilities of a freeway could even operate at LOS 'C' while the freeway itself should desirably maintain LOS 'B'.

Based on the above, it is recommended that the section from Km 26+582 to Km 104+700 should be developed to **8 lane facility in the opening year**.

## 2.4 PROPOSED DEVELOPMENT

The proposed Mumbai- Vadodara Expressway is to be built as an access controlled expressway with access allowed only at proposed interchanges. It will be an eight lane divided carriageway. The carriageway width is 15 m with 3.0 m wide paved and 2.0 m wide earthen shoulders on both sides. Further it is proposed to build connecting roads along the expressway at some locations to facilitate movement of local traffic. The expressway has been designed as per IRC SP 99-2013.

### 2.4.1 Right of way

The proposed right of way is 100 m / 120 m in general. At interchanges, highway amenities, truck lay byes additional land shall be required as per actual design. The **typical cross sections** are shown in **Figure 2-2**.

### 2.4.2 Type of Pavement

Rigid pavement shall be provided for the main carriageway including paved shoulders, loops and ramps of the interchanges. For slip roads, cross roads, connecting roads and interconnecting roads of VUPs / LVUPs / SVUPs, flexible pavement shall be provided. Rigid pavement has been designed for a minimum design period of 30 years and flexible pavement for 15 years.

### 2.4.3 Bridges

The expressway alignment is crossing major / minor rivers, drains and nala at number of locations where major / minor bridges have been proposed as per hydraulic considerations. **8 major bridges** (Table 2-5) and **29 minor bridges** (Table 2-6) have been proposed.

**Table 2-5 Details of Major Bridge**

Sl. No.	Major Bridge over	Chainage	Length (m)
1.	Vaitarna River – 1	31+300	1968.050
2.	Vaitarna River – 2	35+750	1296.050
3.	canal + road	42+858	68.334
4.	canal + road	43+725	67.213
5.	Vaitarna River - 3	45+040	672.050
6.	Surya River	68+420	236.050
7.	Suseri Nallah	72+190	111.650
8.	Vadvali Nadi	96+208	96.650

Source: DPR Prepared by the ICT Pvt. Ltd.

**Table 2-6 Details of Minor Bridges over Rivers / Streams / Nallas / Utility**

Sl. No.	Minor Bridge over	Chainage	Length (m)
1.	Local Stream	37+780	27.35
2.	Local Stream	37+965	19.16
3.	Local Stream	48+393	32.25
4.	Local Stream	50+000	16.6
5.	Local Stream	52+728	13.3
6.	Local Stream	54+310	27.25
7.	Local Stream	57+885	29.25
8.	Local Stream	59+888	37.25
9.	Canal	60+712	29.25
10.	Local Stream	61+539	19.16
11.	Canal	62+421	21.37
12.	Local Stream	63+570	32.25
13.	Local Stream	63+925	15.9
14.	Canal	65+134	39.63
15.	Local Stream	66+137	12.44
16.	Local Stream	66+735	15.9
17.	Local Stream	70+000	27.25
18.	Local Stream	74+493	20.9
19.	Canal	76+037	29.25
20.	Local Stream	79+745	21.94
21.	Local Stream	81+332	42.37
22.	Local Stream	83+688	25.75

Sl. No.	Minor Bridge over	Chainage	Length (m)
23.	Local Stream	85+420	20.9
24.	Jagani Nadi	89+604	50.97
25.	Local Stream	91+564	15.9
26.	Canal	93+650	27.84
27.	Canal	94+710	29.25
28.	Local Nala	103+430	20.9
29.	Gas Pipeline	103+998	46.54

Source: DPR Prepared by the ICT Pvt. Ltd.

#### 2.4.4 Culverts

133 RCC box culverts are proposed across the expressway to prevent disturbance of the natural and artificial drainage system.

#### 2.4.5 Interchanges

Interchanges are required on expressways for transfer of traffic from the expressways to other intersecting roads/expressways or vice versa avoiding any conflict. The objective of provision of interchanges is to allow safe and uninterrupted travel for expressway users. Two Interchanges have been proposed at chainage 50+594 & chainage 78+648 on Palghar road and Dahanu road respectively.

#### 2.4.6 Fly-Over

The expressway is an access controlled facility and all other road crossings therefore will be provided either with a flyover or with a vehicular underpass with no access to the expressway. Flyovers are proposed at **4 locations** on major roads like State Highways. Details are given in **Table 2-7**.

**Table 2-7 Details of Fly-overs**

Sl. No.	Description	Chainage	Length (m)
1.	Boisal - NH-8 Road	60+240	27.250
2.	Tarapur-Charoti Road	73+054	93.100
3.	Dhanu-Talasari (SH-31)	91+756	36.462
4.	Umargaun-Talasari (SH-29)	99+915	110.050

Source: DPR Prepared by the ICT Pvt. Ltd.

#### 2.4.7 Vehicular Underpasses

Vehicular underpasses of size 20m x 5.5 m have been proposed on Major District Roads (MDRs). Vehicular underpasses have been proposed at **8 locations** as given in **Table 2-8**.

**Table 2-8 Details of Vehicular Underpass**

Sl. No.	Chainage	Type of Crossing
1.	26+820	Virar – Kharadi
2.	38+653	Safale – NH8
3.	43+849	Sakhade – NH8
4.	55+135	Palghar – Nagazari
5.	61+191	Kirat – Boisar
6.	65+057	Kirat – Ravte
7.	81+660	Rankol – Charoti
8.	96+983	Vadavali – NH8

Source: DPR Prepared by the ICT Pvt. Ltd.

#### 2.4.8 Vehicular Overpass

Based on the topography of the area, at few locations cross roads have been proposed to cross over the expressway. **3** such overpasses of size 2 x 41 m span have been proposed at following locations.

**Table 2-9 Details of Vehicular Overpass**

Sl. No.	Chainage	Type of Crossing	Length ( in Km)
1.	89+308	Asgarh-Chanchol	0.800
2.	101+912	Jhari-Talasari	0.500
3.	102+365	Kawada-Babuapada	0.300

Source: DPR Prepared by the ICT Pvt. Ltd.

#### 2.4.9 Light and Small Vehicular / Cattle Underpasses

The expressway is a greenfield alignment and is access controlled therefore it will be bifurcating the communities on either side. Since it is passing mainly through rural belt the farming communities on either side need to be provided with suitable connection. To serve this purpose, **21 light vehicular Underpasses** (Size 12m x 4 m) and **50 small vehicular / cattle underpasses** (size 7m x 4m) have been proposed. In addition to above, the box culverts of size 6m x 4m and 5m x 4m will act as cattle underpass during summer season.

#### 2.4.10 Connecting Roads

The roads where underpasses have not been provided have been connected to the nearest underpass by connecting roads so that the movement of local traffic across the expressway is not hindered. Connecting roads have also been provided at in the urban areas. Locations of connecting roads are presented in **Table 2-10**.

**Table 2-10 Location of Connecting Roads**

Sl. No.	Stretches (Chainage)		Length (in Km)
	From	To	
<b>Left side Connecting Road</b>			
1.	46+960	47+090	0.130
2.	47+650	47+970	0.320
3.	54+965	55+150	0.185
4.	65+085	65+230	0.145
5.	67+450	67+675	0.225
6.	71+300	71+960	0.660
7.	72+370	72+660	0.290
8.	73+750	74+000	0.250
9.	76+400	76+800	0.400
10.	80+640	80+980	0.340
11.	85+050	85+300	0.250
12.	100+450	100+600	0.150
<b>Right side Connecting Road</b>			
1.	46+960	47+120	0.160
2.	47+700	48+000	0.300
3.	48+650	48+750	0.100
4.	55+080	55+260	0.180
5.	55+840	55+970	0.130
6.	75+600	76+065	0.465
7.	81+660	82+650	0.990
8.	85+130	85+390	0.260
9.	95+200	95+625	0.425

Source: DPR Prepared by the ICT Pvt. Ltd.

#### 2.4.11 Way Side Amenities and Truck Parking

Wayside amenities along the expressway are integral parts and these facilities provide useful services to the traveling public. As per MoRTH guideline, way side amenities along the expressway have been proposed. These facilities provide services to the users who desire to stop for rest, refreshment, information and fuelling or for some emergency requirement. The facilities will include food plaza, restaurant, trauma centre, highway patrol building, toilets, drinking water, passenger shelters, parking lots, kiosk for sale of snacks & miscellaneous items etc. The proposed locations are as follows:

**Table 2-11 Details of Way Side Amenities**

Sl. No.	Chainage	Side
<b>Way side Amenities (Type-A)</b>		
1	90+600	Right
<b>Way side Amenities (Type-B)</b>		
1	42+000	Left
2	47+500	Right



Sl. No.	Chainage	Side
3	67+900	Left
4	70+400	Right

Source: DPR Prepared by the ICT Pvt. Ltd.

#### 2.4.12 Toll Plaza

Since the expressway will be closed tolling systems, toll plazas have been proposed on interchange. In this section, toll plaza on interchange at chainage 50+594 and 78+638 and has been proposed. It may be noted that the interchange at chainage 104+700 (end point) has already been included in Phase-I of the expressway.

#### 2.4.13 Truck Parking

To facilitate the road user, truck parking has been proposed along the expressway at following locations:

**Table 2-12 Details of Truck Parking**

Sl. No.	Chainage	Side
1	41+000	Right
2	49+300	Left

Source: DPR Prepared by the ICT Pvt. Ltd.

#### 2.4.14 Road Safety

To improve the safety of such high speed corridor, Thrie beam metal crash barriers shall be provided in entire length on both sides of each main carriageway (i.e. on median and on earthen shoulder of both carriageway), Loops and Ramps excluding stretches covered by bridges and RE wall structures, where concrete barriers to be provided.

In addition to safety barrier, safety features like road marking, traffic sign, boundary stones, kilometer stones and hectometer stones, pavement marking and lighting has been proposed. Advanced Traffic Management System (ATMS) for entire expressway have been proposed to facilitate the road users, which will include mobile communication system, meteorological data system, automatic traffic counter and vehicle classification, video surveillance system, video incident detection system. To improve antiglare, hedge plantation on median have been proposed.

The engineering design of the expressway has also considered IRC codal provisions related to road safety such as:

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

## 2.6 MODE OF IMPLEMENTATION

The proposed project will be implemented on Hybrid Annuity Mode (HAM)

## 2.7 SOURCES OF CONSTRUCTION MATERIALS

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

### 2.7.1 Borrow Areas

A total of 19 borrow areas were identified in this section of expressway from chainage 26.320 to 104.700 having lead about 0.2 km to 5.5 km. Proposed chainage and village wise location of proposed borrow areas are presented in **Table 2-13**.

**Table 2-13 Location of Proposed Borrow Areas**

Sl. No.	Chainage	Side	Village Name	Lead from Proposed Alignment (km)	Type of Land	Approx. Quantity (m <sup>3</sup> )
1.	29+907	RHS	Khardi	1.7	Government	202350
2.	33+918	LHS	Thamalpada	0.5	Government	121410
3.	36+886	LHS	Tadulwada	3.0	Government	161880
4.	42+894	LHS	Nauze	0.3	Government	182115
5.	48+935	RHS	Dhuktan	0.2	Government	242820
6.	51+923	LHS	Maswan	0.5	Government	242820
7.	53+916	LHS	Katela	0.6	Government	121410
8.	58+895	LHS	Nagshari	0.3	Government	80940
9.	63+828	LHS	Kirat	0.5	Government	60705
10.	67+652	RHS	Shahgaon	1.8	Barren	161880
11.	71+655	LHS	Dhason		Government	80940
12.	75+672	RHS	Rangel	2.5	Government	80940
13.	75+672	RHS	Rangel	2.5	Government	80940
14.	81+616	LHS	Gholanpada	1.2	Government	161880
15.	84+070	LHS	Arjunparad	1.2	Government	121410
16.	84+070	RHS	Arjunparad	0.5	Government	91058
17.	91+483	RHS	Dhundalwadi	2.4	Government	80940
18.	97+297	LHS	Sabarpada	1.1	Private	40470
19.	103+600	LHS	Mandalpada	0.6	Government	101175

Source: DPR Prepared by the ICT Pvt. Ltd.

## 2.7.2 Stone / Coarse Aggregate Material

Four (4) stone quarries were identified having lead distance between 3.3 km to 18.5 km. from the proposed alignment. Quantity available in the identified quarries is adequate meeting the requirements for the construction of the project road, except one source:

- Chainage 7+921, Karnal Pada – due to low specific gravity and comparatively high water absorption along with high soundness suggest to limit the use in granular sub-base course and in concrete of minor structures

However, sources shall be rechecked prior to construction for use in bituminous works. Proposed chainage and village wise location of proposed borrow areas are presented in **Table 2-14**.

**Table 2-14 Location of Stone / Coarse Aggregate Material**

Sl. No.	Chainage	Side	Location / Village Name	Lead from Proposed Alignment (km)
1	7+921	RHS	Karnal Pada	18.5
2	12+931	LHS	Balaji Stone Crusher / Raja Wadi Village	13.5
3	32+915	LHS	M/s Bandhu Seth / Kander	3.3
4	123+100	LHS	J J Stone Crusher / Sarigaam	18.4

Source: DPR Prepared by the ICT Pvt. Ltd.

## 2.7.3 Sand / Fine Aggregate Material

Two sources were identified as potential sources for sand. The lead distance from the project vicinity is found in the range from 0.5 km to 18.4 km. Sand of both locations area suitable for base and sub-base course of pavement as well as concrete work.

**Table 2-15 Location of Sand / Fine Aggregate Material**

Sl. No.	Chainage	Side	Description	Lead from Proposed Alignment (km)
1	045+094	RHS	Vaitarna River Sand	0.5
2	123+100	RHS	Daman Ganga River Sand	18.4

Source: DPR Prepared by the ICT Pvt. Ltd.

## 2.7.4 Fly Ash

Fly ash samples have been collected from two sources namely Nani Naroli (GIPCL, Surat) and Ukai (GETPC, Ukai). Fly ash sample from Nani Naroli exhibits a CBR of 175% and the other one from Ukai exhibits a CBR of 5 %. Tests were repeated to confirm the high CBR from Nani Naroli, which may be due to its chemical composition. Owing to the good CBR and reasonably low dry density and specific gravity, the fly ash can be considered as good embankment material.

### 2.7.5 Cement

Ordinary Portland cement of Grade 43 and 53 manufactured by various manufacturers are locally available. During material survey, 19 factories are identified nearby the project area.

### 2.7.6 Bitumen

Three (3) sources are identified as nearest sources of bitumen one is HPCL, Mumbai in Maharashtra State, IOCL, Vadodara and Jamnagar in Gujarat State.

### 2.7.7 Steel

High strength deformed bars manufactured by various steel manufacturing companies conforming to IS 1786 are available with local traders.

## 2.8 PROJECT COST

Total Project Cost for the proposed expressway is summarized below:

**Table 2-16 Summary of Project Cost**

S No.	Description	Amount in Crores
1	Cost of Civil Construction	3,852
2	Total Project Cost	7,010

## 2.9 DEVELOPMENT PROCESS

### 2.9.1 Stages & Activities of the Proposed Project

The development process of the proposed expressway has three distinct stages and each of the stage has several activities and sub-activities. These three stages are:

- A) Design and Pre-Construction Stage
- B) Construction Stage
- C) Post-Construction / Operations & Maintenance Stage

The activities and sub-activities which would be undertaken in each of the three stages are detailed in **Figure 2-3**.

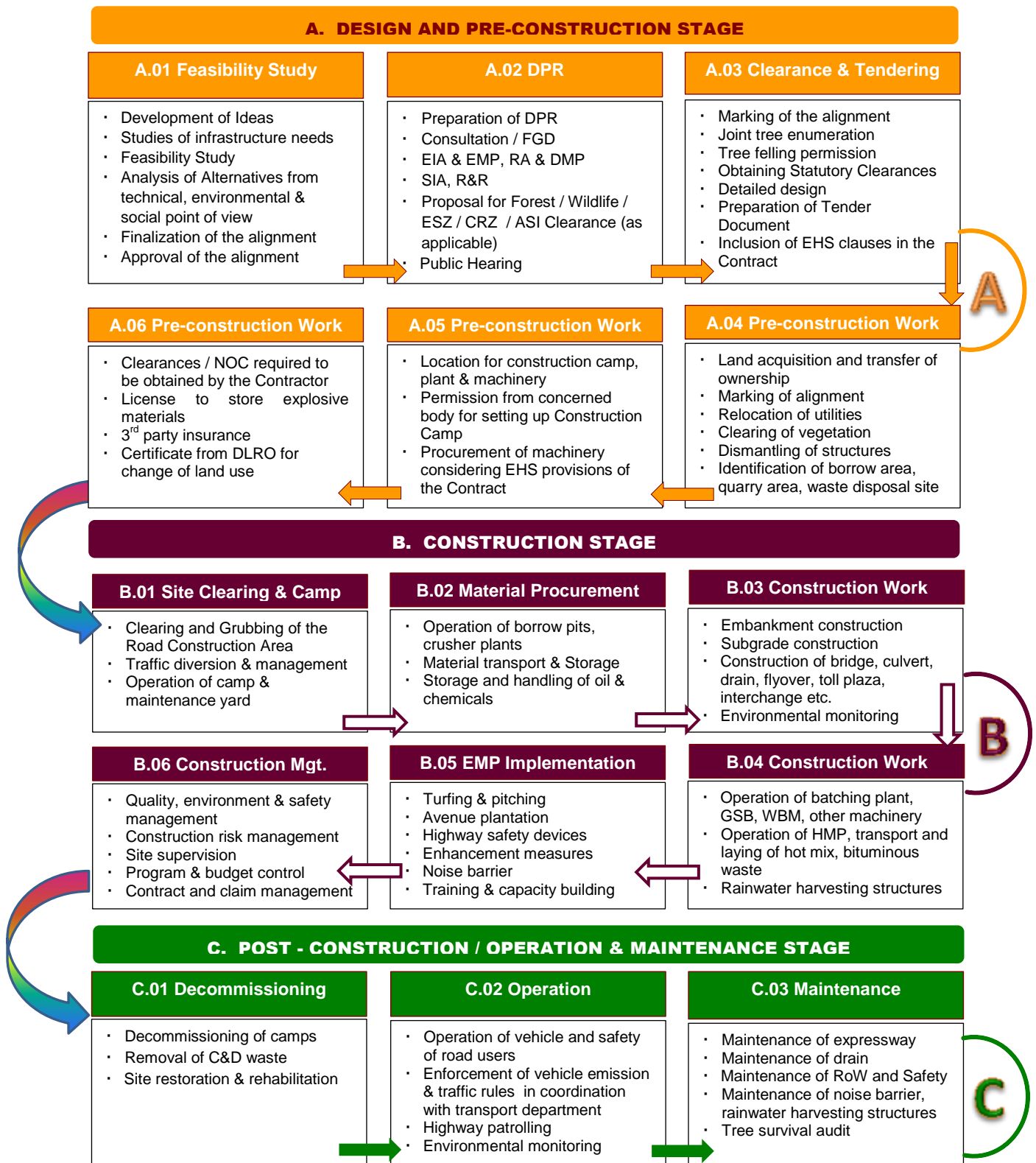


Figure 2-3 Activities in the Typical Expressway Development Project

## 2.9.2 Infrastructure Requirement

During the construction and operations of the highway the following infrastructure would be developed and maintained by the Contractor.

- **Construction Camp:** Even though local labour would be employed to the extent possible, the number of activities would require specialized skilled labour e.g. operator of the vehicle and machinery, skilled crews for operations of bar-bending and casting etc. These labours in most cases would be migrant from other parts of the state or country. The Contractor would setup a construction camp for the accommodation of the workers.
- **Hot Mix Plant:** For the manufacturing of the bituminous material, the Contractor would setup a Hot mix Plant. The plant would be setup considering the sitting guidelines specified by regulatory authorities.
- **Batching Plant:** The Concrete batching plant would be installed for concrete casting of structures i.e. minor bridges, box and hume pipe culverts. The Batching plant in addition to cylos for cement, aggregates and sand; would also require an area for storage of cement and additives.
- **Lay down Areas:** The contractor would identify an area for storage of the raw-material required for construction including soil, sand GSB and aggregates. These would be stored as open heaps within the laydown area. The lay down area might also be used as a maintenance yard for the vehicles and machinery.
- **Waste Storage Area:** The excavate material would have to be stored at some places before it can be utilized or disposed of at a permanent disposal site provided by the concerned local body



## 2.9.3 Resource Requirement

**Construction Material:** The Project entails development of a green-field expressway and will require construction materials like aggregates, sand, stone, etc., which shall be procured from nearby approved quarries. However, separate environmental approval shall be sought by the Contractor for any new quarry. The estimated raw materials requirement during construction stage is given in **Table 2-17**.

**Table 2-17 Raw Materials requirement during Construction**

Sl. No.	Item & Unit	Unit	Quantity	Mode of Transport	Source
1.	Earth Work – fill	Cum	1,35,52,116	Truck	Identified Borrow areas / generated from cutting



Sl. No.	Item & Unit	Unit	Quantity	Mode of Transport	Source
2.	Granular Sub Base	Cum	9,22,598	Truck	Pre-identified quarry areas and Local Traders
3.	Wet Mix Macadam	Cum	27,517	Truck	
4.	Dense Bituminous Macadam	Cum	5,173	Truck	
5.	Bituminous Concrete	Cum	4,138	Truck	
6.	DLC	Cum	4,40,468	Truck	
7.	PQC	Cum	9,52,116	Truck	
8.	Bitumen	MT	1,004	Tanker	
9.	Emulsion	MT	130	Tanker	Refinery
10.	Cement	MT	8,07,000	Truck	Local traders
11.	Aggregates (cum)	Cum	30,72,000	Truck	Pre-identified quarry areas
12.	Sand (cum)	Cum	20,50,000	Truck	Pre-identified quarry areas
13.	Steel (MT)	MT	78,641	Truck	Local traders
14.	Fly Ash (cum)	Cum	1,09,32,287	Covered Dumper	Thermal Power Station
15.	Diesel (KL)	KL	40,000	Tanker	Local petrol pumps

Source: DPR prepared by the ICT Pvt. Ltd.

**Water Requirement:** During construction period water is required for compaction of embankment, dust suppression, concrete making and domestic use in construction camp. The estimated tentative water requirement during construction stage is given in **Table 2-18**.

**Table 2-18 Breakup of Water Requirement during Construction**

S. N	Purpose	Unit	Quantity
1	For road construction:		
	a) Construction related to earthwork	KL	45,00,000.00
	b) Construction related to Fly Ash		
	c) Construction of GSB		
	d) Construction of WMM		
e) Bridges, culverts, retaining walls & other structures			
2	Dust suppression	KL	5,00,000.00
3	For drinking & other domestic purpose	KL	10,00,000.00
	<b>Total</b>		<b>60,00,000.00</b>

Source: DPR prepared by the ICT Pvt. Ltd.

During the operations phase the water would be required primarily for drinking and domestic use at the toll plaza and for landscaping.

**Power Requirement:** Power required at the construction camp would be drawn from the grid where it is available else DG sets would be used to supply the power to the Construction & Labour Camps.

**Land Requirement:** The land required for construction of proposed expressway is tentatively **901.9141 ha**, which includes forest land 191.5894 ha forest land and 710.3247 ha private / government land. Joint measurement of both private and forest land is ongoing and the above data may revise based on the final survey results.

**Manpower Requirement:** The manpower requirement would vary over the construction period depending on the quantum and type of work involved. About 450 nos. manpower would be required during the construction phase.

**Construction Period:** Construction period would be 24 months.

#### 2.9.4 Pollutant Sources during Construction Phase

During construction phase environmental impacts are likely to result primarily from operation of heavy machinery and equipment's, vehicular movement and from construction camp. The potential pollutant sources for construction phase and their characterization has been discussed in the subsequent section.

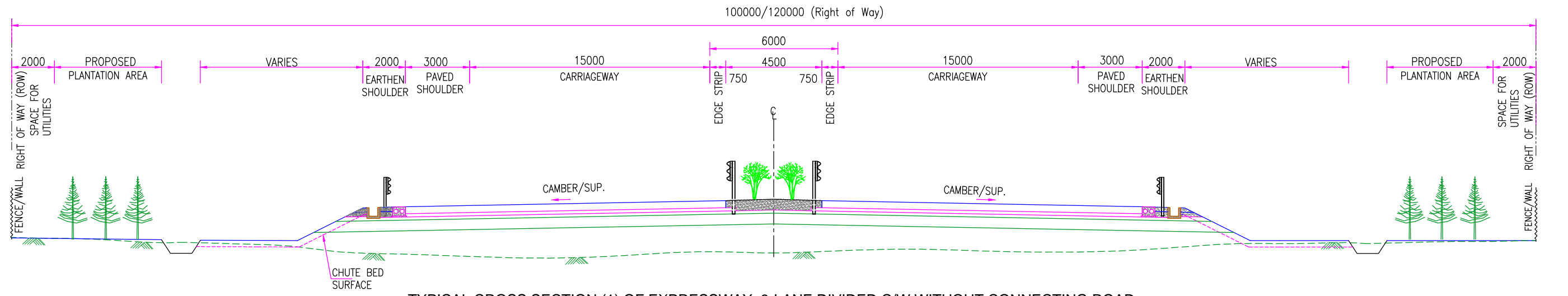
**Operations of Heavy Machineries & Vehicular Movement:** The operations of construction vehicles, diesel generators and machineries would contribute to particulate matter (PM), sulphur dioxides (SO<sub>2</sub>), oxides of nitrogen (NO<sub>x</sub>), carbon monoxide (CO) and hydrocarbons (HC). In addition, fugitive emissions are envisaged from plying of vehicles and also from storage, handling and transportation of materials during the construction phase. Dust will be emitted during material transport and loading-unloading activities. Noise will be generated from operating heavy machineries and from vehicular movement. During construction phase, spillage of construction materials, such as, cement, POL, bitumen etc. could lead to an increase in water pollution level of the receiving water body.

**Generation of Construction Waste:** There would be waste from the batching plant, hot mix plant, demolition of structures within proposed ROW. Some of the material would be recycled and used for back filling. Material which cannot be recycled would be considered as construction and demolition waste and has to be disposed of as per the Construction and Demolition Waste Management Rules, 2016.

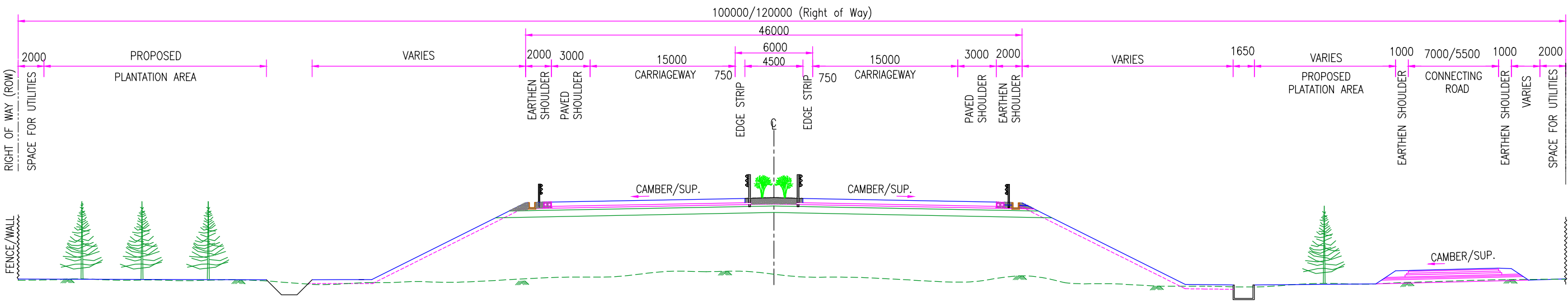
**Construction Camp:** liquid & solid waste will be generated from construction camps.

#### 2.9.5 Pollutant Sources during Operation Phase

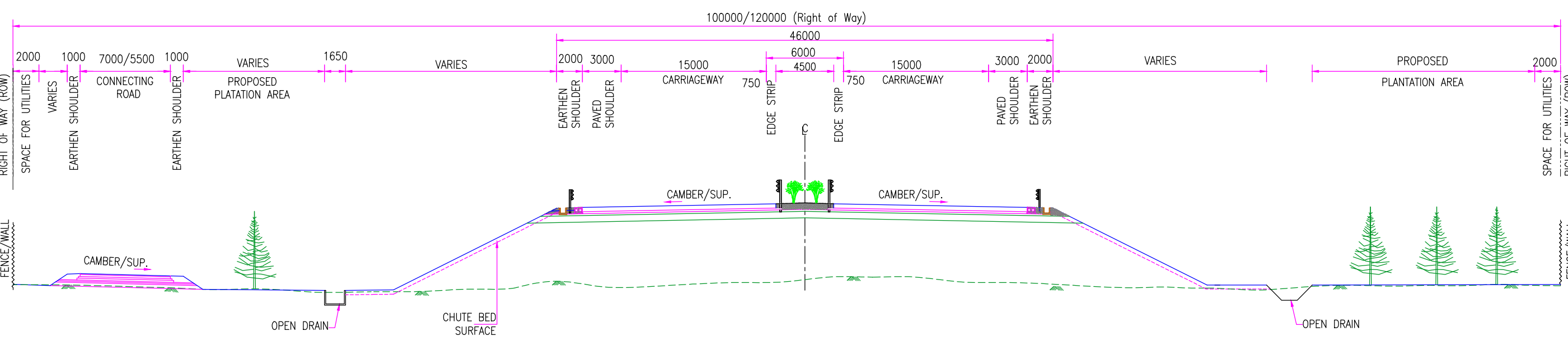
During operation phase of the proposed expressway, liquid & solid (municipal) waste would be primarily generated from toll plaza and rest area. Bituminous layer would be excavated during the repair of pavement, which is hazardous in nature.



TYPICAL CROSS SECTION (1) OF EXPRESSWAY 8-LANE DIVIDED C/W WITHOUT CONNECTING ROAD



TYPICAL CROSS SECTION (2) OF EXPRESSWAY 8-LANE DIVIDED C/W WITH RIGHT SIDE CONNECTING ROAD



TYPICAL CROSS SECTION (3) OF EXPRESSWAY 8-LANE DIVIDED C/W WITH LEFT SIDE CONNECTING ROAD

## **CHAPTER-3: DESCRIPTION OF THE ENVIRONMENT**

### **3.1 GENERAL**

Baseline environmental status outlines the existing environment conditions of the project area. EIA is a formal process for identifying the likely impacts of particular activities or projects on the environment, human health and welfare. EIA also encompasses the development of mitigation measures to address these impacts and suggested approaches for implementation of mitigation and monitoring measures. EIA is not to be regarded as an academic exercise as this has to ensure that environmental values and factors have to be integrated into the decision-making process. EIAs convey information about environmental impacts of a project to decision makers at a stage when such information can materially affect the output. As a precursor for the prediction of various types of environmental impacts likely to arise due to implementation of the project, it is essential to establish the baseline environmental status of the physical and biological parameters in the Direct and Indirect Area of Influence. Details of baseline environment parameters are required for decision making for the project are discussed in this chapter.

### **3.2 STUDY AREA & PERIOD**

As per the EIA Guidance Manual for Highways (MoEF&CC, February 2010), a study area of 15 km radius from the proposed expressway was considered for secondary data collection. Primary data has been collected within 500 meters on either side of the proposed alignment. Baseline environment monitoring was carried out for the period of March to May, 2017.

### **3.3 PHYSIOGRAPHY AND TERRAIN**

The proposed expressway is passing through 4 talukas (Vasai, Palghar, Dahanu and Talasari) of Palghar district in the state of Maharashtra. Physiographically, Palghar district can be divided into two broad divisions - Undulating Hilly Tract and Coastal Plain in western part. The area is drained by innumerable streams and tributaries of Vaitarna and Ulhas River. The four main tributaries of river Vaitarna are Surya, Tansa, Deharaja and Pinjal Rivers. Ulhas River is the other important river in the district.

The proposed alignment is located in the coastal plain of the district. The narrow strip of coastal land between the Sahyadri and the Arabian Sea is called the "Konkan Coastal Strip". The Konkan coastal tract runs almost 500 km north to south with width varying between 30 and 100 km; it is wider in the north and narrows down in the south.

Geographically the proposed expressway lies between latitude 19°29'19.5"N, to 20° 9'2.4"N and between 72°52'58.8"E to 72°54'55.7"E longitude with elevation varies from about 3 m to 1113 m above MSL (**Figure 3-1**).



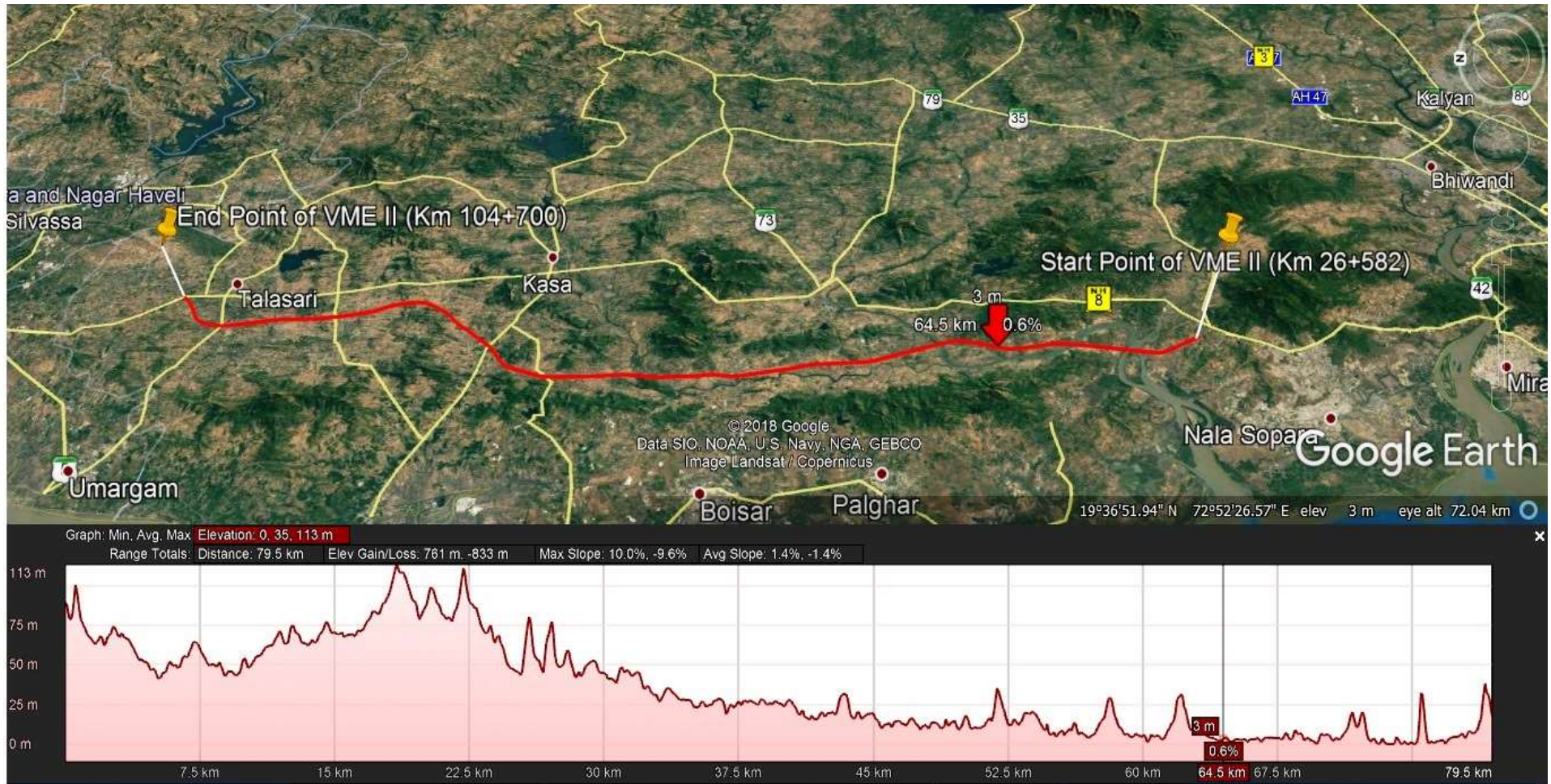


Figure 3-1 Elevation Profile of the Project Area



The proposed expressway passes through mainly plain terrain except for a few stretches where it passes through rolling terrain.

**Coastal Plain Region:** The Coastal Plain Region, adjacent to the sea, is flat and is therefore subject to flooding and periodic inundation both by the sea and the rivers. It is characterized by mud flats, rice paddy and in some locations, the marshes support mangrove vegetation. These estuaries and tidal marshes provide fishing grounds, as well as feeding and breeding areas for a wide variety of aquatic plant and animal life.

**Rolling Terrain Region:** The rolling terrain region is characterized by undulating landscape and soils with good constructability.

### 3.4 GEOLOGY AND SEISMICITY

Palghar region is underlain by basaltic rocks. Basalt flow forms the predominant formation capped at a few places by laterite at higher levels. A number of hot springs occur in Palghar district which have positive relation with the geology of the area. However, there is no hot spring within the RoW of the proposed expressway. The hill ranges in the area are predominantly aligned north-south and have more or less escarpments. Basalt flows, popularly known as Deccan traps, forms the predominant formation. It is capped by laterite on a few high plateaus and covered by shore sands along the coast. The topographical sheets, superimposed with the alignment of proposed expressway and its 10 & 15 km radius are provided in **Annex 3.1**.

The project area is situated in the **Zone III** (having moderate seismic intensity) of the Seismic Map of India (as per IS: 1893, Part I, 2002) and therefore has a moderate risk of potential damage due to earthquake.

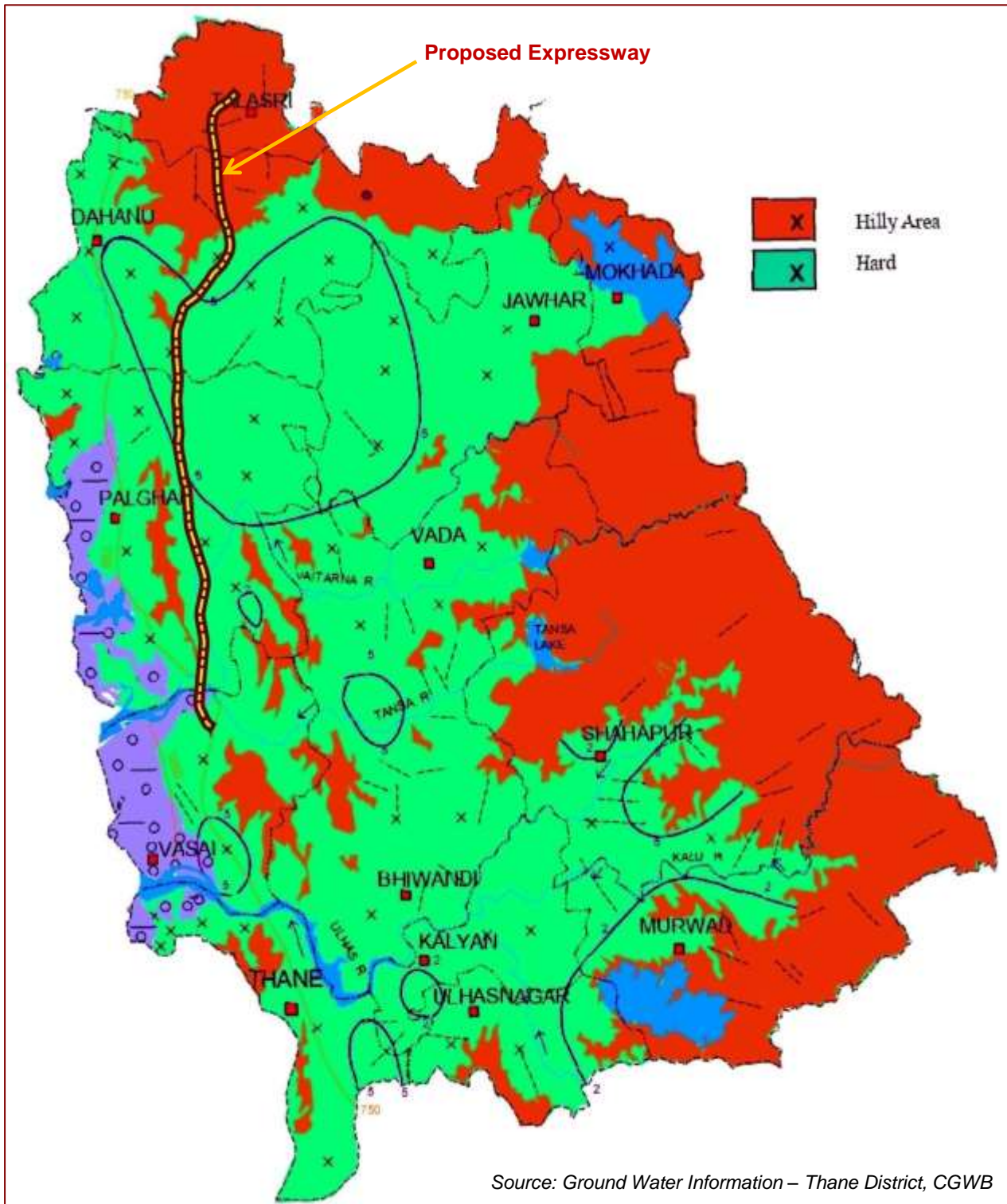
### 3.5 HYDROLOGY

#### 3.5.1 Hydrogeological Features of the Study Area

Deccan trap Basalt of Upper Cretaceous to Lower Eocene age is the major rock type of the district while coastal alluvium is occurring in western end of the district. A map showing the hydrogeological features of the study area is presented as **Figure 3-2**.

**Alluvium:** These are developed in the western part of the area along the coast and river courses and are lacustrine in nature. Along the coast, alluvium consists of clayey and mud deposits. The quality of water is slightly brackish. The alluvium constitutes the potential aquifer in the area. The river alluvium is highly stable and has high water holding capacity. Alluvium forms good aquifer with high degree of porosity and permeability. Alluvium has lesser vertical and more horizontal permeability due to deposition of material in horizontal layers.

In Thane & Palghar districts, the coastal alluvium occurs from north of Chikhaley to Dahanu and extends to Palghar, Virar, Vasai and Nalasopara in the south. The beach sands are less than half a km wide but the mud flats have width upto 5 km and thickness up to 36 m. It comprises clay, silt, sands, and gravel.



**Figure 3-2 Map Showing the Hydrogeological Features of the Study Area**

The yield potential of dug wells ranges from 150 to 900 m<sup>3</sup>/day in winter to 100 to 230 m<sup>3</sup>/day in summer. The fluviatile alluvial deposits occur along river courses (Vaitarna and Ulhas Rivers) and form locally significant hydrogeological units wherever they have adequate thickness (more than 10 m) and considerable lateral extent. The alluvium generally comprises silts, clays, sands, gravels and occasionally the cobble beds. Due

to higher topographic gradients the extent of alluvial deposits is rather restricted and the thickness along the riverbanks seldom exceeds 4 to 6 m. The quality of ground water in areas experiencing tidal backwater effects is brackish or saline but fresh in the elevated lands.

### 3.5.2 Hydrological Investigations of the Proposed Alignment

A reconnaissance survey was carried out to gather general idea regarding topography of the catchment areas, to collect information on performance of the embankment and existing bridges on NH-48 (old NH-8) and other nearby roads during recent critical flood years (2004 and 2006) and to collect hydrological and hydraulic data from various sources.

- The proposed corridor i.e. from Km 26+582 to Km 104+700 comes under the influence of Ghat area.
- The alignment of proposed expressway runs parallel to and/ or very near to Rivers Vaitarna, Surya and Suseri between Km 30+000 and km 72+200. Vertical profile of the proposed expressway shall, therefore, be governed by the HFL of these major Rivers along the entire stretches.
- Many of the minor proposed bridges are in the vicinity of old vented causeway structures constructed over the local roads across local streams. These existing structures shall have a bearing on the hydraulic design of the proposed structures. Apart from these vented causeways, weirs are also there across local streams for facilitating local irrigation. These weirs, when in the vicinity of the proposed crossing points, shall also affect the design of the proposed structures.
- The river beds for the stretch between Km 26 to Km 45 seem to be made up of sandy / loamy soil. Large scale sand mining from the beds of Rivers Ulhas and Vaitarna were seen.
- Rocks were visible in the beds of rivers (at old NH8 crossing points) namely Surya (Km 68+420), Suseri (Km 72+190) and Vadvali (Km 96+208).
- Amongst the major ones, Vaitarna River experience tidal fluctuations in water levels at the proposed crossing points with the expressway. The maximum extent of tidal fluctuation generally observed was 3m, as informed by the local people. The manmade barrier constructed across them to prevent ingress of saline sea water into the landward course. Such weirs prevent sea water from coming into the main course but at the same time cause a constant pool of water to remain in the river. The hydraulic consequence of construction of such weirs is reduction of effective area of the rivers, upstream of such weirs, irrespective of prevalent tidal cycle at any particular instant. The heights of most of these gated weirs are not more than 2m - 2.5m above average bed levels of the rivers.
- It was observed that after widening of NH48 (old NH-8) the bridges over the widened



Manmade Barrier on Vaitarna River

portions (new) were higher than the older ones though the distances between their abutments (Gross waterway) were, in most of the cases, same. This observation gave an idea that the vertical clearances of the older bridges were encroached while passing some critical discharge. The new bridges have fewer piers providing more net waterway for passing flood discharge. Local enquiry reveals that the new bridges, in most of the cases, have passed 2004 / 2006 floods without any harmful afflux. However, scour holes and dislocation of bed blocks were clearly visible in many bridges on NH48. The appended photograph show difference in levels of new and old bridges over NH48. No instance of outflanking of bridge abutment was visible or informed.



*New and Old Bridges over Wanki on NH-48 showing difference of level*

### 3.5.3 River, Nala and Canal Crossings En-route

The alignment of the proposed greenfield expressway crosses many river, canal and nala en-route, which have been provided in **Table 3-1**. Vaitarna River and Surya River (tributary of the Vaitarna) are the major rivers in the study area. Brief details of the outfall points / estuaries of Vaitarna River and Surya River are presented in **Table 3-2**.

**Table 3- 1 List of River, Canal and Nala Crossings en-route**

Sl. No.	Proposed Chainage	Name of River/ Canal	Village
1	31+300	Vaitarna Crossing-1	Wadhiv Saravali
2	35+725	Vaitarna Crossing-2	Sonave
3	42+858	Canal	Navje
4	43+725	Canal	Sakhare
5	45+040	Vaitarna Crossing-3	Khamloli
6	60+712	Canal	Lalonde
7	62+421	Canal	Kirat
8	65+134	Canal	Ravte
9	68+420	Surya River	Dhabon
10	72+190	Suseri Nalla	Dhabon
11	76+037	Canal	Chandwad
12	89+604	Jogani River	Chinchale
13	93+650	Canal	Vankas
14	94+491	Canal	Vankas
15	96+208	Vadvali / Tumb River	Vankas
16	99+955	Kangan Nala	Awarpada / Kawade

Source: Field Survey conducted by ICT Pvt. Ltd

The proposed alignment is also crossing local streams flowing through the irrigated



agricultural lands at several locations. These streams carry the surplus irrigation supplies from irrigated lands during non-monsoon periods. During flood, canal supplies cease but the nalas carry the surface runoff to the nearest outfall streams. As such, flow is observed in these streams throughout the year. Some channels carry discharges from the industrial areas. These channels appear to be manmade artificial ones and perhaps not aligned along natural valleys. These channels, though very long, do not carry discharges proportionate to the area they are supposed to cater.

**Table 3- 2 Details of Outfalls / Estuaries**

Name of the River	Type of River at crossing point	Proposed Chainage	Distance between crossing point and confluence with main river or sea mouth (Km)	Brief details of outfall / Estuary	Tidal Fluctuation at Crossing point
Vaitarna (crossing-1)	Wide, Shallow and Anabranching	31+300	15.72	Wide and Large	Yes
Surya	Narrow, Deep	68+420	31.0	Narrow	No
Vadvali	Narrow, Deep	96+208	29.05	Narrow	No

Source: DPR prepared by ICT Pvt. Ltd

### 3.5.4 Hydro-Meteorologically Homogenous Sub Zones

The Central Water Commission (CWC) has divided the Geographical Territory of India into 26 distinct hydro-meteorologically homogenous sub zones. The Study area comes under **Sub zone 5(a)** for West Coast Region (Konkan Coasts). River bridges of the study area shall come under relevant Hydro-Meteorologically Homogenous Sub zone based on the locations of proposed crossing.

### 3.5.5 Design Rainfall

The Design Rainfall (24 hr. maximum) of the study area has been judiciously selected from the following:

- The 50 Year / 100 Year Isopluvial Map of the Sub zone concerned
- The recorded and published daily maximum rainfalls of Palghar district
- The recorded daily maximum rainfall as collected during reconnaissance survey

The following **Table 3-3** reflects the return periods and corresponding maximum 24 hour rainfall adopted for design of the proposed major bridges of expressway.

**Table 3- 3 Return Period and Rainfall Adopted for Expressway Bridges**

Sl. No.	Proposed bridge over River	Proposed Chainage	100-Year / 24-Hr rainfall (mm)	50-Year / 24-Hr rainfall (mm)
1	Vadvali	96+208	500	423
2	Surya	68+420	506	430
3	Vaitarna (Crossing-3)	45+040	501	425

Source: DPR prepared by ICT Pvt. Ltd



### 3.5.6 Catchment Area and Drainage Network

The watersheds of the rivers at the proposed crossing points have been delineated with the help of ArcGIS 9.2 Software. The watershed area, total and centroidal stream lengths, segmental stream length and corresponding falls have been determined with the help of GIS Software. The superimposition of delineated catchment areas over the digitized Isopluvial Maps (50 Year / 100 Year-24 hr.) has also been done. For small watersheds not traceable in Digital Elevation Model, catchment areas, stream lengths and falls have been estimated through study of toposheets of the concerned area and satellite imagery. **Annex-3.2** reflects the catchment areas over the whole study area of the proposed expressway including drainage network, delineated with the help of ArcGIS Software and details of catchment area is presented in **Table 3-4**.

**Table 3- 4 Catchment Area of Rivers & Local Stream along the Proposed Expressway**

S. No.	Chainage	River / Nala	Village	Catchment Area (sq.km)
1.	35+750	Vaitarna Crossing-2	Sonave	2970.417
2.	37+780	Local Stream	Pargaon	4.254
3.	37+965	Local Stream	Pargaon	2.642
4.	45+040	Vaitarna Crossing-3	Khamloli	2152.19
5.	48+393	Local Stream	Dhuktan	5.376
6.	50+000	Local Stream	Dhuktan	1.824
7.	52+728	Local Stream	Wakadi	1.33
8.	54+310	Local Stream	Katale	3.103
9.	57+885	Local Stream	Nihe	4.959
10.	59+888	Local Stream	Nagzari	9.032
11.	61+539	Local Stream	Kirat	1.763
12.	63+570	Local Stream	Kirat	5.751
13.	63+925	Local Stream	Borsheti	2.015
14.	66+137	Local Stream	Ravate	2
15.	66+735	Local Stream	Chinchare	2.8
16.	68+420	Surya River	Dhabon	615.729
17.	70+000	Local Stream	Dhabon	5.141
18.	72+190	Suseri Nallah	Dhabon	78.25
19.	74+493	Local Stream	Rankol	2.225
20.	79+745	Local Stream	Navnath	3.03
21.	81+332	Local Stream	Ganeshbag	0.956
22.	83+688	Local Stream	Dhaniwari	1.53
23.	89+604	Jogani Nadi	Chinchale	19.76
24.	91+564	Local Stream	Talote	2.51
25.	96+208	Vadvali Nadi	Vankas	58.73

Source: DPR prepared by ICT Pvt. Ltd

### 3.6 AGRICULTURE AND IRRIGATION PRACTICES

In Palghar district agriculture is a primary source of livelihood activity. The district is predominantly rainfed and receives an annual rainfall of more than 2500 mm, but steep slopes and rocky terrain results in poor water retention. According to 2011 Census the land use pattern indicates that 41.93% is the net sown area and only 1.9% of the total area is sown more than once. In order to overcome the problem, Social Forestry Department and Agriculture Department of Govt. of Maharashtra have undertaken small schemes of water conservation and artificial recharge.

Agro-ecological situations of the study area including their characteristics and coverage are given in the **Table 3-5**

**Table 3-5 Agro-ecological Situations of the Study Area**

Items	Description
Agro Ecological Sub Region (ICAR)	Western Ghats and Coastal Plain, Hot Humid-Perhumid Eco-Region (19.1) Western Ghats And Coastal Plain, Hot Humid-Perhumid Eco-Region (19.3)
Soil Depth	Medium black soil
Irrigation source available	Medium irrigated conditions
Special Features	Coastal zone resulting in soil affected by salt
Major Field crops	Paddy, Finger millet, Proso millet, Pulses (Cowpea, blackgram, pigeon pea, chick pea, etc.), ground nut etc.
Horticultural crops – Fruits	Mango, Sapota, Cashew
Horticulture crops – Vegetables	Okra, Brinjal, Chilli and Leafy vegetables
Plantation crops	Coconut

Source: Dept. of Agriculture, Govt. of Maharashtra

### 3.7 LAND USE

#### 3.7.1 Method of Data Preparation

The land use / land cover of the study area i.e. covering aerial distance of 15 Km from the alignment of proposed expressway has been presented in the form of a map on 1: 25,000 scale as per requirement of the MoEFCC. The map has been prepared using Survey of India Topographical sheet (1:50000 scale), satellite images, maps of forest division etc. as listed in **Table 3-6**.

**Table 3-6 Secondary Data and Images Used for Preparation of Land Use Map**

Sr. No.	Data/Maps	Source
1	SOI Toposheets at 1:50000 scale (46D15, 46D16, 46H3, 46H4, 47A13, 47A14, 47A15, 47D12, 47A9, 47A10, 47E1, 47E2, 47E3)	Survey of India
2	Remote Sensing Data: Satellite Imagery: Cartosat-1 (2.5m) Dated, April,2011)	National Remote Sensing Center (NRSC), Hyderabad
3	Tungreshwar Wildlife Sanctuary Boundary Map	Thane Forest Division
4	Dadra & Nagar Haveli Wildlife Sanctuary Boundary Map	DNH Wild Life Department, Silvassa
5	Others	Google Earth Images

Source: EIA Study carried out by ICT Pvt. Ltd.

The data has been processed using geo-processing software ArcGIS and Erdas Imagine software supported with ground truth verification. Area and distance calculations have been carried out using the software after geo-referencing the interpreted data with the help of the topographical maps. The **land use map** of the study area covering 15 km on either side is provided in **Annex 3.3**.

Ground Surveyed Map on 1:2000 Scale showing the existing features falling within the right of way is provided in **Annex 3.4**.

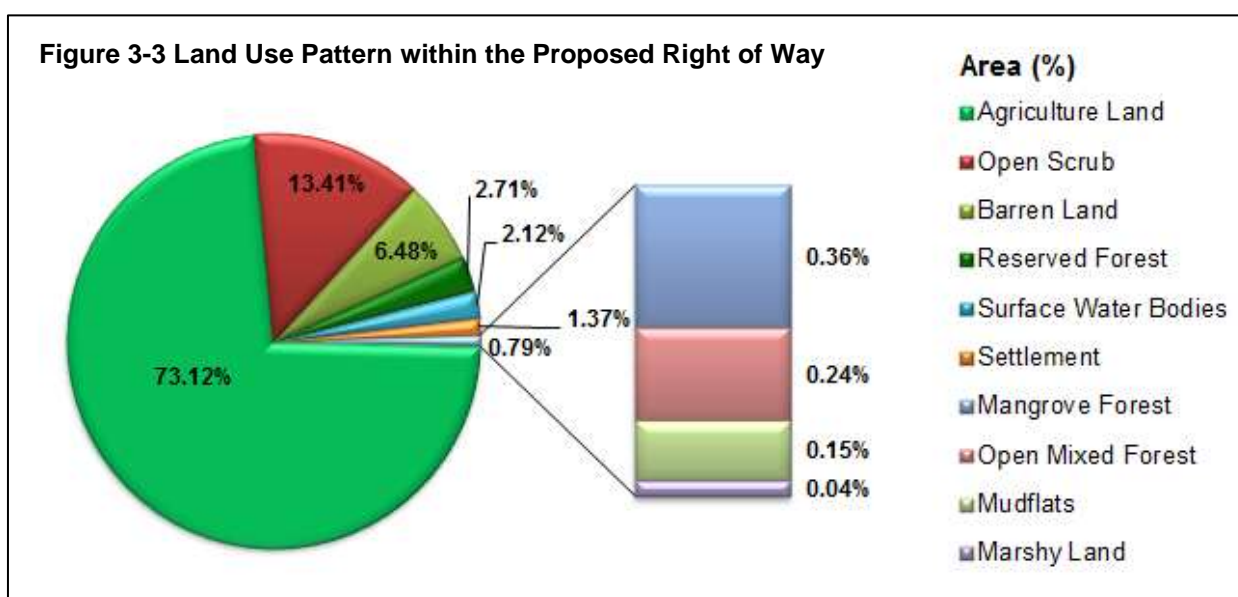
#### 3.7.2 Land Use within PROW (100m-120m)

Agricultural and allied uses occupied largest part amounting to 678.8697 ha. (73.13%) of the total area, followed by open scrub 124.49 ha (13.41%), barren land 60.17 ha (6.48%), reserved forest 25.16 ha (2.71%), surface water bodies (River, pond and dam) 2.12%, settlements 12.67 ha (1.37%), mangrove forest 3.31 ha (0.36%), open mixed forest 2.22 ha (0.24%), mudflats 1.4 ha (0.15%) and marshy land 0.36 ha (0.04%) of the total area (**Table 3-7**). This has been graphically represented in **Figure 3-3**. Based on analysis of data and ground verification, it can be concluded is that majority portion of the alignment is passing through agricultural land followed by barren land with undulating terrain. The main agricultural activities within PROW are plantation, cropland and pasture. This agricultural land includes forest under Section-35.

**Table 3-7 Land Use distribution within PROW**

Land Use Type	Area (Ha)	Area (%)
Agriculture Land	678.87	73.13
Open Scrub	124.49	13.41
Barren Land	60.17	6.48
Reserved Forest	25.16	2.71
Surface Water Bodies	19.63	2.12
Settlement	12.67	1.37
Mangrove Forest	3.31	0.36
Open Mixed Forest	2.22	0.24
Mudflats	1.4	0.15
Marshy Land	0.36	0.04
<b>Total</b>	<b>928.28</b>	<b>100</b>

Source: EIA Study carried out by ICT Pvt. Ltd.



### 3.7.3 Land Use within Study Area

Total study area is 3027.325 ha. Agriculture land occupied major part (48.27%) of the total area, followed by reserved forest (31.39%), settlement (both urban and rural) (5.83%), surface water bodies (3.66%), marshy land (22.82%), open scrub (2.57%), open mixed jungle (1.83%), industrial (1.1%), mangrove forest (0.85%), salt pan (0.71%), barren land (0.64%), mudflats (0.34%).

**Table 3-8 Land Use within 15 km Radius of the Proposed Alignment**

Land Use Type	Area (Ha)	Area (%)
Agriculture Land	1461.1861	48.27
Reserved Forest	950.1328	31.39
Settlement (Urban and Rural)	176.5207	5.83
Surface Water Bodies	110.7939	3.66
Marshy Land	85.2852	2.82
Open Scrub	77.8445	2.57

Land Use Type	Area (Ha)	Area (%)
Open Mixed Jungle	55.2606	1.83
Industrial Area	33.4404	1.1
Mangrove Forest	25.835	0.85
Salt Pan	21.5732	0.71
Barren Land	19.2519	0.64
Mudflats	10.2007	0.34
<b>Total</b>	<b>3027.325</b>	<b>100</b>

Source: EIA Study carried out by ICT Pvt. Ltd.



Figure 3-4 Field Visit - Ground Verification of Land Uses



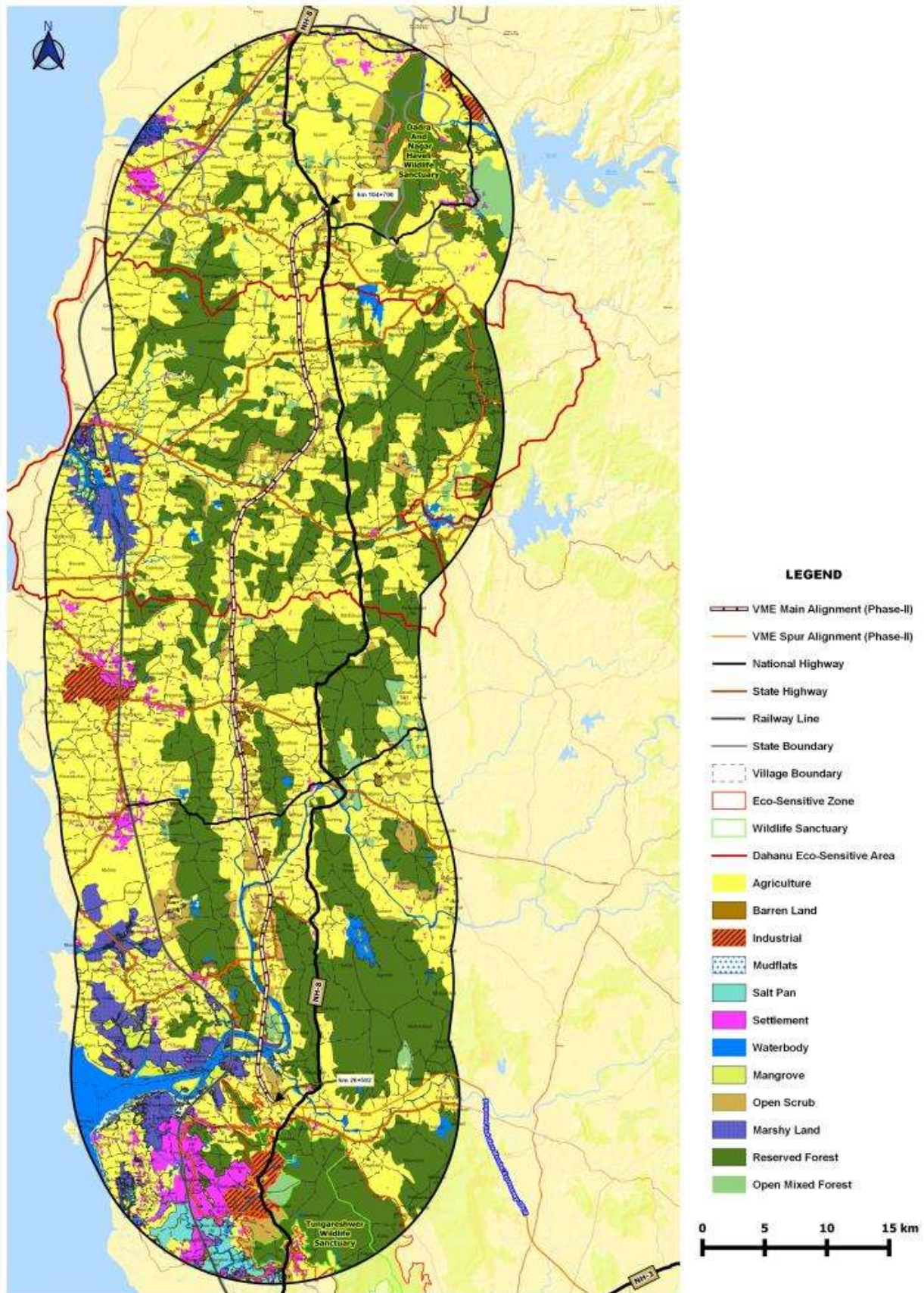


Figure 3-5 Land Use Pattern within 15km Radius from the Proposed Expressway

### 3.8 SOIL QUALITY

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

#### 3.8.1 Soil Types of the Study Area

Most of the soils in the study area can be considered as being derived from trap (Basaltic) rocks. The soil has been classified into three broad categories based on the characteristics and relationship with topographic set up.

- a) **Soil of Coastal Lands with Residual Hills** - These soils are slightly deep, poorly drained, fine soils on gentle sloping land and very fine soil on sloping land. These soils are calcareous and occur along the coast of Vasai, Palgarh and Dahanu
- b) **Lighter Colored soils** - These soils are occurring on the undulating, elongated hills and intervening valleys. These are medium to deep grayish in color, poor in fertility, clayey to loamy in nature, shallow in depth and coarse in texture. These soils are known as Varkas and are suitable for rice. These soils occur on the eastern part of the district.
- c) **Black Colored Soil** - These soils occur on plains in the middle and eastern part of the district along the valleys.

#### 3.8.2 Soil Monitoring Stations

The physico-chemical characteristics of soils within the study area were examined by obtaining soil samples from selected points and analyzing the same. Details of the sampling stations are provided in **Table 3-9** and shown in **Figure 3-6**. M/s Anacon Laboratories Pvt. Ltd., Nagpur (A NABL Accredited laboratory) was engaged for collection and analysis of Soil samples. Four (4) sampling locations of different land use within 500 meters on either side of the proposed alignment were collected for studying soil characteristics.

#### 3.8.3 Soil Characteristics of the Study Area

Composite soil samples from 4 different land use area were taken from 15 to 30 cm soil layer by adopting all the standard procedures. The samples weighing approximately 1 Kg were packed, tagged and transported to the laboratory for detailed analysis.

The soil analysis data of river bed and mangrove area (**SQ1**) presented in **Table 3-10** below reveal that the soils are silt clay in texture and alkaline in reaction. Very high electrical conductivity of water extract indicated that the soil should have higher concentrations of some of the nutrients like potassium, chloride, sodium, iron, lead etc. and it is indicated in the soil analysis. These are not so desirable indicators for good plant growth. Very low quantities of nitrogen, phosphorus and poor organic matter content indicate that the soils are poor in soil fertility. The soil generally not so suitable for agricultural crops but external addition of nitrogen, phosphorus and organic matter will help in improving the soil fertility, improve the moisture content of the soil and to



some extent mitigate the adverse effect of nutrient elements leading to higher pH and electrical conductivity.

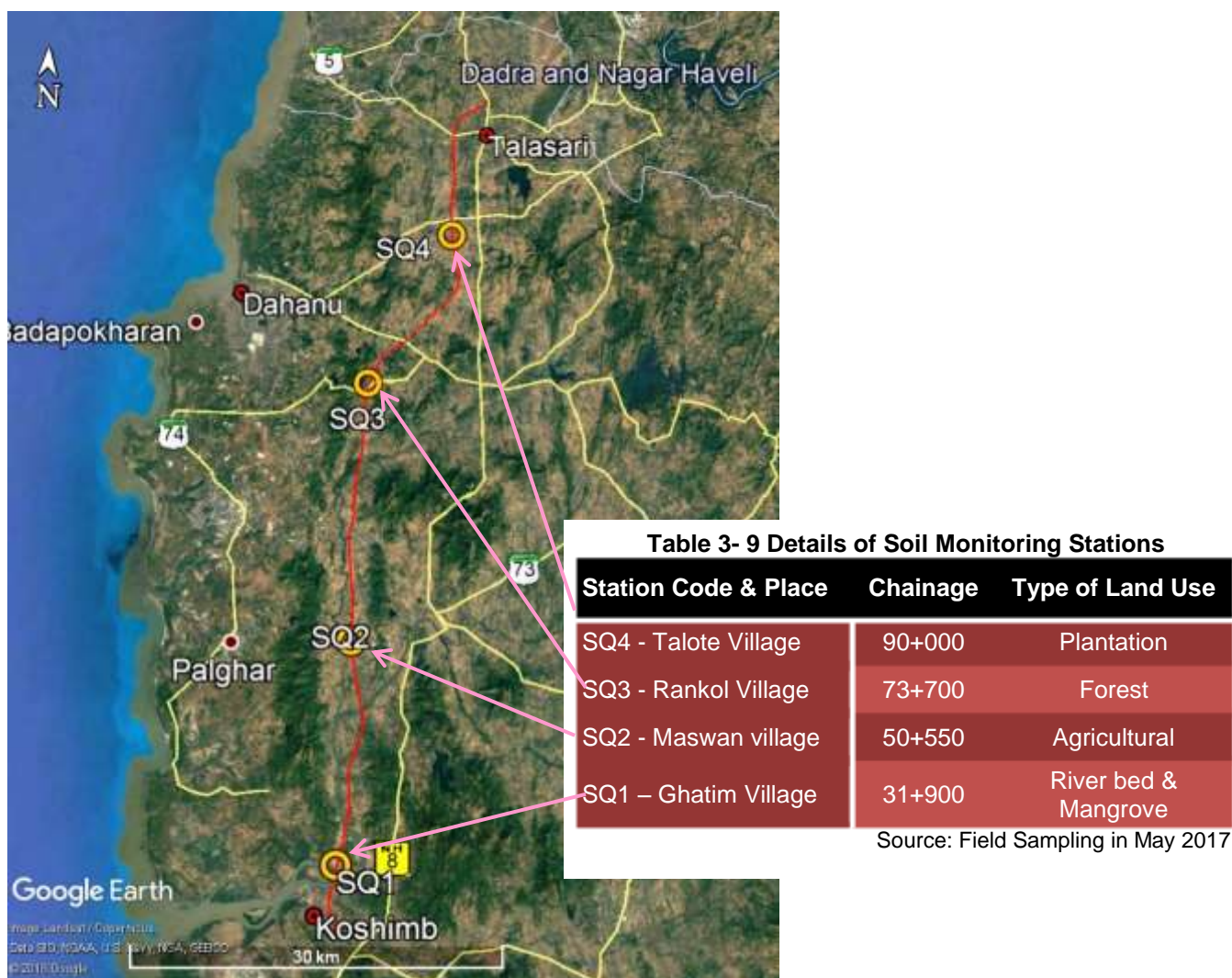


Figure 3-6 Map Showing Location of Soil Sampling

Table 3-10 Soil Analysis Result of River bed & Mangrove Area (SQ1)

Sr. No.	Test Parameter	Measurement Unit	Test Results
1.	pH (1:5 water extract)	-	8.00 at 25°C
2.	Electrical Conductivity at 25°C (1:5 water extract)	µs/cm	2950
3.	Soil Type	--	Low fertile
4.	Texture	-	Silty Clay
5.	Sand	%	13
6.	Slit	%	52
7.	Clay	%	35
8.	Moisture Content	%	11.57
9.	Organic Matter	%	0.21
10.	Bulk Density	g/cc	1.428
11.	Porosity	%	17.28

Sr. No.	Test Parameter	Measurement Unit	Test Results
12.	Nitrogen (as N)	Kg/ha	103.48
13.	Potassium (as K)	Kg/ha	508.05
14.	Phosphorous (as P)	Kg/ha	0.34
15.	Chloride (as Cl <sup>+</sup> )	mg/Kg	5264.58
16.	Sodium	mg/Kg	66.39
17.	Sodium Absorption Ratio	--	3.22
18.	Sodium Sulphate	%	13.75
19.	Calcium Sulphate	%	12.47
20.	Lead (as Pb)	mg/Kg	0.72
21.	Iron	mg/Kg	6.46

Source: Test Report provided by M/s Anacon Laboratories Pvt. Ltd., Nagpur

Unlike river bed & mangrove area soils, the soil of agricultural area (**SQ2**) is fertile and neutral in reaction (pH). The favourable organic matter content accompanied by medium levels of nitrogen and phosphorus, high levels of potassium and electrical conductivity within the required limits make the soils quite fertile (**Table 3-11**). A bulk density of 1.528 g/cc indicated the clay loam texture of soil with sufficient proportion of sand in soil texture. But still with the dominance of silt and clay the soil porosity could not be as good as desired for ideal agricultural land. Though this is good so far as water holding capacity is concerned but the water infiltration rate into the soil will be reduced. The value of electrical conductivity indicates the permissible levels of soluble salts like sodium in the soil. Overall it can be concluded that with normal package of practices and application of required nutrients and organic matter, good crops can be raised. No need of specific amendments.

**Table 3-11 Soil Analysis Result of Agricultural Area (SQ2)**

Sr. No.	Test Parameter	Measurement Unit	Test Results
1.	pH (1:5 water extract)	-	7.50 at 25°C
2.	Electrical Conductivity at 25 <sup>0</sup> C (1:5 water extract)	µs/cm	512
3.	Soil Type	--	Highly fertile
4.	Texture	--	Silty Clay Loam
5.	Sand	%	24
6.	Silt	%	42
7.	Clay	%	34
8.	Moisture Content	%	12.29
9.	Organic Matter	%	1.2
10.	Bulk Density	g/cc	1.528
11.	Porosity	%	16.58
12.	Nitrogen (as N)	Kg/ha	409.76
13.	Potassium (as K)	Kg/ha	480
14.	Phosphorous (as P)	Kg/ha	18.76
15.	Chloride (as Cl <sup>+</sup> )	mg/Kg	312.24
16.	Sodium	mg/Kg	291.96
17.	Sodium Absorption Ratio	--	19.62

Sr. No.	Test Parameter	Measurement Unit	Test Results
18.	Sodium Sulphate	%	17.18
19.	Calcium Sulphate	%	14.62
20.	Lead (as Pb)	mg/Kg	2.12
21.	Iron	mg/Kg	11.92

Source: Test Report provided by M/s Anacon Laboratories Pvt. Ltd., Nagpur

The soil analysis data of forest area (SQ3) have been presented in **Table 3-12** below. Forest soils are slightly towards alkaline in reaction but the electrical conductivity wise within the permissible limits. With silt as the dominating fraction the soil can be classified as Silt clay loam. With nitrogen and phosphorus levels being in medium range and potassium being quite high the soils can be classified as fertile one. The organic matter being quite low shows that it is a degraded forest soil where there is very little addition of organic matter from the perennial trees. With the dominance of silt and clay it was natural to have low soil porosity. Since it is forest land therefore, not much of the amendments are required except that it should not remain degraded. It should be covered with better plantation so that there is an increase in organic matter proportion of the soil & porosity and as a consequence the water infiltration and water holding capacity of soil improves.

**Table 3-12 Soil Analysis Result of Forest Area (SQ3)**

Sr. No.	Test Parameter	Measurement Unit	Test Results
1.	pH (1:5 water extract)	-	8.00 at 25°C
2.	Electrical Conductivity at 25°C (1:5 water extract)	µs/cm	318
3.	Soil Type	--	Fertile
4.	Texture	--	Silty Clay Loam
5.	Sand	%	12
6.	Silt	%	49
7.	Clay	%	39
8.	Moisture Content	%	11.68
9.	Organic Matter	%	0.68
10.	Bulk Density	g/cc	1.452
11.	Porosity	%	18.27
12.	Nitrogen (as N)	Kg/ha	316
13.	Potassium (as K)	Kg/ha	290
14.	Phosphorous (as P)	Kg/ha	13.14
15.	Chloride (as Cl <sup>+</sup> )	mg/Kg	282.63
16.	Sodium	mg/Kg	108.20
17.	Sodium Absorption Ratio	--	8.64
18.	Sodium Sulphate	%	15.21
19.	Calcium Sulphate	%	13.83
20.	Lead (as Pb)	mg/Kg	0.41
21.	Iron	mg/Kg	16.72

Source: Test Report provided by M/s Anacon Laboratories Pvt. Ltd., Nagpur



The soil analysis data of plantation area (SQ4) have been presented in **Table 3-13** below. The soil having a dominant fraction of silt and clay with a minor fraction of sand can be easily categorized as silt clay loam. The soil reaction tended slightly towards alkaline but the electrical conductivity has been well within the desired level. With nitrogen, phosphorus and potassium being in medium range, the soil can be categorized as fertile one. The sodium absorption ratio being well within the range does not show the problem of salinity. The only problem is that of low organic matter which has resulted in higher bulk density and will therefore influence the rate of water infiltration into the soil adversely. The soil needs lot of organic matter addition and slightly higher doses of nitrogen, phosphorus and potassium for raising any crop.

**Table 3-13 Soil Analysis Result of Plantation Area (SQ4)**

Sr. No.	Test Parameter	Measurement Unit	Test Results
1.	P <sup>H</sup> (1:5 water extract)	-	7.90 at 25°C
2.	Electrical Conductivity at 25°C (1:5 water extract)	µs/cm	290
3.	Soil Type	--	Fertile
4.	Texture	-	Silty Clay Loam
5.	Sand	%	14
6.	Silt	%	48
7.	Clay	%	38
8.	Moisture Content	%	12.78
9.	Organic Matter	%	0.34
10.	Bulk Density	g/cc	1.423
11.	Porosity	%	16.39
12.	Nitrogen (as N)	Kg/ha	290
13.	Potassium (as K)	mg/Kg	260
14.	Phosphorous (as P)	Kg/ha	11.77
15.	Chloride (as Cl <sup>+</sup> )	mg/Kg	145.92
16.	Sodium	mg/Kg	118.58
17.	Sodium Absorption Ratio	mg/Kg	8.35
18.	Sodium Sulphate	%	16.43
19.	Calcium Sulphate	%	14.12
20.	Lead (as Pb)	mg/Kg	0.58
21.	Iron	mg/Kg	18.86

Source: Test Report provided by M/s Anacon Laboratories Pvt. Ltd., Nagpur

### 3.9 CLIMATE & METEOROLOGY

#### 3.9.1 Climatic Conditions of the Study Area

Climate of the study area is characterized by high humidity throughout the year, a hot summer followed by well distributed and heavy rainfall during the southwest monsoon season. The winter season starts from December to February followed by summer from March to May. The southwest monsoon season is from June to September while October and November constitute the post monsoon season.

Past meteorological data of nearest IMD Observatory at Dahanu is considered to be deemed representative for the study area, has been collected for the period of 1981-2010 to establish the baseline climatic conditions of the study area. The key parameters of collected meteorological data have been summarized in **Table 3-14** below.

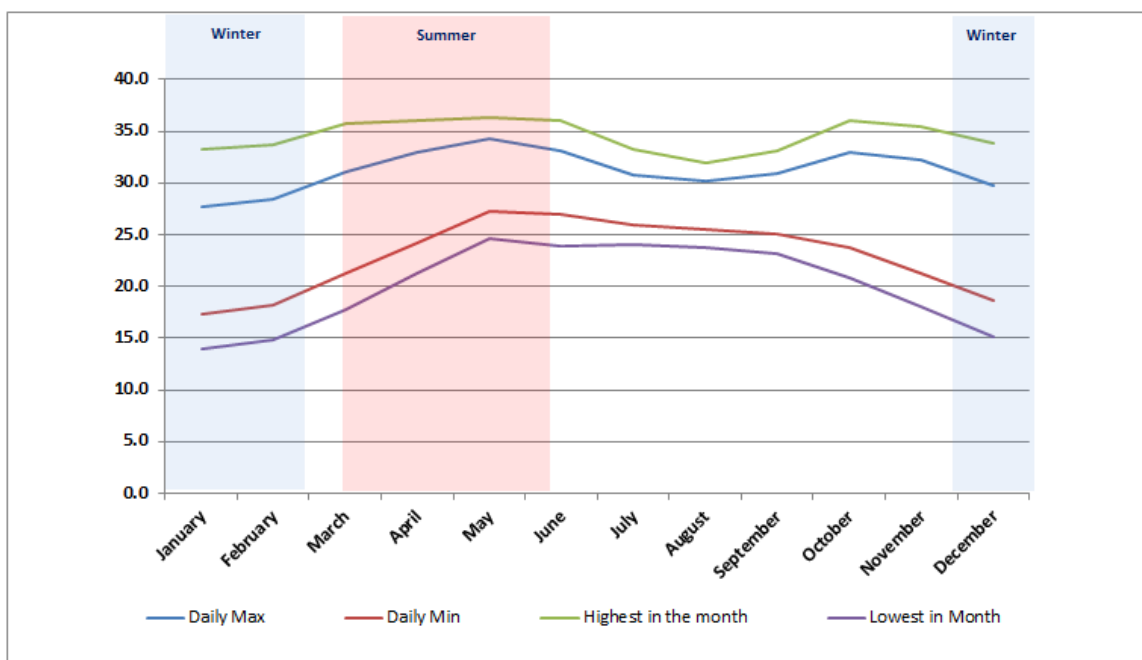
**Table 3- 14 Summaries of Climatological Data of the Study Area**

Parameter	IST	Monthly Range	Annual Total OR Mean
Mean Daily Maximum Temperature (°C)		27.7 (Jan) – 34.3 (May)	31.2
Mean Daily Minimum Temperature (°C)		17.3 (Jan) – 27.2 (May)	22.9
Relative Humidity (%)	0830	63 (Feb) – 88 (Jul)	73
	1730	62 (Mar) – 84 (Jul)	70
Total Rainfall (mm)		0.0 (Feb) – 650.7 (Jul)	1874.6
Wind Speed (km/h)		5.2 (Dec) – 16.6 (Jul)	9.4
Cloud Cover (Oktas of sky)	0830	0.9 (Jan) – 6.8 (Aug)	3.0
	1730	0.6 (Feb) - 6.6 (Jul)	2.7

Source: Climatological Data of Dahanu, Indian Meteorological Department (1981-2010)

**Temperature:** A tropical climate, characterized by typical monsoon, tropical hot summers and warm winters is observed in the study area. Past climatic data show that May is the hottest month with the mean daily maximum temperature around 34.4°C. With the onset of the monsoon in June, there is gradual decrease in day temperature but that of night temperature is remains almost same. January is recorded to be the coldest month with the mean daily minimum temperature of 17.3°C. The monthly ambient temperature profile in the study area is presented in **Figure 3-7**.

**Rainfall & Relative Humidity:** The normal annual rainfall in the study area ranges from 1900 mm to 2600 mm and mean annual rainfall during the year 1981 to 2010 is **1874.6 mm**. Historical data shows that heavy rains occur in the month of July due to SW monsoon. The southwest monsoon contributes around 96.5 percent of the annual rainfall. The northeast monsoon yields around 3.2 percent rainfall and the balance of around 0.3 percent results from the pre-monsoon and winter shower.



**Figure 3-7 Monthly Ambient Temperature Profile**

The average monthly rainfall, number of rainy days, mean wind speed and relative humidity at 08:30 hours and 17:30 hours are provided in **Table 3-15**.

**Table 3- 15 Monthly Rainfall, Wind Speed and Relative Humidity in the Study Area**

Months	Monthly Rainfall (mm)	No of Rainy Days	Mean Wind Speed (kmph)	Relative Humidity (%)	
				08:30 Hours	17:30 Hours
January	0.3	0.1	5.8	66	67
February	0.0	0.0	6.8	63	63
March	0.1	0.0	7.8	64	62
April	0.5	0.1	9.2	70	64
May	4.5	0.8	11.5	72	67
June	399.9	11.4	13.1	81	76
July	650.7	19.9	16.6	88	84
August	493.9	19.2	16.1	88	83
September	265.2	10.7	9.4	86	77
October	47.5	2.7	6	74	69
November	11.7	0.6	5.3	64	67
December	0.3	0.2	5.2	64	67
<b>Annual Total or Mean</b>	<b>1874.6</b>	<b>65.7</b>	<b>9.4</b>	<b>73</b>	<b>70</b>

Source: Climatological Data of Dahanu, Indian Meteorological Department (1981-2010)

The rainfall profile in the study area is presented in **Figure 3-8**.

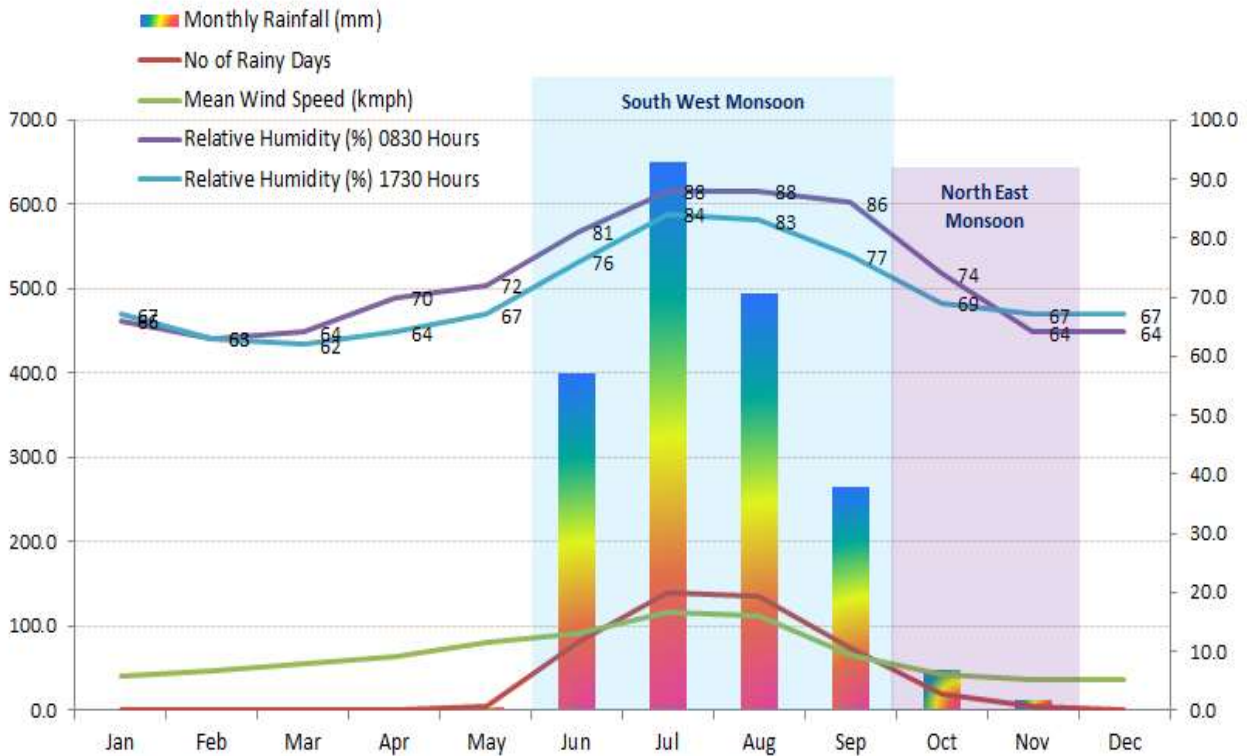


Figure 3-8 Monthly Rainfall, Rainy Days, Wind Speed and Relative Humidity of Dahanu IMD

**INDIA METEOROLOGICAL DEPARTMENT**  
**RMC MUMBAI**

**Rainfall % Departures from the Long Period Averages for Districts in MAHARASHTRA**

PERIOD : 01.06.2019 - 04.09.2019

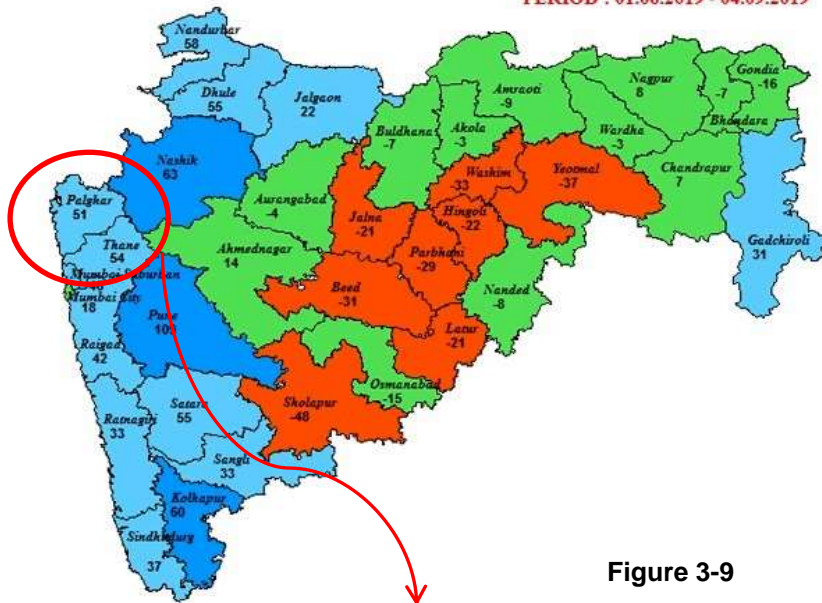


Figure 3-9

**LEGEND:** ■ L. EXCESS (+60% OR MORE) ■ EXCESS (+20% TO +59%) ■ NORMAL (+19% TO -19%)  
 ■ DEFICIENT (-20% TO -59%) ■ L. DEFICIENT (-60% TO -99%) ■ NO RAIN (-100%) ■ NO DATA

July and August are the wettest months with more than 19 rainy days on average and maximum relative humidity (88% in the morning to 83% in the evening). Mean annual humidity in the study area is 73% in the morning and 70% in the evening.

Since past few years Palghar district receives heavy rainfall, sometimes exceeding 300 mm within span of 12 hours. As per IMD records, during the period of 1<sup>st</sup> June to 4<sup>th</sup> September 2019 (monsoon season), the study area (Palghar district) receives 20% to 59% excess rainfall (Figure 3-9).

**Weather Extremes:** High summer temperature over 40°C occurs occasionally during the month of April to June. Highest temperature has been recorded to be 40.6°C in April 1955 and 40.4°C in May 2004. Thunder storms occur in June - July and also in September-October but dust storm and hails have not been recorded. Due to the geographical location, climatological conditions and other natural factors put western coast of Maharashtra under the moderately vulnerable category as far as cyclones are concerned<sup>1</sup>. However, the study area is vulnerable to floods. On an average, the study area received 0.3 mm or more rainfall in 91.6 days in a year. Occurrence of fog in winter is rare. **Table 3-16** shows the extreme weather data with bar projections denoting incremental frequency.

**Table 3- 16 Numbers of days with Extreme Weather Condition in the Study Area**

Months	Weather Phenomena					Visibility#				
	Rain more than 0.3 mm	Hail	Thunder	Fog	Dust Strom	Up to 1 km	1-4 km	4-10 km	10-20 km	Over 20 km
January	0.3	0.0	0.1	0.1	0.0	0-0	0.7-0	4.3-1.5	26-29.5	0-0
February	0.1	0.0	0.0	0.0	0.0	0-0	0.2-0	3-0.2	24.8-27.7	0-0.1
March	0.2	0.0	0.1	0.0	0.0	0-0	0-0	0.9-0.3	30.1-30.7	0-0
April	0.1	0.0	0.0	0.0	0.0	0-0	0-0	1.3-0.2	28.7-29.8	0-0
May	1.3	0.0	0.2	0.0	0.0	0-0	0-0	1.4-0.4	29.6-30.6	0-0
June	15.8	0.0	2.7	0.0	0.1	0-0	0.3-0.2	8-6.2	21.7-23.6	0-0
July	26.4	0.0	1.0	0.0	0.0	0-0	0.8-0.9	14.4-12.3	15.8-17.9	0-0
August	26.8	0.0	0.3	0.0	0.0	0-0	0.8-0.6	14.8-13.1	15.4-17.3	0-0
September	15.8	0.0	2.7	0.0	0.0	0-0	0.4-0.1	8.2-6.5	21.5-23.4	0-0
October	3.5	0.0	1.2	0.0	0.0	0-0	0.1-0	3-1.6	27.9-29.4	0-0
November	1	0.0	0.3	0.0	0.0	0-0	0.1-0	2.9-1.1	27-28.9	0-0
December	0.3	0.0	0.0	0.1	0.0	0-0	0.5-0.1	3.6-1.3	27-29.6	0-0
<b>Annual Total OR Mean</b>	<b>91.6</b>	<b>0.0</b>	<b>8.6</b>	<b>0.2</b>	<b>0.1</b>	<b>0-0</b>	<b>3.9-1.9</b>	<b>65.8-44.7</b>	<b>295.5-318.4</b>	<b>0-0.1</b>

Source: Climatological Data of Dahanu, Indian Meteorological Department (1981-2010)

# Hyphenated values refers to the visibility at 0830 hours and 1730 hours

### 3.9.2 On-site Meteorological Monitoring

An automatic weather station was established at Nagzari village for collection of meteorological data from 6<sup>th</sup> March 2017 to 31<sup>st</sup> May 2017 (summer season). M/s Anacon Laboratories Pvt. Ltd., Nagpur (A NABL Accredited laboratory) was engaged for collection of on-site meteorological data. The location details and meteorological monitoring parameters measured through the meteorological station are provided in **Table 3-17**.

**Table 3- 17 Location of Meteorological Station and Monitored Parameters**

Parameters	Frequency	Location	Latitude & Longitude
Hourly Wind Speed, Wind Direction, Relative Humidity, Temperature & Rainfall	Hourly data	Nagzari	19°46'47.9"N 72°51'01.0"E

Source: Field Survey during March to May 2017

<sup>1</sup> Maharashtra State Disaster Management Plan, April 2016



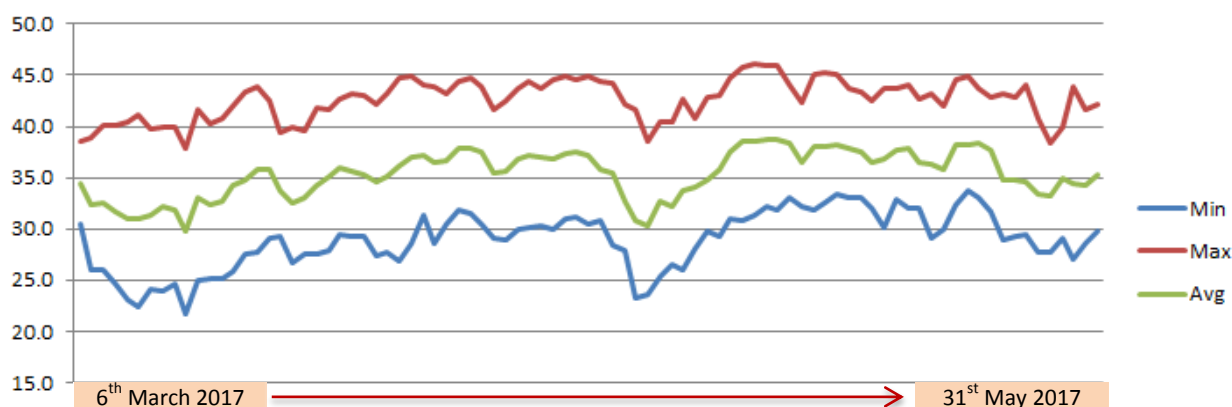
The weather station is equipped with sensors for temperature, relative humidity, wind speed, wind direction, atmospheric pressure, solar radiation and rain fall mounted on a tripod stand. The station consists of a weatherproof enclosure, which contains the data logger & power supply and having a solar panel. The data stored in a pocket-sized data shuttle from where the data downloaded in the computer. After downloading the data has been processed. The daily average of meteorological parameters like temperature, relative humidity, wind speed, wind direction and rain fall is presented in **Annex-3.5** and summarized in **Table 3-18**.

**Table 3- 18 Summary of Meteorological Data of the Study Area**

Parameters	Mar– May, 2017
Maximum Temperature (° C)	46.1
Minimum Temperature (° C)	21.6
Maximum Relative Humidity (%)	81.8
Minimum Relative Humidity (%)	5.41
Total Rainfall (mm)	27.4
Average Wind Speed (m/sec)	3.98
Calm condition (%)	0.63
Predominant wind direction (blowing from)	North West
Dry hours (%)	99.2%

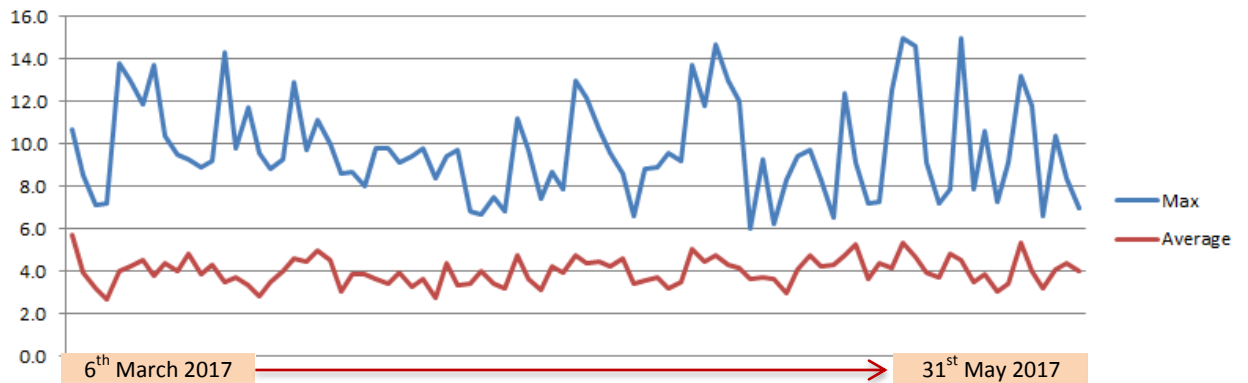
Source: On-site Monitoring during Dec15 to Jan16

**Meteorological Monitoring Results:** A maximum temperature of 46.1°C and minimum temperature of 21.6°C was observed during the monitoring period. Daily fluctuations in maximum and minimum temperature are presented graphically in **Figure 3-10**. The temperature during study period shows a consistent but limited uprising trend from early March to end of May.



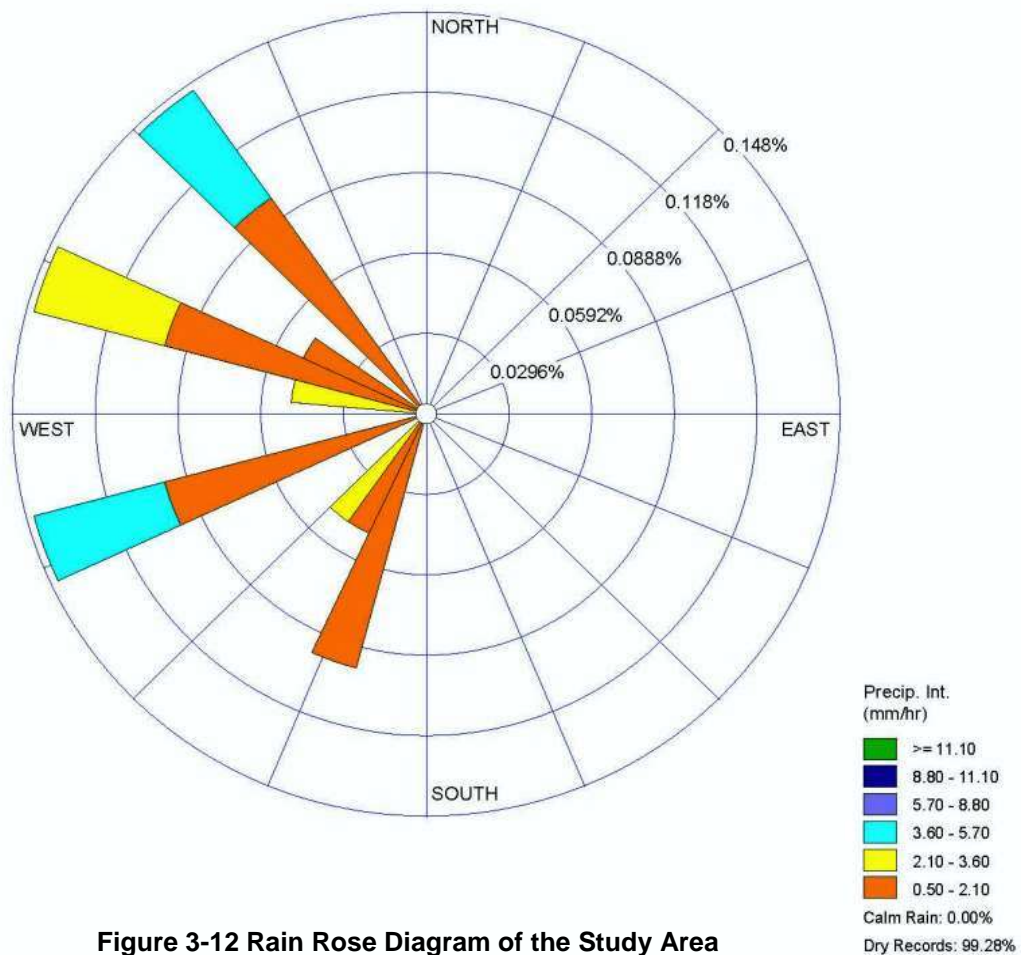
**Figure 3-10 Daily Fluctuations of Temperature in the Study Area**

Maximum wind speed monitored was found to be 15.0 m/sec while the average wind speed was 3.98 m/sec. The wind speeds show a consistent trend throughout monitoring period. Daily fluctuation of wind speed during the monitoring period is shown in **Figure 3-11**.

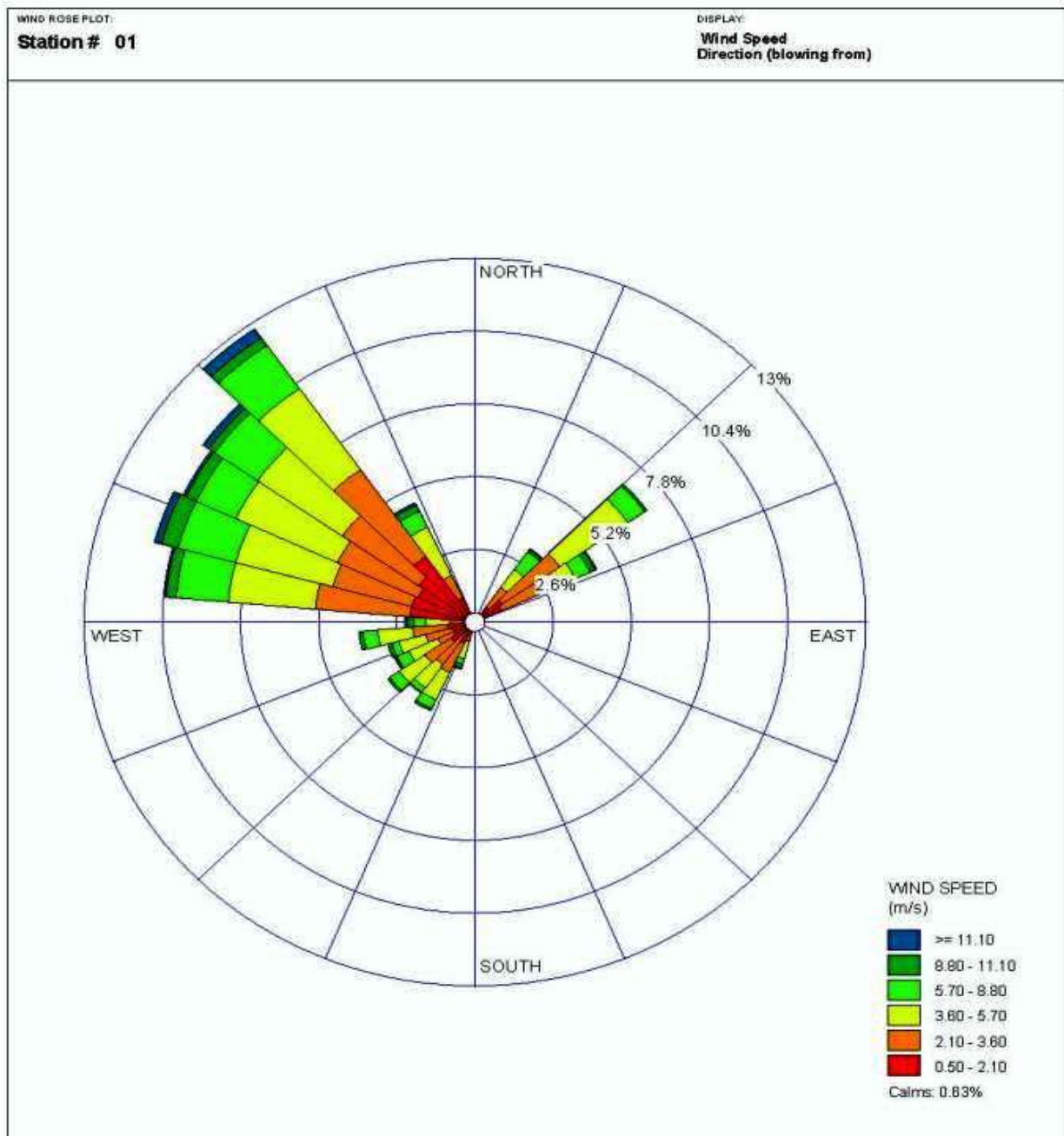


**Figure 3-11 Daily Fluctuation of Wind Speed in the Study Area**

Maximum Relative humidity during the monitoring period is found to be 81.4% while the average relative humidity was about 32%. The period was mostly dry with occasional rains totaling 27.4 mm. Rain rose and wind rose diagram of the study area are presented in **Figure 3-12** and **Figure 3-13** respectively. Predominant wind direction during the monitoring period is observed to be North West (blowing from).



**Figure 3-12 Rain Rose Diagram of the Study Area**



**Figure 3-13 Wind Rose Diagram of the Study Area**

<b>COMMENTS:</b> Data: Micro meteorological monitoring data at Project Site	<b>DATA PERIOD:</b> Start Date: 06-03-2017 - 00:00 End Date: 31-05-2017 - 17:00	<b>COMPANY NAME:</b> <b>Intercontinental Consultants and Technocrats Pvt Ltd</b>	
	<b>CALM WINDS:</b> 0.63%	<b>MODELER:</b> <b>Tirthankar Banerjee</b>	<b>PROJECT NO.:</b> <b>VME PHASE II</b>
	<b>AVG. WIND SPEED:</b> 3.98 m/s	<b>TOTAL COUNT:</b> 2070 hrs.	
		<b>DATE:</b> 11-10-2019	

WRPLOT.View - Lakes Environmental Software

### 3.10 AMBIENT AIR QUALITY

#### 3.10.1 Ambient Air Quality Monitoring Locations

M/s Anacon Laboratories Pvt. Ltd., Nagpur (A NABL Accredited laboratory) was engaged for ambient air quality monitoring. Five sampling stations were set up for monitoring ambient air quality within the study area. Monitoring locations were selected following the CPCB guidelines for ambient air quality monitoring so as to accord an overall idea of the ambient air quality scenario in the study area. Logistic considerations such as accessibility, security and availability of reliable power supply were also considered while finalizing the monitoring locations. Details of ambient air quality monitoring locations are given in **Table 3-19**.

**Table 3- 19 Details of Ambient Air Quality Monitoring Locations**

SN	Station Code	Location	Chainage	Side	Distance# (m)	Area category
1	AQ1	Khardi Village	29+000	RHS	231	Residential & Rural
2	AQ2	Pargaon Village	38+950	RHS	265	
3	AQ3	Kirat Village	62+800	LHS	240	
4	AQ4	Dhabon Village	70+900	LHS	90	
5	AQ5	Bharmanwadi Village (Parasapada)	92+000	LHS	500	

Source: On-site Field Monitoring during March to May 2017

# Distance in meter from proposed centerline

#### 3.10.2 Parameters Monitored & Monitoring Period

Monitoring was conducted in respect of the following parameters:

- Particulate matter of size less than 2.5 micron or PM<sub>2.5</sub>
- Particulate matter of size less than 10 micron or PM<sub>10</sub>
- Sulphur Dioxide (SO<sub>2</sub>)
- Nitrogen Dioxide (NO<sub>2</sub>)
- Carbon monoxide (CO)

Ambient air quality monitoring was conducted in pre-monsoon season (March to May 2017) at a frequency of twice a week at each station adopting a 24-hours schedule. CO has been measured 1-hourly.



#### 3.10.3 Monitoring Results

**Particulate Matter of Size less than 2.5 micron or PM<sub>2.5</sub>:** There is no major variation in PM<sub>2.5</sub> levels across the monitoring locations. The lowest concentration (14.7 µg/m<sup>3</sup>) was found at AQ-3 and AQ4 while highest concentration (23.8 µg/m<sup>3</sup>) was found at AQ1. The 98-percentile values of PM<sub>2.5</sub> across all stations was found to be 22.82 µg/m<sup>3</sup> which is within the stipulated limit of 60 µg/m<sup>3</sup> for Industrial, Residential, Rural & other areas as per National Ambient Air Quality Standards, 2009 (**Table 3-20**). Station wise

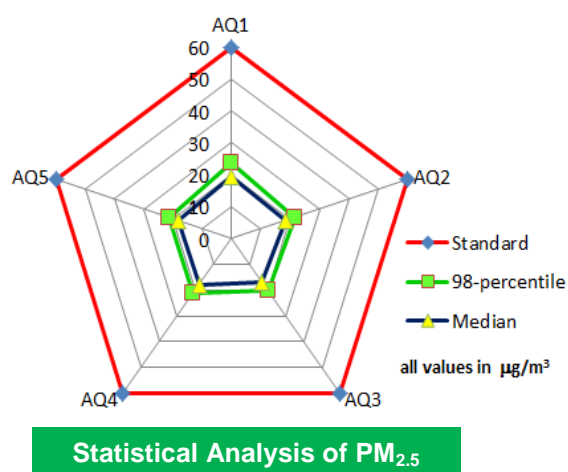
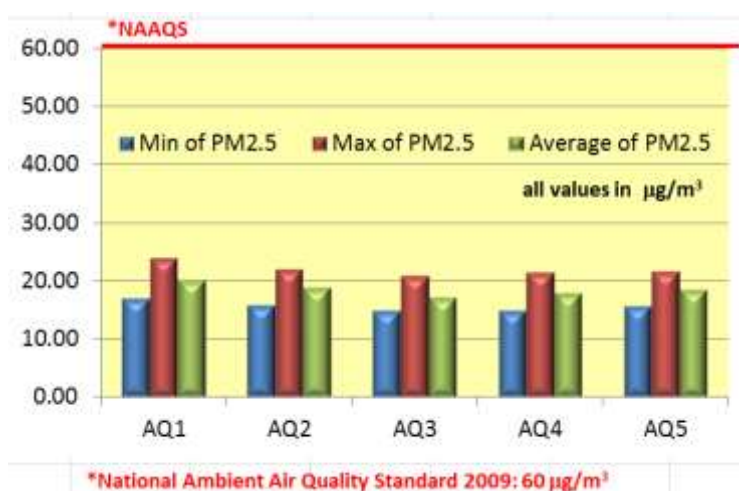


minimum, maximum and average values of PM<sub>2.5</sub> during the monitoring period are graphically presented below. The graph showing statistical analysis depicts the most occurring levels (median values), levels within 98% of measured time as well as stipulated standards for comparative typecasting.

**Table 3- 20 Summary of PM<sub>2.5</sub> levels in Study Area**

Station Code	Station Location	PM <sub>2.5</sub> (µg/m <sup>3</sup> )				
		Minimum	Maximum	Median	98%	NAAQS
AQ1	Khardi village	16.80	23.80	19.6	23.57	60
AQ2	Pargaon village	15.70	21.80	18.3	21.70	
AQ3	Kirat Village	14.70	20.70	16.8	20.32	
AQ4	Dhabon Village	14.70	21.30	17.7	21.20	
AQ5	Bharmanwadi Village	15.50	21.50	18.0	21.40	
<b>Overall of 5 locations</b>		<b>14.70</b>	<b>23.80</b>	<b>18</b>	<b>22.82</b>	

Source: On-site Field Monitoring during March to May 2017



**Particulate Matter of Size less than 10 micron or PM<sub>10</sub>:** Minor variation is observed in PM<sub>10</sub> levels across the monitoring locations. The lowest concentration (42.6 µg/m<sup>3</sup>) was found at AQ-3 while highest concentration (62.9 µg/m<sup>3</sup>) was found at AQ1. The 98-percentile values of PM<sub>10</sub> across all stations was found to be 60.17 µg/m<sup>3</sup> which is within the stipulated limit of 100 µg/m<sup>3</sup> for Industrial, Residential, Rural & other areas as per National Ambient Air Quality Standards, 2009 (Table 3-21).

**Table 3- 21 Summary of PM<sub>10</sub> levels in Study Area**

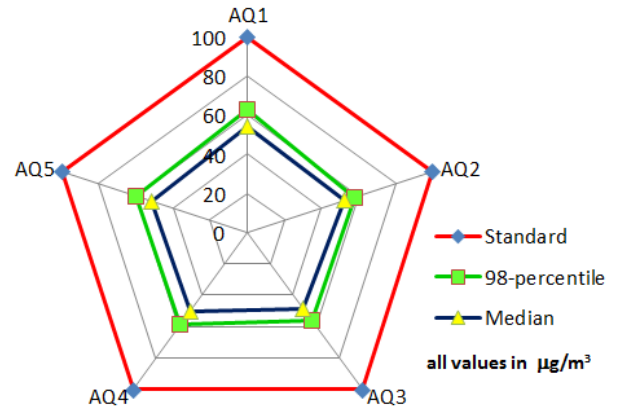
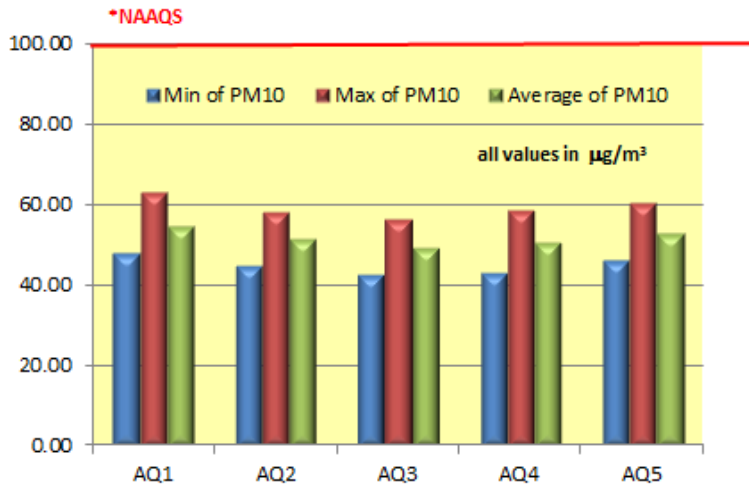
Station Code	Station Location	PM <sub>10</sub> (µg/m <sup>3</sup> )				
		Minimum	Maximum	Median	98%	NAAQS
AQ1	Khardi village	47.80	<b>62.90</b>	54.4	62.62	100
AQ2	Pargaon village	44.80	58.20	52.2	57.96	
AQ3	Kirat Village	<b>42.60</b>	56.40	48.7	56.35	
AQ4	Dhabon Village	43.10	58.50	50.2	58.26	
AQ5	Bharmanwadi Village	46.30	60.40	51.7	60.16	
<b>Overall of 5 locations</b>		<b>42.60</b>	<b>62.90</b>	<b>51.55</b>	<b>60.17</b>	

Source: On-site Field Monitoring during March to May 2017

Station wise minimum, maximum and average values of PM<sub>10</sub> during the monitoring period are graphically presented below. The graph showing statistical analysis depicts

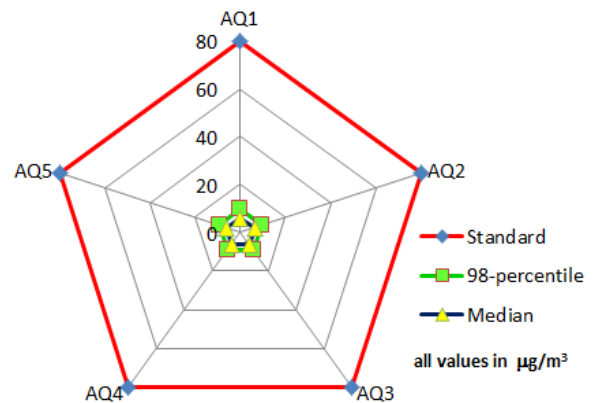
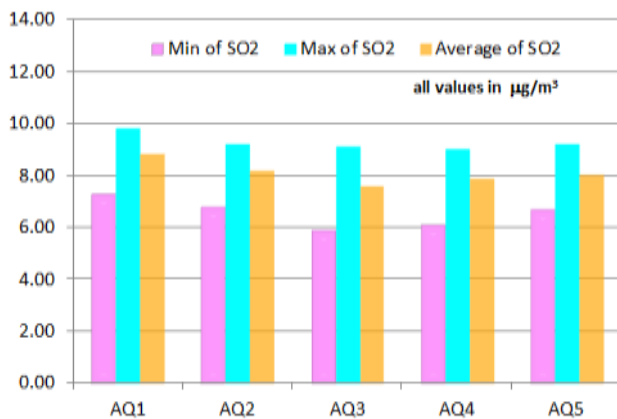


the most occurring levels (median values), levels within 98% of measured time as well as stipulated standards for comparative typecasting.



Statistical Analysis of PM<sub>10</sub>

**Sulphur Dioxide (SO<sub>2</sub>):** The lowest concentration (5.9 µg/m<sup>3</sup>) was found at AQ-3 while highest concentration (9.8 µg/m<sup>3</sup>) was observed at AQ1. The 98-percentile values of SO<sub>2</sub> across all station was found to be 9.80 µg/m<sup>3</sup> which is within the stipulated limit of 80 µg/m<sup>3</sup> for Industrial, Residential, Rural & other areas as per National Ambient Air Quality Standards, 2009 (Table 3-22). The minimum, maximum and average values of SO<sub>2</sub> during the monitoring period are graphically presented below. The graph showing statistical analysis depicts the most occurring levels (median values), levels within 98% of measured time as well as stipulated standards for comparative typecasting.



Statistical Analysis of SO<sub>2</sub>

**Table 3- 22 Summary of SO<sub>2</sub> levels in Study Area**

Station Code	Station Location	SO <sub>2</sub> (µg/m <sup>3</sup> )				NAAQS
		Minimum	Maximum	Median	98%	
AQ1	Khardi village	7.30	<b>9.80</b>	8.85	9.80	80
AQ2	Pargaon village	6.80	9.20	8.2	9.67	
AQ3	Kirat Village	<b>5.90</b>	9.10	7.6	9.28	
AQ4	Dhabon Village	6.10	9.00	8	9.18	

Station Code	Station Location	SO <sub>2</sub> (µg/m <sup>3</sup> )				
		Minimum	Maximum	Median	98%	NAAQS
AQ5	Bharmanwadi Village	6.70	9.20	8.1	9.18	
<b>Overall of 5 locations</b>		<b>5.90</b>	<b>9.80</b>	<b>8.2</b>	<b>9.80</b>	

Source: On-site Field Monitoring during March to May 2017

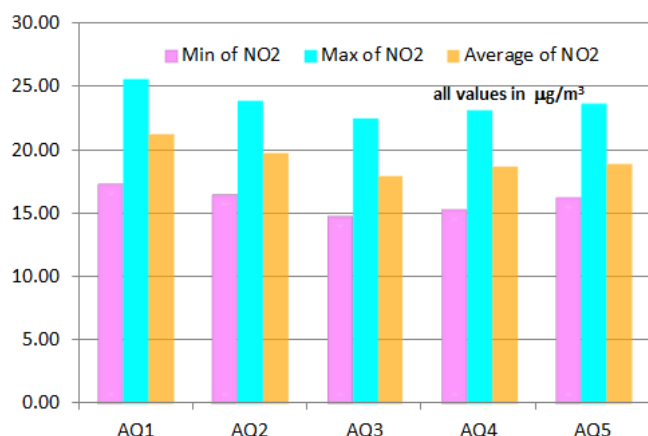
**Nitrogen Dioxide (NO<sub>2</sub>):** The lowest concentration (14.80 µg/m<sup>3</sup>) was found at AQ-3 while highest concentration (25.60 µg/m<sup>3</sup>) was observed at AQ1. The 98-percentile values of NO<sub>2</sub> across all stations were found to be 23.81 µg/m<sup>3</sup> which is within the stipulated limit of 100 µg/m<sup>3</sup> for Industrial, Residential, Rural & other areas as per National Ambient Air Quality Standards, 2009 (Table 3-23).

**Table 3- 23 Summary of NO<sub>2</sub> levels in Study Area**

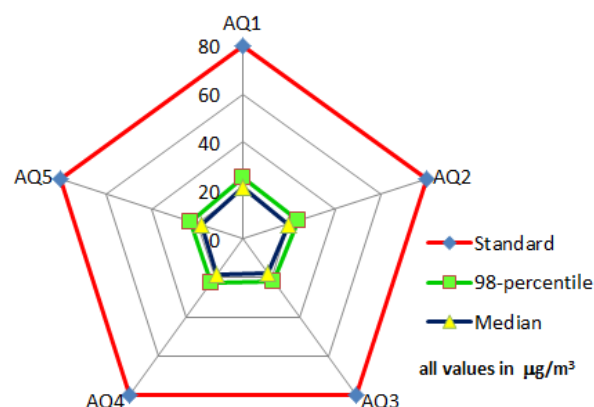
Station Code	Station Location	NO <sub>2</sub> (µg/m <sup>3</sup> )				
		Minimum	Maximum	Median	98%	NAAQS
AQ1	Khardi village	17.30	25.60	21.2	25.28	80
AQ2	Pargaon village	16.40	23.90	19.5	23.80	
AQ3	Kirat Village	14.80	22.50	17.4	21.68	
AQ4	Dhabon Village	15.30	23.10	18.4	22.28	
AQ5	Bharmanwadi Village	16.20	23.60	18.5	22.78	
<b>Overall of 5 locations</b>		<b>14.80</b>	<b>25.60</b>	<b>19.15</b>	<b>23.81</b>	

Source: On-site Field Monitoring during March to May 2017

The minimum, maximum and average values of NO<sub>2</sub> during the monitoring period are graphically presented below. The graph showing statistical analysis depicts the most occurring levels (median values), levels within 98% of measured time as well as stipulated standards for comparative typecasting.



National Ambient Air Quality Standard 2009: 80 µg/m<sup>3</sup>



**Statistical Analysis of NO<sub>2</sub>**

**Carbon monoxide (CO):** The lowest concentration (0.19 mg/m<sup>3</sup>) was found at AQ-4 while highest concentration (0.32 mg/m<sup>3</sup>) was observed at AQ1 and AQ-5.

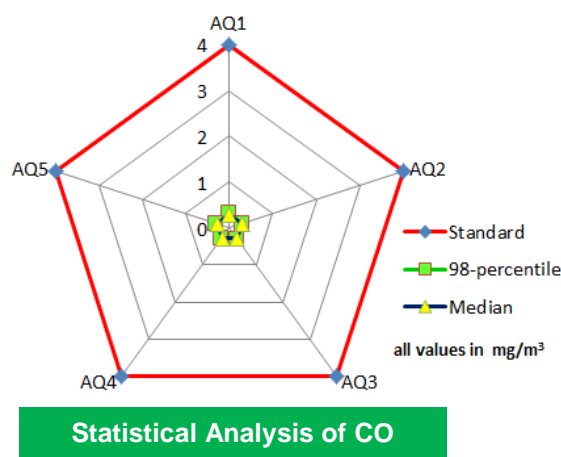
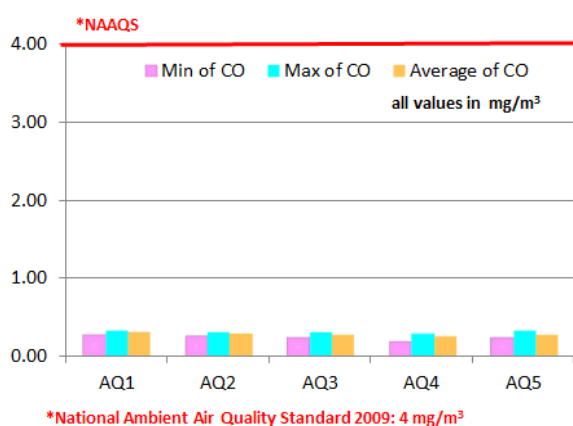
**Table 3- 24 Summary of CO levels in Study Area**

Station Code	Station Location	CO (mg/m <sup>3</sup> )				
		Minimum	Maximum	Median	98%	NAAQS
AQ1	Khardi village	0.27	0.32	0.3025	0.32	4
AQ2	Pargaon village	0.25	0.31	0.294	0.31	

Station Code	Station Location	CO (mg/m <sup>3</sup> )				
		Minimum	Maximum	Median	98%	NAAQS
AQ3	Kirat Village	0.25	0.30	0.273	0.30	
AQ4	Dhabon Village	0.19	0.29	0.265	0.29	
AQ5	Bharmanwadi Village	0.24	0.32	0.279	0.31	
<b>Overall of 5 locations</b>		<b>0.19</b>	<b>0.32</b>	<b>0.282</b>	<b>0.32</b>	

Source: On-site Field Monitoring during March to May 2017

The 98-percentile values of CO across all stations was found to be 0.32 mg/m<sup>3</sup> which is within the stipulated limit of 4 mg/m<sup>3</sup> for Industrial, Residential, Rural & other areas as per National Ambient Air Quality Standards, 2009 (**Table 3-24**). The minimum, maximum and average values of CO during the monitoring period are graphically presented below. The graph showing statistical analysis depicts the most occurring levels (median values), levels within 98% of measured time as well as stipulated standards for comparative typecasting.



Monitoring station-wise as well as overall statistical analysis comprising of minimum, maximum, arithmetic mean, median, standard deviation and 98-percentile of the ambient air quality data are shown in **Table 3-25**. Arithmetic mean of the 24-hourly average values have been calculated to show the average levels of various parameters in ambient air, while the median values represents the most occurring levels of a particular parameter during the monitoring period.

**Table 3- 25 Statistical Analysis of Ambient Air Quality in the Study Area**

Pollutant	AAQMS	Location	Mes	Min	Max	AM	MD	SD	p98	PTV
PM <sub>2.5</sub> (µg/m <sup>3</sup> )	AQ1	Khardi village	24	16.80	23.80	19.95	19.6	1.86	23.57	0
	AQ2	Pargaon village	25	15.70	21.80	18.60	18.3	1.63	21.70	0
	AQ3	Kirat Village	25	14.70	20.70	17.08	16.8	1.52	20.32	0
	AQ4	Dhabon Village	25	14.70	21.30	17.72	17.7	1.66	21.20	0
	AQ5	Bharmanwadi Village	25	15.50	21.50	18.24	18	1.47	21.40	0
<b>Overall 5 Locations</b>			<b>124</b>	<b>14.70</b>	<b>23.80</b>	<b>18.31</b>	<b>18</b>	<b>1.89</b>	<b>22.82</b>	<b>0</b>
PM <sub>10</sub> (µg/m <sup>3</sup> )	AQ1	Khardi village	24	47.80	62.90	54.72	54.4	3.85	62.62	0
	AQ2	Pargaon village	25	44.80	58.20	51.68	52.2	3.31	57.96	0

Pollutant	AAQMS	Location	Mes	Min	Max	AM	MD	SD	p98	PTV
	AQ3	Kirat Village	25	42.60	56.40	49.34	48.7	3.22	56.35	0
	AQ4	Dhabon Village	25	43.10	58.50	50.55	50.2	3.72	58.26	0
	AQ5	Bharmanwadi Village	25	46.30	60.40	52.58	51.7	3.57	60.16	0
<b>Overall 5 Locations</b>			<b>124</b>	<b>42.60</b>	<b>62.90</b>	<b>51.75</b>	<b>51.55</b>	<b>3.98</b>	<b>60.17</b>	<b>0</b>
SO <sub>2</sub> (µg/m <sup>3</sup> )	AQ1	Khardi village	24	7.30	9.80	8.83	8.85	0.60	9.80	0
	AQ2	Pargaon village	25	6.80	9.20	8.19	8.2	0.74	9.67	0
	AQ3	Kirat Village	25	5.90	9.10	7.58	7.6	0.54	9.28	0
	AQ4	Dhabon Village	25	6.10	9.00	7.87	8	0.70	9.18	0
	AQ5	Bharmanwadi Village	25	6.70	9.20	8.04	8.1	0.69	9.18	0
<b>Overall 5 Locations</b>			<b>124</b>	<b>5.90</b>	<b>9.80</b>	<b>8.10</b>	<b>8.2</b>	<b>0.68</b>	<b>9.80</b>	<b>0</b>
NO <sub>x</sub> (µg/m <sup>3</sup> )	AQ1	Khardi village	24	17.30	25.60	21.19	21.2	2.31	25.28	0
	AQ2	Pargaon village	25	16.40	23.90	19.78	19.5	2.17	23.80	0
	AQ3	Kirat Village	25	14.80	22.50	17.97	17.4	1.98	21.68	0
	AQ4	Dhabon Village	25	15.30	23.10	18.68	18.4	2.01	22.28	0
	AQ5	Bharmanwadi Village	25	16.20	23.60	18.92	18.5	2.12	22.78	0
<b>Overall 5 Locations</b>			<b>124</b>	<b>14.80</b>	<b>25.60</b>	<b>19.29</b>	<b>19.15</b>	<b>2.39</b>	<b>23.81</b>	<b>0</b>
CO (mg/m <sup>3</sup> )	AQ1	Khardi village	24	0.27	0.32	0.30	0.30	0.02	0.32	0
	AQ2	Pargaon village	25	0.25	0.31	0.29	0.29	0.01	0.31	0
	AQ3	Kirat Village	25	0.25	0.30	0.27	0.27	0.02	0.30	0
	AQ4	Dhabon Village	25	0.19	0.29	0.26	0.27	0.03	0.29	0
	AQ5	Bharmanwadi Village	25	0.24	0.32	0.28	0.28	0.02	0.31	0
<b>Overall 5 Locations</b>			<b>124</b>	<b>0.19</b>	<b>0.32</b>	<b>0.28</b>	<b>0.28</b>	<b>0.02</b>	<b>0.32</b>	<b>0</b>

Source: On-site Field Monitoring during March to May 2017

Note: AAQMS: Ambient Air Quality Monitoring Station Code, Mes: Number of Measurements, Min: Minimum; Max: Maximum, AM: Arithmetic Mean; MD: Median; SD: Standard Deviation, p98: 98-Percentile Value, PTV: Percent time violation with respect to the Indian standards

As evident from **Table 3-25** and the discussion above, the ambient air quality at the monitored locations does not exceeds National Standards and well within the limits. No industrial sources of air emission are observed along the proposed alignment of the expressway.

**Indian Air Quality Index (IND - AQI):** An AQI scheme transforms weighted values of individual air pollutant concentrations into a

Breakpoints for AQI Scale 0-500					
AQI Category (Range)	PM10 24-hr (µg/m <sup>3</sup> )	PM2.5 24-hr (µg/m <sup>3</sup> )	NO <sub>2</sub> 24-hr (µg/m <sup>3</sup> )	SO <sub>2</sub> 24-hr (µg/m <sup>3</sup> )	CO 8-hr (mg/m <sup>3</sup> )
Good	0-50	0-30	0-40	0-40	0-1.0
Satisfactory	51-100	31-60	41-80	41-80	1.1-2.0
Moderately polluted	101-250	61-90	81-180	81-380	2.1-10
Poor	251-350	91-120	181-280	381-800	10-17
Very poor	351-430	121-250	281-400	801-1600	17-34
Severe	430+	250+	400+	1600+	34+

Source: National Air Quality Index, 2015 by CPCB, MoEF&CC

single number or set of numbers. AQI is a number used by government agencies to communicate to the public how polluted the air currently is or how polluted it is forecast to become. There are six AQI categories, namely Good, Satisfactory, Moderately Polluted, Poor, Very Poor, and Severe. The AQI considered various pollutants for which short-term (up to 24-hourly averaging period) National Ambient Air Quality Standards are prescribed. Based on the measured ambient concentrations, corresponding standards and likely health impact, a sub-index is calculated for each of these pollutants. The worst sub-index reflects overall AQI.

**AQI of the Study Area:** Air quality data of the study area generated through manual monitoring network has been utilized to calculate the monitoring date wise AQI of the study area and presented in **Table 3-26**.

**Table 3-26 Air Quality Index (AQI) of the Study Area**

Khardi (AQ1)		Pargaon (AQ2)		Kirat (AQ3)		Dhabon (AQ4)		Bharmanwadi (AQ5)	
Date	AQI	Date	AQI	Date	AQI	Date	AQI	Date	AQI
06.03.2017	59	06.03.2017	55	06.03.2017	53	06.03.2017	55	06.03.2017	57
09.03.2017	63	09.03.2017	58	09.03.2017	56	09.03.2017	59	09.03.2017	60
14.03.2017	52	14.03.2017	48	14.03.2017	49	14.03.2017	48	14.03.2017	50
17.03.2017	57	17.03.2017	53	17.03.2017	51	17.03.2017	53	17.03.2017	55
22.03.2017	53	22.03.2017	49	22.03.2017	47	20.03.2017	49	21.03.2017	51
25.03.2017	59	25.03.2017	55	25.03.2017	53	24.03.2017	55	24.03.2017	57
30.03.2017	58	30.03.2017	53	30.03.2017	52	27.03.2017	54	27.03.2017	55
02.04.2017	62	02.04.2017	58	02.04.2017	56	31.03.2017	58	31.03.2017	60
05.04.2017	54	05.04.2017	50	05.04.2017	47	04.04.2017	50	04.04.2017	52
08.04.2017	56	08.04.2017	52	08.04.2017	50	07.04.2017	53	07.04.2017	54
11.04.2017	53	11.04.2017	49	11.04.2017	46	12.04.2017	49	12.04.2017	51
14.04.2017	54	14.04.2017	50	14.04.2017	47	15.04.2017	50	15.04.2017	52
17.04.2017	56	17.04.2017	52	17.04.2017	50	19.04.2017	53	19.04.2017	54
20.04.2017	48	20.04.2017	45	20.04.2017	43	22.04.2017	45	22.04.2017	47
25.04.2017	53	25.04.2017	49	25.04.2017	47	26.04.2017	49	26.04.2017	51
28.04.2017	51	28.04.2017	47	28.04.2017	45	29.04.2017	48	29.04.2017	49
03.05.2017	55	03.05.2017	51	03.05.2017	49	02.05.2017	51	02.05.2017	53
07.05.2017	54	07.05.2017	50	07.05.2017	47	05.05.2017	50	05.05.2017	52
10.05.2017	57	10.05.2017	53	10.05.2017	50	09.05.2017	53	09.05.2017	55
13.05.2017	48	13.05.2017	55	13.05.2017	46	12.05.2017	46	12.05.2017	48
18.05.2017	51	18.05.2017	56	18.05.2017	49	15.05.2017	48	15.05.2017	46
24.05.2017	56	21.05.2017	48	21.05.2017	51	19.05.2017	47	19.05.2017	52
27.05.2017	55	24.05.2017	55	24.05.2017	48	23.05.2017	43	23.05.2017	49
31.05.2017	49	27.05.2017	53	27.05.2017	49	26.05.2017	47	26.05.2017	53
		31.05.2017	49	31.05.2017	53	30.05.2017	51	30.05.2017	55

From the above interpretation of AQI, it can be concluded that **60% time** of the monitoring period air quality of the area was **satisfactory** while **40% time** of the monitoring period air quality of the area was **good**.



### 3.11 AMBIENT NOISE LEVEL

#### 3.11.1 Noise Monitoring Stations

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

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

M/s Anacon Laboratories Pvt. Ltd., Nagpur (A NABL Accredited laboratory) was engaged for ambient noise monitoring. The locations of the ambient noise level monitoring stations in the study area are given in **Table 3-27**.

**Table 3- 27 Details of Noise Monitoring Locations**

SN	Station Code	Location	Chainage	Side	Distance# (m)	Area Category
1	NQ1	Khardi Village	29+000	RHS	231	Residential
2	NQ2	Pargaon Village	38+950	RHS	265	
3	NQ3	Kirat Village	62+800	LHS	240	
4	NQ4	Dhabon Village	70+900	LHS	90	
5	NQ5	Bharmanwadi Village (Parasapada)	92+000	LHS	500	

Source: On-site Field Monitoring during March to May 2017

# Distance in meter from proposed centerline

#### 3.11.2 Methodology of Noise Monitoring

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

A-weighted equivalent continuous sound pressure level (Leq) values were computed from the values of A-weighted SPL measured with the noise meter. Noise measurement was conducted as per IS:4954 as adopted by CPCB. Ambient noise level monitoring was carried out during May 2017.

#### 3.11.3 Ambient Noise Levels in the Study Area

The ambient noise levels of the study area are presented in **Table 3-28**. The green marks in the table indicates the corresponding values are within the respective standards of residential or silence zones, while the higher values have been flagged by red indicators.

**Table 3- 28 Ambient Noise Levels of the Study Area**

Zone	Station	L <sub>d10</sub>	L <sub>d90</sub>	L <sub>deq</sub>	L <sub>n10</sub>	L <sub>n90</sub>	L <sub>neq</sub>	L <sub>dn</sub>	L <sub>eq(24)</sub>	L <sub>Min</sub>	L <sub>Max</sub>
Residential	NQ1	64.5	57.1	57.5	56.1	49.0	48.5	58.1	56.0	40.0	83.9
Residential	NQ2	67.0	56.9	57.8	56.3	49.2	48.7	58.2	56.3	39.2	84.5
Residential	NQ3	43.1	39.9	39.7	37.1	36.8	36.4	43.8	39.1	35.2	48.0
Residential	NQ4	44.2	40.5	40.3	41.2	38.5	38.6	45.3	39.8	31.4	74.5
Residential	NQ5	58.6	50.2	50.8	41.1	39.1	38.8	50.4	49.2	35.2	76.0

Source: On-site Noise Monitoring during April 2017

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

Noise Standard in Silence Zone : Day Time: 50 dB(A) Night Time: 40 dB(A)

Day time is reckoned from 6 A.M to 10 P.M

Night time is reckoned from 10 P.M to 6 A.M.

The daytime and night time equivalent noise levels show that the ambient noise levels are exceed the stipulated noise standards in residential area except NQ5. However, the equivalent levels are close to stipulated limits during both day and night hours. Highest equivalent noise level during day time [57.8 dB(A)] and during night time [48.7 dB(A)] is observed at Pargaon village (NQ2).

L<sub>d10</sub> and L<sub>n10</sub> values indicate that measured noise levels exceeded the stipulated standards in 10% of the time of measurement duration at all monitoring locations except NQ3. It has been calculated that noise levels remained below the stipulated limits at about 60% of the measurement time across various monitoring stations. This signifies that the noise levels in the study area are at threshold limit. This is further established by the L<sub>d90</sub> values of the study area, which varied between 39.9-57.1 dB(A) and L<sub>n90</sub> values of the study area remained between 36.8-49.2 dB(A); signifying moderately high equivalent levels of background noise.

The day-night average sound level (L<sub>dn</sub>) in the study area is found to be in the range of 43.8-58.2 dB(A), which is the weighted average noise level over a 24-hour period that accounts increased annoyance to noise during night hours. In absence of any stipulated limits, the values may be compared with the Federal Aviation Administration guidelines, which considers 65 dB(A) as the threshold level for residential communities and envisages that further increase in noise level are eligible for noise control measures.

The measured and calculated values of the study area indicate that ambient noise levels slightly exceed the threshold limits. As the proposed expressway is non-existent as on date; it can be inferred that such noise levels originate from local activities i.e. "without project scenario", which may escalate during the operation stage i.e. "with project scenario".

### 3.12 SURFACE WATER

#### 3.12.1 Surface Water Quality of the Study Area<sup>2</sup>

Surface water quality of the study area has been established based on **secondary data**.

Maharashtra Pollution Control Board (MPCB), being the state nodal agency under CPCB, regularly monitors the water quality across 294 water quality monitoring stations (WQMS) for both surface and ground water under two programs of NWMP (National Water Quality Monitoring Program) and SWMP (State Water Quality Monitoring Program) in the State of Maharashtra. Surface water samples are monitored once every month whereas the ground water samples are monitored bi-annually.

Four parameters namely pH, Dissolved Oxygen, Biochemical Oxygen Demand and Faecal Coliform are used by the MPCB for calculating the WQI for surface water. Upon determining the WQI, the water quality is described for easy understanding and interpretation as shown in **Table 3-29**.

**Table 3- 29 Classification of Water Quality for Surface Water**

Water Quality Index – Surface Water			
WQI	Quality Classification	Remarks	Colour Code
63 – 100	Good to Excellent	Non-Polluted	
50 – 63	Medium to Good	Non-Polluted	
38 – 50	Bad	Polluted	
38 and less	Bad to Very Bad	Heavily Polluted	

Source: [http://www.mpcb.gov.in/envtdata/Ebulletin\\_pdf/E\\_bulletin\\_Oct2016.pdf](http://www.mpcb.gov.in/envtdata/Ebulletin_pdf/E_bulletin_Oct2016.pdf)

During the year 2017-18, MPCB carried out surface water quality monitoring at about 228 stations located on various rivers, sea, creek and nallahs in the State of Maharashtra. out of which, few stations have been selected to establish the surface water quality of the study area (**Table 3-30**).

**Table 3- 30 Surface Water Quality Monitoring Stations at West Flowing Rivers, Creek & Nallahs**

Station ID	Type	Station Name	Village	Taluka
1092	West Flowing Rivers	Kalu at Atale village	Atale	Kalyan
1093		Ulhas at U / s of NRC Bund	Mohane	Kalyan
2696		Pelhar dam	Pelhar	Vasai
2707		Surya at MIDC pumping station	Garvashet	Palghar
2785	Nallahs	BPT Navapur	Navapur	Palghar
2786		Tarapur MIDC nallah near sump no. 1	Palghar	Palghar
2787		Tarapur MIDC nallah	Palghar	Palghar
2788		Tarapur MIDC nallah near sump no. III	Palghar	Palghar

<sup>2</sup> Water Quality Status of Maharashtra 2017-2018 (Compilation of Water Quality Data Recorded by MPCB), Jan 2019

Station ID	Type	Station Name	Village	Taluka
2798	Creek	Kharekuran Murbe Creek	Kharekuran	Palghar
2799		Dandi Creek	Dandi	Palghar
2801		Savta Creek	Savta	Dahanu
2802		Dahanu Creek at Dahanu Fort	Danugaon	Dahanu

Source: Water Quality Status of Maharashtra 2017-2018, Maharashtra Pollution Control Board

Being a coastal state, Maharashtra has a coast line of about 720 km. The proposed expressway is located in Palghar, a coastal district of Maharashtra. The rivers of the study area are west flowing rivers originating from Western Ghats and joins Arabian Sea at the end. Unlike East flowing rivers, these rivers do not form deltas, but only estuaries. These Rivers are important source of drinking water, agricultural and industrial applications in the study area. Apart from rivers, there are several creeks and nallahs in the study area. Water Quality Index of selected WQMS is presented in **Table 3-31**.

**Table 3- 31 Water Quality Index of Selected WQMS (Coastal Basin)**

Month	West Flowing Rivers				Nallahs				Creeks			
Apr	69	66	69	71	22				50	50	47	48
May	65	76	70	75	20				48	46	48	48
Jun	No data	73	77	No data	20				40	56	No data	48
Jul	64	76	73	71	21	21	23		54	51	49	62
Aug	69	74	75	77	21	21	21	22	55	53	52	50
Sep	64	77	76	70	22	19	21	20	51	49	55	49
Oct	75	73	75	74	23				48	45	57	49
Nov	62	71	75	70	20				48	46	54	53
Dec	43	75	75	72	14				51	46	48	44
Jan	45	71	69	71	21				49	49	53	58
Feb	47	76	72	71	18				45	46	54	54
Mar	56	75	73	73	22				45	48	50	51
<b>Station ID</b>	<b>1092</b>	<b>1093</b>	<b>2696</b>	<b>2707</b>	<b>2785</b>	<b>2786</b>	<b>2787</b>	<b>2788</b>	<b>2798</b>	<b>2799</b>	<b>2801</b>	<b>2802</b>

**Legend**

Good to Excellent	Medium to Good	Bad	Bad to Very Bad	No data
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Source: Water Quality Status of Maharashtra 2017-2018, Maharashtra Pollution Control Board

The results showed that the annual average WQI of rivers in the study area were in good to excellent category, nallahs were in bad to very bad category and creeks were recorded under bad category followed by medium to good category. There are huge human settlements and industrial establishments around the creeks in Palghar district. The high level of pollution in creeks and nallahs throughout the year may be attributed to the release of untreated or semi treated sewage directly into the creek water (**Table 3-32**).

**Table 3- 32 Status of Sewage Treatment in the Study Area**

Name	District	Sewage / Effluent generated MLD	Sewage Effluent Treated MLD	% Treatment	Disposal
Vasai-Virar City Municipal Corporation	Palghar	105	0	0.0%	Creek
Dahanu Municipal Council		4	0	0.0%	Nallah / Creek
Palghar Municipal Council		2.4	0	0.0%	

Source: Water Quality Status of Maharashtra 2017-2018, Maharashtra Pollution Control Board

### 3.12.2 Surface Water Sampling Locations

Surface water bodies are important in local context and therefore, their water quality needs to be monitored to assess the impacts of the project. M/s Anacon Laboratories Pvt. Ltd., Nagpur (A NABL Accredited laboratory) was engaged for collection of surface water samples and analysis. For generating data on surface water quality parameters and drawing up the baseline scenario, **8 surface water quality monitoring** stations were selected for sampling. Details of the location of Surface Water Quality Stations are provided in **Table 3-33**.

**Table 3- 33 Details of Surface Water Sampling Locations**

Station Code	Description	Chainage	Village	Side	Distance# (m)
SW1	Vaitarna River	31+400	Vedhi Village	RHS	100
SW2		35+700	Penand Village	LHS	160
SW3		45+040	Khamloli Village	LHS	115
SW4	Surya River	68+400	Dhabon Village	RHS	175
SW5	Canal	76+037	Chandwad Village	LHS	113
SW6	Jogani Nadi	89+600	Chinchale Village	RHS	100
SW7	Vadvali River	96+200	Vadavali Village	RHS	30
SW8	Pond	103+400	Talasari Village	LHS	75

Source: On-site Water Quality Monitoring in May 2017 # Distance in meter from proposed centerline

Water samples (grab samples) were collected once in the month of May 2017 from all the locations and analyzed for physical, chemical and bacteriological parameters as per established standard methods and procedures. All the basic precautions and care were taken during the sampling to avoid contamination. Analysis of the samples was carried out as per established standard methods and procedures prescribed by the CPCB, e.g. relevant IS Codes (IS:2488 (Part-1 to 5) "Methods for Sampling and Testing of Industrial Effluents"), and "Standard Methods for Examination of Water and Wastewater" published by APHA.

### 3.12.3 Analysis Results

The salient water quality parameters of Vaitarna River (SW1, SW2 & SW3) and other surface water bodies (SW4 to SW8) are statistically analyzed and presented **Table 3-34** and **Table 3-35** respectively depicting range (minimum & maximum), arithmetic mean



and standard deviation. The percent time violations (PTV) i.e. the percentages of time the water quality parameters violate the tolerance limit are also presented therein. Details of water quality monitoring results of the surface water bodies are presented in **Table 3-36**.



**Photographs of Surface Water Sampling**

**Table 3- 34 Salient Surface Water Quality Features of Vaitarna River (SW 1 to SW3)**

SN	Parameter	Range		Arithmetic Mean	PTV
		Minimum	Maximum		
1	pH	7.24	8.02	7.8	0%
2	DO (mg/l)	6.2	6.4	6.3	100%
3	BOD (3 days at 27°C) (mg/l)	3.16	34.34	22.6	100%
4	TDS (mg/l)	17,908	31,456	25521.3	100%
5	Nitrate nitrogen (mg/l as NO <sub>3</sub> )	<2	3.06	2.7	0%
6	Iron (mg/l as Fe)	0.24	0.82	0.5	0%
7	Fluoride (mg/l as F)	0.59	0.74	0.7	0%

Source: On-site Water Quality Monitoring in May 2017

PTV- Percent time violations over Tolerance limits (maximum) stipulated for Inland Surface Waters (Class C) i.e. drinking water source with conventional treatment followed by disinfection (IS:2296).

**Vaitarna River:** Alignment of the proposed expressway cross the Vaitarna River at 3 locations as mentioned in Table 3-26 and these are in **inter-tidal zone**. Samples have been collected from all 3 locations. Mangrove vegetation is seen on the bank of Vaitarna River in Vadhiv Village near SW1 location.

pH values of the water were above the neutral mark (7.24-8.02) which were within the tolerance limit of 8.5 (**Table 3-34**). The slight alkalinity of the water may be associated with alkaline soil of the region. Dissolved Oxygen (DO) levels are found to be in the range of 6.2-6.4 mg/l, which is higher than the Class C (4.0 mg/l). The high values of BOD signify presence of decomposable and oxidizable organic matter in the water resulting increase of oxygen demand. Nitrate, Iron and Fluoride content were found to be within the tolerance limit. Electrical Conductivity (EC) and TDS found to be very high in all three samples collected from Vaitarna River at different locations. Such high

values of conductivity and TDS in Vaitarna River water indicate that the water is highly mineralized and salinity level is very high. This water is not suitable for irrigation under ordinary condition.

**Table 3- 35 Salient Surface Water Quality Features (SW4 to SW8)**

SN	Parameter	Range		Arithmetic Mean	PTV
		Minimum	Maximum		
1	pH	7.24	7.85	7.6	0%
2	DO (mg/l)	6.1	6.4	6.3	100%
3	BOD (3 days at 27°C) (mg/l)	2.32	8.4	5.3	80%
4	TDS (mg/l)	120	284	214.8	0%
5	Nitrate nitrogen (mg/l as NO <sub>3</sub> )	<2	<2	-	0%
6	Iron (mg/l as Fe)	0.33	0.49	0.4	0%
7	Fluoride (mg/l as F)	0.56	0.67	0.6	0%

Source: On-site Water Quality Monitoring in May 2017

PTV- Percent time violations over Tolerance limits (maximum) stipulated for Inland Surface Waters (Class C) i.e. drinking water source with conventional treatment followed by disinfection (IS:2296).

pH values were above the neutral mark (7.24-7.85) which were within the tolerance limit of 8.5 (**Table 3-35**). The slight alkalinity of the surface water may be associated with alkaline soil of the region. Values of EC and TDS of the samples indicate that the salinity level is low to medium. Plants with moderate salt tolerance can be grown without special practices for salinity control. Dissolved Oxygen (DO) levels are found to be in the range of 6.1-6.4 mg/l, which is higher than the Class C (4.0 mg/l). The high values of BOD signify presence of decomposable and oxidizable organic matter in the water resulting increase of oxygen demand. Nitrate, Iron and Fluoride content were found to be within the tolerance limit.

**Table 3- 36 Surface Water Quality Analysis Results**

SN	Parameters	Units	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	Limit#
1	pH	-	7.54	8.02	7.82	7.8	7.24	7.54	7.85	7.58	<b>8.5</b>
2	Temperature	°C	27	28	31	32	32	31	31	31	---
3	Electrical Conductivity	µmhos/cm	47660	42500	27550	354.3	421.4	421.4	216.9	507.5	---
4	Colour	Hazen Units	1	2	2	1	1	1	1	2	<b>300</b>
5	Turbidity	NTU	0.9	1.2	1.4	0.6	0.6	0.8	0.9	1.4	---
6	Total Hardness as CaCO <sub>3</sub>	mg/l	5868	5040	2969	131	111	181.8	121.2	212.1	---
7	Total Dissolved Solids	mg/l	31456	27200	17908	198	234	238	120	284	<b>1500</b>
8	Total Suspended Solids	mg/l	24	38	21	18	20	17	12	20	---
9	Sodium (as Na)	mg/l	6804	5602	4002	8.2	7.4	15.2	5.2	31.1	---
10	Potassium (as K)	mg/l	243	160	144	5.2	4.9	2.8	1.7	4.2	---
11	Calcium (as Ca)	mg/l	395.92	327.20	238.36	28.28	24.24	44.44	40.40	48.48	---
12	Magnesium (as Mg)	mg/l	1187.8	1028.0	577.95	14.8	12.3	17.2	4.9	22.1	---
13	Dissolved Oxygen	mg/l	6.40	6.30	6.20	6.40	6.30	6.10	6.20	6.40	<b>4</b>
14	COD	mg/l	110.92	88.92	11.92	7.84	11.76	20.13	18.24	23.15	---
15	BOD 3 days at 27°C	mg/l	34.34	30.33	3.16	2.32	3.92	6.52	5.13	8.40	<b>3</b>

SN	Parameters	Units	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	Limit#
16	Chloride (as Cl)	mg/l	17867	16675.68	10074.89	99.26	19.85	34.74	24.81	39.70	<b>600</b>
17	Sulphate (as SO <sub>4</sub> )	mg/l	920	803.37	699.71	3.63	3.36	3.11	2.33	5.44	<b>400</b>
18	Total Kjeldahl Nitrogen	mg/l	4.48	3.36	2.80	3.08	3.30	2.52	2.52	4.96	---
19	Nitrate (as NO <sub>3</sub> )	mg/l	3.06	2.30	<2	<2	<2	<2	<2	<2	<b>50</b>
20	Iron (as Fe)	mg/l	0.82	0.53	0.24	0.37	0.49	0.36	0.39	0.33	<b>50</b>
21	Manganese (as Mn)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	---
22	Cadmium (as Cd)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<b>0.01</b>
23	Arsenic (as As)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<b>0.2</b>
24	Total Chromium (as Cr)	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<b>0.05</b>
25	Copper (as Cu)	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<b>1.5</b>
26	Mercury (as Hg)	mg/l	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	---
27	Lead (as Pb)	mg/l	0.03	<0.001	0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<b>0.1</b>
28	Zinc (as Zn)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<b>15</b>
29	Boron (as B)	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	---
30	Fluoride (as F)	mg/l	0.74	0.68	0.59	0.57	0.62	0.56	0.63	0.67	<b>1.5</b>
31	Free Residual Chlorine	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	---
32	Phenolic Compound	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<b>0.005</b>
33	Surfactants (as PO <sub>4</sub> )	mg/l	0.34	<0.01	0.28	ND	ND	ND	0.39	0.17	---
34	Faecal Coliform	MPN/100ml	0	0	0	0	0	0	0	0	---
35	Total Coliform	MPN/100ml	<2	<2	<2	31	22	<2	11	27	<b>5000</b>

Source: On-site Water Quality Monitoring in May 2017

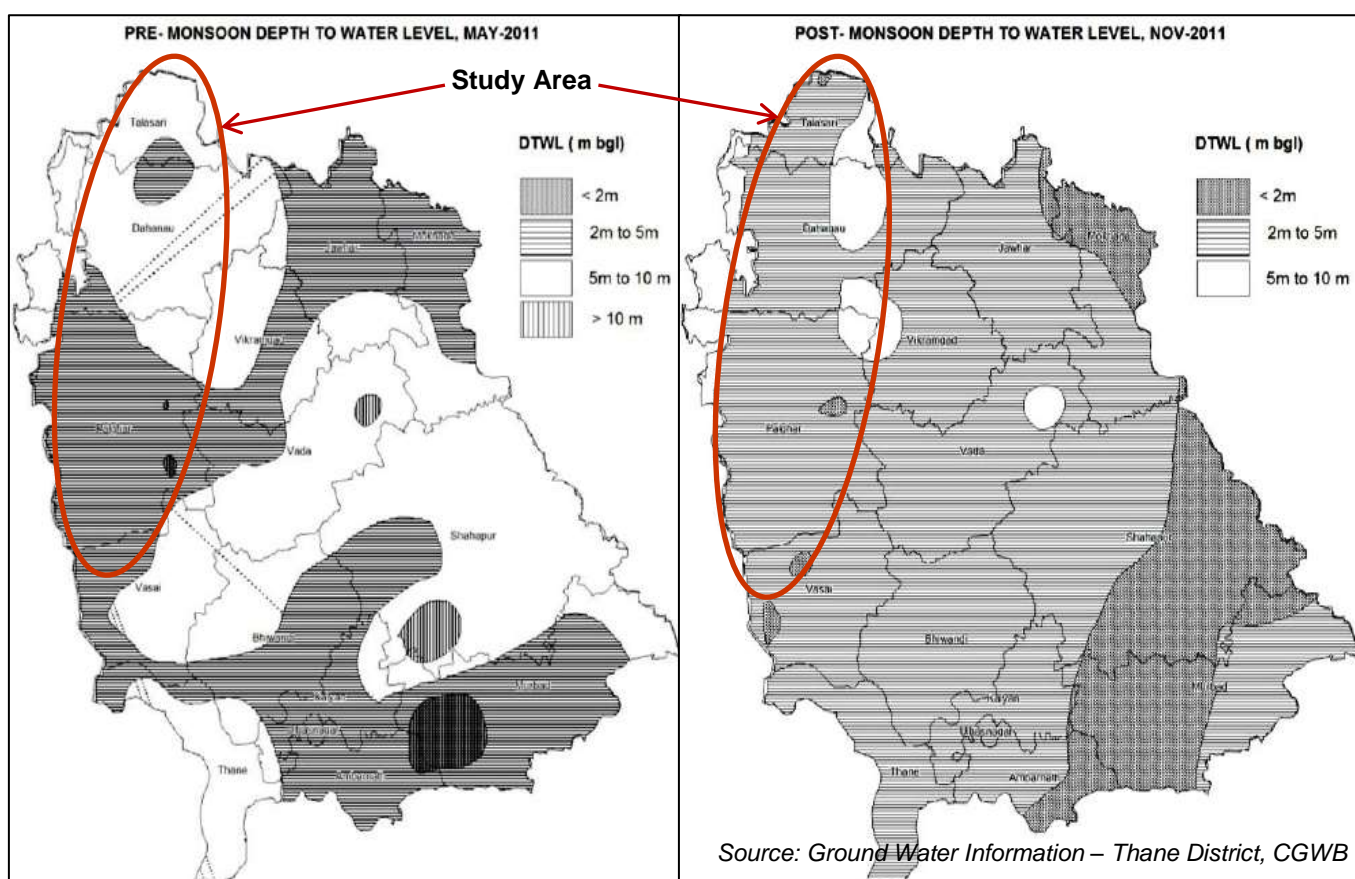
# Tolerance Limit as per IS:2296 (Class-C)

### 3.13 GROUND WATER

Ground water has been found to be an important source for catering to the local needs of water consumption in the rural and urban areas. Therefore, any kind of deterioration in the quality of ground water owing to the developmental activities will pose threat to the local population and attention needs to be paid towards maintaining the quality of water using all possible tools. Since the ground water is used without treatment by a large portion of population for drinking purpose and domestic use, the quality of ground water is of more concern.

#### 3.13.1 Depth of Ground Water<sup>3</sup>

Spatial distribution of pre monsoon and post-monsoon water level in the study area is depicted in **Figure 3-14**.



**Figure 3-14 Pre-Monsoon & Post-Monsoon Depth to Water Level in the Study Area**

In the study area, pre monsoon depth to water level (May-2011) ranging between 2 to 5 mbgl and 5 to 10 mbgl while post-monsoon depth to water level (Nov- 2011) ranging between 2 to 5 mbgl in major part of the study area. Mean water level range of 2 to 5 mbgl is observed in the Palghar, Dahanu and Talasari area.

<sup>3</sup> Ground Water Information – Thane District, Central Ground Water Board, Ministry of Water Resources, GoI

### 3.13.2 Ground Water Resources and Category

Ground water resource estimation has been done jointly by the Central Ground Water Board (CGWB) and the Groundwater Surveys and Development Agency (GSDA), Government of Maharashtra based on GEC-1997 methodology for the base year 2009. The ground water resources of Vasai, Palghar, Dahanu and Talasari Talukas (assessment units), through which the proposed expressway is passing is summarized in **Table 3-37**.

**Table 3- 37 Ground water Resources (as on March 2009)**

Talukas	Net Annual Ground Water Availability (ham)	Existing Gross Ground Water Draft for Irrigation (ham)	Existing Gross Ground Water Draft for Domestic and Industrial Water Supply (ham)	Provision for Domestic and Industrial requirement supply to 2025 (ham)	Net Ground Water Availability for Future Irrigation Development (ham)	Stage of Ground Water Development
Vasai	3661.47	981.86	83.78	173.85	3100.85	29.11%
Palghar	16002.60	1665.73	158.04	305.07	13581.06	11.40%
Dahanu	4296.61	1225.38	194.44	389.10	2683.99	33.05%
Talasari	1691.75	273.75	58.01	116.89	1308.23	19.61%

Source: Ground Water Information – Thane District, CGWB, Ministry of Water Resources, GoI

As per “Dynamic Ground Water Resource Estimation-2013”, the assessment units (talukas) are divided into different categories adopting criteria such as stage of ground water development, significant long term water level decline trend during pre-monsoon and post-monsoon etc. As per the CGWA classification, all the Talukas, through which the proposed expressway is passing, fall under **safe** category (**Table 3-38**)

**Table 3- 38 Classification of Ground Water based on the CGWA Classification**

List of Non-Notified Areas		
S. No	Sub District	Area Type Category
State: MAHARASHTRA [ 1 ]		
District: PALGHAR		
1	VASAI	Safe
2	PALGHAR	Safe
3	DAHANU	Safe
4	TALASARI	Safe

Source: <http://cgwa-noc.gov.in/Sub/Report/AreaType/AreaType.aspx>

**Note: Non Notified Area:** The Blocks / Talukas / Mandals / areas, other than notified by CGWA for regulation of ground water development and management are non-notified areas

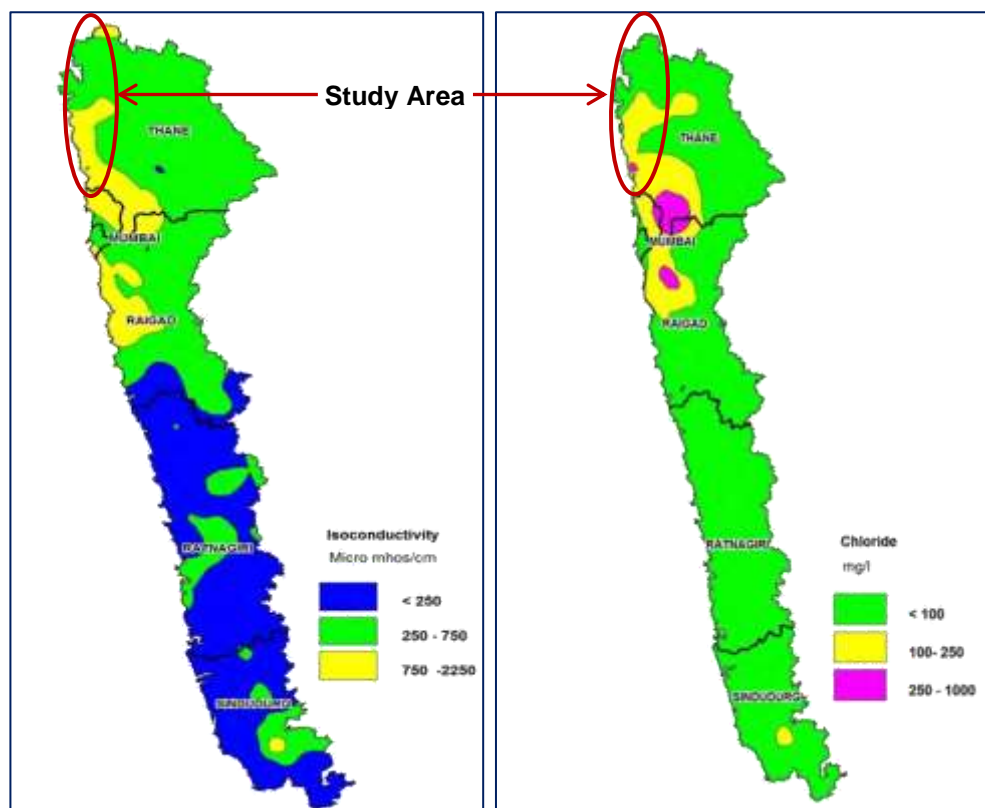
### 3.13.3 Ground Water Quality of the Study Area<sup>4</sup>

CGWB is monitoring the ground water quality of the Thane district (before **1 August 2014**, Palghar district was part of Thane district) since the last four decades through its established monitoring wells. In the coastal districts of Maharashtra, the overall range of

<sup>4</sup> Report on Status of Ground Water Quality in Coastal Aquifers of India, Central Ground Water Board, Ministry of Water Resources, GoI, **February 2014**



pH of ground water indicates that it is weakly acidic to weakly alkaline in nature. The average value of Electrical Conductivity (EC) and Total Dissolved Solids (TDS) suggests that the ground water in the shallow aquifers is not highly mineralized, except a few samples from Thane and Raigarh districts. The higher concentration of these ions in a few ground water samples of Thane and Raigarh districts may be due to anthropogenic sources. Spatial distribution of EC & Chloride in the study area is shown in **Figure 3-15**.



**Figure 3-15 Spatial Distribution of EC and Chloride in ground water in the Study Area**

Source: Report on Status of Ground Water Quality in Coastal Aquifers of India, CGWB, Feb 2014

The ground water samples having high Sodium also indicates that mixing of seawater with ground water is taking place at a few locations.

EC in the ground water of the study area varies in the range of 250 – 750  $\mu$ mhos/cm (Medium Salinity Water) to 750 – 2250  $\mu$ mhos/cm (High Salinity Water) while chloride varies in the range of <100 mg/l to 100 – 250 mg/l. However, ground water in the major part of the coastal area has low to medium salinity hazard and is suited for irrigation applications in most soil types. Fluoride content in ground water is below 1.5 mg/l in all the aquifers in the coastal tract. Nitrate content in ground water is also within permissible limit of 45 mg/l in the major part of the coastal tract, except in isolated urban areas where it is above this limit, probably due to anthropogenic activities. Studies on the presence of heavy metals in ground water in the coastal area of Maharashtra indicated the presence of Copper in traces but well below the acceptable limit of 0.05 mg/l. Iron exceeds the acceptable limit of 0.3 mg/lit in parts of Thane, Zinc was also found in traces but below acceptable limit at places.

### 3.13.4 Ground Water Sampling Locations

M/s Anacon Laboratories Pvt. Ltd., Nagpur (A NABL Accredited laboratory) was engaged for collection of ground water samples and analysis. **Five (5) ground water sampling locations** comprising hand operated tube wells (hand-pumps) were identified for the monitoring and assessment of ground water quality along the proposed alignment. The details of ground water quality monitoring stations are provided in **Table 3-39**.



**Photographs of Ground Water Sampling**

**Table 3- 39 Details of Ground Water Sampling Locations**

SN	Station Code	Location	Chainage	Side	Distance# (m)	Usage
1	GW1	Khardi village	29+000	RHS	231	Drinking
2	GW2	Pargaon village	38+950	RHS	265	
3	GW3	Kirat Village	62+800	LHS	240	
4	GW4	Dhabon Village	70+900	LHS	90	
5	GW5	Bharmanwadi Village	92+000	LHS	500	

Source: On-site Water Quality Monitoring in May 2017

# Distance in meter from existing centerline

Ground water samples were collected once in the month of May 2017 from all locations and analyzed for physical, chemical and bacteriological parameters as per established standard methods and procedures.

### 3.13.5 Analysis Results

The salient features of ground water quality analysis results are provided in **Table 3-40** and detailed monitoring results are presented in **Table 3-41**.

There has been little fluctuation in pH level (6.87-7.9) of the analyzed samples and the overall range of pH of ground water indicates that it is weakly acidic to weakly alkaline in nature. However, pH value of all the samples are found to be within the acceptable limits of 6.5-8.5 stipulated in drinking water quality standards (IS 10500:2012). Turbidity is found to exceed the acceptable limit at GW4 and GW5. Total hardness, total alkalinity and total dissolved solids (TDS) values for all the samples are observed to be within the acceptable limits as per the Indian Standards.

The amount of dissolved ions in the ground water is represented by the parameter electrical conductivity, which varies between 612 – 710  $\mu\text{mhos/cm}$ . It is observed from the Table 3-34 that all samples (100%) falls under the category of “Medium Salinity Water”. This indicates that the ground water from shallow aquifer in the area may be used for irrigation with proper soil and crop management practices during the pre-monsoon season (March to May).

**Table 3-40 Salient Ground Water Quality Features**

SN	Parameter	Range		Arithmetic Mean	PTV
		Minimum	Maximum		
1.	pH	6.87	7.9	7.43	0%
2.	TDS (mg/l)	346	422	378.50	0%
3.	Total hardness (mg/l as CaCO <sub>3</sub> )	151.5	192.34	171.81	0%
4.	Chloride (mg/l as Cl <sup>-</sup> )	91.46	106.39	98.15	0%
5.	Iron (mg/l as Fe)	0.06	4.97	1.53	20%

Source: On-site Water Quality Monitoring in May 2017

Note: PTV- Percent time violations over “Acceptable Limit” stipulated for drinking water (IS:10500-2012).

**Table 3-41 Ground Water Quality Analysis Results**

SN	Parameters	Units	GW1	GW2	GW3	GW4	GW5	Indian Standard <sup>1</sup>	
								Acceptable Limit	Permissible Limit
1.	pH	-	6.87	7.83	7.9	7.1	7.61	6.5-8.5	No relaxation
2.	Temperature	°C	25	25	25	25	25	-	-
3.	Electrical Conductivity	$\mu\text{mhos/cm}$	612	682	710	625.5	647.54	-	-
4.	Turbidity	NTU	0.5	0.6	0.6	1.2	1.1	1	5
5.	Total Hardness as CaCO <sub>3</sub>	mg/l	151.5	163.62	179.78	192.34	195.65	200	600
6.	Total Alkalinity as CaCO <sub>3</sub>	mg/l	95.33	101.32	122.47	110	118	200	600
7.	Total Dissolved Solids	mg/l	350	396	422	346	356	500	2000
8.	Sodium as Na	mg/l	49.11	57.48	72	29.53	28.4	-	-
9.	Potassium as K	mg/l	1.22	1.68	1.93	7.6	7.8	-	-
10.	Calcium as Ca	mg/l	33.13	37.17	45.25	57.18	54.64	75	200
11.	Magnesium as Mg	mg/l	16.72	17.22	16.23	11.42	14.38	30	100
12.	Chloride as Cl	mg/l	91.46	96.44	106.39	98.3	103.24	250	1000
13.	Sulphate as SO <sub>4</sub>	mg/l	18.33	29.14	36.42	4.22	2.12	200	400
14.	Nitrate as NO <sub>3</sub>	mg/l	10.21	21.09	25.43	<2	<2	45	No relaxation
15.	Iron as Fe	mg/l	4.97	0.06	0.75	0.35	0.57	0.3	No relaxation
16.	Manganese as Mn	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	0.1	0.3
17.	Cadmium as Cd	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	No relaxation
18.	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.05

SN	Parameters	Units	GW1	GW2	GW3	GW4	GW5	Indian Standard <sup>1</sup>	
								Acceptable Limit	Permissible Limit
19.	Total Chromium as Cr	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	0.05	No relaxation
20.	Copper as Cu	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	0.05	1.5
21.	Mercury as Hg	mg/l	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.001	No relaxation
22.	Lead as Pb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	No relaxation
23.	Zinc as Zn	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	5	15
24.	Boron as B	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	0.5	1
25.	Fluoride as F	mg/l	0.21	0.28	0.38	0.62	0.61	1	1.5
26.	Total Coliform	MPN/100ml	<2	23	13	<2	<2	Absent	Absent

Source: On-site Water Quality Monitoring in May 2017

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

NOTE — It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under “Acceptable Limit” render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under ‘Permissible Limit” in the absence of alternate source.

Chloride varied between 91.46 to 106.39 mg/l, Sulfate content varied between 2.12 to 36.42 mg/l, Calcium content varied between 33.13 to 57.18 mg/l and magnesium varied between 11.42 to 17.22 mg/l for the samples. Iron levels are found to be within the acceptable limit except GW1 (Khardi village). The fluoride levels are found to be in 0.21-0.62, within the acceptable limit. Heavy metals (Cr, Cu, Hg, Pb, Zn, B) are found to be below the detection limit (BDL). Samples collected from Pargaon village (GW2) and Kirat Village (GW3) are found to be contaminated with total coliforms, while no contamination is observed in GW1, GW4 and GW5.

From the above discussion, it can be concluded that the physico-chemical qualities of the ground water satisfy the acceptable limit as stipulated in Drinking Water Standards of India (IS 10500 : 2012) and suitable for human consumption.

### 3.14 ECOLOGY AND BIODIVERSITY

#### 3.14.1 Introduction

The Vadodara Mumbai Expressway (Phase-II) starts at proposed chainage 26+582 (at Koshimb village of Vasai Taluka) and ends at proposed chainage 104+700 (km 390+864 of NH-8) at Ibhadpada village of Talasari Taluka in the state of Maharashtra. Total length of expressway (Phase-II) is 78.118 km. The alignment passes through coastal plain and rolling terrain of Vasai, Palghar, Dahanu and Talasari Taluka of Palghar district. Land use along the alignment is predominantly agricultural & allied uses followed by open scrub, barren land, forest and settlements.

Climate of the study area is characterized by high humidity throughout the year, a hot summer followed by well distributed and heavy rainfall during the southwest monsoon season. The normal annual rainfall in the study area ranges from 1900 mm to 2600 mm and mean annual rainfall during the year 1981 to 2010 is 1874.6 mm.

Vaitarna River and Surya River (tributary of the Vaitarna) are the major rivers in the study area. The project alignment crosses Vaitarna River at three locations (Km 31+300, Km 35+725 and Km 45+040). Babul (*Acacia nilotica*) occurs in narrow strip along the rivers. *Dendrocalamus strictus* (Manvel) and *Bambusa arundinacea* (Kata) are common along the river banks, valleys and ravines.

The project alignment is running parallel to the west coast. The coastal region is flat and subject to flooding and periodic inundation both by the Arabian Sea and the rivers. In this region, the rivers form marshy estuaries in the broad tidal flats. The marshes support mangrove vegetation - Tiwar (*Avicennia alba*) and Maraudi (*Acanthus ilicifolius*). Plantation of Suru (*Casuarina equisetifolia*) and Coconut (*Cocos nucifera*) is done in the coastal areas. Locations of the road crossing the Vaitarna River fall in the Coastal Regulation Zone (CRZ). Alluvium soil is found along the banks of rivers, sandy soil along the coastal area. Black cotton soil is found in the flat area, in the hilly areas the soil is loamy and varies greatly in colour, depth and texture.



View of Casuarina and Coconut plantation

Locations of the road crossing the Vaitarna River fall in the Coastal Regulation Zone (CRZ). Alluvium soil is found along the banks of rivers, sandy soil along the coastal area. Black cotton soil is found in the flat area, in the hilly areas the soil is loamy and varies greatly in colour, depth and texture.

Agriculture is the main occupation of the people residing in project area. Paddy (*Oryza sativa*) is grown in the low lying areas and nagli (*Eleusine coracana*) and warai (*Panicum sumatrense*) in the hilly tract. Pulses (cowpea, blackgram, pigeon pea, chick pea), and ground nut are also cultivated. Farms of Chickoo (*Manilkara zapota*), Naryal (*Cocos nucifera*), Papaya (*Carica papaya*) and Banana (*Musa sps*) are located in the area. Taal (*Borassus flabellifer*), Teak (*Tectona grandis*), Chinch (*Tamarindus indica*), Mango (*Mangifera indica*), Neem (*Azadirachta indica*), Khajoor (*Phoenix dactylifera*), Karanj (*Pongamia pinnata*), Pipal (*Ficus religiosa*), Umber (*Ficus glomerata*), Palash (*Butea monosperma*), Khair (*Acacia cataechu*), Drumstick (*Moringa oleifera*) and



Gulmohar (*Delonix regia*) are commonly found in the area.



View of Agriculture fields in the Project area

### 3.14.2 Quadrat Study of Flora

Quadrat study of flora was carried in the month of October, 2017 at **15 locations** between Koshimbe village to Talasari village. The quadrat sampling plots for floral inventory were selected randomly. 5 plots were laid at each location, 100 m x 20 m quadrat for trees, 5 m x 5 m quadrat for shrubs and 1 m x 1m for herbs. The location of sampling along with GPS coordinates and altitude of each sample plots is presented in **Table 3-42** and shown in **Figure 3-16**.

**Table 3-42 Location, GPS Coordinates and Altitude of Sampling Plots**

Location	Sub-plots	Latitude	Longitude	Altitude (m)
Koshimbe	a	19 <sup>0</sup> 29' 09.3"N	72 <sup>0</sup> 52' 48.9"E	11
	b	19 <sup>0</sup> 29' 12.3"N	72 <sup>0</sup> 52' 51.4"E	13
	c	19 <sup>0</sup> 29' 31.7"N	72 <sup>0</sup> 52' 47.8"E	5
	d	19 <sup>0</sup> 29' 21.0"N	72 <sup>0</sup> 52' 45.5"E	7
	e	19 <sup>0</sup> 29' 26.9"N	72 <sup>0</sup> 52' 46.4"E	7
Navghar	a	19 <sup>0</sup> 32' 01.1"N	72 <sup>0</sup> 52' 32.7"E	7
	b	19 <sup>0</sup> 32' 01.0"N	72 <sup>0</sup> 52' 32.8"E	11
	c	19 <sup>0</sup> 32' 01.5"N	72 <sup>0</sup> 52' 30.9"E	8
	d	19 <sup>0</sup> 32' 01.8"N	72 <sup>0</sup> 52' 29.3"E	11
	e	19 <sup>0</sup> 32' 00.8"N	72 <sup>0</sup> 52' 26.3"E	8
Penand	a	19 <sup>0</sup> 33' 53.8"N	72 <sup>0</sup> 52' 23.2"E	13
	b	19 <sup>0</sup> 33' 52.8"N	72 <sup>0</sup> 52' 25.1"E	13
	c	19 <sup>0</sup> 33' 52.8"N	72 <sup>0</sup> 52' 28.7"E	10
	d	19 <sup>0</sup> 33' 51.8"N	72 <sup>0</sup> 52' 29.9"E	9
	e	19 <sup>0</sup> 33' 49.5"N	72 <sup>0</sup> 52' 28.5"E	11
Sonave	a	19 <sup>0</sup> 34' 29.6"N	72 <sup>0</sup> 52' 33.3"E	8
	b	19 <sup>0</sup> 34' 26.8"N	72 <sup>0</sup> 52' 33.7"E	8
	c	19 <sup>0</sup> 34' 30.8"N	72 <sup>0</sup> 52' 36.5"E	12
	d	19 <sup>0</sup> 34' 29.4"N	72 <sup>0</sup> 52' 37.1"E	8
	e	19 <sup>0</sup> 34' 28.9"N	72 <sup>0</sup> 52' 39.4"E	12
Sakhare	a	19 <sup>0</sup> 37' 59.0"N	72 <sup>0</sup> 52' 39.1"E	41
	b	19 <sup>0</sup> 38' 00.2"N	72 <sup>0</sup> 52' 44.8"E	30
	c	19 <sup>0</sup> 38' 00.0"N	72 <sup>0</sup> 52' 46.4"E	37
	d	19 <sup>0</sup> 37' 59.8"N	72 <sup>0</sup> 52' 47.1"E	40
	e	19 <sup>0</sup> 37' 59.5"N	72 <sup>0</sup> 52' 44.7"E	31

Location	Sub-plots	Latitude	Longitude	Altitude (m)
Masvan	a	19 <sup>0</sup> 41' 55.1"N	72 <sup>0</sup> 51' 36.2"E	8
	b	19 <sup>0</sup> 41' 58.7"N	72 <sup>0</sup> 51' 35.9"E	7
	c	19 <sup>0</sup> 41' 05.3"N	72 <sup>0</sup> 51' 32.3"E	14
	d	19 <sup>0</sup> 42' 10.1"N	72 <sup>0</sup> 51' 35.9"E	9
	e	19 <sup>0</sup> 42' 46.9"N	72 <sup>0</sup> 51' 35.9"E	11
Kirat	a	19 <sup>0</sup> 49' 52.9"N	72 <sup>0</sup> 50' 49.1"E	36
	b	19 <sup>0</sup> 49' 54.6"N	72 <sup>0</sup> 50' 49.7"E	32
	c	19 <sup>0</sup> 49' 56.2"N	72 <sup>0</sup> 50' 51.5"E	25
	d	19 <sup>0</sup> 49' 59.3"N	72 <sup>0</sup> 50' 54.9"E	34
	e	19 <sup>0</sup> 50' 00.5"N	72 <sup>0</sup> 50' 56.3"E	26
Dhabon	a	19 <sup>0</sup> 51' 49.2"N	72 <sup>0</sup> 50' 35.0"E	19
	b	19 <sup>0</sup> 51' 52.3"N	72 <sup>0</sup> 50' 36.1"E	17
	c	19 <sup>0</sup> 51' 51.5"N	72 <sup>0</sup> 50' 34.4"E	27
	d	19 <sup>0</sup> 51' 50.7"N	72 <sup>0</sup> 50' 31.3"E	26
	e	19 <sup>0</sup> 51' 49.7"N	72 <sup>0</sup> 50' 28.0"E	28
Aine	a	19 <sup>0</sup> 53' 52.0"N	72 <sup>0</sup> 50' 59.6"E	29
	b	19 <sup>0</sup> 53' 55.3"N	72 <sup>0</sup> 50' 59.5"E	35
	c	19 <sup>0</sup> 53' 57.8"N	72 <sup>0</sup> 50' 59.1"E	34
	d	19 <sup>0</sup> 53' 56.5"N	72 <sup>0</sup> 50' 57.6"E	42
	e	19 <sup>0</sup> 53' 55.8"N	72 <sup>0</sup> 50' 57.0"E	39
Chandwas	a	19 <sup>0</sup> 55' 28.7"N	72 <sup>0</sup> 51' 08.5"E	56
	b	19 <sup>0</sup> 55' 31.4"N	72 <sup>0</sup> 51' 11.1"E	53
	c	19 <sup>0</sup> 55' 31.7"N	72 <sup>0</sup> 51' 13.2"E	54
	d	19 <sup>0</sup> 55' 26.9"N	72 <sup>0</sup> 51' 06.8"E	53
	e	19 <sup>0</sup> 55' 24.1"N	72 <sup>0</sup> 51' 05.9"E	55
Ganeshbag	a	19 <sup>0</sup> 56' 28.7"N	72 <sup>0</sup> 52' 22.9"E	47
	b	19 <sup>0</sup> 56' 29.4"N	72 <sup>0</sup> 52' 22.5"E	51
	c	19 <sup>0</sup> 56' 30.0"N	72 <sup>0</sup> 52' 23.6"E	51
	d	19 <sup>0</sup> 56' 30.3"N	72 <sup>0</sup> 52' 26.7"E	47
	e	19 <sup>0</sup> 56' 28.3"N	72 <sup>0</sup> 52' 27.6"E	45
Dhaniwari	a	19 <sup>0</sup> 58' 14.8"N	72 <sup>0</sup> 54' 9.0"E	116
	b	19 <sup>0</sup> 58' 13.5"N	72 <sup>0</sup> 53' 69.0"E	123
	c	19 <sup>0</sup> 58' 15.2"N	72 <sup>0</sup> 53' 56.9"E	109
	d	19 <sup>0</sup> 58' 13.5"N	72 <sup>0</sup> 55' 9.0"E	108
	e	19 <sup>0</sup> 58' 08.7"N	72 <sup>0</sup> 53' 57.0"E	99
Chinchale	a	20 <sup>0</sup> 01' 22.4"N	72 <sup>0</sup> 54' 20.5"E	76
	b	20 <sup>0</sup> 01' 21.0"N	72 <sup>0</sup> 54' 18.9"E	69
	c	20 <sup>0</sup> 01' 21.8"N	72 <sup>0</sup> 54' 17.8"E	74
	d	20 <sup>0</sup> 01' 22.1"N	72 <sup>0</sup> 54' 16.9"E	72
	e	20 <sup>0</sup> 01' 24.0"N	72 <sup>0</sup> 54' 17.6"E	72
Vankas	a	20 <sup>0</sup> 04' 36.7"N	72 <sup>0</sup> 53' 43.2"E	46
	b	20 <sup>0</sup> 04' 39.9"N	72 <sup>0</sup> 53' 41.4"E	46
	c	20 <sup>0</sup> 04' 44.3"N	72 <sup>0</sup> 53' 42.6"E	47
	d	20 <sup>0</sup> 04' 35.7"N	72 <sup>0</sup> 53' 41.1"E	54
	e	20 <sup>0</sup> 04' 32.9"N	72 <sup>0</sup> 53' 42.2"E	41
Talasari	a	20 <sup>0</sup> 09' 22.4"N	72 <sup>0</sup> 54' 52.7"E	80
	b	20 <sup>0</sup> 09' 05.9"N	72 <sup>0</sup> 54' 50.7"E	80
	c	20 <sup>0</sup> 09' 04.5"N	72 <sup>0</sup> 54' 50.5"E	76
	d	20 <sup>0</sup> 09' 03.5"N	72 <sup>0</sup> 54' 51.4"E	90
	e	20 <sup>0</sup> 09' 07.2"N	72 <sup>0</sup> 54' 51.1"E	81

Source: Quadrat study carried out by ICT Pvt. Ltd. in October 2017

**Floristic Composition:** Floral species were botanically identified to the species level in each plot for trees, shrubs and herbs; and their scientific names and numbers were recorded during field survey for further analysis.





**Analysis of Data:** The primary data was assessed for calculating frequency density abundance, Important Value Index (IVI) Shannon Diversity Index and Simpson's Diversity Index using the formula given below.

Frequency	Number of quadrats in which the species occurred	x 100
	Total number of quadrats studied	
Density	Total number of individuals of a species in all quadrats	
	Total number of quadrats studied	
Abundance	Total number of individuals of a species in all quadrats	
	Total number of quadrats in which the species occurred	

**Shannon's index (H')**: Shannon's index (H') is a measure of species abundance and richness to quantify diversity of the species.

$$\text{(Shannon index) } H' = - \sum p_i \ln p_i$$

wherein  $p_i = n_i/N$

$n_i$  = Number of individuals belonging to the  $i^{\text{th}}$  species,

$N$  = Number of individuals in the sample,

$S$  = Number of species

**Simpson's index of Diversity:** Simpson index (D) was calculated as:

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

Where,  $p_i$  is same as in formula of Shannon's index. It is noteworthy that  $0 \leq D \leq 1$ , with values near zero corresponding to highly diverse or heterogeneous ecosystems and values near one corresponding to more homogenous ecosystems. Hence, another response is to redefine Simpson's index of diversity (SD) as:

$$\text{Simpson's index of diversity (SD)} = 1 - D$$

**Results and Discussions:** Overall **144 floral species** were recorded during quadrat study out of which, 72 were tree species, 20 shrubs and 52 herb species. Frequency, density and abundance have been calculated and provided in **Annex-3.6**.

**Among tree species**, *Tectona grandis* showed highest frequency with 41.33% occurrence. Other species showing high frequency were *Phoenix dactylifera* (38.667%), *Bombax ceiba* (34.667%), *Terminalia tomentosa* (32%), *Butea monosperma* (32%) etc. Highest density was observed for *Tectona grandis* (0.480) followed by *Terminalia tomentosa* (1.013), *Phoenix dactylifera* (0.853), *Bombax ceiba* (0.667), *Butea monosperma* (0.587), *Acacia catechu* (0.480) etc. *Parkinsonia aculeata*, *Ficus mysorensis*, *Tectona grandis*, *Casuarina equisetifolia*, *Manilkara zapota*, species exhibited high abundance.

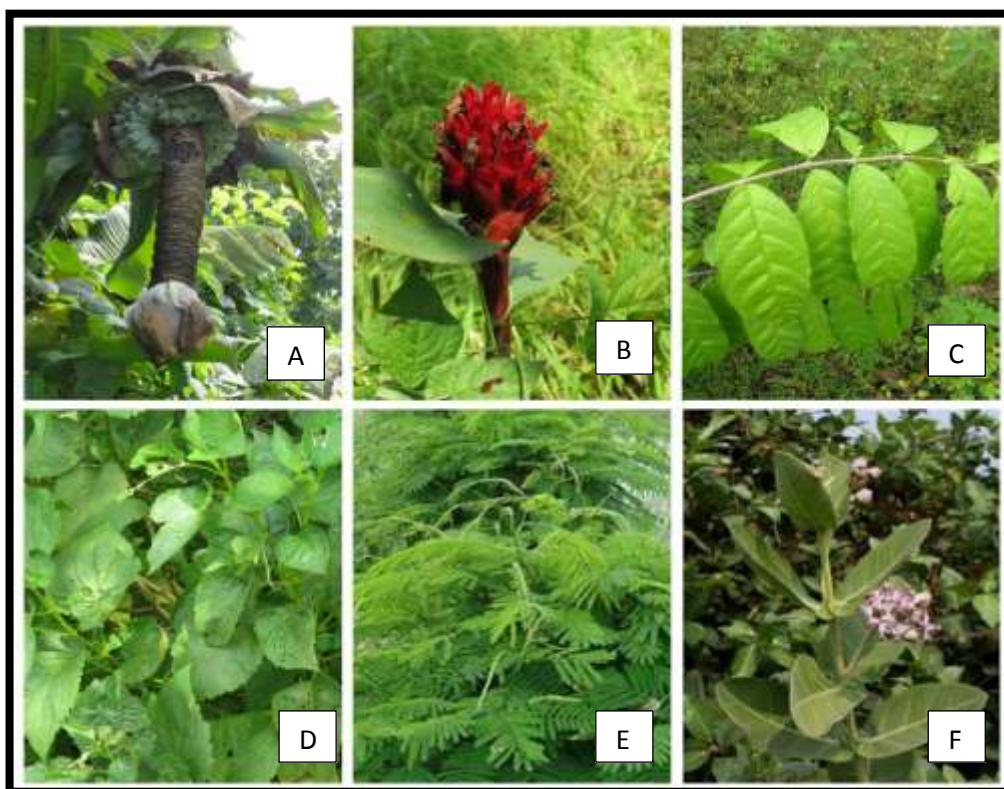
**Among shrub species,** *Euphorbia neriifolia* showed highest frequency of 26.667% other species with high frequency were *Holorina antidysenterica* (25.33%), *Jatropha curcas* (20%), *Leea indica* (18.667%) and *Calotropis gigantea* (17.33%). Density of *Euphorbia neriifolia* (0.640) was highest followed by *Holorina antidysenterica* (0.560), *Leea indica* (0.467) and *Calotropis gigantea* (0.453). Species showing high abundance were *Euphorbia tetragona*, *Costus speciosus*, *Synedrella nodiflora* and *Lantana Camara*



**Tree species:** (A) *Annona squamosa* (B) *Tectona grandis* (C) *Borassus flabellifer*, (D) *Butea monosperma* (E) *Dillenia pentagyna* (F) *Ficus religiosa* (G) *Grewia tilifolia* (H) *Oroxylum indicum*, (I) *Sonneratia alba*

**Among herbs species,** *Indigofera tinctoria* showed highest frequency with 58.667% of occurrence. Other species with high frequency were *Celosia argentea* (44%), *Cassia tora*(42.667%) *Ludwigia peruviana* (42.667%) *Sida acuta* (33.33%), *Abelmoschus moschatus* (33.33%). Density was highest for *Cassia tora*, (4.067), followed by *Celosia argentea* (3.560), *Sida acuta* (2.347), *Indigofera tinctoria* (2.120) and *Elephantopus scaber* (1.947). *Senna tora*, *Celosia argentea*, *Sida acuta* *Themeda triandra*, *Agave americana*, and *Curculigo orchioides* were abundantly found.





Shrub species: (A) *Ensete superbum*, (B) *Costus speciosus*, (C) *Holorina antidysenterica*, (D) *Lantana camera*, (E) *Acacia concinna*, (F) *Calotropis procera*

Shannon and Simpson's index of diversity were calculated, the values of diversity indices are presented in **Table 3-43**.

**Table 3-43 Shannon's and Simpson's Diversity Index**

Flora	Shannon's Diversity Index (H)	Simpson's index of Diversity (1-D)
Tree	3.57	0.95
Shrub	2.55	0.90
Herb	3.28	0.94

Source: Quadrat study carried out by ICT Pvt. Ltd. in October 2017

Shannon's diversity index was 3.57 for trees 2.55 for shrubs and 3.28 for herbs. Shannon's diversity index values obtained for different sites was found to be moderate to low when compared to reported values of 3.6 to 5.4 for Tropical Forests (Knight, 1975) and is nearer to the range (2.557 to 3.375) reported for permanent preservation plots at Western Ghats of Karnataka (Karthik, 2009) and 2.1 to 3.2 for the northern western Ghats in Maharashtra (Kanade *et al.*, 2008). The Shannon's diversity index is usually fall between 1.5 and 3.5 and only rarely it surpasses 4.5 and it does not seem to exceed 5.0 (Krebs, 1989). The High diversity of tree species may be attributed to varied topography and plantation activity such as horticulture and shelter belt development.

Simpson's Diversity Index takes into account the number of species present, as well as the abundance of each species. The value of Simpson index for diversity ranges between 0 and 1, the greater the value, the greater the sample diversity. In the present

study the value was highest for trees 0.95 followed by herbs 0.94 and lowest 0.90 for shrubs.



Herb species: (A) *Colocasia esculenta* (B) *Hugrophylla schulli* (C) *Curcuma aroma*  
 (D) *Derris scandens* (E) *Hemidesmus indicus* (F) *Ludwigia octovalvis*  
 (G) *Oxalis corniculata* (H) *Sida acuta* (I) *Tridax procumbens*

A comprehensive list of flora was prepared which included flora recorded in quadrat sampling as well as observed in the surrounding area during the study period. Total **195 floral species** observed are given in the **Table 3-44**.

**Table 3-44 List of Flora observed in the Study Area**

S. No.	Botanical Names	Common Names	IUCN Status
<b>Trees</b>			
1.	<i>Acacia auriculiformis</i>	Papuan Wattle	LC
2.	<i>Acacia catechu</i>	Khair	-
3.	<i>Acacia nilotica</i>	Babool	LC
4.	<i>Acacia tortilis</i>	Umbrella thorn acacia	-

S. No.	Botanical Names	Common Names	IUCN Status
5.	<i>Manilkara zapota</i>	Chikoo	-
6.	<i>Adina cordifolia</i>	Haldu	-
7.	<i>Aegle marmelos</i>	Bel	-
8.	<i>Albizia lebbbeck</i>	Siris tree	-
9.	<i>Albizia procera</i>	Safed Siris	-
10.	<i>Anacardium occidentale</i>	Kaju/ Cashew	-
11.	<i>Annona squamosa</i>	Sharifa/ Custard apple	-
12.	<i>Anogeissus latifolia</i>	Axle Wood Tree / Dhaura	-
13.	<i>Areca catechu</i>	Supari / Betel Palm	-
14.	<i>Artocarpus hirsutus</i>	Wild Jackfruit	-
15.	<i>Avicennia alba /A. marima</i>	Tivar Mangrove	LC
16.	<i>Azadirachta indica</i>	Neem	-
17.	<i>Barringtonia acutangula</i>	Samundarphal Mangrove	-
18.	<i>Bauhinia malabarica</i>	Amlosa/ Koral	-
19.	<i>Bauhinia racemosa</i>	Bidi Leaf Tree/ Jhinjheri	-
20.	<i>Bergera koenigii</i>	Curry leaf/ Kari patta	-
21.	<i>Bombax ceiba</i>	Semal/ Silk Cotton Tree	-
22.	<i>Borassus flabellifer</i>	Wine palmTaad	-
23.	<i>Bridelia retusa</i>	Spinous Kino Tree	-
24.	<i>Butea monosperma</i>	Palash/ Dhak	-
25.	<i>Calophyllum inophyllum</i>	Nag champa	-
26.	<i>Careya arborea</i>	Wild Guava/ Kumbhi	-
27.	<i>Carica papaya</i>	Papaya	-
28.	<i>Casearia tomentosa</i>	Chilla	-
29.	<i>Cassia fistula</i>	Amaltas	-
30.	<i>Casuarina equisetifolia</i>	Whistling Pine/ Junglisaru	-
31.	<i>Chukrasia tabularis</i>	Indian Redwood/ Chikrasi	-
32.	<i>Cinnamomum verum</i>	Dalchini	-
33.	<i>Citrus limon</i>	Lemon	-
34.	<i>Citrus sinensis</i>	Mausami/ Sweet orange	-
35.	<i>Cocos nucifera</i>	Coconut/ Naral	-
36.	<i>Commiphora wightii</i>	Guggal	-
37.	<i>Cordia dichotoma</i>	Indian Cherry/Lasora	-
38.	<i>Croton tiglium</i>	Croton Tree	-
39.	<i>Dalbergia sisso</i>	Indian rosewood/ Shisham	-
40.	<i>Delonix regia</i>	Gulmohar/ Flame Tree	LC
41.	<i>Dillenia pentagyna</i>	Karmal	-
42.	<i>Diospyros ebony</i>	Abnus/ Indian Ebony	-
43.	<i>Diospyros melanoxylon</i>	Tendu /Coromandel Ebony	-
44.	<i>Erythrina indica</i>	Lenten tree/ Pangara	LC
45.	<i>Eucalyptus globulus</i>	Eucalyptus	-
46.	<i>Excoecaria agallocha</i>	Geva (Mangrove)	LC
47.	<i>Ficus benghalensis</i>	Krishna Fig /Vad	-
48.	<i>Ficus hispida</i>	Devil fi/ Bokeda	-
49.	<i>Ficus mysorensis</i>	Mysore Fig	-
50.	<i>Ficus racemosa</i>	Cluster Fig / Goolar	-



S. No.	Botanical Names	Common Names	IUCN Status
51.	<i>Ficus religiosa</i>	Peepal	-
52.	<i>Garcinia indica</i>	Kokam	-
53.	<i>Garuga pinnata</i>	Garuga/ Kakad	-
54.	<i>Glochidion zeylanicum</i>	Umbrella Cheese Tree	-
55.	<i>Gmelina arborea</i>	Gamhar	-
56.	<i>Grewia tiliifolia</i>	Dhaman/ Dhamani	-
57.	<i>Haldina cordifolia</i>	Haldu/	-
58.	<i>Heterophragma quadriloculare</i>	Waras	-
59.	<i>Holoptelea integrifolia</i>	Kanju/ Papri	-
60.	<i>Lagerstroemia microcarpa</i>	Ben Teak	-
61.	<i>Lannea coromandelica</i>	Indian Ash Tree / Shimati	-
62.	<i>Leucaena leucocephala</i>	Wild tamarind/ Safed babool	-
63.	<i>Madhuca latifolia</i>	Indian Butter Tree/ Mahua	-
64.	<i>Mallotus tetracoccus</i>	Rusty Kamala	-
65.	<i>Mangifera indica</i>	Mango	DD
66.	<i>Manilkara hexandra</i>	Ceylon Iron Wood/ Khirmi	-
67.	<i>Miliusa tomentosa</i>	Hoom /Humb	-
68.	<i>Morinda citrifolia</i>	Indian Mulberry	-
69.	<i>Moringa oleifera</i>	Drumstick Tree/ Senjana	-
70.	<i>Morus alba</i>	White Mulberry/ Shahtoot	-
71.	<i>Neolamarkia cadamba</i>	Kadam	-
72.	<i>Olea dioica</i>	Rose Sandalwood	-
73.	<i>Desmodium oojeinense</i>	Tiwas	-
74.	<i>Oroxylom indicum</i>	Broken Bones Tree	-
75.	<i>Parkinsonia aculeata</i>	Jerusalem thorn/ Vilayti Kikar	-
76.	<i>Peltophorum pterocarpum</i>	Peela gulmohar	-
77.	<i>Phoenix dactylifera</i>	Pineapple Palm	LC
78.	<i>Phoenix sylvestris</i>	Wild Date Palm	-
79.	<i>Phyllanthus emblica</i>	Indian gooseberry/ Amla	-
80.	<i>Pithecellobium dulce</i>	Jangal Jalebi	-
81.	<i>Pongamia pinnata</i>	Indian Beech Tree/ Karanj	LC
82.	<i>Prosopis juliflora</i>	Algaroba/ Junglee kikar	-
83.	<i>Psidium guajava</i>	Guava	-
84.	<i>Pterocarpus marsupium</i>	Indian Kino Tree/ Bijasal	NT
85.	<i>Pterocarpus santalinus</i>	Red sanders	NT
86.	<i>Punica granatum</i>	Pomegranate/ Dalimb/ Anar	-
87.	<i>Samanea saman</i>	Rain Tree/ Gulabi Siris	-
88.	<i>Santalum album</i>	Chandan	VU
89.	<i>Saraca asoca</i>	Ashok	VU
90.	<i>Schleichera oleosa</i>	Koshimb	-
91.	<i>Simarouba glauca</i>	Paradise tree	-
92.	<i>Sonneratia alba</i>	Pandheri Chipi Mangrove	LC
93.	<i>Sonneratia apetala</i>	Kandal/Chipi Mangrove	LC
94.	<i>Spathodea campanulata</i>	Fountain tree/ Rugtoora	LC
95.	<i>Sterculia urens</i>	Indian-tragacanth/ Kulu	-
96.	<i>Stereospermum suaveolens</i>	Fragrant Padri Tree	-

S. No.	Botanical Names	Common Names	IUCN Status
97.	<i>Syzygium cumini</i>	Jamun	-
98.	<i>Tamarindus indica</i>	Tamarind/ Imlı	-
99.	<i>Tectona grandis</i>	Teak/ Sagun	LC
100.	<i>Terminalia bellirica</i>	Baheda	LC
101.	<i>Terminalia tomentosa</i>	Asan	-
102.	<i>Terminalia elliptica</i>	Ain/ Saj	-
103.	<i>Thespesia populnea</i>	IndianTulip / Bhendi	LC
104.	<i>Toona ciliata</i>	Toon/ Red cedar	LR
105.	<i>Trema orientalis</i>	Indian Charcoal Tree/ Gio	-
106.	<i>Wrightia tinctoria</i>	Sweet Indrajao	-
107.	<i>Wrightia tomentosa</i>	Dudhi/ Pandu Kuda	-
108.	<i>Ziziphus jujuba</i>	Indian Plum/ Ber	-
<b>Shrubs</b>			
109.	<i>Acanthus ilicifolius</i>	Maraudi Mangrove	LC
110.	<i>Acacia concinna</i>	Shikekai	-
111.	<i>Adhatoda vasica</i>	Adulsa	-
112.	<i>Agave americana</i>	Kantala	-
113.	<i>Ananas comosus</i>	Ananas/ Pineapple	-
114.	<i>Calotropis gigantea</i>	Crown Flower/ Aak	-
115.	<i>Carissa carandas</i>	Karonda	-
116.	<i>Chromolaena odorata</i>	Bitter bush/Tivra gandha	-
117.	<i>Costus speciosus</i>	Crepe Ginger/ kushtha	-
118.	<i>Ensete superbum</i>	Rock Banana/ Jungli Kela	-
119.	<i>Euphorbia tetragona</i>	Cathedral cactus	-
120.	<i>Euphorbia nerifolia</i>	Danda Thaur / Newagunda	-
121.	<i>Helicteres isora</i>	Murudsheng	-
122.	<i>Holarrhena antidysenterica</i>	Indrajav	-
123.	<i>Jatropha curcas</i>	Jatropha/ Ratanjot	-
124.	<i>Lantana camara</i>	Lantana	-
125.	<i>Lawsonia inermis</i>	Mehendi	-
126.	<i>Leea indica</i>	Bandicoot Berry/ Kukur Jihwa	-
127.	<i>Meyna laxiflora</i>	Muyna	-
128.	<i>Nerium oleander</i>	Kanher	-
129.	<i>Nyctanthes arbor-tristis</i>	Parijat	-
130.	<i>Opuntia littoralis</i>	Coastal Pricklypear	-
131.	<i>Premna integrifolia</i>	Agnimantha	-
132.	<i>Ricinus communis</i>	Castor bean/ Arandi	-
133.	<i>Synedrella nodiflora</i>	Cinderella Weed	-
134.	<i>Thespesia lampas</i>	Ranbhendl	-
135.	<i>Urena lobata</i>	Caesarweed/ Bachita	LC
136.	<i>Vitex negundo</i>	Nirgundi	-
137.	<i>Ziziphus oenoplia</i>	Wild Jujube/ Burgi/ Torni	-
138.	<i>Ziziphus nummularia</i>	Jher Beri/ Chanya Bor	-
<b>Herbs &amp; Climbers</b>			
139.	<i>Abrus precatorius</i>	Coral bead vine/Ratti	-
140.	<i>Abelmoschus moschatus</i>	Pink Swamp Mallow	-



S. No.	Botanical Names	Common Names	IUCN Status
141.	<i>Achyranthes aspera</i>	Prickly Chaff Flower/ Latjira	-
142.	<i>Adiantum caudatum</i>	Aadishe/Madhuchada	-
143.	<i>Agave americana</i>	Agave/ Kamal cactus	-
144.	<i>Alternanthera sessilis</i>	Dwarf copperleaf/ Garundi	-
145.	<i>Amorphophallus campanulatus</i>	Elephant Foot Yam	-
146.	<i>Asparagus recemosus</i>	Shatawari	
147.	<i>Bambusa arundinacea</i>	Indian Thorny Bamboo/ Bans	LC
148.	<i>Bougainvillea spectabilis</i>	Bougainvillea	-
149.	<i>Caesulia axillaris</i>	Pink Node Flower	-
150.	<i>Capparis parviflora</i>	Wild Caper Bush/ Kanthari	-
151.	<i>Cardiospermum halicacabum</i>	Balloon Vine/ Kanphata	-
152.	<i>Senna tora</i>	Cassia Tora/ Panwar / Takla	-
153.	<i>Celosia argentea</i>	Cockscomb/ Lalmurga	-
154.	<i>Chloris barbata</i>	Swollen Finger Grass	LC
155.	<i>Colocasia esculenta</i>	Cocoyam/ Arvi	-
156.	<i>Corchorus aestuans</i>	Jute/ East Indian Mallow	-
157.	<i>Crotalaria calycina</i>	Hairy Rattlepod/ Kesal tag	-
158.	<i>Curculigo orchioides</i>	Golden Eye Grass/ Kali musli	-
159.	<i>Curcuma aromatica</i>	Wild Turmeric	-
160.	<i>Cyanotis tuberosa</i>	Sahyadri Dew-Grass	-
161.	<i>Dendrocalamus strictus</i>	Bans/ Hard bamboo	-
162.	<i>Derris scandens</i>	Jewel Vine / Gonj	-
163.	<i>Desmodium heterocarpon</i>	Tick Trifol / Jambhi Dashmi	-
164.	<i>Dichanthium annulatum</i>	Sheda Grass	-
165.	<i>Elephantopus scaber</i>	Elephant Foot/ Hastipata	LC
166.	<i>Hemidesmus indicus</i>	Indian Sarsaparilla	-
167.	<i>Hygrophila auriculata</i>	Marsh Barbel	LC
168.	<i>Hyptis suaveolens</i>	American Mint/ Vilaiti Tulsi	-
169.	<i>Ipomoea aquatica</i>	Water Morning Glory/ Nali	-
170.	<i>Impatiens minor</i>	Lesser Balsam	-
171.	<i>Indigofera tinctoria</i>	Small-leaved indigo	-
172.	<i>Lamprachaenium microcephalum</i>	Bramhadandi	EN
173.	<i>Lepidagathis cristata</i>	Bukhar Jadi	-
174.	<i>Ludwigia octovalvis</i>	Willow Primrose/ Ban long	-
175.	<i>Ludwigia peruviana</i>	Peruvian Water Primrose	-
176.	<i>Malachra capitata</i>	Brazil Jute	-
177.	<i>Martynia annua</i>	Tiger's Claw/ Baghnakh	-
178.	<i>Mucuna monosperma</i>	Negro Bean	-
179.	<i>Mucuna pruriens</i>	Velvet bean/ Kiwach	-
180.	<i>Ocimum gratissimum</i>	Ram Tulsi/ Clove basil	-
181.	<i>Ocimum tenuiflorum</i>	Holy Basil/ Tulsi	-
182.	<i>Oldenlandia corymbosa</i>	Diamond Flower	-
183.	<i>Oxalis corniculata</i>	Creeping Wood Sorrel	-
184.	<i>Phyllanthus amarus</i>	Black Catnip/ Bhui Aonla	LC
185.	<i>Polygala arvensis</i>	Field Milkwort / Mirdoi	-
186.	<i>Rungia pectinata</i>	Comb Rungia /Sut	-

S. No.	Botanical Names	Common Names	IUCN Status
187.	<i>Saccharum spontaneum</i>	Kans grass	LC
188.	<i>Sida acuta</i>	Common Wireweed/ Baraira	-
189.	<i>Sida rhombifolia</i>	Sadeda	-
190.	<i>Sphaeranthus indicus</i>	Gorakhmundi	-
191.	<i>Tephrosia purpurea</i>	Fish Poison /Sharpankha	-
192.	<i>Themeda triandra</i>	Kangaroo Grass	-
193.	<i>Tinospora cordifolia</i>	Gulbel	-
194.	<i>Trichodesma indicum</i>	Indian Borage /Chota Kalpa	-
195.	<i>Tridax procumbens</i>	Coat Buttons	-

Source: Quadrat study carried out by ICT Pvt. Ltd. in October 2017

Note: LC – Least Concern; LR – Low Risk; EN – Endangered; VU – Vulnerable; NT – Near Threatened; DD – Data Deficient

### 3.14.3 Threatened Species of Flora

Threatened species of flora are categorized as per International Union for Conservation of Nature (IUCN) red list. The species falling in threatened category are given below.

**Saraca asoca (Ashok):** It is an evergreen tree with spreading crown. The species is categorized as “Vulnerable”, IUCN, 1998 and needs updating. It is native to India and occurs in South and Central Western Ghats, Burma and Sri Lanka. No subpopulations were found in Sri Lanka during the extensive forest surveys conducted between 1991 and 1996 for the National Conservation Review, suggesting the species is either extremely rare or possibly extinct. The plant is sacred trees of the Hindus and Buddhists, the flowers are used for religious ceremonies and temple decorations.

Threat: The species has become threatened in some parts of its range due to the loss of habitat. As a wild tree, it is a vulnerable species but isolated wild ashoka trees are found in the foothills of the central and eastern Himalayas, in scattered locations of the northern plains of India as well as on the west coast of the subcontinent.



*Saraca asoca*

**Santalum album (Chandan/ Sandalwood):** It is a small to medium-sized evergreen tree, categorized “Vulnerable” as per IUCN, 1998 and needs updating. The species is native to India and also found in China, Indonesia and Philippines. Sandalwood has been found to be distributed all over the country with Southern part of Karnataka and Northern part of Tamil Nadu being the natural area. It is a parasitic plant which is widely scattered in dry deciduous forests. It is used for fine furniture, carving, sandal oil, incense, cosmetics, soaps, medicines, religious practices, etc.



*Santalum album*

Threat: Fire, grazing and exploitation of the wood for fine furniture, carving, oil, etc. are threatening the species. Export of timber is banned in India for conservation of the species. Until 2002, individuals were not allowed to grow and cut sandalwood. During the last decade, considering the huge market value for heartwood and oil along with relaxed Government policies, sandalwood is being cultivated extensively in farmland across the country.

**Lamprachaenium microcephalum (Bramhadandi):**

It is herb species and categorized as “Endangered” as per IUCN, 2014 redlist. It is endemic to Western Ghats in Maharashtra, Goa and Karnataka in India and found commonly on wastelands

Threat: Fire, unsustainable harvest, habitat loss due to agricultural invasion and human settlements are considered threat to this species. This species is found in open grasslands. The plant is bitter and used in skin diseases like Leucoderma and in "Vata" and "Kapha" inflammations



*Lamprachaenium microcephalum*

Other species falling in low risk category are:

- Pterocarpus marsupium (Bijasal) : Near Threatened,
- Pterocarpus santalinus (Red Sanders): Near Threatened

**3.14.4 Forest**

The Forests of Dhanu Division are classified into following categories as per the Classification of Indian Forest Types by Champion and Seth (1968).

- A. Tropical Southern moist Teak bearing Forests
- B. Tropical Southern moist mixed deciduous Forests
- C. Western sub-tropical Hill Forests
- D. Mangrove Scrub Forests

**A. Tropical Southern moist Teak bearing Forests:** Teak forests can be further distinguished as:

**Teak-Ain-Kuda-Karvand association:** Teak (*Tectona grandis*), Ain (*Terminalia tomentosa*), Khair (*Acacia catechu*), Hed (*Haldina cordifolia*), Kalamb (*Mitragyha parvifolia*), Bibla (*Pterocarpus-marsupium*) etc. are major species.

Kuda (*Holarrhena antidysenterica*), Karambel (*Dillenia pentagyna*), Kumbhi (*Careya arborea*), Palas (*Butea monosperma*), Temburni (*Diospyros melanoxylon*) etc. comprise second story of the forest. Main species of



**View of Teak Forest**

shrubs are Karvand (*Carissa carandas*), Ukshi (*Calycopteris floribunda*) and Murud sheng (*Helicteres isora*).

**Teak-Dhavada-Kuda-Takla association** consists of Kakad (*Garuga pinnata*), Shemat (*Lannea coromandelica*), Sawar (*Bombax cieba*), Dhavada (*Anogeissus latifolia*), etc. Kuda (*Holarrhena antidysenterica*), Kudi (*Wrightia tomentosa*), Chera (*Erinocarpus nimononii*), Manvel (*Dendrocalamus strictus*), Bundi (*Oxytenanthera monostigma*)

**Ain-Khair-Koshimb-Karavand association** comprises of Ain (*Terminalia tomentosa*), Khair (*Acacia catechu*), Heda (*Adina cordifolia*), Kalamb (*Mitragyana parvifolia*), Koshimb (*Schleichera oleosa*), Teak (*Tectona grandis*), Shisham (*Dalbergia latifolia*) Bibla (*Pterocarpus marsupium*), Nana (*Lagerstroemia microcarpa*), Shiras (*Albizia lebbeck*) Kinhai (*Albizia procera*), Kala Shiras (*Albizia odoratissima*), Mango (*Mangifera indica*), Jambul (*Syzygium cumini*), Asana (*Bridelia retusa*), Arjuna (*Terminalia arjuna*), Waras (*Heteropharagma quadriculare*), Chamoli (*Bauhinia foveolata*).

**Ain-Bonda association** - Ain (*Terminalia tomentosa*) and Bonda (*Lagerstroemia parviflora*) are the most common species. Other species associated are Kakad (*Garunga pinnata*), Shemat (*Lannea coromandelica*), Kuda (*Holarrhena antidysenterica*) and Takla (*Cassia tora*).

- B. Southern Tropical Moist Mixed Deciduous Forest:** The main species occurring in this Forest are Ain (*Terminalia tomentosa*), Hed (*Adina cardifolia*), Dhavada (*Anogeissus latifolia*), Shisam (*Dalbergie latifolia*), and Savar (*Bombax ceiba*), Kalam (*Mitragyna parvifolia*), Moha (*Madhuca indica*), Mango (*Mangifera indica*), Shendri (*Mallotus philippinensis*).
- C. The Western Sub-Tropical Hill Forests :** Major species are Mango (*Mangifera Indica*) Karanj (*Pongamia pinnata*), Kokam (*Garcinia indica*), Jambul (*Syzygium cumini*), Undi (*Calophyllum inophyllum*), Katekambal (*Sideroxylon tomentosum*), Shisham (*Dalbergia latifolia*), Waras (*Heterophragma quadriloculare*), Asana (*Bridelia retusa*), Hirda, (*Terminalia chebula*), Beheda (*Terminalia belerica*), Wavala (*Holoptelea integrifolia*), Bhoma (*Glochidion lanceolarium*) Payar (*Ficus arnottiana*) Bher Jambhul (*Ammannia baccifera*) Par Jambhul (*Olea dioica*), Chandada (*Macaranga peltata*)
- D. The Mangrove Scrub Forests:** These forests are found in small patches along the coastal regions running along the Arabian Sea. It is also found in the revenue wastelands along the creeks, which have been transferred to Forest Department for management. The Mangrove forests consist mostly of evergreen trees and shrubs belonging to several unrelated families and share similar habitat preferences and a similar physiognomy. The crop consists of mostly of Tiwar (*Avicennia alba*) and Maraudi (*Acanthus ilicifolius*), *Sonneratia* sps and *Excoecaria* sps. Plantations of Suru (*Casuarina equisetifolia*) have been raised also raised along the western coast. Eucalyptus hybrid has been interplanted in Suru plantations



Forests in the Division do not generally occur in large compact blocks but are mostly distributed in scattered small blocks surrounded by the agricultural land or waste lands.

**Species of Local Importance:** The local communities living in the forest tract are mainly Adivasis. They practice primitive type of agriculture; a common practice followed is rab burning. For burning the rab the local people collect the fallen dead leaves from the forest. The people own large herds of cattle and are depended on forests for grazing.



Trees planted in rural area



Forest produce utilized by local Habitants

Forests play a vital role in the life of the local people. The local inhabitants collect and use various plant parts for food and other purpose. Most of the local demand is confined to small sized timber and firewood. The important produces are from Bamboo, Apta, Tembhurni, Bel, Tad, Palm, Ain, Kadi patta, Babul, Moha, Hirda, etc. These plants are very important from socio-economic point to the local people. The plants of local importance are provided in the **Table 3-45**.

**Table 3-45 Dependence of Local Inhabitants on Plants**

S. No.	Botanical Name	Local Name	Parts Used	Remarks
1.	<i>Acacia catechu</i>	Khair	Stem	Fuel , wood ash manure, making hubs and axles of carts
2.	<i>Acacia nilotica</i>	Babul	Stems , twigs	Fuel, toothbrush
3.	<i>Acacia auriculiformis</i>	Acacia	Tree	Fuel and Fodder
4.	<i>Acacia concinna</i>	Shikekai	Fruit	Washing, shampoo
5.	<i>Aegle marmelos</i>	Bel	Fruits, leaves	Fruit used in diarrhea and stomach ache, drink as sarbat, religious functions
6.	<i>Agave sisilana</i>	Agave	Whole plant	Agave leaves used as fibers
7.	<i>Aloe vera</i>	Korphad	Leaves	Apply on injuries and burns
8.	<i>Annona squamosa</i>	Sitaphal	Bark, fruit	Bark decoction used in diarrhea, fruit consumed
9.	<i>Asparagus recemosus</i>	Shatawari	Root	Juice of roots used in diarrhea, piles and cough
10.	<i>Avicennia officinalis</i>	Tiwar	Bark	Tannin and timber
11.	<i>Azadirachta indica</i>	Neem	Leaves, twigs, bark	Twigs used as tooth brush, neem cakes, for shade, mosquito repellent
12.	<i>Bauhinia racemosa</i>	Apta	Leaves	Leaves used for making beedi, cure for



S. No.	Botanical Name	Local Name	Parts Used	Remarks
				digestive diseases
13.	<i>Borassus flabellifer</i>	Toddy Palm	Fruit, Sap	Unfermented sweet sap – Neeru, Fermented drink -Todi, leaves used for thatching roofs, mat, broom etc
14.	<i>Butea monosperma</i>	Palas	Flower , Leaves, bark	Leaves used as plate , flowers for dye, gum
15.	<i>Carica papaya</i>	Papaya	Fruit, Leaves	Fruit, extracts of papaya leaf used in dengue fever
16.	<i>Carissa carandas</i>	Karwand	Fruit, stems and leaves	Fruit, rab purpose - ash manure
17.	<i>Carvia callosa</i>	Karvi	Leaves, stem	Cure stomach ailment, poles and fencing material, ash manure
18.	<i>Cassia tora</i>	Takla/Tarota	Seeds	Seeds used to get relief from stomach pain
19.	<i>Casuarina equisetifolia</i>	Suru	Whole tree	Fuel, wind shelter
20.	<i>Cocos nucifera</i>	Naryal	Leaves, fruit	Mats & thatching, coconut water, oil, husk and shells used for fuel
21.	<i>Dendrocalamus strictus</i>	Bamboo	Whole plant	Fencing, basket making, thatching, ash manure
22.	<i>Diospyros melanoxylon</i>	Tembhurni	leaves	Leaves used for making beedi
23.	<i>Emblica officinalis</i>	Awla	Fruit	Fruit, pickle, powder form
24.	<i>Eucalyptus sps</i>	Nilgiri	Leaves, stem	Fuel , commercial species
25.	<i>Ficus benghalensis</i>	Vad	Whole tree	Religious, shade
26.	<i>Ficus religiosa</i>	Pimpal	Whole tree	Religious
27.	<i>Garcinia indica</i>	Kokam	Powder	Kokam drink, pickle, dye
28.	<i>Jasminum arborescens</i>	Kusari	Flowers	Religious work, women put on hair
29.	<i>Lawsonia inermis</i>	Heena	Leaves	Dye, Mehndi powder
30.	<i>Leucaena leucocephala</i>	Subabul	Whole plant	Fuel and Fodder
31.	<i>Madhuca longifolia</i>	Moha	Flower , Seeds	Flower used to prepare a local brew , oil from seeds used for cooking
32.	<i>Mangifera indica</i>	Mango	Fruit, leaves, stems	Fruit, pickle , leaves in religious functions
33.	<i>Manilkara zapota</i>	Chikoo	fruit	Fruit, chikoo juice, wine
34.	<i>Mimusops elengi</i>	Bakul	Fruits and flower	Used in snake bite & headache. Fruits and flower paste applied on wound
35.	<i>Moringa oleifera</i>	Shevga	Seeds, fruit	Vegetable
36.	<i>Murraya koeingii</i>	Kadipatta	Leaves	Used for seasoning curries, useful in vomiting and poisonous bites
37.	<i>Ocimum tenuiflorum</i>	Kali Tulsi	Leaves	Leaves used in cold and cough, skin disease & religious functions
38.	<i>Pongammia pinnata</i>	Karanj	Seeds	Oil from the seeds used for soap making, burning and medicine
39.	<i>Sapindus trifoliatus</i>	Ritha	Fruit	Washing / shampoo
40.	<i>Sterculia urens</i>	Kandol	Sap	Source of gum
41.	<i>Syzygium cumini</i>	Jamun	Fruit	Fruit, used to cure diarrhea, dysentery
42.	<i>Tamarindus indica</i>	Imli/chinch	Fruit	Fruit, used in dal and curry/pickle
43.	<i>Tectona grandis</i>	Teak	Stem leaves	Timber, firewood
44.	<i>Terminalia arjuna</i>	Arjun	bark, leaves	Bark is used in fever, leaves used for pooja
45.	<i>Terminalia bellerica</i>	Behada	Fruits	stomach disorders and indigestion

S. No.	Botanical Name	Local Name	Parts Used	Remarks
46.	<i>Terminalia chebula</i>	Hirda	Fruit	Cough, wound ulcer, tannin
47.	<i>Terminalia tomentosa</i>	Ain	Bark	Colouring nets, poles, boats building material and as fuel.
48.	<i>Zizyphus jujuba</i>	Bor	Fruits	Fruits consumed

Source: Working Plan of Dahanu Forest Division and local consultation carried out by ICT Pvt. Ltd.

### 3.14.5 Diversion of Forest Land

The proposed project involves diversion of 191.5894 ha of forest land, which includes reserved forest (13.1%), mangrove forest (2%), protected forest (70.5%) and private forest (14.4%). Forest Division, Taluka and Range wise details are provided in **Table 3-46**.

**Table 3-46 Details of Forest Land proposed to be diverted**

Division	Taluka	Range	Type of Forest Land (Ha)**					
			Reserved	Mangrove	Protected	Private	Total	
Thane	Vasai	Mandavi	0	0.4514	8.2130	0	8.6644	
Dahanu	Palghar	Boisar	0	0	14.8682	7.1570	22.0252	
		Dahisar	0.3602	0	12.8516	0	13.2118	
		Palghar	0	0	14.5791	0	14.5791	
		Safale	0	3.4109	7.2148	0	10.6257	
		Bhatane	0.0201	0	15.9311	0	15.9512	
	Dahanu	Dahanu	Boisar	11.9409	0	21.1233	3.9568	37.0210
			Bordi	0	0	0	0	0
			Dahanu	3.6146	0	16.9107	10.8938	31.4191
			Kasa	0.2416	0	1.8096	0	2.0512
			Udhava	8.9823	0	21.5556	5.5028	36.0407
	Talasari	Bordi	0	0	0	0	0	
<b>Grand Total</b>			<b>25.1597</b>	<b>3.8623</b>	<b>135.057</b>	<b>27.5104</b>	<b>191.5894</b>	
<b>% of total forest land</b>			<b>13.1%</b>	<b>2.0%</b>	<b>70.5%</b>	<b>14.4%</b>	<b>100%</b>	

Source: land records and forest records

\*\*Note: Forest land proposed to be diverted may change after completion of Joint Measurement Survey with the Forest Department.

### 3.14.6 Mangrove Forest

Mangrove scrub forests are found in patches along the coastal regions running along the Arabian Sea, which is more than 10 km from the alignment. Mangroves are also found in patches along the Vaitarna River in the project area. The proposed expressway alignment crosses the Vaitarna River at 3 (three) locations, which falls in the intertidal zones and are regulated under CRZ Notification.

Recognizing the importance of mangroves and the need for conservation, a "Mangrove Cell" was created by the Government of Maharashtra in January, 2012 and has also notified all mangroves on Government land as Reserve Forests under the Indian Forest

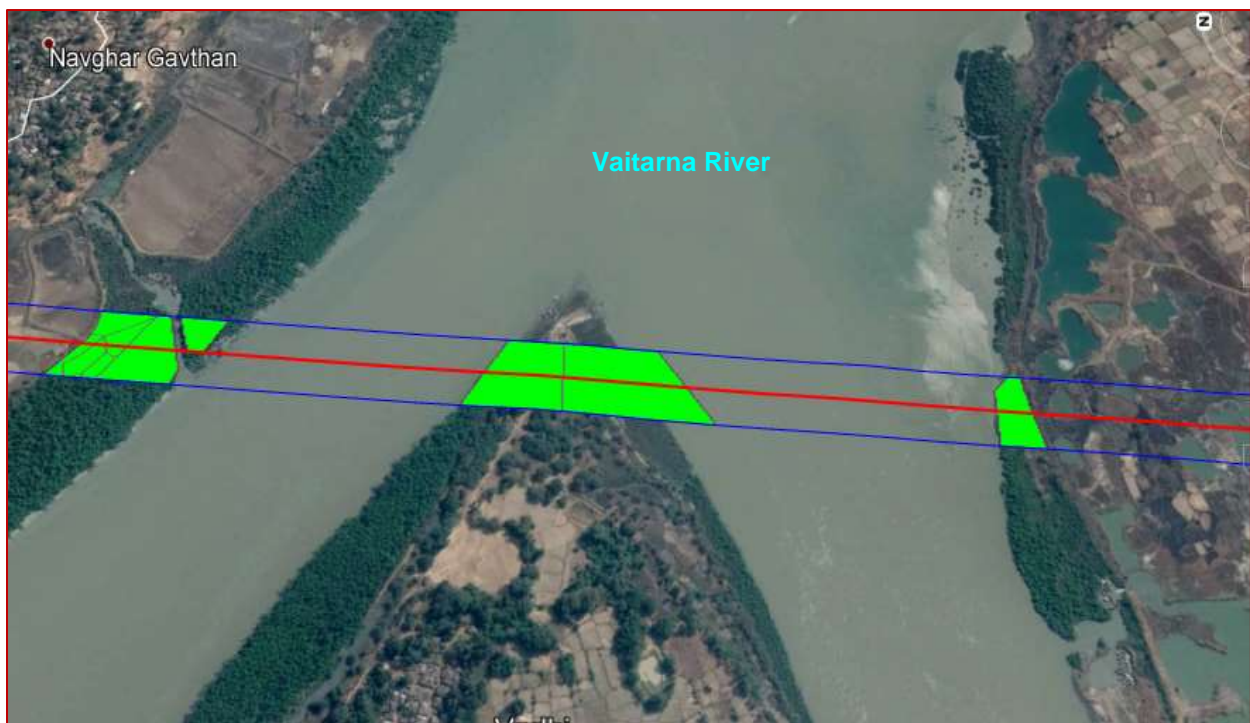
Act. The mangrove located along Vaitarna River consists mostly of Tiwar (*Avicennia alba*) and Maraudi (*Acanthus ilicifolius*), other species are *Avicennia officinalis*, *Sonneratia alba*, *Sonneratia.apetala*, *Excoecaria sps*, *Barringtonia sps*, *Aegiceras corniculatum*, *Rhizophora mucronata*, *Ceriops decandra*, etc. Cutting of mangroves is inevitable as the alignment crosses Vaitarna River. Total **3.8623 ha** area of mangrove will be affected by the project (**Table 3-47**). Mangrove cutting permission shall be taken as per Forest Clearance Procedure, CRZ Clearance shall be obtained from the competent authority and recommendations provided by the authorities will be implemented by the NHA.

**Table 3-47 Village wise Details of affected Mangrove Forest**

Forest Range	Taluka	Village	Mangrove Forest (Ha)**
Mandavi	Vasai	Doliv	0.4514
Safale	Palghar	Navghar	1.4817
		Penand	0.3121
		Vadhiv	1.6171
<b>Total (Ha)</b>			<b>3.8623</b>

Source: land records and forest records

\*\*Note: Mangrove Forest to be diverted may change after completion of Joint Measurement Survey with the Forest Department.



**Mangrove Area within Right of Way of the Proposed Expressway**



### 3.14.7 Faunal Composition

The fauna of project area is based on direct sighting during field survey, stakeholder consultation, review of Forest working plan of Dahanu Division, Wildlife Management plan of Tungeshwar Wildlife Sanctuary, DNH Wildlife Sanctuary and published literature. Consultation was held with the DFO Dahanu Forest Division and Forest Range Officers of Dahanu, Boisar, Palghar, Saphale and Kasa range using structured questionnaire. Filled up questionnaire of Forest Range Officers are attached as **Annex 3.7**. Faunal species sighted during site visit comprised of mammals, reptile, birds, amphibians, insects, gastropods and crustaceans, given in the **Table 3-48**.



Consultation with DFO, Dahanu Forest Division



Consultation at Dahanu Forest Division



Direct Sighting of Faunal Species



Consultation with Range Officer, Kasa

**Table 3-48 Fauna Specie Sighted during Field Survey**

S. No.	Common Name	Scientific Name	IUCN Category
<b>Mammal</b>			
1.	Mongoose	<i>Helogale parvula</i>	Least Concern
2.	Bonnet macaque	<i>Macaca radiata</i>	Least Concern
<b>Bird</b>			
3.	Ashy drongo	<i>Dicrurus leucophaeus</i>	Least Concern
4.	Baya weaver	<i>Ploceus philippinus</i>	Least Concern

S. No.	Common Name	Scientific Name	IUCN Category
5.	Bee eater	<i>Merops apiaster</i>	Least Concern
6.	Bittern heron	<i>Ardea purpurea</i>	Least Concern
7.	Black drongo	<i>Dicrurus macrocercus</i>	Least Concern
8.	Black kite	<i>Milvus migrans</i>	Least Concern
9.	Bronzed head drongo	<i>Dicrurus aeneus</i>	Least Concern
10.	Cattle egret	<i>Bubulcus ibis</i>	Least Concern
11.	Common crow	<i>Corvus brachyrhynchos</i>	Least Concern
12.	Common myna	<i>Acridotheres tristis</i>	Least Concern
13.	Cormorant	<i>Phalacrocorax fuscicollis</i>	Least Concern
14.	Flower pecker	<i>Dicaeum erythrorhynchos</i>	Least Concern
15.	Greater council	<i>Centropus sinensis</i>	Least Concern
16.	House swift	<i>Apus nipalensis</i>	Least Concern
17.	Jungle crow	<i>Corvus macrorhynchos</i>	Least Concern
18.	Jungle myna	<i>Acridotheres fuscus</i>	Least Concern
19.	Little brown dove	<i>Aplopelia larvata</i>	Least Concern
20.	Little cormorant	<i>Microcarbo niger</i>	Least Concern
21.	Median egret	<i>Ardea intermedia</i>	Least Concern
22.	Owl	<i>Bubo bengalensis</i>	Least Concern
23.	Plain flower pecker	<i>Dicaeum minullum</i>	Least Concern
24.	Pond heron	<i>Ardeola grayii</i>	Least Concern
25.	Drongo	<i>Dicrurus paradiseus</i>	Least Concern
26.	Red vented bulbul	<i>Pycnonotus cafer</i>	Least Concern
27.	Scarlet minivet	<i>Pericrocotus speciosus</i>	Not Evaluated
28.	Small blue kingfisher	<i>Alcedo atthis</i>	Least Concern
29.	Small sunbird	<i>Leptocoma minima</i>	Least Concern
30.	Smaller egret	<i>Egretta garzetta</i>	Least Concern
31.	Spotted dove	<i>Spilopelia chinensis</i>	Least Concern
32.	Purple sunbird	<i>Cinnyris asiaticus</i>	Least Concern
33.	Red-rumped swallow	<i>Hirundo daurica</i>	Least Concern
34.	Common Swift	<i>Apus apus</i>	Least Concern
35.	Tickle flower pecker	<i>Dicaeum erythrorhynchos</i>	Least Concern
36.	White cheeked Barbet	<i>Megalaima viridis</i>	Least Concern
37.	White rumped munia	<i>Lonchura striata</i>	Least Concern
38.	Yellow browed bulbul	<i>Acritillas indica</i>	Least Concern
<b>Reptile</b>			
39.	Garden lizard	<i>Calotes versicolor</i>	Not Evaluated
40.	Rat snake	<i>Pantherophis obsoletus</i>	Least Concern
<b>Amphibian</b>			
41.	Bull frog	<i>Lithobates catesbeianus</i>	Least Concern
42.	Frog	<i>Rana asiatica</i>	Least Concern
43.	Mud skipper	<i>Periophthalmus barbarus</i>	Least Concern
<b>Crustacean</b>			
44.	Crab	<i>Brachyura</i> sps.	-
<b>Gastropods</b>			
45.	Snail	<i>Cornu aspersum</i>	Not Evaluated
<b>Insect</b>			



S. No.	Common Name	Scientific Name	IUCN Category
46.	Beetle	<i>Lamprima aurata</i>	Not Evaluated
47.	Blue tiger	<i>Tirumala limniace</i>	Not Evaluated
48.	Borer	-	Not Evaluated
49.	Jewel Bug	<i>Chrysocoris stollii</i>	Not Evaluated
50.	Bumble bee	<i>Bombus fervidus</i>	Not Evaluated
51.	Chocolate fancy	<i>Appias lycnida</i>	Not Evaluated
52.	Common tiger	<i>Danaus genutia</i>	Not Evaluated
53.	Common zezebel	<i>Delias eucharis</i>	Not Evaluated
54.	Cricket	<i>Gryllides spp.</i>	Not Evaluated
55.	Damsonfly	<i>Enallagma cyathigerum</i>	Not Evaluated
56.	Day moth	<i>Apina callisto</i>	Not Evaluated
57.	Dragonfly	-	Not Evaluated
58.	Egg fly	<i>Hypolimnas bolina</i>	Not Evaluated
59.	Emigrant	<i>Catopsilia pomona</i>	Not Evaluated
60.	Glassy tiger	<i>Parantica aglea</i>	Not Evaluated
61.	Grass hoper	<i>Omocestus viridulus</i>	Not Evaluated
62.	Grass yellow	<i>Eurema hecabe</i>	Not Evaluated
63.	Jay	<i>Cyanocitta cristata</i>	Not Evaluated
64.	Lemon yellow	<i>Papilio demoleus</i>	Not Evaluated
65.	Praying mantis	<i>Mantis religiosa</i>	Not Evaluated
66.	Mormon	<i>Papilio polytes</i>	Not Evaluated
67.	Plant bug	<i>Lygus lineolaris</i>	Not Evaluated
68.	Purple Sunbird	<i>Cinnyris asiaticus</i>	Not Evaluated
69.	Solitary bee	<i>Apis sps</i>	Not Evaluated
70.	Stick insect	<i>Ctenomorphodes chronus</i>	Not Evaluated
71.	Wasp	<i>Vespula vulgaris</i>	Not Evaluated

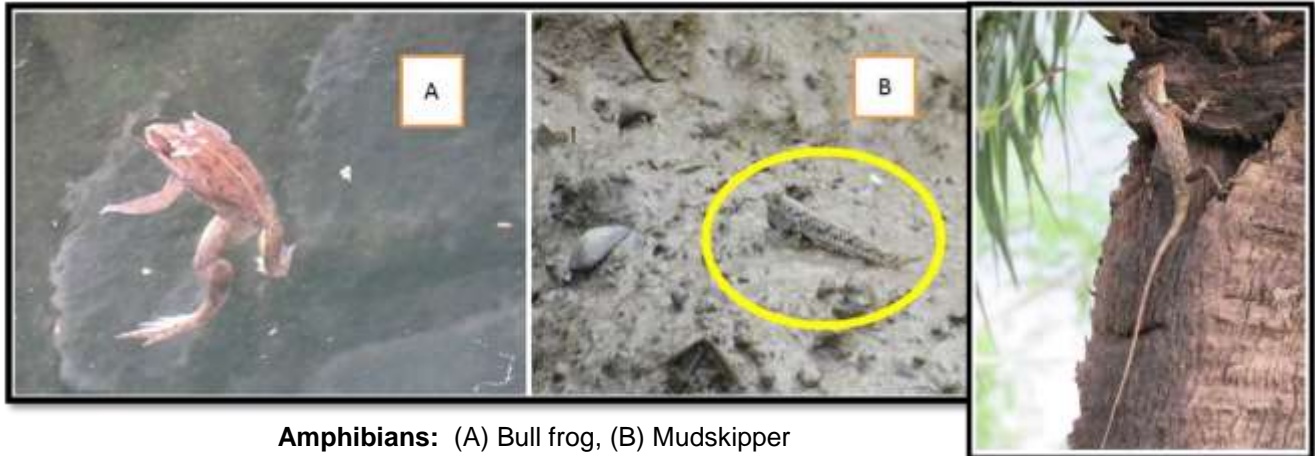
Source: Field Survey carried out by ICT Pvt. Ltd. In 2017-2018



**Butterfly species:** (A) *Parantica aglea*, (B) *Appias lycnida*, (C) *Hypolimnas bolina*, (D) *Delias eucharis* (E) Moth (F) *Catopsilia pomona*



**Bird Species:** (A) *Ardeola ralloides*, (B) *Acridotheres tristis*, (C) *Spilopelia chinensis*, (D) *Ardea intermedia*, (E) *Dicrurus macrocercus* (F) *Ploceus philippinus* (G) *Pycnonotus cafer* (H) *Microcarbo niger*



**Amphibians:** (A) Bull frog, (B) Mudskipper

**Garden Lizard**

The wildlife reported in Dahanu Division are *Panthera pardus* (Leopard), *Felis chaus* (Jungle Cat), *Hyaena hyaena* (Striped Hyena), *Sus scrofa* (Wild Boar), *Presbytis entellus* (Common Langur), *Muntiacus muntjak* (Barking Deer), *Axis axis* (Chital) etc. The wildlife of Dahanu division with conservation status as per Wildlife Protection Act (WPA) and IUCN Red list category is given in the **Table 3-49**.

**Table 3-49 Wildlife of Dahanu Division**

S. No	Scientific Name	Common Name	WPA Status	IUCN Status
<b>Mammals</b>				
1.	<i>Panthera tigris</i>	Tiger	Schedule I	Endangered
2.	<i>Panthera pardus</i>	Panther	Schedule I	Vulnerable
3.	<i>Felis chaus</i>	Wild Cat	Schedule II	Least Concern
4.	<i>Canis lupus</i>	Grey Wolf	Schedule I	Least Concern
5.	<i>Hyaena hyaena</i>	Hyena	Schedule III	Near Threatened
6.	<i>Canis aureus</i>	Golden Jackal	Schedule II	Least Concern
7.	<i>Vulpes bengalensis</i>	Indian Fox	Schedule II	Least Concern
8.	<i>Cuon alpinus</i>	Wild Dog	Schedule II	Endangered
9.	<i>Bos gaurus</i>	Indian Bison	Schedule I	Vulnerable
10.	<i>Melursus ursinus</i>	Bear	Schedule I	Vulnerable
11.	<i>Sus scrofa</i>	Wild Pig	Schedule III	Least Concern
12.	<i>Hystrix indica</i>	Porcupine	Schedule IV	Least Concern
13.	<i>Seiura species</i>	Squirrel	Schedule IV	Not Evaluated
14.	<i>Crocodylus palustris</i>	Alligator	Schedule I	Vulnerable
15.	<i>Rusa unicolor</i>	Sambar	Schedule III	Vulnerable
16.	<i>Axis axis</i>	Spotted Deer	Schedule III	Least Concern
17.	<i>Muntiacus muntjak</i>	Barking Deer	Schedule III	Least Concern
18.	<i>Moschiola indica</i>	Mouse Deer	Schedule I	Least Concern
19.	<i>Boselaphus tragocamelus</i>	Blue Bull	Schedule III	Least Concern
20.	<i>Antilope cervicapra</i>	Black Buck	Schedule I	Least Concern
21.	<i>Tetracerus quadricornis</i>	4 horned Antelope	Schedule I	Vulnerable
22.	<i>Gazella gazella</i>	Mountain gazelle	Schedule I	Endangered
23.	<i>Lepus nigricollis</i>	Common Hare	Schedule IV	Least Concern
<b>Avifauna</b>				
1.	<i>Sarcogyps calvus</i>	Black Vulture	Schedule IV	Critically Endangered
2.	<i>Gyps indicus</i>	Longbilled brown vulture	Schedule I	Critically Endangered
3.	<i>Gyps bengalensis</i>	White Backed Vulture	Schedule I	Critically Endangered
4.	<i>Neophron percnopterus</i>	White Scavenger Vulture	Schedule IV	Endangered
5.	<i>Falco jugger</i>	Laggar Falcon	Schedule IV	Near Threatened
6.	<i>Falco chicquera</i>	Red-headed Falcon	Schedule I	Near Threatened
7.	<i>Cerchoneis tinnunculus</i>	Kestrel	Schedule I	Not Evaluated
8.	<i>Accipiter badius</i>	Shikra	Schedule I	Least Concern
9.	<i>Accipiter nisus</i>	Sparrow Hawk	Schedule I	Least Concern
10.	<i>Aquila rapax</i>	Tawny Eagle	Schedule I	Vulnerable
11.	<i>Neopus malayensis</i>	Black Eagle	Schedule I	Least Concern
12.	<i>Nisaetus bonelli</i>	Creastless Hawk Eagle	Schedule I	Least Concern
13.	<i>Spilornis cheela</i>	Created Tent Eagle	Schedule I	Least Concern
14.	<i>Buteo rufinus</i>	Long Legged Buzzard	Schedule I	Least Concern
15.	<i>Butastur teesa</i>	White Eyed Buzzard	Schedule I	Least Concern
16.	<i>Circus macrourus</i>	Pale Harrier	Schedule I	Near Threatened
17.	<i>Haliastur indus</i>	Brahminy Kite	Schedule I	Least Concern
18.	<i>Milvus govinda</i>	Common Pariah Kite	Schedule I	Least Concern
19.	<i>Strix javanica</i>	Indian Screech Owl	Schedule IV	Not Evaluated



S. No	Scientific Name	Common Name	WPA Status	IUCN Status
20.	<i>Strix candida</i>	Green Owl	Schedule IV	Not Evaluated
21.	<i>Syrnium indrani</i>	Brown Wood Owl	Schedule IV	Least Concern
22.	<i>Bubo bengalensis</i>	Rock Horned Owl	Schedule IV	Least Concern
23.	<i>Carine brama</i>	Spotted Owlet	Schedule IV	Least Concern
24.	<i>Caprimulgus indicus</i>	Jungle Nightjar	Schedule IV	Least Concern
25.	<i>Caprimulgus asiaticus</i>	Common Night jar	Schedule IV	Least Concern
26.	<i>Pelargopsis gural</i>	Brown headed kingfisher	Schedule IV	Least Concern
27.	<i>Halcyon smyrnensis</i>	White breasted kingfisher	Schedule IV	Least Concern
28.	<i>Ceyx tridactyla</i>	Three toed Kingfisher	Schedule IV	Least Concern
29.	<i>Alcedo bengalensis</i>	Common Kingfisher	Schedule IV	Least Concern
30.	<i>Ceryle rudis</i>	Pied Kingfisher	Schedule IV	Least Concern
31.	<i>Psittacula krameri</i>	Rose Ringed Parakeet	Schedule IV	Least Concern
32.	<i>Palacornis purpurens</i>	Ross headed Parakeet	Schedule IV	Not Evaluated
33.	<i>Palacornis columboides</i>	Bule Ringed Parakeet	Schedule IV	Not Evaluated
34.	<i>Picus marathensis</i>	Ross Headed Parakeet	Schedule IV	Least Concern
35.	<i>Picoides arcticus</i>	Black backed woodpecker	Schedule IV	Least Concern
36.	<i>Psilopogon haemacephalus</i>	Coppersmith barbet	Schedule IV	Least Concern
37.	<i>Megalaema inornata</i>	Malber Green Barbet	Schedule IV	Not Evaluated
38.	<i>Psilopogon viridis</i>	Small Green Barbet	Schedule IV	Least Concern
39.	<i>Eudynamys honorata</i>	Indian Koel	Schedule IV	Not Evaluated
40.	<i>Centropus sinensis</i>	Crow Pheasant	Schedule IV	Least Concern
41.	<i>Aethopyga vigorsii</i>	Violert eared sunbird	Schedule IV	Least Concern
42.	<i>Cinnyris asiaticus</i>	Purple Honey Sucker	Schedule IV	Least Concern
43.	<i>Pycnonotus luteolus</i>	White browed Bulbul	Schedule IV	Least Concern
44.	<i>Otocompsa fuscicaudata</i>	Red Whiskered Bulbul	Schedule IV	Least Concern
45.	<i>Melpastes heammorrhous</i>	Common Green Bulbul	Schedule IV	Not Evaluated
46.	<i>Phyllornis malabaricus</i>	Malabar Green Bulbul	Schedule IV	Not Evaluated
47.	<i>Copsychus saularis</i>	Magpie Robin	Schedule IV	Least Concern
48.	<i>Cercotrichas macrura</i>	Shama	Schedule IV	Not Evaluated
49.	<i>Thamnobia fulcata</i>	Indian Black Robin	Schedule IV	Not Evaluated
50.	<i>Pratincola coprata</i>	White Ringed Robin	Schedule IV	Not Evaluated
51.	<i>Pratincola indica</i>	Bush Chat	Schedule IV	Not Evaluated
52.	<i>Pyrrhulanda grisea</i>	Black Bellied Finch Lark	Schedule IV	Not Evaluated
53.	<i>Ploceus indica</i>	Common Weaver Bird	Schedule IV	Not Evaluated
54.	<i>Calandrella brachydactyla</i>	Social Lark	Schedule IV	Least Concern
55.	<i>Spizalanda deva</i>	Small Crested Lark	Schedule IV	Not Evaluated
56.	<i>Spizalanda malabarica</i>	Crowncrest Lark	Schedule IV	Not Evaluated
57.	<i>Croccopus chlorigaster</i>	Pigeon	Schedule IV	Not Evaluated
58.	<i>Streptopelia decaocto</i>	Indian Ringed Dove	Schedule IV	Least Concern
59.	<i>Pavo cristatus</i>	Peacock	Schedule I	Least Concern
60.	<i>Gallus sonneratii</i>	Grey Jungle Fowl	Schedule IV	Least Concern
61.	<i>Galloperdix spadicea</i>	Red Spur Fowl	Schedule IV	Least Concern
62.	<i>Francolinus pictus</i>	Painted Partridge	Schedule IV	Least Concern
63.	<i>Ortigarnis pondicerianus</i>	Grey Partridge	Schedule IV	Least Concern
64.	<i>Perdicula asiatica</i>	Jungle Bush Quail	Schedule IV	Least Concern

S. No	Scientific Name	Common Name	WPA Status	IUCN Status
65.	<i>Perdicula argoondah</i>	Rock Bush Quail	Schedule IV	Least Concern
66.	<i>Perdicula erythrorhyncha</i>	Painted Bush Quail	Schedule IV	Least Concern
67.	<i>Gallinago stenura</i>	Pintail Snipe	Schedule IV	Least Concern
68.	<i>Gallinago gallinago</i>	Common Snipe	Schedule IV	Least Concern
69.	<i>Lymnocyptes minimus</i>	Jack Snipe	Schedule IV	Least Concern
70.	<i>Rynchaea bengalensis</i>	Painted Snipe	Schedule IV	Least Concern
71.	<i>Hydrophasianus chirurgus</i>	Pheasant tailed Jacana	Schedule IV	Least Concern
72.	<i>Parra indicus</i>	Bronze winged Jacana	Schedule IV	Least Concern
73.	<i>Gallinula chloropus</i>	Common Moorhen	Schedule IV	Least Concern
74.	<i>Dissura episorpa</i>	White Necked Stork	Schedule IV	Vulnerable
75.	<i>Ardea purpurea</i>	Purple Heron	Schedule IV	Least Concern
76.	<i>Ardea torra</i>	Purple Honey	Schedule IV	NA
77.	<i>Herodica torra</i>	Small White Heront	Schedule IV	NA
78.	<i>Ardeola grayii</i>	Indian Pond Heron	Schedule IV	Least Concern
<b>Reptiles</b>				
1.	<i>Ahaetulla nasuta</i>	Green Whipsnake	Schedule IV	Least Concern
2.	<i>Amphiesma stolatum</i>	Buff striped keelback	Schedule IV	Least Concern
3.	<i>Argyrogena fasciolatus</i>	Fasciolated Red Snake	Schedule IV	Least Concern
4.	<i>Bendrilaphis tristis</i>	Common Bronzeback	Schedule IV	Least Concern
5.	<i>Bungarus caeruleus</i>	Common Indian Krait	Schedule IV	Least Concern
6.	<i>Calotes versicolor</i>	Common garden lizard	Schedule II	Not assessed
7.	<i>Chameleon zeylanicus</i>	Indian Chameleon	Schedule II	Least Concern
8.	<i>Crocodylus palustris</i>	Indian Crocodile	Schedule I	Vulnerable
9.	<i>Daboia russellia</i>	Russell's Viper	Schedule II	Least Concern
10.	<i>Echis carinatus</i>	Saw Scaled Viper	Schedule II	Least Concern
11.	<i>Eryx conicus</i>	Common Sand Boa	Schedule IV	Least Concern
12.	<i>Eryx Johnii</i>	Blunt Tailed Sand Boa	Schedule IV	Least Concern
13.	<i>Lepidochelys olivacea</i>	Olive Ridley Turtle	Schedule I	Vulnerable
14.	<i>Lycodon capucinus</i>	Common Wolf Snake	Schedule IV	Least Concern
15.	<i>Macropisthodon plumbicolor</i>	Green Keelback	Schedule IV	Least Concern
16.	<i>Melanochelys trijuga</i>	Indian Pond Terrapin	Schedule IV	Near Threatened
17.	<i>Naja naja</i>	Indian Cobra	Schedule II	Data Deficient
18.	<i>Ptyas mucosus</i>	Common Rat Snake	Schedule II	Least Concern
19.	<i>Varanus bengalensis</i>	Indian Monitor	Schedule I	Least Concern

Source: Working Plan for the Forests of Dahanu Forest Division for the Period 2010-11 to 2019-2020

Human – wildlife conflicts have been reported in the area, there are incidences of cattle lifting by Leopard. Movement of Leopard reported in the study area. Damage to crops by wild boars also reported. Domestic animals comprises of goat, cow, ox and poultry animals. The local inhabitants of the area rear large herds of cattle and goats for livelihood.

### 3.14.8 Protected Areas

“Wildlife Protection Act (1972) defines protected areas (PA) as an area declared legally protected by government under the Wildlife Protection Act”. National Parks, Sanctuaries, Conservation Reserves and Community Reserves are the PA's notified under the



Wildlife Protection Act (1972). The proposed Expressway does not pass through any National Park, Wildlife Sanctuary or Conservation Reserve as per Wildlife Conservation Act, 1972. Map showing protected areas within 15 km radius of the proposed expressway alignment (**Figure 3-16**) is given at the end of this chapter.

### ***Tungareshwar Wildlife Sanctuary (TWLS)***

The TWLS is located between longitudes 72°52' E to 73°E and latitude 19°17'N to 19°28' N, in Palgarh and Thane district within 10 km corridor of the expressway alignment. The proposed expressway does not pass through the Wildlife Sanctuary and is located at a distance of **1.28 km** from the boundary of the Sanctuary. Total notified area of TWLS is 85.70 sq.km as declared by Maharashtra Government Resolution No.WLP 10-02/CR-47/F-1 dated 24<sup>th</sup> October, 2003. The terrain of TWLS is mainly hilly and undulating. The area protects the catchments of Pelahar dam, Juchandra M.I. Tank which supplies water to Vasai and Nallasopara area of Vasai Virar Municipal Corporation.

As per classification of forest types of India by Champion and Seth, the forests of TWLS represent Southern Moist Teak Bearing Forests, Southern Moist Mixed Deciduous Forest and Western Sub-tropical Hill Forests. TWLS important habitat for mammalian species like leopard (*Panthera pardus* - Bibtya), wild boar (*Sus scrofa* – Raan Dukkar), four headed antelope (*Tetracero quadricornis* - Bhekar), blacknaped hare (*Lepus nigricollis*), wild cat (Raanmanjar), jackals (Kolha), porcupines (salu), bonnet macaques (Makad), etc. The fauna of the sanctuary comprise of 43 species of mammals, 38 reptiles, 9 amphibians and 250 birds (source: Management Plan for TWLS, 2018-19 to 2027 -28). Reptiles of the tract are Indian pond terrapin (Kasav), common garden lizard, Indian chameleon (*Chameleon zeylanicus*), ghorpud (*Varanus bengalensis*), rough-scaled sand boa (*Eryxconisus*), durkyaghoonas (*Lycodon aulicus*), striped keelback (*Amphiesma stolata*), dhaman (*Ptays mucosus*), common Indian krait (*Bungarum caeruleus*), Indian cobra, Indian rock python, viper, etc. Seven species of bats are reported (Ref: Brosset, 1962). The complete list of Fauna of TWLS is attached as **Annex-3.8**.

Ancient Tungareshwar Mahadev temple, Parashuram kund, Ishwarpuri Mahadev Mandir are located within the wildlife sanctuary. Lakhs of pilgrims visit Tungrashwer Mahedev Temple during Maha Shivratri and auspicious Shravan month. Major Threat to the TWLS are:

- Poaching of wild pigs is a problem in the area. Poaching is mostly done for wild pig for meat for local consumption.
- Illicit cutting of trees
- Illegal removal of Non Timber Forest Produce
- Wild Fires
- Threats from quarries
- NH 8 runs parallel to the sanctuary there have been leopard and other Wild animal deaths on this Highway

Government of India, vide Gazettee Notification [S.O. 3250(E)] dated 11<sup>th</sup> September 2019 finalized the Eco-sensitive Zone (ESZ) of the Tungareshwar Wildlife Sanctuary and the ESZ shall be to an extent of 100 meters to 4.0 kilometers around the boundary of the Sanctuary and the area of the ESZ is 67.26 square kilometres. **The alignment of proposed expressway is located at a distance of 0.456 km from the notified ESZ boundary (Figure 3-16) i.e. outside the ESZ.**

As per MoEFCC Office Memorandum dater 8<sup>th</sup> August 2019 (F. No. 22-43/2018-IA.III), *“Proposal involving developmental activity / project located outside the stipulated boundary limit of notified ESZ and located within 10km of National Park / Wildlife Sanctuary, **prior clearance from Standing Committee of the National Board for Wildlife may not be applicable.** However, such proposal from environmental angle including impact of developmental activity / project on the wildlife habitat, if any, would be examined by the sector specific Expert Appraisal Committee and appropriate conservation measures in the form of recommendations shall be made. These recommendations shall be explicitly mentioned in the environmental clearance later and shall be ensured by the member secretary concerned.”*

#### **Dadra and Nagar Haveli (DNH) Wildlife Sanctuary**

The DNH WLS is situated in the union territory of Dadra & Nagar Haveli and spread across 91.39 sq.km. The Wildlife Sanctuary is located on North – East side of end chainage of proposed expressway at a distance of **4.57 km**. The extent of Eco-Sensitive Zone of the sanctuary is 100m on all side. **The alignment of proposed expressway does not pass through the DNH Wildlife sanctuary and it's ESZ.**

As per the classification of Champion and Seth, the forests of this territory fall under south Indian tropical moist (mixed) deciduous forest. Teak and Khair are the predominant species found in the tract. The Sanctuary is rich in faunal diversity like Panther (*Panthera pardus*), Hyaena (*Hyaena hyaena*), Fox (*Vulpes bengalensis*), Wild-Cat (*Felis chaus*), Four Horned Antelope (*Tetracerus quadricornis*), Jackal (*Canis aureus*), Nilgai (*Boselaphus tragocamelus*), Sambar Deer (*Rusa unicolor*) and Chital Deer (*Axis axis*) and several bird species like Black Drongo (*Dicrurus macrocercus*), Bulbul (*Pycnonotus cafer*), Kingfisher (Alcedines), Egret (Ardeidae), Hoopoe (*Upupa epops*), Myna (*Acridotheres tristis*), Heron (Ardeidae), Red Jungle Fowl (*Gallus gallus*).

#### **3.14.9 Dahanu Taluka Ecologically Sensitive Area**

In exercise of powers conferred by clause (v) of sub-section (2) of section 3 of the Environment (Protection) Act, 1986, the Central Government, in consultation with the Government of Maharashtra, declared Dahanu Taluka as Ecologically Sensitive Area (DTESA) on 20<sup>th</sup> June, 1991. The objective of DTESA was protection and conservation of the ecologically fragile area and to impose restrictions on the setting up of industries which have detrimental effect on the environment. Subsequently, pursuant to the direction of Hon'ble Supreme Court, MoEFCC vide its Notification No. S.O. 884 (E), dated 19<sup>th</sup> December, 1996, has constituted an Authority known as “Dahanu Taluka Environment Protection Authority (**DTEPA**)” in the State of Maharashtra, for protection of fragile ecology of Dahanu Region.

The stretch of proposed expressway traversing through Dahanu Taluka is from proposed km 68+455 to Km 96+200 covering 27.745 km. Main features of Dahanu taluka are:

- Criss crossing drainage and creeks network
- Poor land capability, land has severe limitations for cultivation due to the topographic condition and soil characteristics
- Rich forest resources
- Successful horticulture- mainly chikoo cultivation
- Large tribal population requiring socio- economic security

Restrictions were imposed on the setting up of industries categorized as ‘Red’ which included large-scale polluting or hazardous industries. Construction of New Highway is classified as “Orange” Category as per CPCB classification March, 2016.

Clearance for development of the expressway in Dahanu Taluka will be obtained from DTEPA and recommendations provided by the authority will be implemented by the NHAI.

### 3.14.10 Conclusion

The phytosociological studies conducted in the study area revealed the predominance of tree species like *Tectona grandis*, *Terminalia tomentosa*, *Phoenix dactylifera*, *Bombax ceiba* and *Butea monosperma*. Fruit bearing trees are present in large numbers. The under story species consist of shrubby and herbaceous vegetation like *Euphorbia neriifolia*, *Holorina antidysenterica*, *Leea indica*, *Calotropis gigantea*, *Costus speciosus* and *Jatropha curcas.*, *Cassia tora*, *Celosia argentea tinctoria*, *Sida acuta*, *Ludwigia peruviana*, *Elephantopus scaber* etc. The assessment of diversity index revealed that species diversity exhibited higher values for Trees. The direct impact due to the development of the project will be on agricultural land with large number of fruit trees and on forestland. Felling of trees will impact the water recharge capacity, microclimate, soil quality and fauna dwelling in the area.

The fauna of the project area comprised of Schedule-I and threatened species such as *Panthera pardus*, *Felis chaus*, *Tragulus meminna*, *Axis axis*, *Sus scrofa*, *Antilope cervicapra*, *Muntiacus muntjak*, *Accipiter badius*, *Gyps bengalensis*, *Haliaeetus leucogaster* etc. Fauna dwelling will be directly impacted due to loss of habitat. Impact on fauna will be during construction and operation phase which include restriction in movement, disturbance due to noise, competition for resources, man animal conflicts, road kills and injuries etc.

### 3.15 COASTAL REGULATION ZONE (CRZ)

The proposed expressway passes through the intertidal zone of Vaitarna River. CRZ map and report was prepared by the National Centre for Earth Science Studies (NCESS), Thiruvananthapuram in October 2015. NCESS has revised the CRZ map and report (draft available, final awaited) based on the new CRZ classification as per CRZ Notification, 2019 and recently approved Coastal Zone Management Plan (CZMP) of Thane and Palghar district by MoEFCC on 28.02.2019.

Based on the Draft Map prepared by the NCESS, location and length in CRZ along the expressway is given in **Table 3-50** and classification of CRZ area is given in **Table 3-51**. This may be changed/ updated in the Final CRZ map and report, which will be incorporated in this report upon receipt of the same. CRZ application can be submitted after Final CRZ Map & Report are available.

**Table 3-50 Length of Expressway in CRZ (Tentative)**

Proposed Ch. Km		Length (Km)	Village	River
From	To			
28+300	28+500	0.200	Doliv	Vaitarna River
29+991	30+374	0.383		
30+540	30+854	0.314		
30+854	32+056	1.202	Wadhiv & Navghar	
35+325	36+020	0.695	Penand & Sonave	
44+828	45+264	0.436	Sakhare & Khamloli	
<b>Total</b>		<b>3.230</b>		

Source: Draft CRZ Map prepared by NCESS

Note: to be updated after finalization of CRZ Map & Report

**Table 3-51 Break-up CRZ area with Classification (Tentative)**

Description	CRZ IA	CRZ IB	CRZ II	CRZ III	CRZ IV B	Grand Total
Doliv Village	0.1563	1.8691	3.7068	-	-	5.7322
Wadhiv Village	1.0347	0.5688	-	1.0306	-	2.6341
Navghar Village	1.1634	0.9162	-	1.2813	-	3.3609
Penand Village	0.1506	0.7004	-	2.7783	-	3.6293
Sonave Village	0.0058	0.8291	-	2.1091	-	2.944
Sakhare Village	-	0.919	-	1.031	-	1.95
Khamloli Village	-	0.3796	-	1.2172	-	1.5968
Vaitarna River	-	-	-	-	10.9942	10.9942
<b>Grand Total</b>	<b>2.5108</b>	<b>6.1822</b>	<b>3.7068</b>	<b>9.4475</b>	<b>10.9942</b>	<b>32.8415</b>

Source: Draft CRZ Map prepared by NCESS

Note: to be updated after finalization of CRZ Map & Report

### 3.16 ARCHAEOLOGICAL SITES

There are no archaeological sites within 300 m on either side of the proposed expressway.

### 3.17 ENVIRONMENTALLY SENSITIVE RECEPTORS

**Educational Institutions:** there are 50 educational institutions within 500m from the centre line on either side of the proposed expressway. Chainage wise list of educational institutions along with it's location, side and distance from the proposed center (C/L) line of the expressway are given in **Table 3-52**.

**Table 3-52 List of Educational Institutions along the alignment of Proposed Expressway**

SL. No.	Description	Chainage	Side	Dist. From Proposed C/L (m)	Village
1.	Primary School (Talyachyapada)	27+350	RHS	69.1	Koshimbe
2.	Upper Primary School	28+800	RHS	258.9	Khardi
3.	Upper Primary School, Navghar	32+300	RHS	270.9	Navghar
4.	Primary School, Ghateem	33+400	LHS	336.6	Ghateem
5.	Primary School (Talekhalpada)	34+500	RHS	296.4	Ghateem
6.	Primary School	34+950	LHS	477.7	Penand
7.	Secondary School	38+500	RHS	273.4	Pargaon
8.	Higher Secondary School	39+180	RHS	265.5	Pargaon
9.	Primary School	40+360	RHS	363.6	Girale
10.	Primary School	46+250	LHS	402.2	Khamloli
11.	Primary School	46+600	RHS	431.5	Bahodoli
12.	Higher Secondary School	46+680	RHS	332.8	Bahodoli
13.	Primary School (Divakarpada)	47+530	RHS	405.3	Bahodoli
14.	Primary School (Ranolipada)	48+290	LHS	295.5	Dhuktan
15.	Primary School	48+900	RHS	437.3	Dhuktan
16.	Secondary School	50+850	LHS	470.7	Maswan
17.	Primary School	51+490	LHS	401.1	Maswan
18.	Primary School	52+300	RHS	267.5	Wandivali
19.	Primary School (Moripada)	53+380	LHS	178.4	Katale
20.	Primary School (Kolhemalpada)	55+170	LHS	86.2	Katale
21.	Primary School (Tandelpada)	56+000	RHS	164.2	Lovare
22.	Primary School	57+350	RHS	495.2	Nihe
23.	Primary School	59+610	RHS	178.7	Nagzari
24.	Primary School	60+275	LHS	323.2	Lalonde
25.	Late Sau Vidya Vinod Adhikari Vidyalyay	60+370	RHS	73.3	Lalonde
26.	Primary School	62+400	LHS	209.7	Kirat
27.	Upper Primary School	65+150	RHS	120.9	Ravte
28.	Primary School (Titwalipada)	67+320	LHS	241.1	Chinchare
29.	Primary School	67+550	RHS	489.9	Chinchare
30.	Primary School	69+210	RHS	195.9	Dhabon
31.	Primary School (Pilenapada)	70+200	RHS	316.3	Dhabon
32.	Primary School (Patilpada)	71+240	RHS	157.1	Dhabon
33.	Upper Primary School	72+420	LHS	349.3	Aine
34.	Primary School	72+725	LHS	374.3	Aine
35.	Primary School (Bodanpada)	74+018	RHS	221.0	Rankol
36.	Primary School (Pardhipada)	74+735	RHS	333.3	Rankol
37.	Primary School (Raytali-Gadgpada)	76+310	LHS	240.6	Chandwad
38.	Primary School (Divarpada)	77+800	LHS	450.1	Ganjad
39.	Primary School (Kohralipada)	78+965	LHS	151.1	Navnath
40.	Primary School (Thakarpada)	82+010		1.0	Ganeshbagh
41.	Primary School (Ibhabpada)	85+615	RHS	163.6	Dhaniwari



SL. No.	Description	Chainage	Side	Dist. From Proposed C/L (m)	Village
42.	Primary School	85+700	LHS	150.4	Dhaniwari
43.	Primary School, (Khadkipada)	87+950	RHS	394.6	Chinchale
44.	Primary School (Basarpada)	88+080		0.3	Chinchale
45.	Primary School (Bhonarpada)	88+225	LHS	358.1	Nagzari
46.	Primary School (Randolpada)	89+435	RHS	236.7	Chinchale
47.	Primary School	90+540	LHS	372.1	Talotha
48.	Primary School	92+618	RHS	290.6	Bramhanwadi
49.	Primary School, (Sonarpada)	97+000	RHS	230.6	Vadavali
50.	Upper Primary School (Bobapada)	102+400	RHS	50.2	Talasari

Source: Field Survey carried out by ICT

**Medical Facilities:** there are 7 primary health centre within 500m from the centre line on either side of the proposed expressway. Chainage wise list of medical facilities along with it's location, side and distance from the proposed center (C/L) line of the expressway are given in **Table 3-53**.

**Table 3-53 List of Medical Facilities along the alignment of Proposed Expressway**

SL. No.	Description	Chainage	Side	Dist. From Proposed C/L (m)	Village
1.	Primary Health Centre	29+000	RHS	225.6	Khardi
2.	Primary Health Centre	39+117	RHS	284.5	Paragon
3.	Primary Health Centre	48+590	RHS	306.9	Dhuktan
4.	Primary Health Centre	55+265	LHS	118.6	Katale
5.	Primary Health Centre	64+250	RHS	144.7	Borsheti
6.	Primary Health Centre	72+500	LHS	358.1	Aine
7.	Primary Health Centre	78+700	RHS	119.9**	Ganjad

Source: Field Survey carried out by ICT

Note: Located within outer boundary of the proposed Junction, but could be saved

### 3.18 SOCIO-ECONOMIC PROFILE

Main demographic features of the project impacted district have been presented in this section. The description of socio-economic features of the district and project affected villages through which the greenfield expressway traverses, comprises the demographic, social and economic aspect of the population, which includes the features of population distribution, density of population, workforce and share of workers in major economic categories and the vulnerable groups.

#### 3.18.1 Demographic Features of Project Influence District

The proposed expressway is passing through 4 talukas (Vasai, Palghar, Dahanu and Talasari) of **Palghar district** in the state of Maharashtra. On 1<sup>st</sup> August 2014, the Maharashtra State Government announced the formation of the 36<sup>th</sup> district of Maharashtra, when a new Palghar District was carved out of the Thane district. Palghar District starts from Dahanu at the north and ends at Naigaon. It comprises the talukas of

Palghar, Vada, Vikramgad, Jawhar, Mokhada, Dahanu, Talasari and Vasai-Virar. The district is bounded by Thane and Nashik Districts on the east and north-east, and by Valsad District of Gujarat State and Union Territory of Dadra and Nagar Haveli on the north. The Arabian Sea forms the western boundary, while Vasai-Virar is part of Mumbai Metropolitan Region.

**Transport:** The Western Railway network passes through Vasai, Palghar and Dahanu talukas of the district. Palghar is well connected to the major cities of the country through rail and road network. The nearest Airport is Chhatrapati Shivaji International Airport, Mumbai and distance is approx. 102 km from Palghar.

**Agriculture:** In Palghar district agriculture is a primary source of livelihood activity. The district is predominantly rain-fed and receives an annual rainfall of more than 2500 mm, but steep slopes and rocky terrain results in poor water retention. The major field and horticultural crops grown in the district are Paddy, Millet, Ragi, Sapota / Chickoo, Mango, Coconut and Cashew.

**Economy:** Palghar has India's first atomic power plant located at Tarapur. The industrial town of Boisar is home to one of Maharashtra's largest industrial area at Tarapur MIDC. Maharashtra's largest fishing port Satpati is located in Palghar. Dahanu is best known for their chickoo production in the whole of India.

**Tourism:** Important tourist destinations in the district are Jawhar Rajwada, Arnala Fort, Vasai Fort, Tarapur Fort, Kelva Fort, Shirgaon Fort etc.

**Population:** In the 2011 Census, Palghar district had a total population of 2,990,116 out of which, no. of male is 1,545,779 and no. of female is 1,444,337. Palghar has an urban population of 1,435,210 that is 48% of total population. Total ST population of the district is 1,118,008, which is 37.39% of the total population.

**Population Density:** The district has been incorporated on 1<sup>st</sup> August 2014. Hence, decadal comparison is not available. However, the present density of the Palghar district is 578/ km<sup>2</sup> which are greater than the state (370/ km<sup>2</sup>).

**Literacy Rate:** literacy rate of Palghar district is 66.65%. Maximum literacy rate is observed in Vasai Taluka (76.94%) where ST population is minimum (7.32%). Minimum literacy rate is observed in Mokhada Taluka (46.54%) where ST population is maximum (92.08%).

It can be concluded from **Table 3-54** that literacy rate is low in tribal dominated talukas (Dahanu, Talasari, Jawhar, Mokhada and Vikramgad). Literacy rate in Dahanu taluka is cooperatively better in comparison to other tribal dominated talukas due to it's locational advantage and better infrastructural facility. The reason behind low literacy rate in Talasari, Jawhar, Mokhada and Vikramgad talukas are non-availability of proper schools, basic infrastructural and transport facility.

**Table 3-54 Total Population, ST Population and Literacy Rate in Palghar District**

Sr. No.	Tehsil	Total Villages	Villages in Scheduled Area	Total Population			ST Population	% of ST Population	Literacy Rate (%)
				Male	Female	Total			
1	Vasai	125	51	709,771	633,631	1343,402	98,298	7.32	76.94
2	Palghar	222	164	288,514	261,652	550,166	168,152	30.56	70.49
3	Dahanu	183	183	199,574	202,521	402,095	277,904	69.11	51.15
4	Talasari	46	46	76,417	78,401	154,818	140,273	90.61	47.33
5	Jawhar	109	109	69,333	70,854	140,187	128,462	91.64	47.88
6	Mokhada	59	59	41,691	41,762	83,453	76,842	92.08	46.54
7	Vikramgad	94	94	68,489	69,136	137,625	126,368	91.82	53.60
8	Wada	170	170	91,990	86,380	178,370	101,709	57.02	63.15
	<b>Total</b>	<b>1008</b>	<b>876</b>	<b>1,545,779</b>	<b>1,444,337</b>	<b>2,990,116</b>	<b>1,118,008</b>	<b>37.39</b>	<b>66.65</b>

Source: <https://palghar.gov.in/about-district>

### 3.18.2 Socio Economic Profile of the Project Area

Social and demographic profile of the project-affected villages / population is essential to create database and develop indicators for the evaluation of the social impacts. To understand the social context of the proposed project and for providing necessary inputs for social analysis, relevant baseline data on social, economic and cultural conditions were collected from various available primary and secondary sources. The proposed expressway passes through **51 villages** in **Palghar district**, in the State of Maharashtra. The important demographic features of those villages, i.e., population, social categories, literacy level and workforce are described as a part of baseline data in the following section.

**Total Population:** The population composition of the villages is important to anticipate the extent of project impact. Population details of the 51 villages have been derived from primary census abstract 2011 and total population is 85,476, out of which 42,390 are male and 43,086 are female. Village wise composition of population with respect to male and female is shown in **Table 3-55**.

**Tribal Population:** Total tribal population of 51 villages is 66,819 (Scheduled Cast – 1,123 and Scheduled Tribes – 65,696), which is 78.2% of the total population. As per Census of India, 2011, 100% population of Chandwad village is Scheduled Tribes. Out of 51 villages, maximum tribal population is observed in Vadavali village (5375 nos.) and in 24 villages, tribal population is more than 90%. Village wise details of SC & ST population is presented in **Table-3-55**.

**Literacy Rate:** Among 51 villages, highest literacy rate is observed in Nagaze village of Palghar Taluka (male – 92.02%, female – 78.88%). Lowest literacy rate among male observed in Dhaniwari village (44.01%) of Dahanu Taluka and among female observed in Ganeshbag village (18.52%) of Dahanu Taluka. In Dhaniwari and Ganeshbag village, tribal population is more than 99% (**Table-3-55**). Overall literacy levels among tribals are lower than that of the general population.

**Table 3-55 Village wise Total Population, Tribal Population and Literacy Rate**

Sr. No	Taluka	Village	Total Population			Tribal Population				Literacy Rate	
			Male	Female	Total	SC	ST	Total	% of Total Population	Male (%)	Female (%)
1	Vasai	Koshimbe	As per PCA 2011, Population of Koshimbe village has been included in the Vasai-Virar City Municipal Corporation								
2		Khardi	655	638	1293	0	60	60	4.6	90.53	65.80
3		Doliv	345	345	690	0	2	2	0.3	83.60	64.24
4	Paighar	Wadhiv Saravali	396	376	772	0	0	0	0	91.87	71.55
5		Navghar	594	585	1179	4	309	313	26.5	86.84	72.93
6		Ghatim	342	367	709	0	387	387	54.6	79.17	66.56
7		Penand	615	591	1206	0	1113	1113	92.3	78.66	59.88
8		Sonave	1348	1302	2650	16	1900	1916	72.3	73.52	51.34
9		Pargaon	798	799	1597	35	430	465	29.1	86.86	75.32
10		Girale	489	461	950	51	397	448	47.2	77.30	61.79
11		Nagaze	261	281	542	0	16	16	3.0	<b>92.02</b>	<b>78.88</b>
12		Navje	997	1001	1998	11	754	765	38.3	85.42	67.44
13		Sakhare	820	832	1652	14	737	751	45.5	84.19	66.12
14		Dahisar T. Manor	1267	1290	2557	83	1481	1564	61.2	75.18	58.37
15		Khamlioli	769	765	1534	17	574	591	38.5	81.28	64.33
16		Dhuktan	1410	1440	2850	86	2174	2260	79.3	81.02	60.67
17		Gowade	521	521	1042	19	623	642	61.6	82.92	69.93
18		Maswan	825	842	1667	33	1249	1282	76.9	79.92	70.46
19		Wandivali	265	279	544	0	523	523	96.1	69.47	45.02
20		Wakadi	162	149	311	18	286	304	97.7	83.70	72.22
21		Wasaroli	123	109	232	6	200	206	88.8	88.42	68.32
22		Katale	634	607	1241	13	489	502	40.5	82.57	65.96
23		Loware	563	555	1118	11	651	662	59.2	77.04	61.76
24		Nihe	1147	1099	2246	0	1592	1592	70.9	70.97	48.14
25		Nagzari	964	847	1811	75	685	760	42.0	83.63	69.34
26		Lalonde	690	797	1487	45	882	927	62.3	76.21	47.48
27		Kirat	878	839	1717	0	1393	1393	81.1	68.72	46.37
28		Borsheti	974	975	1949	0	1641	1641	84.2	67.64	41.56
29		Ravate	472	455	927	0	868	868	93.6	63.97	42.11
30		Chinchare	461	452	913	0	909	909	99.6	58.29	36.52
31		Dahanu	Dhabon	1742	1702	3444	10	3335	3345	97.1	58.74
32	Aine		657	698	1355	1	1273	1274	94.0	56.78	30.64
33	Rankol		1436	1481	2917	0	2508	2508	86.0	64.45	42.80
34	Chandwad		622	660	1282	0	<b>1282</b>	<b>1282</b>	<b>100.0</b>	49.90	31.41
35	Navnath		821	930	1751	3	1522	1525	87.1	48.34	23.41
36	Ganjad		954	1012	1966	1	1782	1783	90.7	70.73	52.78
37	Somnath		989	951	1940	0	1938	1938	99.9	51.90	27.79
38	Ganeshbag		673	692	1365	4	1352	1356	<b>99.3</b>	48.89	<b>18.52</b>
39	Awadhani		1027	1110	2137	0	2126	2126	99.5	52.40	21.83

Sr. No	Taluka	Village	Total Population			Tribal Population				Literacy Rate	
			Male	Female	Total	SC	ST	Total	% of Total Population	Male (%)	Female (%)
40		Dhaniwari	655	735	1390	0	1389	1389	99.9	44.01	25.04
41		Chinchale	749	700	1449	0	1379	1379	95.2	67.39	46.01
42		Taloth	238	291	529	0	528	528	99.8	56.02	24.11
43		Punjave	232	235	467	6	458	464	99.4	55.38	39.29
44		Bramhanwadi	430	441	871	0	855	855	98.2	57.54	29.51
45		Vankas	1903	2116	4019	0	4005	4005	99.7	47.68	22.97
46	Talasari	Vadavali	2783	3108	5891	21	5354	5375	91.2	69.42	44.76
47		Sawane	1652	1356	3008	0	2967	2967	98.6	66.69	27.17
48		Kawad	1495	1632	3127	0	3116	3116	99.6	54.85	29.53
49		Awarpada	767	795	1562	540	1018	1558	99.7	54.21	32.36
50		Talasari	2166	2208	4374	0	4009	4009	91.7	56.55	33.35
51		Ibhadpada	614	634	1248	0	1175	1175	94.2	61.95	38.00
<b>Total / Overall</b>			<b>42,390</b>	<b>43,086</b>	<b>85,476</b>	<b>1,123</b>	<b>65,696</b>	<b>66,819</b>	<b>78.2</b>	-	-

Source: Census of India, 2011

**Workforce in Project Area:** In general, majority of work force belongs to the category of main workers followed by the category of marginal workforce. However, in some villages, numbers of marginal workers are more in comparison to main workers. Village wise details of workforce are presented in **Table 3-56**.

**Table 3-56 Workers in the Project Area**

Sr. No	Taluka	Village	Main Workers			Marginal Worker			Total Workers		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
1	Vasai	Koshimbe	As per PCA 2011, Population of Koshimbe village has been included in the Vasai-Virar City Municipal Corporation								
2		Khardi	152	123	275	29	34	63	181	157	338
3		Doliv	210	147	357	8	30	38	218	177	395
4	Paighar	Wadhiv Saravali	255	12	267	4	1	5	259	13	272
5		Navghar	50	7	57	280	45	325	330	52	382
6		Ghatim	147	58	205	71	43	114	218	101	319
7		Penand	265	94	359	100	214	314	365	308	673
8		Sonave	596	317	913	141	249	390	737	566	1303
9		Pargaon	343	131	474	191	233	424	534	364	898
10		Girale	265	105	370	6	2	8	271	107	378
11		Nagaze	99	13	112	61	14	75	160	27	187
12		Navje	457	212	669	129	162	291	586	374	960
13		Sakhare	268	125	393	259	294	553	527	419	946
14		Dahisar T. Manor	613	514	1127	175	190	365	788	704	1492
15		Khamloli	448	410	858	7	1	8	455	411	866
16		Dhuktan	484	121	605	342	333	675	826	454	1280
17		Gowade	158	87	245	128	124	252	286	211	497
18		Maswan	284	117	401	216	249	465	500	366	866



Sr. No	Taluka	Village	Main Workers			Marginal Worker			Total Workers			
			Male	Female	Total	Male	Female	Total	Male	Female	Total	
19		Wandivali	141	110	251	3	2	5	144	112	256	
20		Wakadi	6	6	12	88	30	118	94	36	130	
21		Wasaroli	58	23	81	5	9	14	63	32	95	
22		Katale	361	113	474	9	44	53	370	157	527	
23		Loware	283	176	459	57	151	208	340	327	667	
24		Nihe	659	582	1241	11	9	20	670	591	1261	
25		Nagzari	219	60	279	172	153	325	391	213	604	
26		Lalonde	400	226	626	42	63	105	442	289	731	
27		Kirat	434	310	744	45	117	162	479	427	906	
28		Borsheti	478	169	647	44	141	185	522	310	832	
29		Ravate	268	263	531	11	7	18	279	270	549	
30		Chinchare	218	211	429	20	21	41	238	232	470	
31		Dahanu	Dhabon	721	689	1410	199	148	347	920	837	1757
32			Aine	307	230	537	38	36	74	345	266	611
33	Rankol		438	491	929	139	155	294	577	646	1223	
34	Chandwad		309	334	643	42	38	80	351	372	723	
35	Navnath		358	373	731	11	33	44	369	406	775	
36	Ganjad		263	101	364	124	207	331	387	308	695	
37	Somnath		458	439	897	16	26	42	474	465	939	
38	Ganeshbag		197	180	377	168	214	382	365	394	759	
39	Awadhani		569	449	1018	79	241	320	648	690	1338	
40	Dhaniwari		328	352	680	2	11	13	330	363	693	
41	Chinchale		141	167	308	72	90	162	213	257	470	
42	Talotha		143	192	335	13	6	19	156	198	354	
43	Punjave		132	141	273	0	2	2	132	143	275	
44	Bramhanwadi		159	6	165	78	246	324	237	252	489	
45	Vankas		580	400	980	384	708	1092	964	1108	2072	
46	Talasari		Vadavali	718	504	1222	536	679	1215	1254	1183	2437
47			Sawane	485	177	662	136	304	440	621	481	1102
48		Kawad	696	631	1327	88	13	101	784	644	1428	
49		Awarpada	141	27	168	271	154	425	412	181	593	
50		Talasari	659	296	955	362	478	840	1021	774	1795	
51		Ibhadpada	278	200	478	38	117	155	316	317	633	
			16,699	11,221	27,920	5,450	6,871	12,321	22,149	18,092	40,241	

Source: Census of India, 2011

**Category wise Distribution of Main Workforce:** Agriculture does play an important sector in engaging the workforce in the project area. It is evident from the **Table 3-57** that majority of main workers are cultivators (42.8%) followed by agricultural labours (33.2%), other workers (22.0%) and only 2.0% population are engaged in household industry such as handloom, weaving, biri rolling, papad making, toy making, etc.

**Table 3-57 Village and Category wise Distribution of Main Workforce**

Village	Cultivators			Agricultural Laborers			Household Industries			Other Workers			Total Main Workers
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
Koshimbe	Population of Koshimbe village has been included in the Vasai-Virar City Municipal Corporation												-
Khardi	117	111	228	6	6	12	6	0	6	23	6	29	275
Doliv	17	22	39	4	1	5	95	73	168	94	51	145	357
Wadhiv Saravali	30	7	37	65	39	104	8	7	15	90	21	111	267
Navghar	1	1	2	0	0	0	2	1	3	47	5	52	57
Ghatim	41	15	56	50	22	72	0	0	0	56	21	77	205
Penand	85	35	120	103	31	134	8	7	15	69	21	90	359
Sonave	201	31	232	233	196	429	3	2	5	159	88	247	913
Pargaon	133	48	181	89	40	129	22	17	39	99	26	125	474
Girale	119	65	184	113	30	143	1	1	2	32	9	41	370
Nagaze	1	1	2	0	1	1	3	0	3	95	11	106	112
Navje	193	86	279	151	104	255	3	0	3	110	22	132	669
Sakhare	79	39	118	47	40	87	3	2	5	139	44	183	393
Dahisar T. Manor	100	69	169	222	217	439	44	30	74	247	198	445	1127
Khamlioli	211	196	407	171	193	364	2	0	2	64	21	85	858
Dhuktan	136	31	167	171	39	210	12	5	17	165	46	211	605
Gowade	52	24	76	62	40	102	4	7	11	40	16	56	245
Maswan	51	7	58	67	25	92	3	1	4	163	84	247	401
Wandivali	1	1	2	122	105	227	0	0	0	18	4	22	251
Wakadi	0	0	0	0	0	0	1	0	1	5	6	11	12
Wasaroli	0	0	0	40	15	55	0	0	0	18	8	26	81
Katale	127	40	167	29	17	46	4	0	4	201	56	257	474
Loware	158	150	308	68	14	82	3	1	4	54	11	65	459
Nihe	223	181	404	208	212	420	7	6	13	221	183	404	1241
Nagzari	4	2	6	11	6	17	3	2	5	201	50	251	279
Lalonde	107	68	175	169	134	303	0	0	0	124	24	148	626
Kirat	124	106	230	125	128	253	4	1	5	181	75	256	744
Borsheti	140	56	196	179	80	259	2	3	5	157	30	187	647
Ravate	76	74	150	174	181	355	2	0	2	16	8	24	531
Chinchare	70	74	144	109	126	235	0	0	0	39	11	50	429
Dhabon	351	319	670	282	295	577	11	16	27	77	59	136	1410
Aine	88	45	133	130	163	293	6	4	10	83	18	101	537
Rankol	183	205	388	167	214	381	3	2	5	85	70	155	929
Chandwad	192	208	400	105	123	228	0	0	0	12	3	15	643
Navnath	184	229	413	90	106	196	6	3	9	78	35	113	731
Ganjad	99	28	127	49	40	89	18	6	24	97	27	124	364
Somnath	90	62	152	277	366	643	0	3	3	91	8	99	897
Ganeshbag	29	16	45	149	148	297	1	1	2	18	15	33	377
Awadhani	389	281	670	169	162	331	1	2	3	10	4	14	1018
Dhaniwari	257	236	493	60	102	162	4	0	4	7	14	21	680
Chinchale	99	122	221	22	30	52	10	2	12	10	13	23	308
Taloth	128	189	317	2	0	2	0	0	0	13	3	16	335
Punjave	19	19	38	86	98	184	0	0	0	27	24	51	273

Village	Cultivators			Agricultural Laborers			Household Industries			Other Workers			Total Main Workers
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
Bramhanwadi	145	4	149	10	1	11	1	0	1	3	1	4	165
Vankas	276	190	466	104	134	238	9	3	12	191	73	264	980
Vadavali	422	345	767	121	82	203	0	3	3	175	74	249	1222
Sawane	241	23	264	85	126	211	9	3	12	150	25	175	662
Kawad	597	525	1122	16	73	89	0	1	1	83	32	115	1327
Awarpada	13	7	20	76	10	86	1	1	2	51	9	60	168
Talasari	446	205	651	115	37	152	3	4	7	95	50	145	955
Ibhadpada	152	148	300	13	11	24	0	0	0	113	41	154	478
<b>Total</b>	<b>11,943</b>			<b>9,279</b>			<b>548</b>			<b>6,150</b>			<b>27,920</b>
<b>Percentage</b>	<b>42.8%</b>			<b>33.2%</b>			<b>2.0%</b>			<b>22.0%</b>			

Source: Census of India, 2011

### 3.18.3 Conclusion

Overall, it can be concluded that in the project influence villages, majority of the population are Scheduled Tribe and agriculture sector is the main source of employment. One of the distinct features of the area is poor industrialization; as a result large scale population engaged in farming and allied activities. However, Palghar district has 5757 small registered Industries, 1883 temporary small registered industries and 427 large / medium industries.

Literacy of male population is higher than female population. Overall literacy levels among tribals are lower than that of the general population and a gap is still exists between tribals vis-à-vis the total population. The gaps are substantial, and their persistence is a serious social and ethical problem. The latest Maharashtra Human Development Report admits that the condition of tribal population is far behind that of the total population in terms of most human development Indicators.

The proposed project will provide better connectivity; establish linkages between distant cities; increase employment opportunity and thereby enhance the quality of life. The construction of the expressway will also help the farmers in getting good prices of their produce by way of quick and fast transportation of perishable goods to the market places. The expressway connectivity will also help in import of new techniques of agriculture to the backward areas.

## CHAPTER - 4: ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

### 4.1 INTRODUCTION

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

### 4.2 LAND ENVIRONMENT

#### 4.2.1 Topography & Geology

##### 4.2.1.1 Construction Phase

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

#### **Impacts:**

- Disfiguration & change in existing profile of the land due to proposed greenfield expressway
- Disfiguration of topography due to indiscriminate digging of borrow pits
- Uncontrolled digging of borrow pits resulting in water accumulation & breeding of vector disease
- Disturbance on geological setting due to quarrying
- Establishment of Construction Camp

***Seismological Characteristics of the Area:*** The proposed expressway is in **Zone III** (having moderate seismic intensity) of the Seismic Map of India (as per IS: 1893, Part I, 2002) and therefore has a moderate risk of potential damage due to earthquake. The bridges are designed for seismic force as per provisions of IRC: 6-2014.

***Road Building Materials:*** During construction, stone aggregates & bitumen will be required for pavement, while stone aggregates, sand & cement will be required for

concrete making for rigid pavement, bridges, culverts, drains etc. Diesel will be required to run construction equipment. Stone aggregates and sand will be brought from the pre-identified quarry areas. The contractors usually depend on the local commercial suppliers for obtaining various construction materials. Active existing sources are most likely to be used with cost and the quality considerations. The estimated raw materials requirement during construction stage is given in **Table 4-1**.

**Table 4-1 Raw Materials requirement during Construction**

Sl. No.	Item & Unit	Unit	Quantity	Mode of Transport	Source
1.	Earth Work – fill	Cum	1,35,52,116	Truck	Identified Borrow areas / generated from cutting
2.	Granular Sub Base	Cum	9,22,598	Truck	Pre-identified quarry areas and Local Traders
3.	Wet Mix Macadam	Cum	27,517	Truck	
4.	Dense Bituminous Macadam	Cum	5,173	Truck	
5.	Bituminous Concrete	Cum	4,138	Truck	
6.	DLC	Cum	4,40,468	Truck	
7.	PQC	Cum	9,52,116	Truck	
8.	Bitumen	MT	1,004	Tanker	
9.	Emulsion	MT	130	Tanker	Refinery
10.	Cement	MT	8,07,000	Truck	Local traders
11.	Aggregates (cum)	Cum	30,72,000	Truck	Pre-identified quarry areas
12.	Sand (cum)	Cum	20,50,000	Truck	Pre-identified quarry areas
13.	Steel (MT)	MT	78,641	Truck	Local traders
14.	Fly Ash (cum)	Cum	1,09,32,287	Covered Dumper	Thermal Power Station
15.	Diesel (KL)	KL	40,000	Tanker	Local petrol pumps

Source: DPR prepared by the ICT Pvt. Ltd.

**Earth Cutting:** the proposed project involve cutting of earth along the alignment of the expressway. Details of area to be cut, locations and quantity of earth to be removed along the alignment of the expressway are presented in **Table 4-2**.

**Table 4-2 locations and Quantity of Earth to be removed along the alignment of the Expressway**

Chainage		Length (m)	Chainage		Length (m)
From	To		From	To	
26+730	26+770	40	75+600	75+725	125
27+220	27+295	75	75+770	76+000	230
29+745	30+075	330	76+055	76+070	15
32+990	33+380	390	76+400	76+485	85
33+705	33+835	130	76+580	76+590	10
35+025	35+075	50	76+610	76+750	140
36+535	36+645	110	76+990	77+380	390



Chainage		Length (m)	Chainage		Length (m)
From	To		From	To	
43+090	43+545	455	77+875	78+485	610
46+975	46+990	15	78+725	78+935	210
47+015	47+470	455	78+990	79+685	695
47+650	47+735	85	80+640	80+655	15
47+765	47+915	150	80+685	80+730	45
47+945	48+005	60	80+780	81+210	430
48+650	48+790	140	81+280	81+305	25
48+820	48+855	35	81+370	81+590	220
49+100	49+130	30	81+670	81+695	25
51+240	51+275	35	81+840	81+890	50
51+660	51+680	20	82+080	82+460	380
53+095	53+530	435	82+800	83+300	500
54+965	55+025	60	83+495	83+565	70
55+045	55+060	15	84+230	84+375	145
55+080	55+125	45	84+460	84+490	30
55+140	55+155	15	84+510	84+955	445
55+200	55+265	65	85+050	85+305	255
55+940	55+975	35	85+350	85+395	45
60+415	60+425	10	85+610	85+670	60
61+600	61+610	10	85+910	86+935	1025
61+615	62+255	640	88+645	88+665	20
62+320	62+330	10	88+800	88+905	105
64+660	64+665	5	90+500	90+780	280
65+085	65+110	25	90+870	90+920	50
65+200	65+235	35	90+940	90+975	35
67+450	67+515	65	91+300	91+360	60
67+650	67+680	30	95+200	95+290	90
69+710	69+795	85	95+405	95+465	60
70+405	70+485	80	95+580	95+625	45
70+805	70+835	30	95+815	95+925	110
71+300	71+315	15	96+385	96+565	180
71+410	71+455	45	97+590	98+040	450
71+530	72+000	470	100+450	100+590	140
72+370	72+665	295	100+850	100+915	65
73+750	73+790	40	100+980	101+025	45
73+810	74+005	195	101+064	102+800	1736
74+150	74+435	285	102+980	103+235	255
<b>Subtotal</b>		<b>5645</b>	<b>Subtotal</b>		<b>10,001</b>
Total Length of Cutting = 15,645 m = 15.645 Km					
Quantity of earth generated from cutting = <b>37,98,707 cum</b>					

Apart from the above locations, earth will also be generated during construction of drain, structures and culverts. Quantity of such earth is 24,99,706 cum. Therefore, total quantity of earth material likely to be generated through cutting operation is **62,98,413 Cum.**

**Construction of Borrow Areas:** about **1,35,52,116 cubic meter** of earth materials is to be used for the expressway. This has to be obtained from earth generated through

cutting or from the existing borrow areas. Quantity of earth material likely to be generated through cutting operation is **62,98,413 Cum**. Therefore, **72,53,703 Cum** earth will be required from the borrow area. The details of proposed borrow areas investigated with their respective locations; corresponding chainage and lead from nearest point to expressway are tabulated in **Table-4.3**.

**Table 4-3 Location of Proposed Borrow Areas**

Sl. No.	Proposed Chainage	Side	Location / Village Name	Lead from Proposed Alignment (km)	Type of Land	Approx. Quantity (m <sup>3</sup> )
1.	29+907	RHS	Khardi	1.7	Government	2,02,350
2.	33+918	LHS	Thamalpada	0.5	Government	1,21,410
3.	36+886	LHS	Tadulwada	3.0	Government	1,61,880
4.	42+894	LHS	Nauze	0.3	Government	1,82,115
5.	48+935	RHS	Dhuktan	0.2	Government	2,42,820
6.	51+923	LHS	Maswan	0.5	Government	2,42,820
7.	53+916	LHS	Katela	0.6	Government	1,21,410
8.	58+895	LHS	Nagshari	0.3	Government	80,940
9.	63+828	LHS	Kirat	0.5	Government	60,705
10.	67+652	RHS	Shahgaon	1.8	Barren	161,880
11.	71+655	LHS	Dhason		Government	80,940
12.	75+672	RHS	Rangel	2.5	Government	80,940
13.	75+672	RHS	Rangel	2.5	Government	80,940
14.	81+616	LHS	Gholanpada	1.2	Government	1,61,880
15.	84+070	LHS	Arjunparad	1.2	Government	1,21,410
16.	84+070	RHS	Arjunparad	0.5	Government	91,058
17.	91+483	RHS	Dhundawadi	2.4	Government	80,940
18.	97+297	LHS	Sabarpada	1.1	Private	40,470
19.	103+600	LHS	Mandalpada	0.6	Government	1,01,175

Source: DPR Prepared by the ICT Pvt. Ltd.

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

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

### **Mitigation Measures:**

All construction works are directly related to the land environment. Therefore, contractor needs to follow several Guidelines for various construction activities. These Guidelines are listed below and detailed out in Annexes of the EIA Report.

- Guidelines for Siting and Layout of Construction Camp (Annex-9.2)
- Guidelines for Siting, Operation and Re-Development of Borrow Areas (Annex-9.3)
- Guidelines for Siting, Operation and Re-development of Quarrying and Stone Crushing Operations (Annex-9.4)
- Guidelines for Siting and Management of Debris Disposal Site (Annex-9.7)
- Guidelines for Preparing Comprehensive Waste Management Plan (Annex-9.8)

Some of the important provisions are given below:

- Earthquake resistance structures with seismic restrainers are being planned to be constructed under the project as per IRC: 6-2014. Design of all structures like bridges and CD structures have taken the area's seismic characteristics into account.
- Opening up new borrow pits will be in accordance with the IRC: 10-1961 specifications. Topsoil from the new borrow pits should be preserved and reused in restoring the pits to the satisfaction of the Authority Engineer (AE). Opening up of new borrow pits will be restricted to 1 m depth followed by resurfacing of pits with top soil (15 cm).
- No borrow pits will be allowed within 1.0 km of the forest area.
- Uncontrolled digging of borrow pits will be avoided to prevent water accumulation in abandoned pits which results in breeding ground of vector disease.
- Construction materials will be procured from existing approved and licensed quarries only where crusher is already operating. Therefore, mitigative measure for the environmental impacts due to quarrying and rehabilitation plan of the quarries is the responsibility and scope of the licence holder of the quarry.
- On owner's choice, borrow pits will be converted to water bodies (pond) with proper landscaping (i.e. rectangular in shape, proper sloping and plantation on the bank) which will add scenic beauty in those localities.

#### **4.2.1.2 Operation Phase**

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

#### **4.2.2 Soil**

##### **Impacts:**

**Soil Erosion:** Erosion of topsoil can be considered a moderate, direct and long term negative impact resulting from construction and maintenance of the expressway. Erosion problems may occur on newly constructed slopes and fills depending on the soil

type, angle of slope, height of slope and climatic factors like wind (direction, speed & frequency) and rain (intensity & duration). Total length of embankment is 70.617 km and average height of embankment is more than 3.5 m throughout the expressway. Slope protection measures (stone pitching or turfing with **Coir Geotextile & Vetiver grasses**) form part of good engineering practice and therefore, it has been proposed.

**Construction of Bridges & Culverts:** Along the expressway a number of bridges (8 major and 29 minor bridges) and culverts (133) is planned. Construction of bridges involves excavation for construction of the foundation and piers. If the residual spoil is not properly disposed of, increased sedimentation may take place during the monsoon.

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

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

#### **Mitigation Measures:**

- The top soil from all sites including road side widening and working area, cutting areas, quarry sites, borrow areas, construction camps, haul roads in agricultural fields (if any) and areas to be permanently covered shall be stripped to a specified depth of 15 cm and stored in stock piles for reuse. At least 10% of the temporary acquired area shall be earmarked for storing top soil. Contractor has to strictly follow the “Guidelines for Top Soil Conservation and Reuse” as given in **Annex-9.1**.
- Accidental spills of lubricants / oil and molten asphalt will be avoided by following the “Guideline for Storage, Handling, Use and Emergency Response for Hazardous Substances” as given in **Annex-9.11**.
- Oil Interceptor shall be provided for wash down, refueling areas and accidental spill of oil and diesel.
- Vehicle parking area of the construction camp will be made impervious using 75 mm thick P.C.C. bed over 150 mm thick rammed brick bats. The ground will be uniformly slopped towards to adjacent edges towards the road. A drain will take all the spilled material to the oil interceptor.

#### ***Slope Stabilization & Soil Conservation***

Adequate measures like adequate drainage, embankment consolidation & slope stabilization will be taken along the expressway to avoid soil erosion and soil conservation. The slopes have been restricted to 1 vertical : 2 horizontal for most of the sections. Soil erosion through embankments will be prevented and controlled by stone



pitching or turfing with Coir Geotextile & Vetiver grasses. **Bio-engineering** is the technique of utilizing vegetation in addressing geotechnical problems. Vegetation as an aid to artificial methods in controlling surficial soil erosion is gaining larger acceptability among engineers all over the world. Growth of appropriate vegetation on exposed soil surface is facilitated by use of natural geotextiles such as **Coir Geotextiles**. Properly designed Coir Geotextiles lay on slopes or any other exposed soil surface provides a cover over exposed soil lessening the probability of soil detachment and at the same time reduces the velocity of surface runoff, the main agent of soil dissociation. Natural geotextiles bios-degrade quicker than man-made counterpart, but facilitate growth of vegetation quicker and better due to its inherent characteristics. Road slope stabilization can range from allowing **native grass (Vetiver grass)** to re-establish on a disturbed slope to building an engineered wall.

### **Role of Coir Geotextile in Slope Stabilization**

Coir is a biodegradable organic fiber material which is coarse, rigid and strong. The constituents of coir have been found to be mostly cellulose and lignin. Coir fiber is weather resistant and resistant to fungal and bacterial decomposition. The rate of decomposition of coir is much less than any other natural fiber. These characteristics are attributed due to the high lignin content in the fiber. Coir in the form of woven mesh mattings or non-woven stitch bonded blankets are used in engineering applications in the geotechnical field. Due to growing awareness to preserve environment, use of biodegradable natural material has gained popularity. The natural fiber, coir, which has been used in geotextiles for the past 20 years, has already proved its worth. Further, in coastal area of Maharashtra, coir based industries has been developed substantially.



**Coir Mesh 400 gsm**



**Coir Geo-textile laid on the Embankment**

Coir geotextiles are made from coconut fiber extracted from the husk of coconut. Like other polymeric counterparts, coir geotextiles are developed for specific application in civil engineering like erosion control, ground improvement, filtration, drainage, river bank protection, road pavements, slope stability etc. This biodegradable and environment friendly material is virtually irreplaceable by any of the



modern synthetic substitutes. Advantages of Coir Geotextile:

- ✓ The high tensile strength of coir fiber protect steep surface from heavy flows and debris movement
- ✓ It can withstand considerable pedestrian movement and vehicular traffic without deterioration
- ✓ Easy to install and huge contour of the soil surface due to its heavy weight and ability to absorb water
- ✓ Totally Biodegradable, 100% natural
- ✓ Water absorbent, thus act as mulch on the surface and as a wick in the soil mantle
- ✓ Environmental friendly and aesthetically pleasing and nonpolluting
- ✓ Provides excellent microclimate for plant establishment and healthy growth
- ✓ The thick and protruding fibers from the yarn render an extra protection against soil erosion and Provide roughness to the surface floor and hold the soil particles in place.
- ✓ The coir geo textile gives the grass plenty of room to grow and at the same time provides large number of "CHECK DAMS" per square meter of soil media
- ✓ During the manufacturing process of coir yarn, non-chemicals are used
- ✓ Holds the seeds and saplings in place
- ✓ Allows sunlight to pass through

Coir Geotextile is laid on the shoulder and slope surface helped retain the soil particles and prevented detachment of soil particles from the prepared slope. Establishment of vegetation ensured stabilization of the soil on the slope surface. It is a bio-degradable natural geotextile, can conveniently be used for controlling surface soil erosion and help growth of vegetation as a bio-engineering measure. After biodegradation coalesces with the soil and adds nutrient to the soil and fosters growth of vegetation.

### **Role of Vetiver Grass in Slope Stabilization**

Vetiver grass (*Chrysopogon zizanioides*) is native to India. It has been shown to be a simple and economical method to conserve soil by slowing the velocity of water and trapping sediment, filtering out nutrients, and stabilizing steep slopes. In western and northern India, it is popularly known as khus. Several aspects of Vetiver make it an excellent erosion control plant in warmer climates:

- ✓ Vetiver grass does not have stolons or rhizomes. It's massive finely structured root system that can grow very fast; in some applications rooting depth can reach 3 to 4m in the first year. This deep root system makes



- Vetiver plant extremely drought tolerant and difficult to dislodge by strong current.
- ✓ Stiff and erect stems, which can stand up to relatively deep water flow
  - ✓ Highly resistance to pests, diseases and fire
  - ✓ A dense hedge is formed when planted close together acting as a very effective sediment filter and water spreader
  - ✓ New roots grow from nodes when buried by trapped sediment. Vetiver will continue to grow up with the deposited silt eventually forming terraces, if trapped sediment is not removed.
  - ✓ Tolerance to extreme climatic variation such as prolonged drought, flood, submergence and extreme temperature from  $-14^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$
  - ✓ Tolerance to wide range of soil pH from 3.3 to 12.5 without soil amendment
  - ✓ High level of tolerance to herbicides and pesticides
  - ✓ Highly efficient in absorbing dissolved nutrients such as N and P and heavy metals in polluted water.
  - ✓ Highly tolerant to growing medium high in acidity, alkalinity, salinity and magnesium
  - ✓ Highly tolerant to Al, Mn and heavy metals such as As, Cd, Cr, Ni, Pb, Hg, Se and Zn in the soils



**Vetiver Grass used for Slope Stabilization in Bridge ↑ & Road ↓ Embankment**



- ✓ As typical tropical grass, Vetiver is intolerant to shading. Shading will reduce its growth and in extreme cases, may even eliminate Vetiver in the long term. Therefore Vetiver grows best in the open and weed free environment, weed control may be needed during establishment phase. On erodible or unstable ground Vetiver first

reduces erosion, stabilizes the erodible ground (particularly **steep slopes**), then because of nutrient and moisture conservation, improves its microenvironment so other volunteered or sown plants can establish later. Because of these characteristics Vetiver can be considered as a nurse plant on disturbed lands.

- ✓ Vetiver is useful to treat pollution due to its capacity to quickly absorb nutrients and heavy metals, and its tolerance to elevated levels of these elements. Although the concentrations of these elements in Vetiver plants is often not as high as those of hyper-accumulators, its very fast growth and high yield allows Vetiver to remove a much higher volume of nutrients and heavy metals from contaminated lands than most hyper-accumulators.
- ✓ When planted closely together, Vetiver plants form dense hedges that reduce flow velocity, spread and divert runoff water and create a very effective filter that controls erosion. The hedges slow down the flow and spreads it out, allowing more time for water to soak into the ground.
- ✓ Acting as a very effective filter, Vetiver hedges help to reduce the turbidity of surface run-off. Since new roots develop from nodes when buried by trapped sediment, Vetiver continues to rise with the new ground level. Terraces form at the face of the hedges, this sediment should never be removed. The fertile sediment typically contains seeds of local plants, which facilitates their re-establishment

### 4.2.3 Land Use

#### 4.2.3.1 Construction Phase

The proposed expressway will lead to change in land use pattern of areas that comes under the proposed ROW. Agricultural and allied uses occupied largest part of the PROW amounting to 678.8697 ha. (73.13%) of the total area, followed by open scrub 124.49 ha (13.41%), barren land 60.17 ha (6.48%), reserved forest 25.16 ha (2.71%), surface water bodies (River, pond and dam) 2.12%, settlements 12.67 ha (1.37%), mangrove forest 3.31 ha (0.36%), open mixed forest 2.22 ha (0.24%), mudflats 1.4 ha (0.15%) and marshy land 0.36 ha (0.04%).

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

#### **Impacts:**

- Changes in existing land use pattern of the PROW for construction of the expressway
- Loss of agricultural land, forest land etc. due to land acquisition

### **Mitigation Measures:**

- Earth material generated from excavation shall be reused to the maximum possible extent as filling material during site development.
- Construction debris shall be disposed of by mechanical transport in suitable pre-identified (jointly by project proponent & local administration) dumping areas in tune with the local condition to avoid land degradation & water logging due to indiscriminate dumping.
- Identification, operation and redevelopment of dumping areas shall be as per the Guideline provided in **Annex-9.7**.
- Construction camp shall be provided for construction personnel to avoid indiscriminate settlement of construction workers & labourers.
- Regular inspection of haul roads and construction site shall be carried out to ensure regular and timely removal of construction debris to the designated dumping sites.
- Construction activities shall be kept confined to PROW only.

#### **4.2.3.2 Operation Phase**

### **Impacts:**

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

### **Mitigation Measures:**

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



## 4.3 WATER ENVIRONMENT

### 4.3.1 Drainage & Hydrological Flow

#### Impacts:

- The alignment of the proposed greenfield expressway crosses many Vaitarana River at three locations, Surya River, Suseri Nalla, Jogani Nadi, Vadvali / Tumb River, Kangan Nala and canal & streams at several locations. The drainage network along the expressway is subject to adverse impacts due to construction of embankment and various construction activities as well as during the operation stage of the project.
- 2 Ponds shall be fully affected and 2 ponds are likely to be partially affected due to the proposed alignment. The details are shown below:



**Chainage – 27+850**  
**Total area of the Pond: 8,622.50 Sq.m**  
**Affected area of the Pond: 8,216.79 Sq. m**



**Chainage – 32+000**  
**Total area of the Pond: 15,336.23 Sq.m**  
**Affected area of the Pond: 3,557.39 Sq. m**



**Chainage – 32+400**  
**Total area of the Pond: 1,676.19 Sq.m**  
**Affected area of the Pond: 588.16 Sq. m**



**Chainage – 41+200**  
**Total area of the Pond: 2988.08 Sq.m**  
**Affected area of the Pond: 2988.08 Sq. m**

- Increased incidence and duration of floods due to obstruction of natural drainage courses by the embankment



- Chances of filling of existing drainage courses during earth filling
- There may be potential drainage impacts relating to the establishments of construction camps and various plants such as hot mix plant, batching & asphalt mixing plants etc. drainage impacts at these locations may result in loss of top soil.

**Mitigation Measures:**

- To minimize the impact drainage & hydrological flow, 8 major bridges, 29 minor bridges, 133 culverts are proposed to be constructed along the expressway. It has been ensured that free flow of water is maintained wherever the expressway alignment crosses river / local streams / nallah etc., as detailed in **Table 4-4**.

**Table 4-4 Chainage wise details of Clear Waterway and Length of Proposed Bridges**

Sl. No	Major / Minor Bridge over	Chainage	Clear Waterway (m)	Length of Proposed Bridge (m)	Remarks
1	Vaitarna River - 1	31+300	1860	1968.05	Extra length for CRZ area
2	Vaitarna River - 2	35+750	390	1296.05	Extra length for CRZ area
3	Local Stream	37+780	24	27.353	-
4	Local Stream	37+965	16	19.162	-
5	Vaitarna River - 3	45+040	280	672.05	Extra length for CRZ area
6	Local Stream	48+393	28	32.25	-
7	Local Stream	50+000	15	16.6	-
8	Local Stream	52+728	11	13.3	-
9	Local Stream	54+310	22	27.25	-
10	Local Stream	57+885	28	29.25	-
11	Local Stream	59+888	35	37.25	-
12	Local Stream	61+539	13	19.162	-
13	Local Stream	63+570	28	32.25	-
14	Local Stream	63+925	15	15.9	-
15	Local Stream	66+137	12	12.44	-
16	Local Stream	66+735	15	15.9	-
17	Surya River	68+420	230	236.05	-
18	Local Stream	70+000	25	27.25	-
19	Suseri Nallah	72+190	93	111.65	-
20	Local Stream	74+493	18	20.9	-
21	Local Stream	79+745	17	21.94	-
22	Local Stream	81+332	21	42.426	Extra length to accommodate check dam at site
23	Local Stream	83+688	17	25.759	-
24	Local Stream	85+420	21	20.9	-
25	Jagani Nadi	89+604	40	50.973	-

Sl. No	Major / Minor Bridge over	Chainage	Clear Waterway (m)	Length of Proposed Bridge (m)	Remarks
26	Local Stream	91+564	15	15.9	-
27	Vadvali Nadi	96+208	80	96.65	-

Source: DPR Prepared by the ICT Pvt. Ltd.

- Design made to avoid physical loss to the water bodies to the extent possible. Scope for further design modification is being explored to minimize the physical loss of the pond likely to be partially affected due to proposed alignment. Compensatory digging (in case acquisition is unavoidable) to the other side of pond is proposed to prevent the volumetric capacity loss.
- Silt fencing shall be provided between expressway and water bodies to avoid any siltation due to runoff from construction area
- Shoulder and toe drains shall be provided along the expressway to facilitate its better maintenance and increase in the life of the carriageway. This will also help in avoiding soil erosion and land degradation due to water stagnation on the either side of the expressway.
- Detailed drainage survey and hydrological investigations have been carried out and accordingly capacity of cross drainage (CD) structures have been designed to accommodate high discharges to avoid flooding & formation of water pool
- All bridges have been designed for a return period of 100 years and culverts have been designed for a return period of 50 years
- Construction works of culverts and bridge (cross drainage structures) are taken up during the lean flow periods in summer to minimize the impacts on drainage.
- Construction work near natural drainage channels have to be carried out in such a way that flow of water is not blocked and even if it has to be blocked then the contractor must ensure that the local communities are informed about the same in advance
- Suitable drainage at construction camp will be provided to eliminate the chances of formation of stagnant water pools that leads to soil erosion & breeding of mosquitoes

#### 4.3.2 Water Use

##### **Impacts:**

During construction period water is required for compaction of embankment, dust suppression, concrete making and domestic use in construction camp. The estimated tentative water requirement during construction stage is given in **Table 4-5**.

**Table 4-5 Breakup of Fresh Water Requirement during Construction**

S. N	Purpose	Unit	Quantity
1	For road construction:		
	a) Construction related to earthwork	KL	45,00,000.00
	b) Construction related to Fly Ash		
	c) Construction of GSB		
	d) Construction of WMM		
e) Bridges, culverts, retaining walls & other structures			
2	Dust suppression	KL	5,00,000.00

S. N	Purpose	Unit	Quantity
3	For drinking & other domestic purpose	KL	10,00,000.00
		<b>Total</b>	<b>60,00,000.00</b>

Source: DPR prepared by the ICT Pvt. Ltd.

### **Mitigation Measures:**

- Minimum use of water from existing sources for construction purpose shall be ensured to minimize likely impacts on other users
- The contractor shall arrange water required for construction in such a way that the water availability and supply to nearby communities remain unaffected.
- If new tube-wells are to be bored, due to the non-availability of water required for construction, prior sanctions and approvals by the Ground Water Department has to be obtained by the Contractor
- Wastage of water during the construction should be minimized

## **4.3.3 Water Quality**

### **4.3.3.1 Construction Phase**

#### **Impacts:**

- During construction phase, leakage of POL could lead to an increase in water pollution level of the receiving water body. Anticipated potential impacts are due to spillage of construction materials, such as, cement, POL, bitumen etc. falling in to the drainage channels from workshops, construction camps, quarry / borrow areas etc. of the Contractor.
- Accident involving hazardous materials (bitumen) may cause pollution but the occurrence of large scale spillage of bitumen is not anticipated.
- Increase of sediment load in the run off from construction sites and increase in turbidity in receiving water bodies
- Water pollution due to use of flyash in the embankment
- Water pollution due to generation of wastewater from construction camps

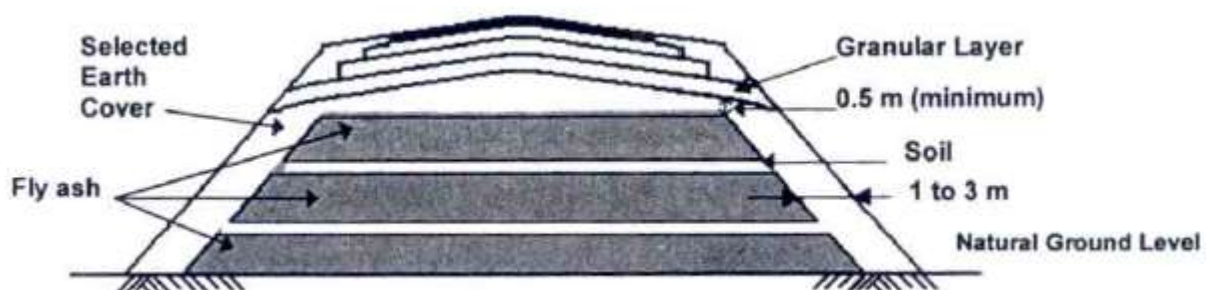
#### **Mitigation Measures:**

- Quality of construction wastewater emanating from the construction site will be controlled through suitable drainage system with silt traps for arresting the silt / sediment load before its disposal into the main natural drainage system around the site
- An effective traffic management plan is to be implemented to avoid any accidental spillage of hazardous materials.
- All the construction and preparatory activities including construction of culverts and bridges will be carried out preferable during dry seasons
- The CD structures should not be drained to the agricultural and horticultural farms or to the immediate vicinity of houses of the villagers.
- The fuel storage and vehicle cleaning area shall be stationed at least 500m away from the nearest water body

- Provision for oil interceptors shall be made at all the construction camps / workshop areas to separate the oil and grease waste generated from servicing of equipment and vehicles used in the construction
- The drains carrying storm water shall be connected to the nearest natural drainage channel, water bodies with silt traps.
- **Mitigation Measures for Fly Ash Embankment:** The fly ash embankment for this road project has been designed as per the Special Publication 58 of the Indian Roads Congress, IRC:SP:58-2001 “Guidelines for Use of Fly Ash in Road Embankments”. In section 3.3.1.10 of IRC:SP:58, it is mentioned that “The leaching problem can be minimised by controlling the amount of water, which infiltrates into fly ash embankment. Normally, percolation of water into the fly ash core will be minimum when sides and top are protected using good earth. Side slopes should be properly protected with soil cover with vegetation or soil cover. Monitoring of fly ash embankments has indicated that relatively little water tends to percolate through the complete embankment. Even in such a case, the alkaline nature of the fly ash-water solution restricts heavy metal leaching.”

In section 3.4.2 of IRC:SP:58 it is mentioned that “Special emphasis is required with respect to provision of earth cover for fly ash embankments since ash is easily erodable. Height and side slope of the embankment govern the thickness of earth cover. For embankment up to 3 m height, in general, the side cover thickness (measured horizontally) of about 1 m would be sufficient. For high embankments and for embankments to be constructed in flood prone areas, the cover thickness may be increased. The embankment would, therefore, be designed as a composite structure with fly ash in the core and earth cover on the sides.”

In line with the above specifications of IRC:SP:58, method of construction of Fly Ash embankments is proposed by alternate layers of fly ash and soil i.e. **Sandwich Type Construction (Figure-4.1)**.



**Figure 4-1 Typical Cross section of embankment with alternate layer of fly ash and soil**

In this method, all the trees, stumps etc. falling in the fill area should be cut at least to 500mm below the ground level and pits should be filled with suitable material and compacted thoroughly. The side cover thickness should be between 1m to 3m and the layer just above the original ground level should always be of fly ash. The sandwich layer of construction allows greater stability to the fly ash – earth

composite embankment by containing fly ash with alternative compacted borrow soil layers. A typical embankment design using fly ash in sandwich type construction would be top 1m thick borrow soil underlain by fly ash & borrow soil is 0.5m thicknesses each duly compacted at 98% compaction. The thickness of the side containment of this sandwich is 1.0m to 3.0m (side slopes).

As per IRC, the top 0.5 m of the embankment (between the granular layer of the pavement and the top of the fly ash core) has been designed as selected good earth to form the subgrade for the pavement. This will prevent the seepage the water from the pavement to the embankment.

- **Wastewater Treatment in Construction Camp:** The construction period of the proposed project is 24 months and it is estimated that 150 labors will be engaged during the construction period in each construction package. Fresh water will be used in the construction camp for a variety of domestic uses such as washing, bathing & flushing toilets. The water that emerges after these uses contains vegetable matter, oils, detergents, dirt, soap, oils & greases. This water is called “Grey Water” or sullage. Sewage generated from the construction camp must necessarily be treated and then re-used /re-cycled for various uses that do not need potable water quality. Recycling / re-using treated sewage can reduce fresh water requirements very substantially, by almost 50-60%. Water used to flush toilets to evacuate human excreta is called “Black Water” is to be treated properly otherwise it will contaminate the surrounding surface / ground water.

As per the calculation; daily water requirement for drinking & domestic purposes in the 3 construction camps are **46,296 liters** (15,432 liters in each construction camp) and generation of wastewater is **37,037 liters** (12,346 liters in each construction camp). Therefore, **Packaged Wastewater Treatment Plant** (MARS 3000-4K model) has been recommended for the construction camp. Guideline for wastewater treatment in construction camp is given in **Annex-9.6**. However, any other type of packaged wastewater treatment plant may be installed.

- **Water Quality Monitoring:** Apart from provision of the mitigation measures, water quality shall be monitored to understand the effectiveness and further improvement in designs in reducing the concentration of pollutants. The monitoring plan shall be functional in construction as well as in operation stages. The frequency, duration and responsibility will be as per the Environmental Monitoring Program (Table 6-2 of Chapter-6). All deviated results shall be reported to Sr. Environmental Specialist of the Authority Engineer for remedial measures. It should be ensured that no construction camps or stockyards are set up near rivers and water bodies to prevent oil spills.
- **Silt Fencing:** Silt fencing will be provided to prevent sediments from the construction site entering into the nearby watercourses. The silt fencing consists of geo textile with extremely small size supported by a wire mesh mounted on a panel made up of angle / wooden frame and post. The frame will be installed at the edge of the water body along which construction is in progress. It is proposed to install silt



fence at the edge of all water bodies abutting the project road including major and minor bridge locations.

Silt fence will be mounted on pole fixed at a distance of 2 to 3 m apart and last 2 m of fence shall be framed up slope. The location of silt traps will depend on contractor's proposal for site facilities and work sites and should be provided in the contractor's proposals. This will be checked by Sr. Environmental Specialist of the Authority Engineer and monitored by PIU. Drawing of typical silt trap is given in **Annex-4.1**.

- **Oil Interceptor:** Oil and grease from road run-off is another major concern during construction as well as operation. During construction, discharge of oil and grease is most likely from workshops, oil and waste oil storage locations, vehicle parking areas of the contractor camp. Therefore, location of Oil Interceptors has been considered such that each construction camp having refueling stations, oil and lubricants storage places will have one oil interceptor to stop & separate the floating oils. The arrested products shall be disposed as per MoEF&CC and CPCB guidelines. Actual number will be decided by the Contractor with the consent of Sr. Environmental Specialist of the Authority Engineer. Drawing of typical Oil Interceptor is given in **Annex-4.2**.

- **Rainwater Harvesting Structures**

The normal annual rainfall in the study area ranges from 1900 mm to 2600 mm and mean annual rainfall during the year 1981 to 2010 is 1874.6 mm. Pre monsoon depth to water level (May-2011) ranging between 2 to 5 mbgl and 5 to 10 mbgl while post-monsoon depth to water level (Nov- 2011) ranging between 2 to 5 mbgl in major part of the study area. Mean water level range of 2 to 5 mbgl is observed in the Palghar, Dahanu and Talasari area. As per the CGWA classification, **all the Talukas** (Vasai, Palghar, Dahanu and Talasari) through which the proposed expressway is passing **fall under safe category**. Therefore, rainwater harvesting structure has not been proposed along the expressway. However, as per MoRTH requirement rainwater harvesting structure has been proposed at toll plaza and wayside amenities. Typical drawing of rainwater harvesting structure is shown in **Figure 4-2**.

#### 4.3.3.2 Operation Phase

##### Impacts:

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

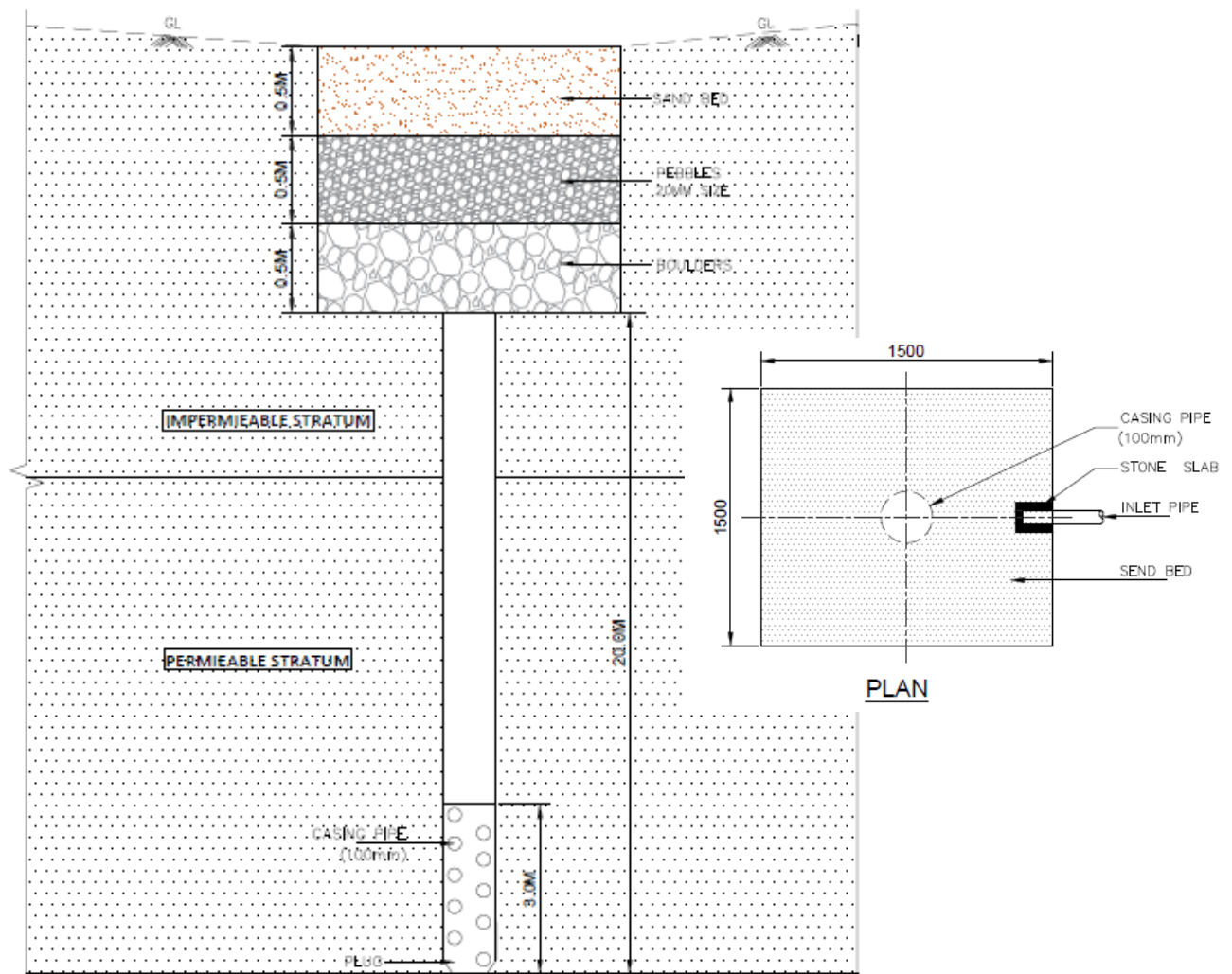


Figure 4-2 Typical Drawing of Rainwater Harvesting Structure

**Mitigation Measures:**

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

## 4.4 AIR ENVIRONMENT

### 4.4.1 Construction Phase

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

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

#### 4.4.1.1 Hot Mix Plant

Asphalt is used for paving roads; which is a mixture containing thousands of different chemicals. The chemicals in asphalt vary depending on the source of the crude oil, the type of asphalt being made and the process used. In general, the fumes emitted from hot mix plant are a mixture of several different types of chemicals including carbon monoxide, nitrogen oxides, sulfur, volatile organic compounds, polycyclic aromatic hydrocarbons etc.

Fumes created from heating asphalt can be inhaled into the lungs or can condense onto exposed areas of the skin. People who work in asphalt plants have the greatest exposure to asphalt fumes. Residents living near an asphalt plant also would be more likely to breathe low levels of asphalt fumes for a long period of time.

**Control System:** To avoid problems of air pollution following **Guidelines**<sup>1</sup> is to be considered by the Contractor for setting up hot mix plant:

- Hot mix plant shall be at-least 500 m away from nearest settlement / educational institute / religious places / water bodies and 200 m away from the centerline of National Highway / State Highway
- In case of existing Hot Mix plants, operating with CTE of the State Pollution Control Board, which are located at lesser distance then 200 meter from existing highways, the unit shall provide minimum 6 meter high compound wall of GI sheets along plot periphery towards highway side.
- Adequate dust control system shall be provided
- Hot Mix Plant with Pollution Control Measures having **Fabric Filter** with reverse air cleaner based on the principle of Reverse Air Cleaning or Dry dust collector (Multicy-

<sup>1</sup> Guideline for Hot Mix Plant, Gujarat Pollution Control Board

clone) with multiple wet scrubber shall be installed and elevators at loading section shall be fully covered

- The plant shall have centralized control panel / cabin capable of pre-setting controlling / synchronization all operations, starting from feeding of aggregates to the discharge of hot mix to ensure proper mixing. It shall have adequate water scrubbing mechanism to control the dust coming out of the dryer.
- Hot Mix plant must have at-least **6 m stack height** for the discharge of its scrubbed flue gases
- Conveyor belts shall be fully covered from top and sides.
- Considering predominant wind direction, wind breaking wall shall be constructed.
- Regular sprinkling of water shall be ensured on all roads and surrounding area of the plant to minimize dust pollution
- Regular cleaning and wetting of ground within premises shall be carried out
- Only approved fuel such as diesel, light diesel oil (LDO) shall be used. In no case unauthorized fuel such as solvents, industrial waste shall be used.
- **Safety measures:** Adequate measures of safety for workers working in Hot Mix plant shall be taken. Personal Protective Devices such as Goggles, mask, Helmet and safety shoes shall be provided to workers

#### **4.4.1.2 Stone Crushers**

Stone processing operations including crushing, screening, material handling and transfer operations are potential sources of particulate emissions.

- a. **Emission during Crushing Operation:** During crushing operation, generation of particulate emissions is inherent and the emissions are most apparent at crusher feed and discharge points. The greater the reduction in size during subsequent crushing stages from primary, secondary to tertiary crushing, the higher the emissions.
- b. **Emissions during Screening:** In the screening section, the mixture of stones is classified and separated according to size. Screening efficiency is generally considered to be in the range of 60 to 75%. Commonly used screening equipment are grizzlies, shaking screens, vibrating screens and revolving screens. Screening may be performed wet but dry screening is the most common. Dust is emitted from screening operations as a result of the agitation of dry stone. The screening of fine sizes produces higher emissions than the screening of coarse sizes.
- c. **Emissions during Material Handling:** Various handling devices like feeders, belt conveyors, bucket elevators and screw conveyors are used to transport crushed materials from one point to another. Particulates may be emitted from any of the material handling operations. Most of the emissions occur at transfer points. The amount of uncontrolled emissions depends on the size distribution of the material handled, the belt speed and the free fall distance.
- d. **Nature and Spread of Emissions:** The major source of dust generation is during size reduction in the primary, secondary & tertiary crushers. The dust is also generated during handling of stones, especially at the point where the stones fall through a height from places like one belt to another or from belt to hopper or stock piles etc. During vibratory screen large quantity of fine dust is emitted and gets air

borne.

- e. **Impacts due to Emission:** Some percentage of the fugitive dust emissions may get settled down within the unit premises but a substantial percentage of airborne emissions are carried away to the surroundings by wind currents. Dust that settles within the plant gets air borne again due to vehicular movement or by wind and acts as a secondary emission source.

Dust emissions affect the human health, vegetation, climate and damage the material. When the amount of particulates increases in the atmosphere, it absorbs incoming solar radiation, causing an increase in the atmospheric and land surface temperature. The physical properties of atmospheric particulates affect human health either by allowing penetration of the lung and causing irritation to the internal membrane, or by transporting absorbed toxic gases and vapors deeper into the lung than they would normally travel. The work place environment at stone crusher sites contain millions of suspended mineral particles of respirable size that get deposited in lungs during inhalation.

- f. **Emission Control System – Combination of Dry and Wet Type**

A combination of dry and wet type control system is suggested to minimize the impact on air quality. In the combination system the dust is suppressed at some point with water sprays and from some points the dust is extracted with the help of an induced draft fan and can be captured in dry type or wet spray chamber type control equipment. Such combination control systems are commonly used in stone crusher in developed countries. In the combination control system the water is to be sprayed at the primary crushing stage and in the secondary / tertiary stages the dust is to be extracted out and separately controlled. This will have benefit in terms of avoiding a coating of dust on the stone products and at the same time lesser expensive than dry type control system.

The **Wet Type Dust Suppression System** comprises of introducing moisture into the material flow by spraying water at key dust generating locations so as to restrain fine particulate matter from becoming air borne. The objective of wet dust suppression is to prevent emission by keeping the material moist at all process stages. Small quantities of specially formulated wetting agents or surfactants are often blended with water to reduce its surface tension and improve its wetting efficiency so that dust generation may be suppressed with a minimum of added moisture.

The **Dry Type Dust Control System** comprises of adequate enclosure of key locations with hooding arrangement for extraction of the dust and arrangement of Cyclone or Settling Chamber to collect the coarser portion of the dust and a Bag-filter house to capture the finer portion of the emission not captured by Cyclone or Settling Chamber etc. The sufficient capacity of extraction and pressure drop across the system would be required to be provided by installing an induced draft fan of sufficient capacity. In case the pre-collector not to be installed, it would increase the dust load on the bag-filter house and would call for either more number of filter bags or more frequent cleaning of the filter bags. Therefore, the pre-collectors are recommended to reduce dust load on the bag filter.



**Table 4-6 Typical Points where Water to be sprayed or dust to be extracted**

Dry Extraction From	Wet Suppression at
Secondary /Tertiary crusher discharges	Primary crusher
Transfer points / tertiary crushing	Transfer points (before secondary crushing)
	Tertiary crusher feeds

To avoid problems of air pollution following **Guideline**<sup>2</sup> is to be considered by the Contractor for setting up Stone Crushers:

- Stone crushing unit shall be at-least 500 m away from nearest settlement / educational institute / religious places / water bodies and 200 m away from the centerline of National Highway / State Highway
- Stone crushing Unit shall not be allowed / permitted within 1 Km from the periphery of ancient/Historical monuments & archaeological sites
- Stone crushing units shall have to obtain necessary permission of land use from competent Authority
- Each stone crusher unit shall install adequate pollution control measures including erection of G.I. Sheets cover and the sprinklers before commencement of operations.
- Dust doom shall be provided in the unit.
- Crusher shall be covered and water sprinkling system shall be provided on crusher to suppress the dust generated due to material handling / loading / unloading activity.
- Screen classifier shall be adequately covered by G.I. Sheets to prevent the emission into the atmosphere due to screening / grading activity.
- All conveyor belts shall be adequately covered by G.I. Sheet / M.S. sheet only.
- Regular wetting of roads shall be carried out to suppress the ground level dust within the premises to control the air borne dust emission due to wind velocity.
- All approach roads and ramps shall be paved.
- Curtain or wall shall be provided surrounding the stone crusher unit.
- Display board shall be provided at the entrance of stone crusher indicating survey no, name and address of owner and the unit.
- Fine dust generated due to screening / crushing / grading shall be disposed-off into abandoned mines.

#### **4.4.1.3 Other Impacts:**

- Deterioration of air quality due to fugitive dusts emission from construction activities like excavation, backfilling & concreting, and hauling & dumping of earth materials & construction spoils, and vehicular movement along unpaved roads.
- Deterioration of air quality due to gaseous emissions from vehicular traffic

#### **4.4.1.4 Mitigation Measures:**

- Proper and prior planning and appropriate sequencing and scheduling of all major construction activities shall be done, and timely availability of infrastructural supports

<sup>2</sup> Environmental Guidelines for Stone Crushing Units, Gujarat Pollution Control Board

needed for construction shall be ensured to shorten the construction period vis a vis reduce pollution.

- Construction materials shall be stored in covered godowns or enclosed spaces to prevent the windblown fugitive emissions.
- Truck carrying soil, sand and stone shall be duly covered to avoid spilling.
- Adequate dust suppression measures such as regular water sprinkling on unpaved haul roads & vulnerable areas of the construction sites from trucks or other suitable means shall be undertaken to control fugitive dust during material handling & hauling activities particularly near habitation especially in the dry seasons.
- During construction period, all activities are to adhere to the contractual obligations and all clearances and approvals such as 'Consent to Establish' and 'Consent to Operate' shall be obtained from the Maharashtra Pollution Control Board under Air Act. All vehicles operating for the Contractor, Supervision Consultants and PIU shall obtain Pollution under Control (PUC) certificate.
- All required clearances are to be obtained from the Maharashtra Pollution Control Board and the Mining Department for establishing quarries, borrow areas and crushers. Contractor should submit copy of such clearances to PIU & AE before start of activities.
- It will be ensured that all the construction equipment & vehicles are in good working condition, properly tuned and maintained to keep emissions within the permissible limits and engines turned off when not in use to reduce pollution.
- **Air Quality Monitoring:** Apart from provision of the mitigation measures, air quality shall be monitored. The monitoring plan shall be functional in construction as well as in operation stages. The frequency, duration and responsibility will be as per the Environmental Monitoring Plan (Table 6-2 of Chapter-6) and the monitored values should correspond with the National Ambient Air Quality Standards. All deviated results shall be reported to AE for remedial measures.

#### 4.4.2 Operation Phase

##### 4.4.2.1 Prediction of Impacts through Air Dispersion Model (Caline Model)

There are two versions of the CALINE model in current use. CALINE3, published in 1979, replaced the virtual point approximation contained in earlier versions of the model with an equivalent finite line source representation and added a multiple link option. CALINE4, published in 1984, incorporated flexible input/output options including an option for modeling air quality near intersections. It also includes dispersion algorithms to account for vehicle-induced thermal turbulence and wind direction variability. Caline models has high applicability in Indian Scenario and is a recommended model by USEPA for prediction of air quality from line sources like highway projects.

CALINE4 (Caltrans, 1989) is a fourth-generation line source Gaussian plume dispersion model that predicts carbon monoxide (CO) impacts near roadways. Its purpose is to help planners protect public health from the adverse effects of excessive CO exposure. The Caltrans publication, Transportation Project-Level Carbon Monoxide Protocol (CO Protocol) recommends the use of CALINE4 when a proposed transportation project

requires a more detailed analysis than initial screening analysis. The 2011 version of Caline-4 can also be used for prediction of NO<sub>x</sub> and PM<sub>10</sub>.

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

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

Where:

C = Concentration of the pollutant in air [m/L<sup>3</sup>]

Q = Rate of chemical emission [m/T]

U = Wind speed in X direction [L/T]

σ<sub>y</sub> = Standard deviation in y direction [L]

σ<sub>z</sub> = Standard deviation in z direction [L]

y = Distance along a Horizontal axis perpendicular to the wind [L]

z = Distance along a vertical axis.[L]

H = effective stack height [L]

CALINEpro™ Model is a further improved air quality model based on CALINE's algorithm (USEPA Preferred/ Recommended Models) for prediction of pollutant concentration near highways.

It divides individual highway links into a series of elements from which incremental concentrations are computed and then summed to form a total concentration estimate for a particular receptor location. Downwind concentrations from the element are modeled using the crosswind FLS (Finite Line Source) Gaussian formulation, but σ<sub>y</sub> and σ<sub>z</sub> are modified to consider the mechanical turbulence created by moving vehicles and the thermal turbulence created by hot vehicle exhaust in the region directly over the highway, region considered as a zone of uniform emissions and turbulence. Given source strength, meteorology and site geometry, the model can predict pollutant concentrations for receptors located within 500 meters of the roadway. It also has special options for modeling air quality near intersections, bridge and parking facilities.

Quantitative assessment for predicted level of pollutants concentration has been done using CALINEpro™ Model Ver. 2016.

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

**Meteorological Data:** The primary factors affecting transport and dispersion of pollutants are wind and stability. The winds are caused by differences in pressure between areas of the atmosphere. Differences in pressure cause air to move from high-pressure areas to low-pressure areas. Wind speed can affect the pollutant concentration in a selected area. In general, the higher the wind speeds, the lower the pollutant concentration. The winds dilute pollutants and rapidly disperse them throughout the near areas. In the present case, **meteorological data of summer season (March to May 2017)** generated through primary survey has been used for prediction of the impacts.

**Homogeneous Traffic Sections:** The project road has been divided into two homogeneous traffic sections as detailed in **Table 4-7**.

**Table 4-7 Homogeneous Traffic Sections considered for Air Prediction Models**

Section No	Name	Chainage (km)		Length (km)
		Start	End	
2-1 (HS-01)	Khanivade - Dahanu Road	26+582	78+650	52.33
3 (HS-02)	Dahanu Road - Talasari	78+650	104+700	26.05

Source: DPR Prepared by the ICT Pvt. Ltd.

**Receptors:** Predictions of ground level concentration (GLC) has been carried out for representative road segments under both traffic sections (HS01 and HS02). The crossing of Boisar road with Proposed Vadodara Mumbai Expressway at km 60+300 was selected for modeling location for **HS-01**.

The intersection of the proposed expressway with Boisar Road that leads to Mumbai suburb of Boisar town, residential areas of adjoining Lalonde village with 1 primary school, residential areas of adjoining Nagzari village having one primary school and LSVVA School (Pvt. managed high school) near the intersection of two roads favored selection of this location for calculation of ground level concentration of pollutants at various receptors positions, which will be generated due to plying of vehicles on the proposed Expressway and existing Boisar road. The details of the receptors and their distances from proposed centerline of the expressway for HS-01 are provided in **Table 4-8**.

**Table 4-8 Distances of receptors from Proposed Expressway and Boisar Road**

Name	Description	Distances from (m)	
		VME	Boisar Road
Receptor 1	Lalonde Village settlements	400	933
Receptor 2	Lalonde Village settlements	630	344
Receptor 3	LSVV Adhikari Vidyalaya (High School), Lalonde	73	65
Receptor 4	Lalonde Primary school adjoining Sai River Palace (Row House Society), Lalonde	291	106
Receptor 5	Nagzari village settlement (Fulancho Padha)	212	398
Receptor 6	Nagzari village settlement and Nagzari Primary School	178	565

Traffic Section **HS-02** is relatively smaller stretch than HS-01 with sparse settlements and few sensitive receptors. A set of receptors were taken at varying distances of 10 m, 30 m, 50 m, 100 m, 150 and 200 m on both sides from the edge of the carriageway to calculate the concentration of pollutants.

**Predicted Ground Level Concentrations:** The predicted one hourly ground level concentration for Carbon Monoxide (CO) for both homogeneous traffic sections and their spread around the road have been presented in subsequent sections.

#### 4.4.2.2 Prediction Results

**Homogeneous Traffic Sections 01:** Analyses of modeling results ascertain that the predicted level of CO concentration for the homogeneous traffic section 01 is well within the prescribed range of 4 mg/m<sup>3</sup> or 4000 µg/m<sup>3</sup>. The pollutant concentrations tend to increase over the years with the increased traffic volume, but will remain within the stipulated limits.

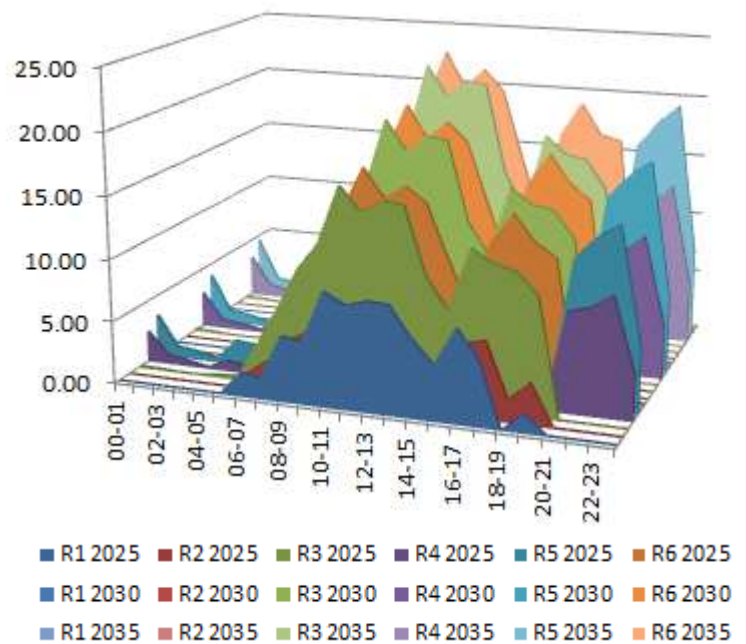
Year 2020 has been considered as a base year and pollutant concentration has been calculated for year 2025, 2030 and 2035. **The predicted values are in µg/m<sup>3</sup> as per model stipulation [1 mg/m<sup>3</sup> = 1000 µg/m<sup>3</sup>].** The calculated GLC in 6 receptor locations for CO are provided in **Table 4-9** and the distribution of Ground Level Concentration (GLC) of CO (µg/m<sup>3</sup>) in all hours across all receptors are shown in **Figure 4-3**, which shows higher concentration of CO are mostly between 10-12 hours and 16-18 hours, which witness high traffic.

Individual receptor-wise distribution of predicted GLC are presented through rose plots in **Figure 4-4**, which shows comparative analysis of the hourly spread of highest GLC in various projected years. Being located in coastal area with characteristic land and sea breeze winds, the pollutant concentration across the receptors varies widely with the time of the day depending on its location and traffic density. The isopleths showing GLC contours at minimum traffic hours are shown in **Figure 4-5, 4-6 and 4-7** for the years 2025, 2030 and 2035 respectively, while the same for the highest traffic hour have been plotted on land use maps to assess the impacted area.



**Table 4-9 Predicted GLC of Carbon Monoxide in Homogeneous Traffic Section 01 (in  $\mu\text{g}/\text{m}^3$ )**

Hour	Receptors						Receptors					
	1	2	3	4	5	6	1	2	3	4	5	6
	<b>Year 2025</b>						<b>Year 2030</b>					
00-01	0.00	0.00	0.10	2.50	3.40	0.00	0.00	0.00	0.20	2.90	4.00	0.00
01-02	0.00	0.00	0.10	0.70	0.90	0.00	0.00	0.00	0.10	0.70	1.00	0.00
02-03	0.00	0.00	0.00	0.40	0.70	0.00	0.00	0.00	0.00	0.50	0.80	0.00
03-04	0.00	0.00	0.00	0.10	0.30	0.00	0.00	0.00	0.00	0.20	0.30	0.00
04-05	0.00	0.00	0.20	0.80	2.00	0.30	0.00	0.00	0.20	0.90	2.40	0.30
05-06	0.00	0.00	0.30	0.60	1.80	0.50	0.00	0.00	0.40	0.70	2.20	0.50
06-07	1.90	1.50	3.20	0.20	0.00	3.20	2.20	1.80	4.10	0.30	0.00	3.80
07-08	1.70	2.60	6.20	0.00	0.40	7.40	2.00	3.10	7.40	0.00	0.40	8.70
08-09	5.20	4.40	9.60	0.40	0.20	9.90	6.20	5.30	11.40	0.50	0.20	11.80
09-10	5.00	5.50	11.80	0.10	0.40	13.30	5.90	6.50	14.00	0.20	0.40	16.00
10-11	9.10	7.50	16.40	0.80	0.20	16.70	10.80	8.90	19.50	1.00	0.20	19.80
11-12	8.20	6.60	14.50	0.80	0.10	14.40	9.70	7.80	17.10	1.00	0.20	17.10
12-13	8.70	7.10	15.50	0.80	0.20	15.50	10.30	8.40	18.40	1.00	0.20	18.60
13-14	8.60	6.90	15.30	1.10	0.00	14.30	10.20	8.10	18.20	1.30	0.00	17.10
14-15	6.20	4.80	10.00	0.20	0.00	10.10	7.40	5.80	11.80	0.30	0.10	12.20
15-16	4.40	3.30	7.60	0.70	0.00	6.40	5.20	3.90	9.20	0.80	0.00	7.60
16-17	7.40	5.70	12.50	0.70	0.00	11.80	8.90	6.70	14.80	0.90	0.00	14.10
17-18	5.20	6.10	11.50	0.00	0.50	14.10	6.20	7.30	13.60	0.00	0.50	16.60
18-19	0.00	1.80	11.10	0.00	1.10	12.00	0.00	2.10	13.30	0.00	1.30	14.30
19-20	1.50	3.30	9.40	0.00	0.80	10.90	1.80	4.00	11.20	0.00	1.00	13.00
20-21	0.00	0.00	0.00	7.90	11.60	0.40	0.00	0.00	0.00	9.40	13.90	0.40
21-22	0.00	0.00	0.00	8.40	13.40	0.50	0.00	0.00	0.00	10.00	15.80	0.50
22-23	0.00	0.00	0.00	9.50	14.40	0.50	0.00	0.00	0.00	11.40	17.00	0.60
23-00	0.00	0.00	0.00	3.70	5.40	0.20	0.00	0.00	0.00	4.40	6.30	0.20
	<b>Year 2035</b>											
00-01	0.00	0.00	0.20	3.40	4.60	0.00						
01-02	0.00	0.00	0.20	1.00	1.20	0.00						
02-03	0.00	0.00	0.00	0.60	0.90	0.00						
03-04	0.00	0.00	0.00	0.30	0.40	0.00						
04-05	0.00	0.00	0.20	1.10	2.80	0.40						
05-06	0.00	0.00	0.40	0.80	2.40	0.60						
06-07	2.50	2.10	4.40	0.30	0.00	4.40						
07-08	2.30	3.60	8.50	0.00	0.40	10.00						
08-09	7.10	6.00	13.20	0.50	0.20	13.60						
09-10	6.80	7.50	16.10	0.20	0.50	18.40						
10-11	12.40	10.30	22.20	1.20	0.20	22.60						
11-12	11.10	9.10	19.80	1.10	0.20	19.70						
12-13	11.80	9.70	21.10	1.20	0.20	21.30						
13-14	11.70	9.50	20.90	1.50	0.10	19.50						
14-15	8.50	6.60	13.60	0.30	0.10	13.90						
15-16	6.10	4.60	10.50	1.00	0.00	8.70						
16-17	10.20	7.80	17.00	1.00	0.00	16.20						
17-18	7.10	8.30	15.50	0.00	0.70	18.90						
18-19	0.10	2.40	15.20	0.00	1.60	16.30						
19-20	2.10	4.50	12.80	0.00	1.10	15.90						
20-21	0.00	0.00	0.00	10.80	15.90	0.50						
21-22	0.00	0.00	0.00	11.50	18.10	0.60						
22-23	0.00	0.00	0.00	13.10	19.60	0.70						
23-00	0.00	0.00	0.00	5.10	7.40	0.20						



**Figure 4-3 Distribution of Ground Level Concentration (GLC) of CO ( $\mu\text{g}/\text{m}^3$ ) across all receptors**

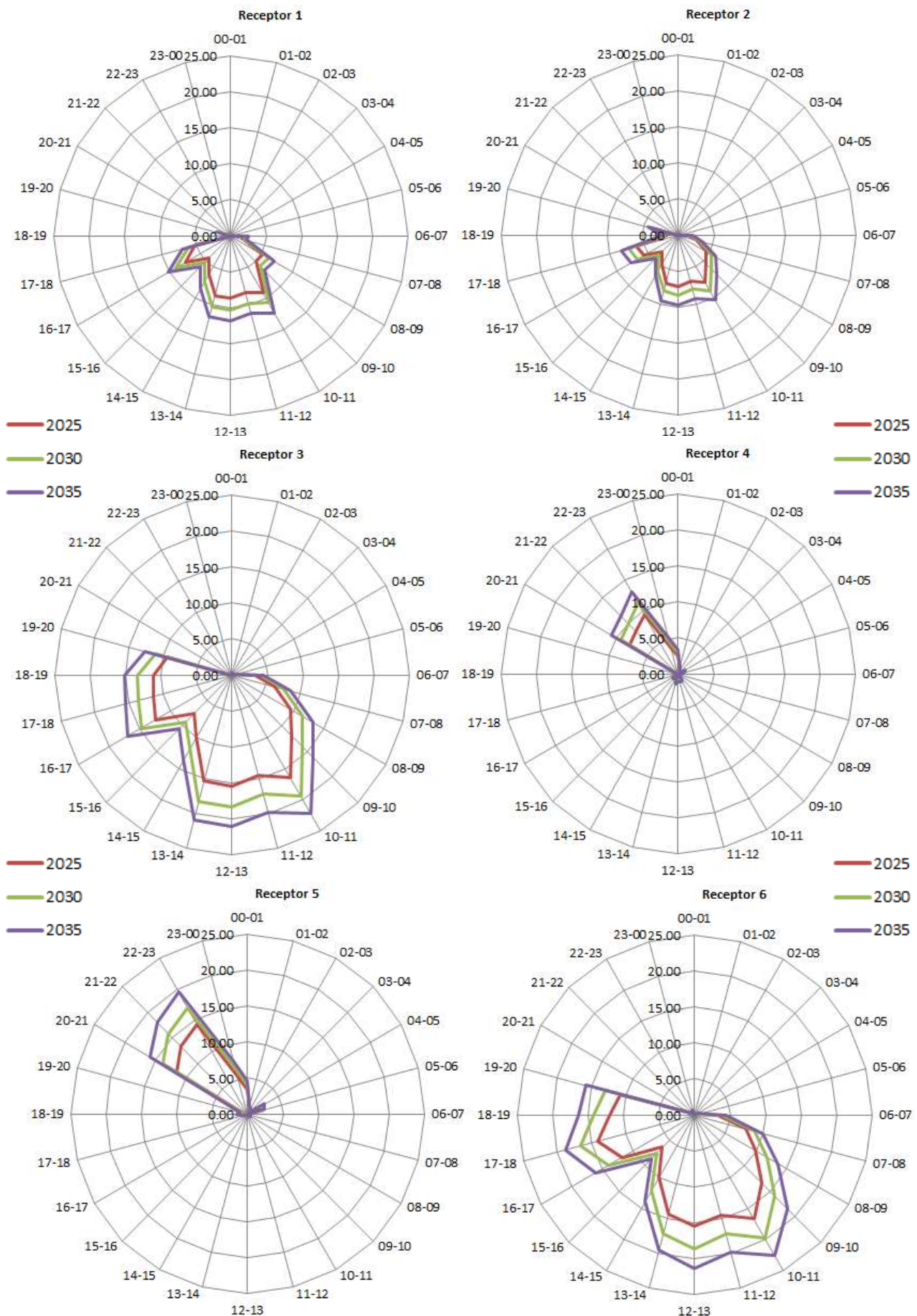


Figure 4-4 Receptor-wise ground level concentration of CO (  $\mu\text{g}/\text{m}^3$  )



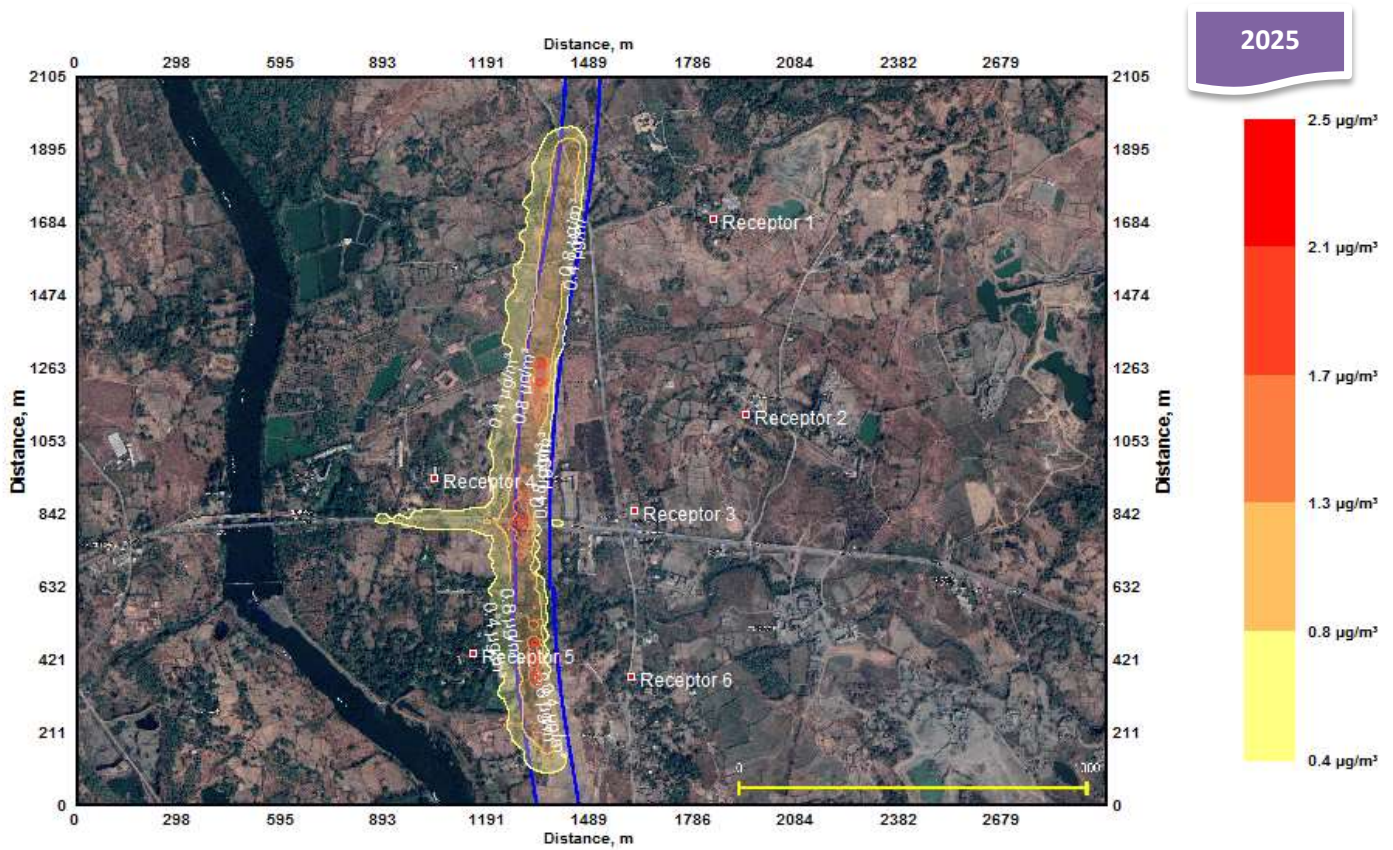


Figure 4-5 GLC Contours of CO ( $\mu\text{g}/\text{m}^3$ ) in lowest traffic hour in 2025 for traffic section 01

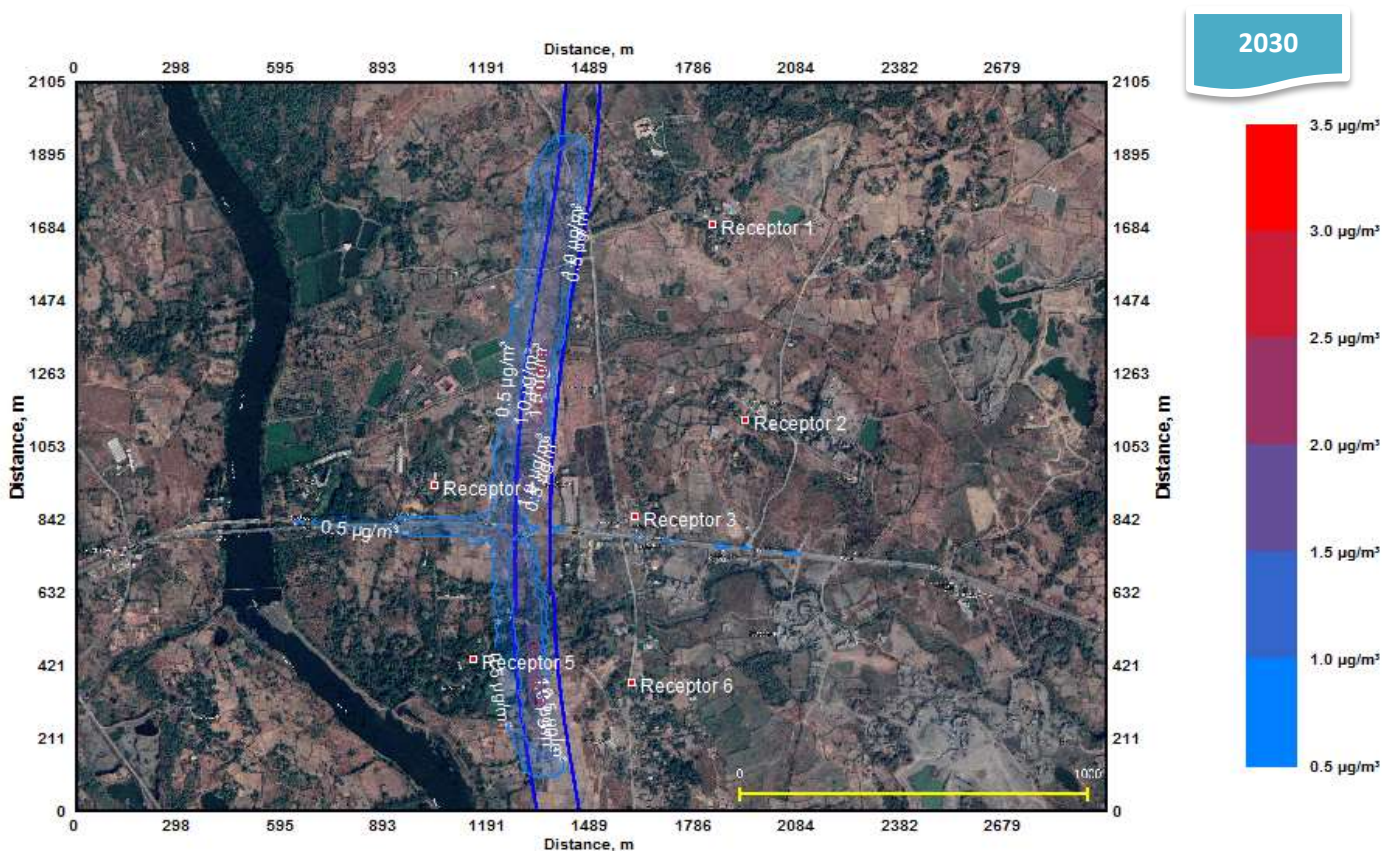


Figure 4-6 GLC Contours of CO ( $\mu\text{g}/\text{m}^3$ ) in lowest traffic hour in 2030 for traffic section 01



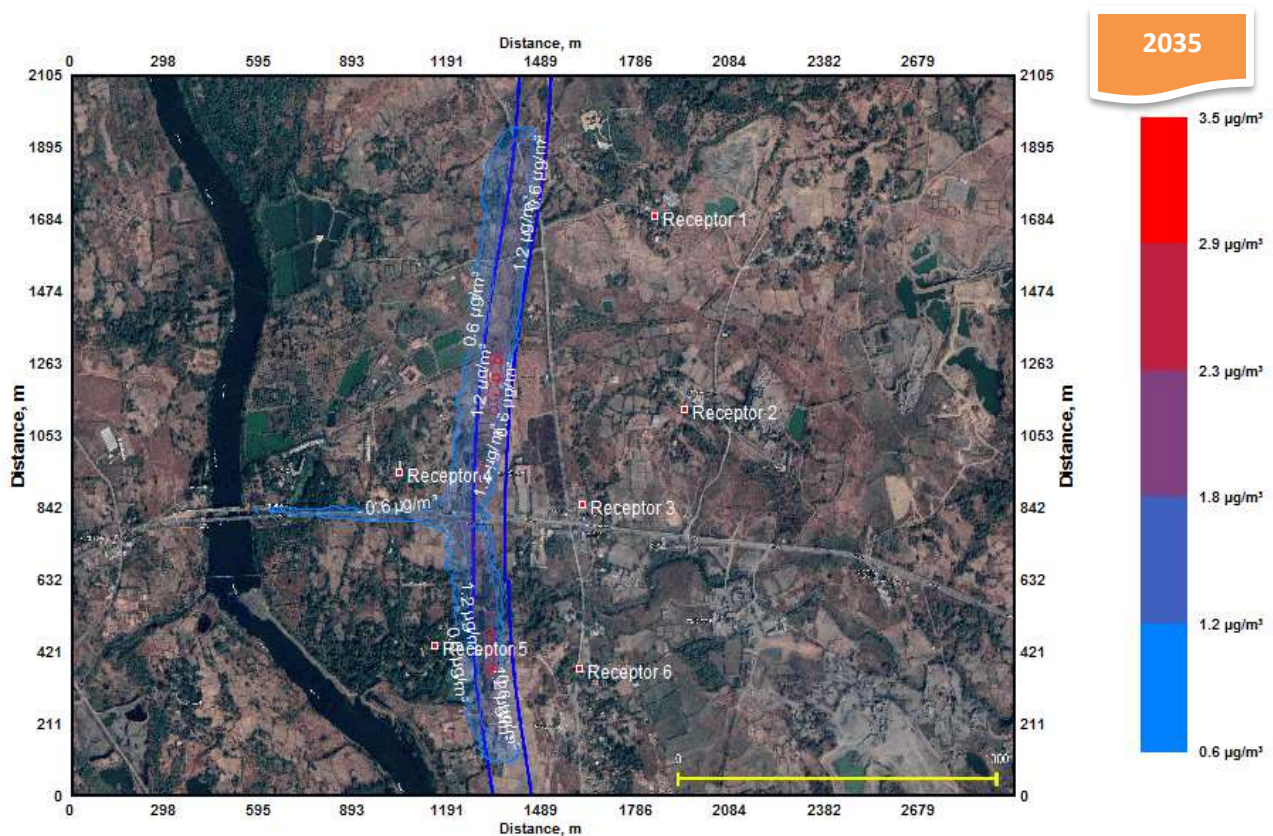


Figure 4-7 GLC Contours of CO ( $\mu\text{g}/\text{m}^3$ ) in lowest traffic hour in 2035 for traffic section 01

The land use of the modeled area is primarily agrarian (71%), followed by settlements (12%), barren land (11%), water body (5%) and forests (1%). The isopleth showing maximum predicted hourly ground level concentration of CO at peak traffic hour in the year 2025 and land use pattern around modeled area is shown in **Figure 4-8**. Similar isopleths for the year 2030 and 2035 on land use map are shown in **Figures 4-9, and 4-10**.

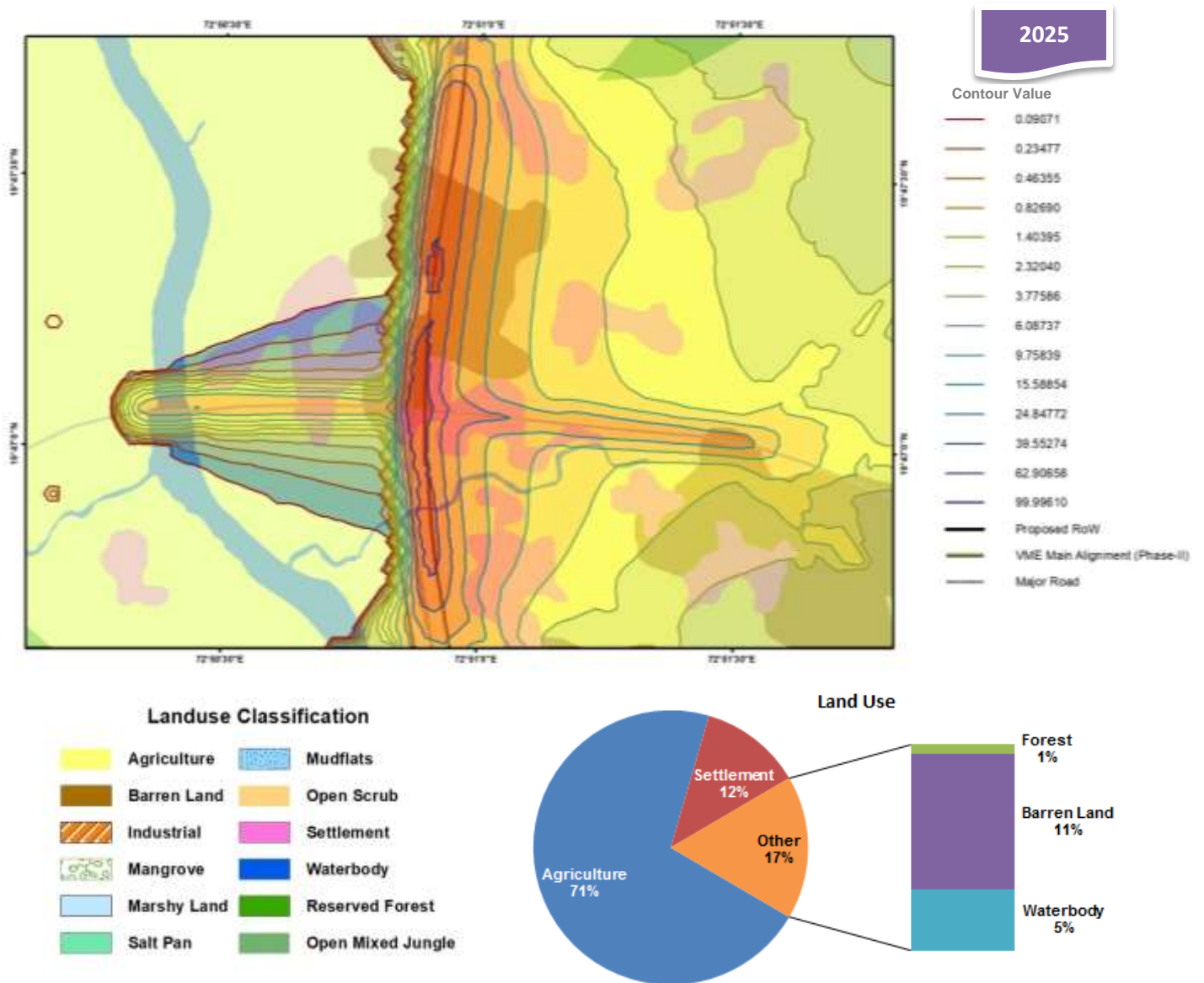


Figure 4-8 GLC Contours of CO ( $\mu\text{g}/\text{m}^3$ ) at peak traffic hour in 2025 on land use for Traffic Section 01



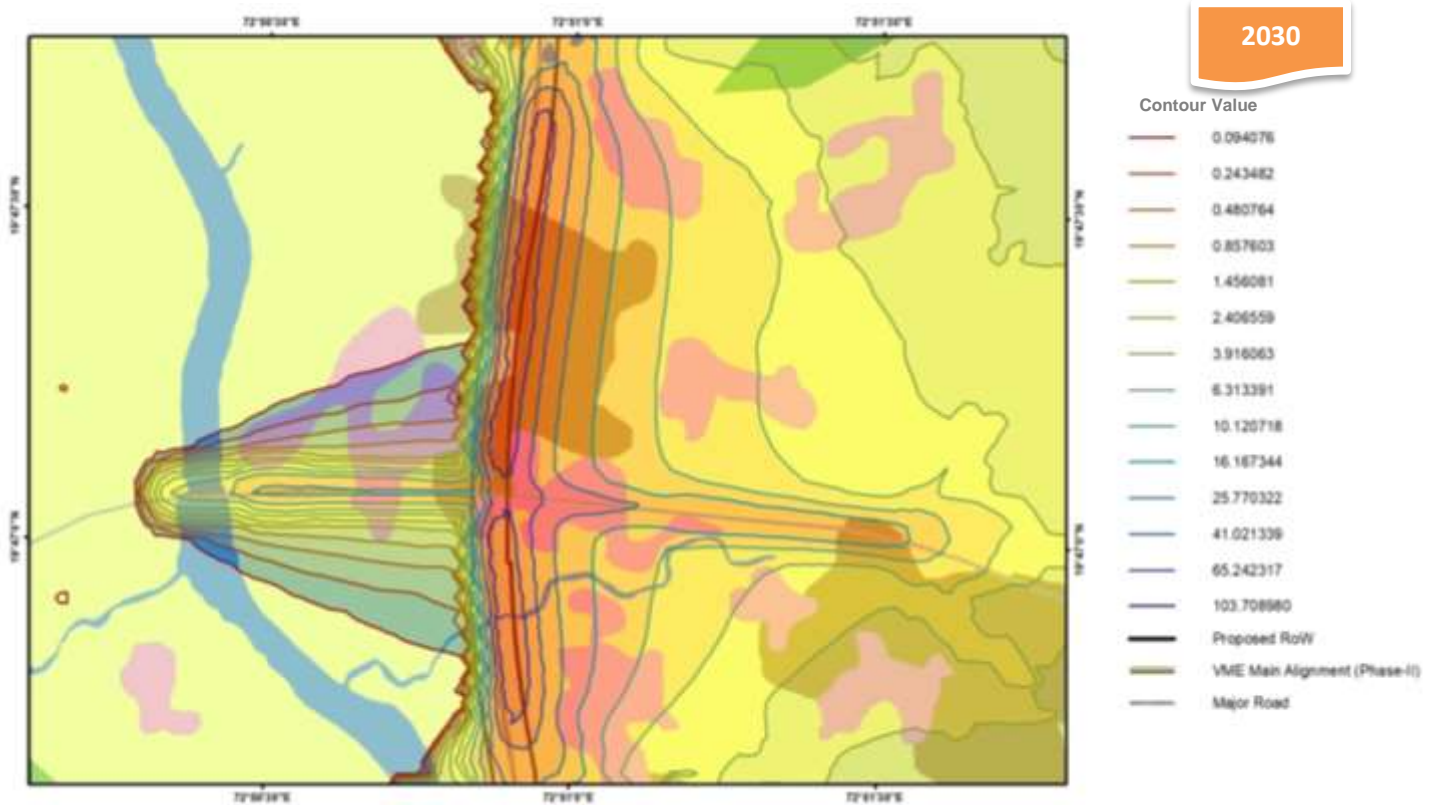


Figure 4-9 GLC Contours of CO ( $\mu\text{g}/\text{m}^3$ ) at peak traffic hour in 2030 on land use for Traffic Section 01

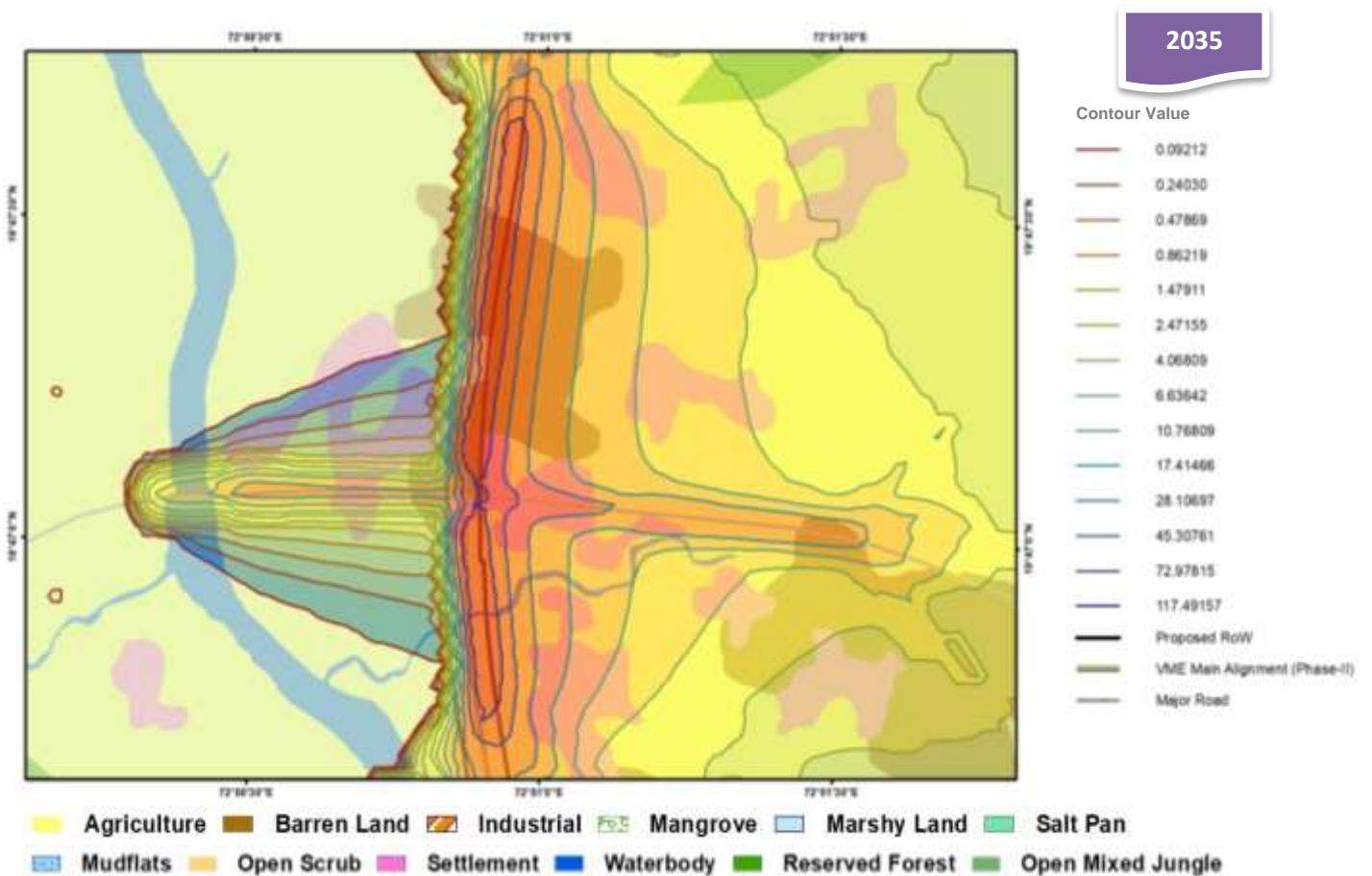


Figure 4-10 GLC Contours of CO ( $\mu\text{g}/\text{m}^3$ ) at peak traffic hour in 2035 on land use for Traffic Section 01

The contour class intervals and the percentage of land cover under various land use category within the limits of the contour is provided in **Table 4-10**. The table also shows the % change in land cover of contours under various contour classes resulting from increased pollution load due to increase in vehicular flow after a decade of expressway made operational. The cumulative % column shows that change in land cover after a decade of operation; such as 90% land will be within  $17.4 \mu\text{g}/\text{m}^3$  or  $0.017 \text{ mg}/\text{m}^3$  in the year 2025 (year of operation) while the same for the year 2035 will be 87%.

**Table 4-10 Land Use in Predicted Contour Class Intervals for Year 2025**

Contour Class	Class Interval ( $\mu\text{g}/\text{m}^3$ )	Land Use (%) for 2025					2025 Cumulative %	2035 Cumulative %
		Agriculture	Settlement	Barren	Water body	Forest		
A	0.000-0.0921	28.4	1.1	0.7	4.0	0.0	34	33
B	0.0921-0.2403	1.5	0.5	0.0	0.2	0.0	36	36
C	0.2403-0.4787	1.0	0.4	0.0	0.1	0.0	38	37
D	0.4787-0.8622	0.8	0.4	0.0	0.1	0.0	39	39
E	0.8622-1.4791	0.9	0.2	0.1	0.1	0.0	41	40
F	1.4791-2.4716	6.0	0.6	2.4	0.1	0.2	50	43
G	2.4716-4.0681	8.6	2.0	2.2	0.1	0.5	63	57
H	4.0681-6.6364	9.0	1.6	1.3	0.1	0.0	75	70
I	6.6364-10.7681	5.9	2.0	0.4	0.2	0.0	84	80
J	10.7681-17.4147	3.0	1.7	1.3	0.2	0.0	90	87
K	17.4147-28.107	2.4	0.8	1.1	0.1	0.0	94	93
L	28.107-45.3076	1.4	0.4	0.7	0.0	0.0	97	96
M	45.3076-72.9782	1.3	0.2	0.9	0.0	0.0	99	98
N	72.9782-117.4916	0.5	0.1	0.4	0.0	0.0	100	100
	<b>Total</b>	71	12	11	5.0	1.0	-	-

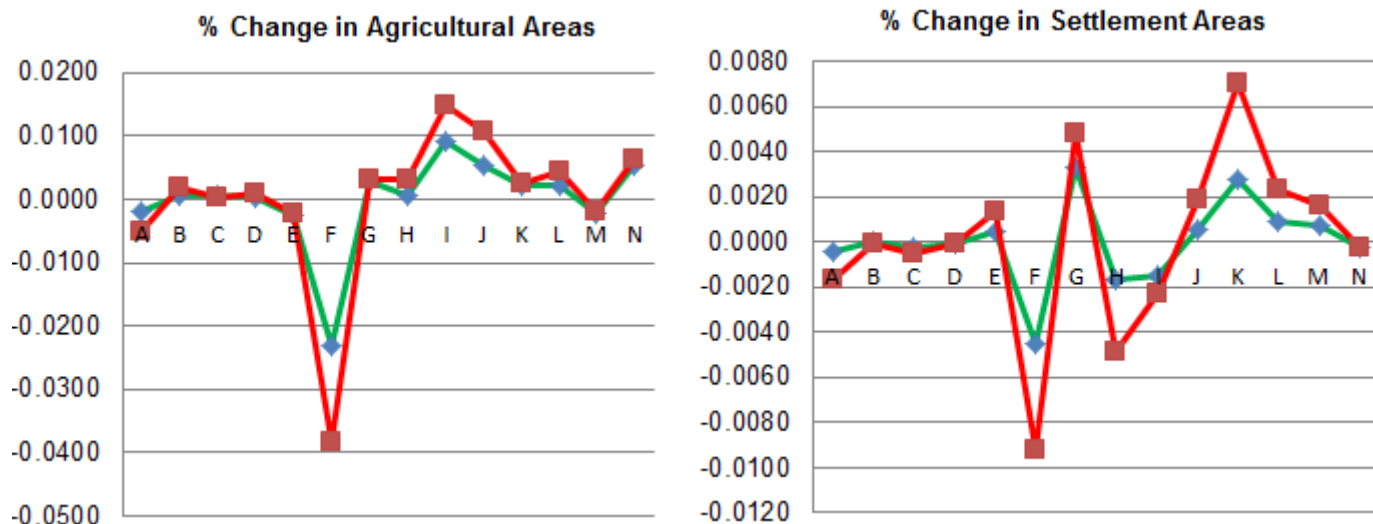
Note:  $1 \text{ mg}/\text{m}^3 = 1000 \mu\text{g}/\text{m}^3$

Contour class-wise percentage change in land use in year 2035 with respect to year 2025 is provided in **Table 4-11**. It has been observed that change is higher in high contour classes and hence increase in area into emission fold is directly proportional to the increase in vehicular flow.

The percentage change pattern for agricultural and settlement areas for the year 2030 and 2035 with respect to the year 2025 are graphically plotted and presented in Figure 4-11. As the settlement areas are located amidst of the agricultural field and at some distance for the proposed expressway, the % change in settlement areas being exposed to higher concentration is linked with mid-contour values, i.e., high concentration of pollutants will travel beyond the settlements and will get more agricultural fields into its fold in comparison to the settlements, provided the habitation boundaries do not expand in the direction of propagation.

**Table 4-11 Contour Class-wise % Change in Land Use in Year 2035 with respect to year 2025**

Contour Class	Agriculture	Settlement	Barren Land	Waterbody	Forest
A	▼ -0.521%	▼ -0.131%	▲ 0.011%	▼ -0.041%	▬ 0.000%
B	▲ 0.174%	▼ -0.011%	▼ -0.002%	▲ 0.018%	▬ 0.000%
C	▲ 0.036%	▼ -0.028%	▼ -0.005%	▲ 0.010%	▬ 0.000%
D	▲ 0.102%	▲ 0.003%	▼ -0.005%	▲ 0.016%	▬ 0.000%
E	▼ -0.238%	▲ 0.088%	▼ -0.034%	▲ 0.016%	▬ 0.000%
F	▼ -3.841%	▼ -0.470%	▼ -1.546%	▲ 0.016%	▼ -0.221%
G	▲ 0.302%	▲ 0.159%	▲ 0.333%	▲ 0.015%	▲ 0.052%
H	▲ 0.303%	▼ -0.315%	▲ 0.913%	▲ 0.005%	▲ 0.169%
I	▲ 1.496%	▼ -0.083%	▲ 0.177%	▼ -0.002%	▬ 0.000%
J	▲ 1.071%	▲ 0.131%	▼ -0.440%	▼ -0.078%	▬ 0.000%
K	▲ 0.255%	▲ 0.433%	▲ 0.292%	▲ 0.006%	▬ 0.000%
L	▲ 0.430%	▲ 0.138%	▲ 0.109%	▲ 0.008%	▬ 0.000%
M	▼ -0.180%	▲ 0.091%	▼ -0.216%	▲ 0.002%	▬ 0.000%
N	▲ 0.618%	▼ -0.002%	▲ 0.409%	▲ 0.003%	▬ 0.000%



**Figure 4-11 Comparison of % change pattern of land under agricultural & settlement use due increased vehicular emission for year 2030 and 2035 with respect to year 2025**

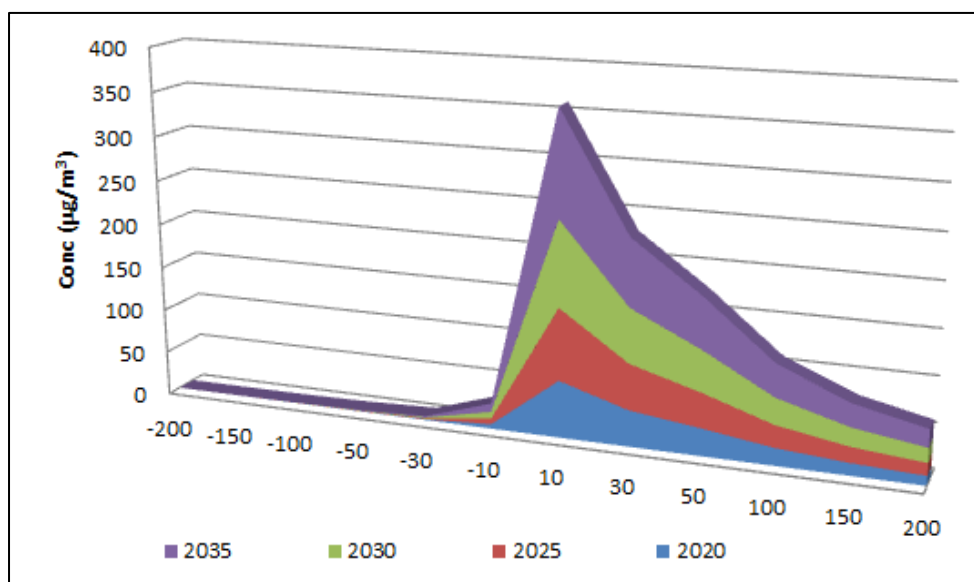
### Homogeneous Traffic Sections 02:

Analyses of modeling results ascertain that the predicted level of Carbon Monoxide concentration for the homogeneous traffic section 02 is well within the prescribed range of  $4 \text{ mg/m}^3$  or  $4000 \text{ } \mu\text{g/m}^3$ . Year 2020 has been considered as a base year and pollutant concentration has been calculated for year 2025, 2030 and 2035. The predicted values are in  $\mu\text{g/m}^3$  as per model stipulation [ $1 \text{ mg/m}^3 = 1000 \text{ } \mu\text{g/m}^3$ ].

The predicted GLC of Carbon Monoxide at peak and lowest traffic hours at receptor positions having distances of 10m, 30m, 50m, 100m, 150m and 200m on both sides of carriageway is provided in **Table 4-12** and graphically presented in **Figure 4-12** and **4-13**. The values in distance columns are along x axis. Negative values indicate left side while the positive values indicate right side of the proposed expressway.

**Table 4-12 Predicted GLC of Carbon Monoxide in Homogeneous Traffic Section 02 (in  $\mu\text{g}/\text{m}^3$ )**

Year ▶	2020	2025	2030	2035		2020	2025	2030	2035
Distance ▼	Peak Traffic Hour (11-12 Hours)					Lowest Traffic Hour (03-04 Hours)			
-200	0.00	0.00	0.00	0.00		0.20	0.20	0.20	0.30
-150	0.00	0.00	0.00	0.00		0.20	0.30	0.30	0.40
-100	0.10	0.10	0.10	0.10		0.30	0.40	0.40	0.50
-50	0.30	0.40	0.40	0.60		0.50	0.60	0.70	0.80
-30	0.80	1.00	1.20	1.50		0.60	0.80	1.00	1.10
-10	5.10	6.50	7.70	9.50		1.10	1.40	1.70	1.90
10	64.10	80.90	95.90	119.00		0.10	0.10	0.10	0.10
30	40.70	51.40	61.00	75.60		0.00	0.00	0.00	0.00
50	30.90	39.00	46.30	57.40		0.00	0.00	0.00	0.00
100	19.70	24.80	29.40	36.50		0.00	0.00	0.00	0.00
150	13.80	17.40	20.70	25.70		0.00	0.00	0.00	0.00
200	10.70	13.60	16.10	19.90		0.00	0.00	0.00	0.00



**Figure 4-12 Ground Level Concentration (GLC) of CO (  $\mu\text{g}/\text{m}^3$  ) in Peak Traffic Hour in HS-02**

The tree plantation and habitat improvement activities included in the project scope will help to check air pollution. Road signage at regular intervals to remind motorists to maintain their vehicles and minimize fuel consumption may be posted. Raising awareness amongst drivers on good driving practices to reduce fuel consumption and promote road safety may also be carried out. As part of the routine maintenance works good riding conditions of the road surface will be maintained to reduce dust and vehicular pollution.

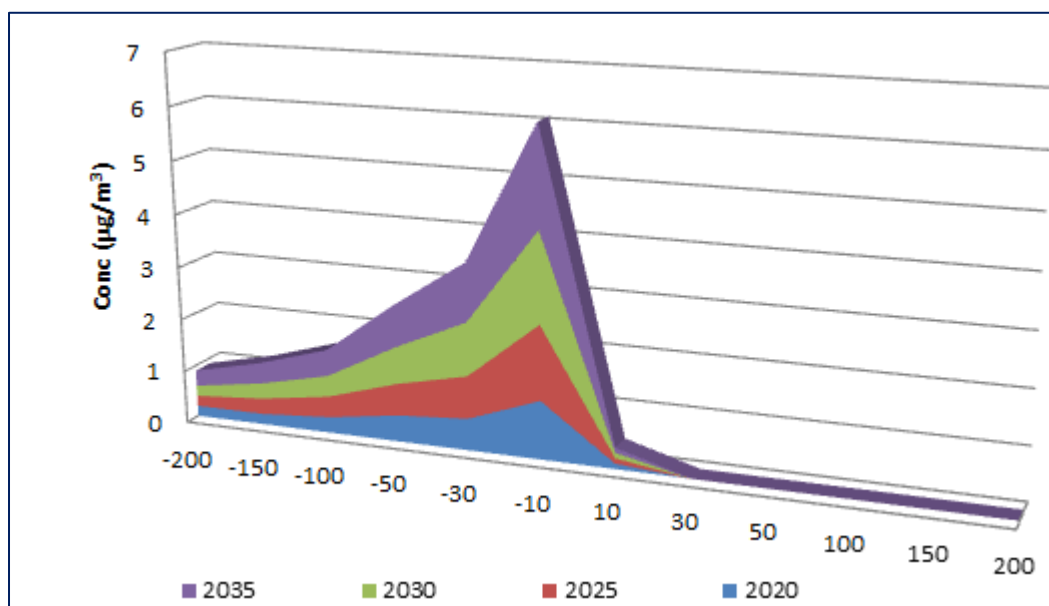


Figure 4-13 Ground Level Concentration (GLC) of CO ( $\mu\text{g}/\text{m}^3$ ) in lowest Traffic Hour in HS-02

**Conclusions:** In the projected scenario, these due to higher carriageway width, air turbulence and high design speed, emissions from traffic are low at receptor locations. With the introduction of BS-VI compliant fuels and vehicles in 2020 onwards, the vehicular emission is expected to further reduce and may offset the increased pollutant concentration due to increased traffic volume. Hence, the pollutant concentration is not expected to increase beyond stipulated limits in operation phase of the project.

#### 4.4.2.3 Mitigation Measures

- Vehicular emission will be controlled through enforcement of laws and public awareness. It will be ensured that all the vehicles have vehicular emission within the permissible limits.
- Regular monitoring of ambient air quality at specified representative locations will be conducted at fixed interval.
- Plantation along the expressway will act as sink of air pollutants. Pollution resistant species, which can grow in high pollutants concentrations and absorb pollutants shall be planted as proposed under Greenbelt Development Plan
- The designed road surface shall generate lesser dust.



## 4.5 NOISE ENVIRONMENT

### 4.5.1 Construction Phase

During the construction phase, noise will be generated due to movement of vehicles, and operation of light & heavy construction machineries including pneumatic tools (hot-mixer, dozer, tipper, loader, excavator, grader, scraper, roller, concrete mixer, generator, pump, vibrator, crane, compressor etc.) that are known to emit sounds with moderate to high decibel value.

Noise generated from sources mentioned above will be intermittent and mostly during daytime. Moreover, villages / settlements being mostly away from the proposed expressway, significant impact on local people is not apprehended, as the noise will generally die down by the time it reaches them. However, the workers are likely to be exposed to high noise levels that may affect them.

#### Impacts:

- Increase in noise level due to construction activities like operation of construction equipment & vehicular traffic.

Operation of construction machinery will lead to rise in noise level to the range between 80-95 dB(A). The magnitude of impact from noise will depend upon types of equipment to be used, construction methods and also on work scheduling. Typical noise level of various activities during construction stage is presented below.

**Table 4-13 Typical Noise Level during Construction Activities**

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

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

General conclusion can be based on the types of construction work anticipated, the likely equipment required and their associated range of noise levels. Typical noise level of principal construction equipment is presented below.

**Table 4-14 Typical Noise Level of Construction Equipment**

Clearing		Structure Construction	
Equipment	Noise Level dB(A)	Equipment	Noise Level dB(A)
Bulldozer	80	Crane	75-77
Front end loader	72-84	Welding generator	71-82
Jack hammer	81-98	Concrete mixer	74-88
Crane with ball	75-87	Concrete pump	81-84
		Concrete vibrator	76

Clearing		Structure Construction	
<b>Excavation &amp; Earth Moving</b>		Air compressor	74-87
Bulldozer	80	Pneumatic tools	81-98
Backhoe	72-93	Bulldozer	80
Front end loader	72-84	Cement & dump trucks	83-94
Dump truck	83-94	Front end loader	72-84
Jack hammer	81-98	Dump truck	83-94
Scraper	80-93	Paver	86-88
<b>Grading &amp; Compaction</b>		<b>Landscaping and Cleanup</b>	
Grader	80-93	Bulldozer	80
Roller	73-75	Backhoe	72-93
<b>Paving</b>		Truck	83-94
Paver	86-88	Front end loader	72-84
Truck	83-94	Dump truck	83-94
Tamper	74-77	Paver	86-88

Source: U.S. Environmental Protection Agency, Noise from Construction Equipment and Operations. Building Equipment and Home Appliance. NJID.300.1. December 31, 1971

The construction noise is generally intermittent and depends on the type of operations, location and function of the equipment and the equipment usage cycle, it attenuates quickly with increases in distance. The noise level generated from a source will decrease with distance as per the following empirical formula (inverse square law).

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

where, SPL1 and SPL2 are the sound pressure levels at distance  $r_1$  and  $r_2$  respectively. Considering the stationary construction equipment as a point source generating 90 dB(A) at a reference distance of 2 m, computed minimum distance required from the stationary source to meet the permissible noise limits during day time for different land use categories are given in **Table 4-15**.

**Table 4-15 Minimum Distance Required from Stationary Noise Source**

Category	Permissible Limits in Day Time (CPCB)	Distance Required (m)
Silence zone	50 dB(A)	200
Residential	55 dB(A)	113
Commercial	65 dB(A)	36
Industrial	75 dB(A)	11

From the above table it may be noted that residence within 113m from the expressway will be exposed to a noise higher than the permissible limit. The impacts will be significant on construction workers, working close to the machinery.

#### **Mitigation Measures:**

- Construction camp and temporary labour sheds will be located away from the

immediate vicinity of the construction sites and major road traffic.

- Protective gears such as ear plugs or ear muffs will be provided to construction personnel exposed to high noise levels as preventive measure (**Annex-9.10**).
- Low noise construction equipment will be used.
- It will be ensured that all the construction equipment & vehicles used are in good working condition, properly lubricated & maintained to keep noise within the permissible limits and engines turned off when not in use to reduce noise.
- Stationary construction equipment will be placed 113 m away from inhabited areas.
- Stationary construction equipment will be placed 200 m away from the school. However, those schools are located within 200m of the proposed expressway; no construction activity shall be carried out in those stretches during school hours. Further, noise barrier has also been proposed in those schools.
- Construction activities carried out near residential area will be scheduled to the daytime only so that minimum disturbances are caused to people.
- "Silence zones will be demarcated and road signs prohibiting the use of horns (No Honk Zone) will be displayed at residential areas, sensitive locations and silence zones
- Noise barrier will be constructed in silence zone, interchanges (300m on each side on outer edge), fly-overs (200m on each side on outer edge), truck parking (500m on one side on outer edge), way side amenity - type A (500m on one side on outer edge) and way side amenity - type B (150m on one side on outer edge)
- **Noise Monitoring:** The effectiveness of mitigation measures and further improvement in designs to reduce the noise level due to construction and operation activity shall be monitored. The frequency, duration and monitoring plan shall be functional in construction as well as in operation stages as per the Environmental Monitoring Plan (**Table 6-2** of Chapter-6) and the monitored values should correspond with the standard. All deviated results shall be reported to AE, for remedial measures.

#### 4.5.2 Operation Phase

The significance of operational noise impacts commensurate with the number of sensitive structures and sensitive areas that exist along the project roads. As stated in Chapter-3, land use pattern within RoW of the proposed expressway is mainly agricultural and allied uses (73.13%) followed by open scrub (13.41%), barren land (6.48%), reserved forest (2.71%), surface water bodies (2.12%), settlements (1.37%), mangrove forest (0.36%), open mixed forest (0.24%), mudflats (0.15%) and marshy land (0.04%). The sensitive receptors comprising educational institutions, medical amenities are located institutions within 500m from the centre line on either side of the proposed expressway and in the operation phase, will be exposed to noise generated by future traffic plying on the expressway.

##### 4.5.2.1 Source of Noise

During the operational phase, movement of traffic, traffic congestion, pedestrian interferences and increase in use of horns will be the prime source of noise. The noise levels at nearby schools, religious place may cause nuisance and irritation.

### ✓ Vehicle Noise and Road Surface Influence on Tire/Road Noise<sup>3</sup>

There are many sources of noise when a vehicle travels down a roadway. Vehicle manufactures have made efforts to reduce tire/road noise and drive train noise. If a vehicle is in a good operating condition and has a reasonably good exhaust system, then the effect that power and drive train noise has on the overall noise level will be negligible at moderate to high speeds. There is a “cross-over speed” where tire / road noise begins to dominate the overall noise level of a vehicle. This speed lies in the range of 30-50 km/h for automobiles and 40-70 km/h for trucks [Sandberg 1992]. It has been found that the noise level increases with the increase in the speed (**Figure 4-14**).

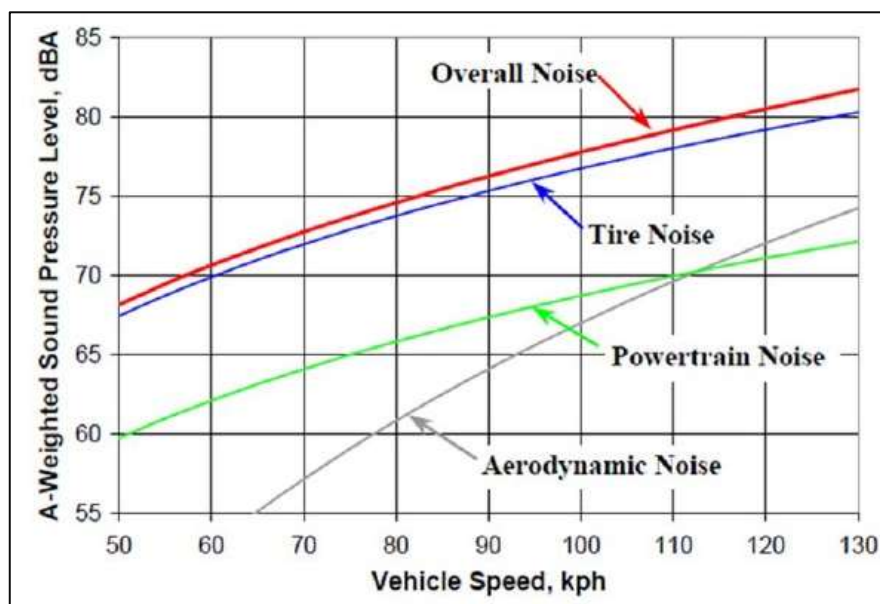


Figure 4-14 Comparison of Noise Level Separated by Component [Donovan, 2007]

There are several parameters, which affect the amount that the road surface contributes to the generation of tire / road noise. These parameters include the texture, age, thickness, and binder material of the pavement. The overall texture of the pavement has a significant impact on tire / road noise levels. Studies performed by the Washington State Department of Transportation to evaluate how tire / road noise changes with pavement age. These studies have shown that asphalt pavements start out quieter than cement concrete pavements, but the asphalt pavements exhibit an increase in noise levels over time [Chalupnik and Anderson 1992]. Another reason for the increase in noise levels is due to an increase in stiffness from traffic loading. Finally, as the asphalt surface wears over time, the coarse aggregate becomes exposed which causes an increase in noise.

#### 4.5.2.2 Prediction of Impacts

**Input Parameters:** Total vehicle flow for the projected period is obtained from the traffic projections. Design speed of 120 km/hr is considered for operation phase. Apart from that, year-wise % of heavy vehicle, gradient, road surface, absorbent ground cover,

<sup>3</sup> U.S. Department of Transportation, Federal Highway Administration

distance from edge of the carriageway and source / receiver height difference are the other input parameters.

**Output:** Impact of traffic movement on noise levels at all sensitive receptors up to 500 m distance on either side along the proposed expressway has been calculated for the year 2025, 2030 and 2035 and provided in **Table 4-16**. Noise levels, in most of the receptors are within the prescribed limit of 50 db(A) in day time for sensitive receptors and places where it exceeds the stipulated limit has been highlighted for ease of reference.

**Table 4-16 Sensitive Receptor Wise Predicted Noise Levels**

Sl. No	Name	Side	▼ Chainage Year ►	Noise Levels in dB(A)		
				2025	2030	2035
1.	Primary School (Talyachyapada), Koshimbe	RHS	27+350	59.5	60.3	60.9
2.	Upper Primary School, Khardi	RHS	28+800	45.6	46.4	47.0
3.	Upper Primary School, Navghar	RHS	32+300	45.2	46.0	46.6
4.	Primary School, Ghateem, Ghatim	LHS	33+400	43.7	44.5	45.1
5.	Primary School (Talekhalpada), Ghatim	RHS	34+500	44.6	45.4	46.0
6.	Primary School, Penand	LHS	34+950	41.3	42.1	42.7
7.	Secondary School, Paragaon	RHS	38+500	45.3	46.1	46.7
8.	Higher Secondary School, Paragon	RHS	39+180	45.4	46.2	46.8
9.	Primary School, Girale	RHS	40+360	43.2	44.0	44.6
10.	Primary School, Khamloli	LHS	46+250	42.9	43.7	44.3
11.	Primary School, Bahodoli	RHS	46+600	42.4	43.2	43.8
12.	Higher Secondary School, Bahodoli	RHS	46+680	44.2	45.0	45.6
13.	Primary School (Divakarpada), Bahodoli	RHS	47+530	43.0	43.8	44.4
14.	Primary School (Ranolipada), Dhuktan	LHS	48+290	44.6	45.4	46.0
15.	Primary School, Dhuktan	RHS	48+900	42.0	42.8	43.4
16.	Secondary School, Maswan	LHS	50+850	41.6	42.4	43.0
17.	Primary School, Maswan	LHS	51+490	43.1	43.9	44.5
18.	Primary School, Wandivali	RHS	52+300	45.3	46.1	46.7
19.	Primary School (Moripada), Katala	LHS	53+380	48.8	49.6	50.2
20.	Primary School (Kolhemalpada), Katala	LHS	55+170	57.4	58.2	58.8
21.	Primary School (Tandelpada), Loware	RHS	56+000	48.8	49.6	50.2
22.	Primary School, Nihe	RHS	57+350	41.1	41.9	42.5
23.	Primary School, Nagzari	RHS	59+610	48.2	49.0	49.6
24.	Primary School, Lalonde	LHS	60+275	44.2	45.0	45.6
25.	Late Sau Vidya Vinod Adhikari Vidyalay, Lalonde	RHS	60+370	58.4	59.2	59.8
26.	Primary School, Kirat	LHS	62+400	47.5	48.3	48.9
27.	Upper Primary School, Ravte	RHS	65+150	51.4	52.2	52.8
28.	Primary School (Titwalipada), Chinchare	LHS	67+320	46.2	47.0	47.6
29.	Primary School, Chinchare	RHS	67+550	41.1	41.9	42.5
30.	Primary School, Dhabon	RHS	69+210	47.7	48.5	49.1
31.	Primary School (Pilenapada), Dhabon	RHS	70+200	44.2	45.0	45.6
32.	Primary School (Patilpada), Dhabon	RHS	71+240	49.2	50.0	50.6
33.	Upper Primary School, Aine	LHS	72+420	43.9	44.7	45.3



Sl. No	Name	Side	Chainage Year	Noise Levels in dB(A)		
				2025	2030	2035
34.	Primary School, Aine	LHS	72+725	43.4	44.2	44.8
35.	Primary School (Bodanpada), Rankol	RHS	74+018	47.1	47.9	48.5
36.	Primary School (Pardhipada), Rankol	RHS	74+735	43.8	44.6	45.2
37.	Primary School (Raytali-Gadgpada), Chandwad	LHS	76+310	46.7	47.5	48.1
38.	Primary School (Divarpada), Ganjad	LHS	77+800	41.7	42.5	43.1
39.	Primary School (Kohralipada), Navnath	LHS	78+965	49.0	49.9	50.4
40.	Primary School (Ibhabpada), Dhaniwari	RHS	85+615	49.1	50.0	50.5
41.	Primary School, Dhaniwari	LHS	85+700	49.7	50.6	51.1
42.	Primary School, (Khadkipada), Chinchale	RHS	87+950	42.3	43.2	43.7
43.	Primary School (Bhonarpada), Nagzari	LHS	88+225	43.0	43.9	44.4
44.	Primary School (Randolpada), Chinchale	RHS	89+435	45.9	46.8	47.3
45.	Primary School, Talothe	LHS	90+540	42.9	43.8	44.3
46.	Primary School, Bramhanwadi	RHS	92+618	44.7	45.6	46.1
47.	Primary School, (Sonarpada), Vadavali	RHS	97+000	46.4	47.3	47.8
48.	Upper Primary School (Bobapada), Talasari	RHS	102+400	61.5	62.4	62.9

Source: CRTN Model Results

As most of these receptors are located distances beyond 100 m from the expressway, the impact of traffic noise is low. **Figure 4-15** graphically depicts the distance category-wise number of receptors within 500 m of the expressway on either side and predicted noise levels (max value) in various years, which shows the noise impact falls drastically in distances beyond 200 m from the proposed expressway.

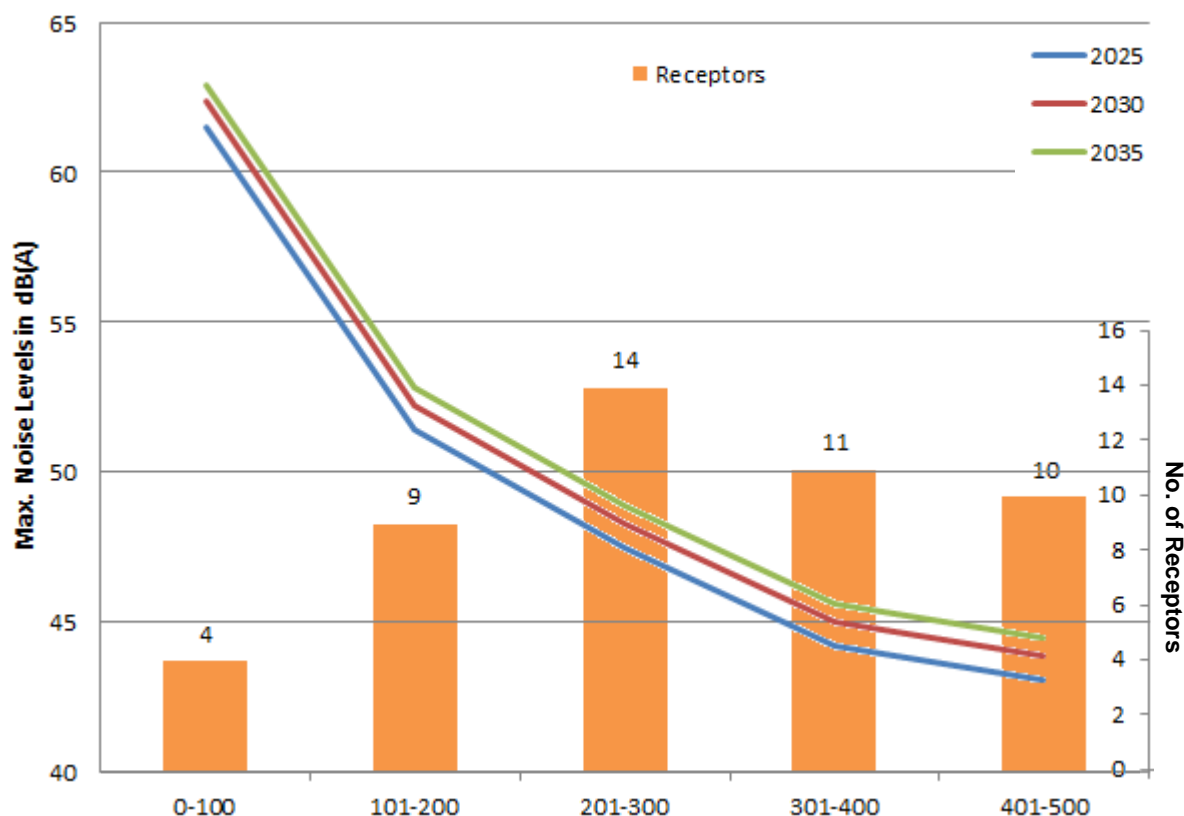
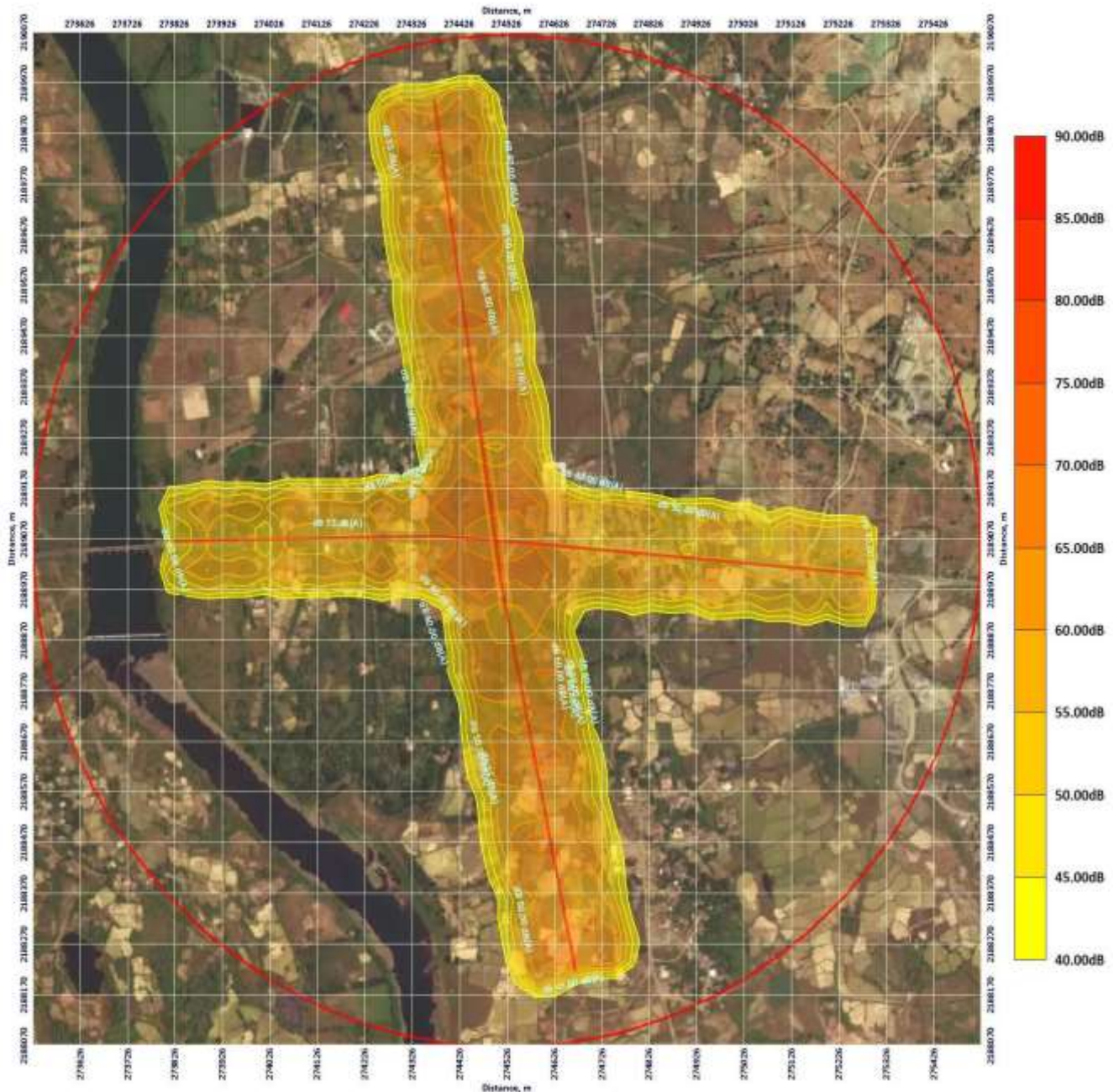


Figure 4-15 Distance-wise Receptors and Predicted Maximum Noise Level

A noise contour map at the junction of proposed expressway with existing Boisar road for the year 2025 considering traffic of both roads is shown in **Figure 4-16**. It shows that there is significant reduction of traffic induced noise levels beyond 100 m distance, which becomes insignificant beyond a distance of 200 m.



**Figure 4-16 Noise Contour Map**

#### 4.5.2.3 Mitigation Measures

**Noise Barrier:** Noise barriers have been proposed to reduce traffic induced noise. Depending on the location of receptors and elevation of the proposed expressway, 2 types of noise barriers have been proposed. Road side barriers along the outer edge of the structures (flyovers / vehicular over passes) have been proposed for receptors located close to the **elevated sections** (interchange / flyovers etc.) of the expressway while boundary walls as noise barriers have been proposed at other locations.

Height and length of the proposed noise barriers is given in **Table 4-17**. It may be mentioned that height of the noise barriers as mentioned in the table refers to the minimum height of the barrier required to attenuate the traffic induced noise at the concerned receptor to the stipulated limits, which has been calculated for traffic levels up to the year 2035. Some receptors do not require noise barriers in 2025 but the need for barriers are envisaged in subsequent years due to increase in traffic volume. The height of the boundary wall is also required to be increased at some locations in subsequent years as indicated in the table. However, height of the roadside noise barriers have been kept fixed at 2 meter at all places for ease of construction. Predicted noise levels of few receptors in year 2025, 2030 and 2035 are graphically presented in **Figure 4-17** including comparison with relevant Indian Standard.

**Table 4-17 Details of proposed Noise Barriers**

Sl. No	Name of the Sensitive Receptor	Village	Chainage	Height <sup>1</sup> (m)			Length <sup>2</sup> (m)	Barrier Type
				2025	2030	2035		
1	Primary School (Talyachyapada)	Koshimbe	27+350	2	2	2.5	62	BW
2	Primary School (Moripada)	Katale	53+380	NR	NR	1.5	56	BW
3	Primary School (KolhemalPada)	Katale	55+170	1.5	1.5	1.7	32	BW
4	Primary School (TandelPada)	Loware	56+000	NR	NR	1.5	50	BW
5	LSVV Vidyalaya	Lalonde	60+370	2	2	2	600 <sup>3</sup>	RS
6	Upper Primary School	Ravte	65+150	1.3	1.6	1.6	70	BW
7	Primary School (Patilpada)	Dhabon	71+240	NR	NR	1.2	45	BW
8	Primary School (Kohralipada)	Navnath	78+965	NR	NR	2	1200 <sup>4</sup>	RS
9	Primary School (Ibhabhpada)	Dhaniwari	85+615	NR	NR	1.2	65	BW
10	Primary School	Dhaniwari	85+700	NR	1.2	1.2	40	BW
11	Upper Primary School (Bobapada)	Talasari	102+400	2	2	2	200 <sup>5</sup>	RS

**Abbreviations:** NR = Not required; BW = Boundary wall barrier; RS = Road side barrier

**Notes:**

1 Refers to Minimum desired of proposed noise meter

2 Indicates approx. length of boundary wall in 3 sides, front side and two lateral sides towards expressway. For road side barriers, values indicate length of barrier along the expressway on the side of the receptor

3 Barrier to be placed on Boisar-NH8 road proposed flyover from km 60+000 to km 60+600

4 Barrier to be placed on the outer edge of the proposed interchange from km 78+500 to km 79+100

5 Barrier to be placed on proposed vehicular overpass km 102+300 to km 102+500

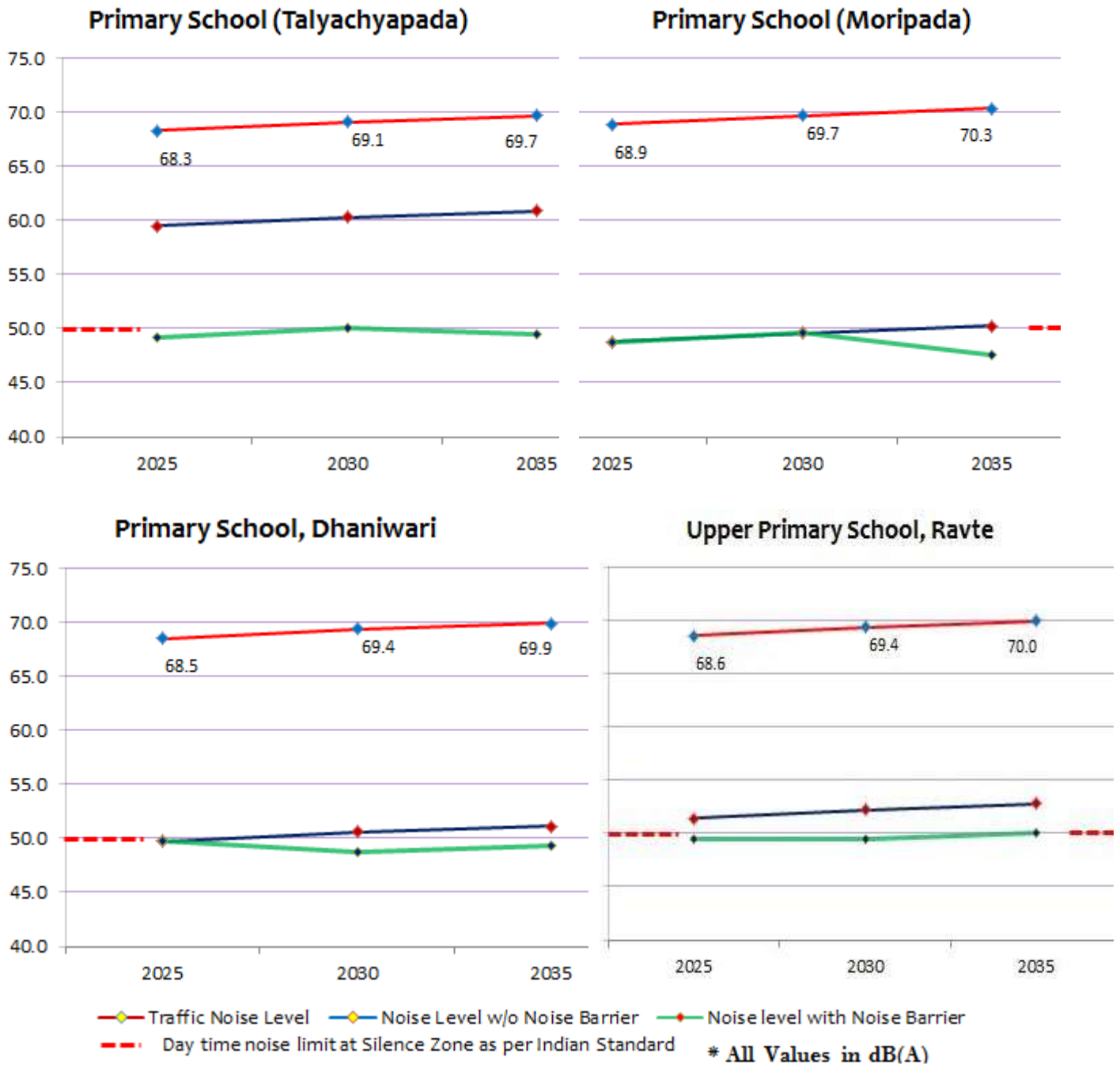


Figure 4-17 Noise level at Receptors - without & with barrier scenario

**Boundary Wall:** Noise barrier in the form of solid boundary wall is proposed for sensitive receptors at 8 locations (Table 4-17). The noise barrier wall shall be constructed by excavation of foundation, laying of brick masonry wall, plastering and painting. It is also proposed to plant shade and flowering trees within the boundary of the sensitive receptors, between the building line and the compound wall. Creepers may be planted in consultation with the local forest officials to give an aesthetic look. Typical drawing of typical noise barrier is given in **Figure 4-18**.



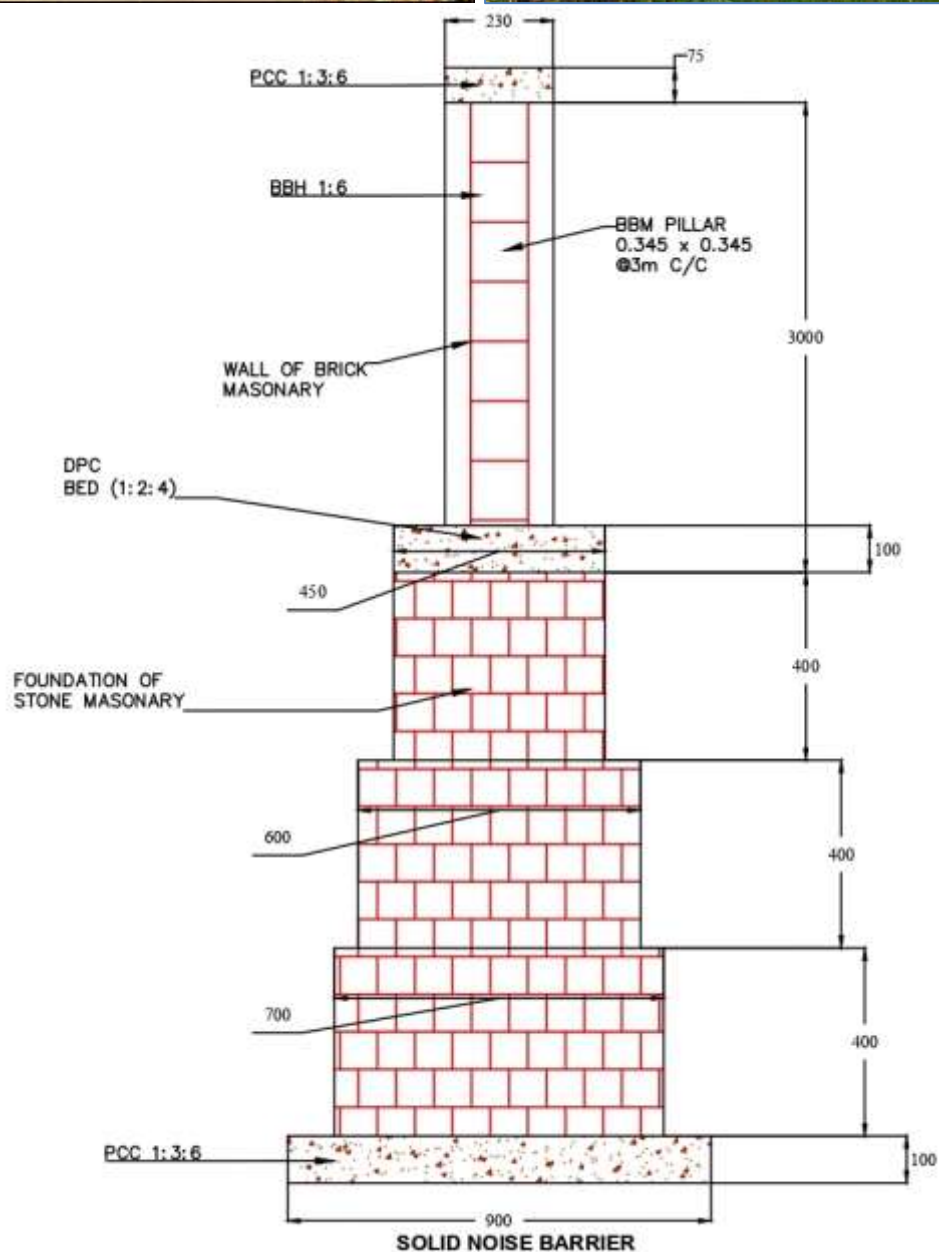


Figure 4-18 Typical Drawing of Solid Noise Barrier



**Roadside Barrier:** Polycarbonate barrier is proposed for sensitive receptors at 3 locations (Table 4-17). It can reduce sound up to 36 dB(A). The frames to be used for installation of noise barriers should be galvanized and are non-corrosive. The barrier should have anti combustion coating to make it fire resistant. These noise barriers have an aesthetic appeal due to their translucent appearance. It can be procured in a choice of colours, which allows it to fit in perfectly with its surroundings. A number of customized designs of these types of barriers are available and it improves the aesthetic appearance of the location. Polycarbonate has a 95% light transmission capability. These are light weight and can easily be placed in elevated sections like interchanges and flyovers. Being coated with a UV protection on both sides, it withstands the continuous sun during all seasons. These sheets are very strong and impact resistant and do not shatter with stone impact. Acrylic also has similar properties to polycarbonate and acrylic barriers may also be installed based on cost consideration.



**Sample View of Polycarbonate / Acrylic Noise Barrier**

### ***Other Mitigation Measures***

- Vehicular noise & use of horns will be controlled through enforcement of laws and public awareness. It will be ensured that all the vehicles are using proper horn as per norms to keep noise within the permissible limits.
- Silence zones will be demarcated and road signs prohibiting the use of horns will be displayed at residential areas, sensitive locations and silence zones.
- Regular monitoring of noise level at specified representative locations will be conducted at fixed interval.
- Plantation near sensitive receptors and inhabited areas will result in noise attenuation.
- Maintenance of noise barrier.

## 4.6 FLORA

### 4.6.1 Construction Phase

#### Impacts:

- VME is a Greenfield project and the alignment is passing predominantly through rural and tribal area with agriculture as major land use. Loss of flora will occur due to vegetation clearing within the proposed Right of Way (ROW).
- The impact on agricultural land will be significant with regard to felling of fruit trees. The fruit trees majorly impacted are *Phoenix sylvestris* (Khajur) , *Borassus flabellifer* (Toddy Palm), *Cocos nucifera* (Coconut), *Mangifera indica* (Mango), *Manilkara zapota* (Chikkoo), *Anacardium occidentale* (Kaju), *Psidium guajava* (Guava), *Tamarindus indica* (Chinch), *Musa sps* (Banana), *Annona squamosa* (Sithaphal), *Syzygium cumini* (Jamun), *Citrus limon* (Lemon), *Garcinia indica* (Kokam), *Emblica officinalis* (Awla), *Ziziphus mauritiana* (Bor), etc.
- Cutting of fruit trees will directly impact the fruit production and intake of fruits by the inhabitants. Due to clearing of agricultural land local crop production will be affected. People depended on agricultural land will be directly impacted. Domestic animals feeding on crops remnants will face shortage of fodder. The avifauna, insects and wild animals consuming the fruits and dwelling in the area will be impacted and will be forced to move out to other locations. Shortage of fruits, agricultural produce and fodder will be caused due acquisition of agricultural land.
- Clear felling of the tree and subsequent clearing of under growth will expose the soil to the impact of rainfall accelerating the runoff and trigger soil erosion. Productive soil will be washed away.
- Trees play an important role to maintain surface temperature and humidity. Due to loss of the vegetation cover change in microclimate is envisaged.
- Deposition of fugitive dust on leaves of nearby vegetation will lead to temporary reduction of photosynthesis along the construction corridor. Such impacts will, however, be confined mostly to the initial periods of the construction phase and in the immediate vicinity of the construction area.
- Labour population during construction phase will cut trees in the area for fuel and making temporary huts.
- Overall impact on the ecology will be severe due to the development of the project. Mitigation measures are suggested to minimize and compensate the adverse impacts.

#### **Diversion of Forest Land:**

- The proposed project involves diversion of approximate **191.5894 ha** forest land as given in **Table 4-18**. Proposal for diversion of forest land has been uploaded on 15<sup>th</sup> October 2018 (FC Proposal No. FP/MH/ROAD/36560/2018) and it is under examination with the State Government. Forest land proposed to be diverted may change after completion of joint measurement survey (JMS) with the Forest Department.

**Table 4-18 Details of Forest Land proposed to be diverted**

Division	Taluka	Range	Type of Forest Land proposed to be diverted (Ha)**				
			Reserved	Mangrove	Protected	Private	Total
Thane	Vasai	Mandavi	0	0.4514	8.2130	0	8.6644
Dahanu	Palghar	Boisar	0	0	14.8682	7.1570	22.0252
		Dahisar	0.3602	0	12.8516	0	13.2118
		Palghar	0	0	14.5791	0	14.5791
		Safale	0	3.4109	7.2148	0	10.6257
		Bhatane	0.0201	0	15.9311	0	15.9512
	Dahanu	Boisar	11.9409	0	21.1233	3.9568	37.0210
		Bordi	0	0	0	0	0
		Dahanu	3.6146	0	16.9107	10.8938	31.4191
		Kasa	0.2416	0	1.8096	0	2.0512
		Udhava	8.9823	0	21.5556	5.5028	36.0407
Talasari	Bordi	0	0	0	0	0	
<b>Grand Total</b>			<b>25.1597</b>	<b>3.8623</b>	<b>135.057</b>	<b>27.5104</b>	<b>191.5894</b>
<b>% of total forest land</b>			<b>13.1%</b>	<b>2.0%</b>	<b>70.5%</b>	<b>14.4%</b>	<b>100%</b>

Source: land records and forest records

\*\*Note: Forest land proposed to be diverted may change after completion of Joint Measurement Survey with the Forest Department.

#### Trees in forest land:

- Joint tree counting with the Forest Department has been completed in Mandavi Range, Dahanu Range, Kasa Range and Udhava Range. In remaining ranges, it is under progress. Village wise number of trees within proposed RoW in these four ranges is presented in **Table 4-19**:

**Table 4-19 No. of Trees to be felled in Mandavi, Dahanu & Kasa Range**

Range	Village	No. of Affected Trees#	Forest Land to be Diverted (ha)
Mandavi	Koshimb	1,229	5.3146
	Doliv	61	3.3498
Dahanu	Chandwad	692	5.7481
	Ganjad	193	2.613
	Navnath	2,990	10.9101
	Somnath	1,163	4.9328
	Ganeshbag	663	7.2151
Kasa	Awadhani	230	2.0512
Udhava	Dhaniwari	2,709	23.5527
	Chinchale	558	12.4880
<b>Total</b>		<b>10,488</b>	<b>78.1754</b>

Source: Joint Survey with Forest Department

Note: # to be updated after completion of Joint Survey with Forest Department in all ranges

- Based on the above data, **tentative** number of trees in the total forest area has been calculated as =  $[(10,488/78.1754) \times 191.5894] = 25,703$  no. This number will be updated after completion of joint survey with the Forest Department in remaining



forest ranges.



Joint Survey with Forest Department in Dahanu Division

#### Trees in non-forest land:

- The proposed project involves diversion of 710.0736 ha non-forest land (private and government land) in 51 villages. As per joint measurement survey of **34 villages**, out of 51 affected villages, approximately **43,392 trees** are falling within the proposed ROW. Species wise **tentative** number of trees falling within proposed ROW in non-forest land of 34 villages is provided in **Table 4-20**.

Table 4-20 Species wise tentative number of Trees in non-forest land of 34 Villages

Tree species	Tentative Number of Trees#	Tree species	Tentative Number of Trees#	Tree species	Tentative Number of Trees#
Aakath	2	Fanas Rope	65	Nilgiri	699
Aalsan	2	Gugal	19	Palas	276
Acacia	686	Gulmohar	16	Pangara	7

Tree species	Tentative Number of Trees#	Tree species	Tentative Number of Trees#	Tree species	Tentative Number of Trees#
Ain	2178	Hed	13	Par Jambhul	32
Amba	2375	Humb	6	Peru / Guava	386
Amba Kalam	948	Indrajaw	10	Petari	18
Amla / Awla	90	Jamal Gota	25	Phungali	12
Ananas	20	Jambul	468	Pipar	20
Apta	123	Jungle Jhad	4438	Popai / Papaya	53
Asana	119	Kadilimb	6	Rakta Chandan	2
Ashi	92	Kadvai	5	Ramphal	48
Ashok	71	Kaju	1186	Ranjan	15
Athroon	11	Kaju Rope	243	Ritha	2
Babul	20	Kakad	84	Sag	6369
Badam	6	Karanj	32	Santre	2
Bamboo	959	Karavati	284	Sawar	222
Bamboo Bet	339	Katram	4	Shemat	272
Bamboo Rope	6	Katru	1	Shevga	169
Bava	25	Kavas	11	Shigot	3
Beheda	62	Kelya/ Banana	610	Shindi	57
Bel	13	Khair	942	Shiras	12
Bhendi	272	Khajuri	9934	Shisam	31
Bhokar	10	Khavas	2	Shivan	13
Bhor Jambhul	646	Kinhai	10	Sithaphal	999
Bibla	8	Kirmira	6	Subabul	204
Bor	12	Kokam	19	Supari	20
Chandan	9	Koral	1	Suru / Casuarina	43
Chickoo	2582	Koshimb	43	Tembhurni	13
Chinch	632	Kuda	74	Tendu	52
Dalchini	1	Kudi	31	Tiwas	3
Dalimb	5	Kumbhi	6	Toddy Palm	707
Dhaman	201	Lemon	136	Umbar	104
Dhavada	15	Mohuva	422	Undi	3
Divala	10	Mosumbi	2	Vad	42
Dolive	2	Muraudi	8	Vilayati Chinch	32
Fruit Tree	90	Coconut	417	Waras	40
Fanas	184	Neem	5		
<b>Subtotal</b>	<b>12,826</b>	<b>Subtotal</b>	<b>19584</b>	<b>Subtotal</b>	<b>10,982</b>
<b>Grand Total - 43,392</b>					

Source: Joint Measurement Survey; Note: # to be updated after completion of JMR in all 51 affected villages

**Trees proposed to be felled:** Therefore, tentative number of trees proposed to be felled / within proposed ROW in forest and non-forest land is as summarized below:



**Table 4-21 Tentative Number of Trees proposed to be felled / within Proposed RoW**

Description	Tentative No. of Trees#
Trees in non-forest land of 34 villages	43,392
Trees in forest-land (191.5894 ha)	25,703
Grand Total	<b>69,095</b>

Note: # to be updated after completion of Joint Survey with Forest Department in all ranges and completion of JMS in all villages and as per JMR

It may be noted that, permission will be taken from the Forest Department for felling trees within proposed ROW. However, during construction of the expressway, few trees shall be saved which are located beyond the toe line / utility corridor.

- **Mangroves** are special plants with ability to thrive in saline environment. Felling of mangrove in **3.8623 ha** area will be required for development of the expressway. Mangroves provide habitats for various organisms such as insects, crustaceans, crabs, fish etc. Mangrove cutting will have adverse impact on the surrounding environment.

### **Mitigation Measures**

- Forest clearance shall be obtained from the Competent Authority for diversion of **191.5894 ha** Forest land for the development of the expressway. No construction activity will be initiated before obtaining the requisite Forest Clearance.
- Vegetation clearing shall be done within PROW; it will be ensured that trees falling outside PROW will not be felled. Efforts will be made to save trees outside formation width standing on edge of the PROW.
- Top soil upto 20 cm depth shall be stockpiled and preserved and reused for plantation. The Contactor shall earmark the area of soil stockpiling and to be approved by Engineer in-Charge.
- Mangroves are notified as Forests therefore for cutting mangrove along Vaitarni creek permission will be taken as per Forest Conservation Act and clearance procedure. Compensatory mangrove plantation will be done as per the norms. Any recommendation provided by the authority for conservation of mangroves will be implemented by the Project Proponent.
- Compensatory afforestation for trees and mangroves shall be carried out as per the recommendations of Competent Authority.
- **90,899 no. of trees and 49,408 no. of hedges** have been proposed to be planted under greenbelt development plan. Preference to native species including fruit species shall be given. These species are valuable from the socio-economic point of view. Plantation will be maintained upto 5 years and protected from cattle, wildlife and illegal felling. Dead saplings will be replaced to maintain the survival percentage of 90%.
- Saplings of horticultural trees such as *Mangifera indica*, *Manilkara zapota*, *Borassus flabellifer*, *Cocus nucifera*, *Psidium guajava*, *Tamarindus indica*, *Annona squamosa*, *Syzygium cumini*, *Citrus limon*, *Garcinia indica*, *Emblica officinalis*, etc. may be distributed to farmers in affected villages and nearby schools freely as part of Corporate Environmental Responsibility (CER) to compensate the loss of horticultural trees in the area. Sapling may be procured from Horticulture

Department / nursery of Forest Department.

- Mangrove species suggested for plantation are *Avicennia officinalis*, *Avicennia alba*, *Avicennia marina*, *Sonneratia alba*, *Sonneratia.apetala*, *Acanthus ilicifolius*, *Aegiceras corniculatum*, etc. Species to be obtained from nurseries of Forest Department as per availability. When the seedlings attain a height of about 40 to 45 cm the seedlings will be planted during the low tide period. Causality replacement to be done in the second year of plantation. No weeding will be done but debris and garbage collected at the base of the seedlings should be removed. The plantation should remain closed to grazing and fishing for minimum 5 years.
- A budget of **Rs. 2,55,00,000 /-** (**Two Crore Fifty five lakh only**) earmarked under CER for fruit sapling distribution and plantation of mangrove species.
- To compensate the loss of medicinal plants, development of herbal garden is proposed. List of some important herbal species of Dahanu Forest Division is given in the table below:

**Table 4-22 List of Important Medicinal Plants of Dahanu Forest Division**

S. No.	Local Name	Botanical Name	Parts used
1.	Amaltas	<i>Cassia fistula</i>	Pods
2.	Anantmul	<i>Hemidesmus indicus</i>	Roots
3.	Arjun	<i>Terminalia arjuna</i>	Fruit , Bark
4.	Ashwagandha	<i>Withania somnifera</i>	Roots
5.	Awala	<i>Emblica officinalis</i>	Fruit
6.	Bala	<i>Sida cordifolia</i>	Bark
7.	Bawachi	<i>Psoralea corylifolia</i>	Seeds
8.	Behada	<i>Terminalia bellirica</i>	Fruits
9.	Bel	<i>Aegle marmelos</i>	Fruits
10.	Biba	<i>Semecarpus anacardium</i>	Seeds
11.	Brahmi	<i>Centella asiatica</i>	Leaves
12.	Chaksoo	<i>Cassia absus</i>	Seed
13.	Dagadphool	<i>Parmelia perlata</i>	Flowers
14.	Dhawri-Phol	<i>Woodfordia floribunda</i>	Flowers
15.	Gadbeej	<i>Litsea sebifera</i>	Seeds
16.	Gokharu	<i>Hygrophila spinosa</i>	Fruits
17.	Gorakhmundi	<i>Sphaeranthus indicus</i>	Fruits
18.	Gudmar	<i>Gymnema sylvestre</i>	Leaves
19.	Gugal	<i>Commiphora mukul</i>	Gum
20.	Gulwel	<i>Tinospora cordifolia</i>	Powder
21.	Heena	<i>Lawsonia inermis</i>	Leaves
22.	Hirda	<i>Terminalia chebula</i>	Fruits
23.	Indrajaw	<i>Wrightia tinctoria</i>	Seeds
24.	Jamal Gota	<i>Croton tiglium</i>	Seed
25.	Joomgoli	<i>Cocculus hirsutus</i>	Seeds
26.	Kali Musali	<i>Curculigo orchoides</i>	Root
27.	Kalmegh	<i>Andrographis paniculata</i>	Plant
28.	Kasni	<i>Cichorium intybus</i>	Seeds

S. No.	Local Name	Botanical Name	Parts used
29.	Kokam	<i>Garcinia indica</i>	Powder
30.	Lendi Pimpali	<i>Piper longum</i>	Fruit
31.	Murud-Sheng	<i>Helicteres isora</i>	Fruit
32.	Narakya	<i>Mappia foetida</i>	Dust form
33.	Neem	<i>Azadirachta indica</i>	Leaves
34.	Palas	<i>Butea monosperma</i>	Root
35.	Safed Musli	<i>Chlorophytum tuberosum</i>	Root
36.	Salai	<i>Boswellia serrata</i>	Leaves
37.	Senna	<i>Cassia angustifolia</i>	Leaves
38.	Shatawari	<i>Asparagus racemosus</i>	Root
39.	Shevga	<i>Moringa oleifera</i>	Seeds
40.	Shevri	<i>Sesbania aegyptiaca</i>	Seeds
41.	Takla/Tarota	<i>Cassia tora</i>	Seeds

Source: Working Plan for the Forests of Dahanu Forest Division for the Period 2010-2011 to 2019-2020

- The species for herbal garden shall be finalized by the Forest Department. Total budget of **Rs. 60,00,000/-** (Sixty Lakhs only) proposed for development of herbal garden by Forest Department under CER. The amount shall be released in a phased manner in 3 years for establishment and maintenance as per requirement of the Forest Department. Local villagers / Shelf Help Groups should be involved in development of nurseries and maintenance of the garden.

#### 4.6.2 Operation Phase

##### Impacts:

- Invasion by alien species, such *lantana* , *parthenium* etc. along the expressway
- Illegal felling of trees
- Deposition of waste along expressway and impact of vehicular emission on plant growth
- Vehicular emission will have impacts on vegetation along the expressway. Plant along expressway will be exposed to various pollutants from vehicles. Vehicular emission affects mainly photosynthetic pigments, respiratory activities, enzymatic activities, uptake of water etc. Pollutants affect the growth of photosynthetic pigments in the plants. Various gases such as nitrous oxide (NO)<sub>x</sub> volatile organic compound and Suspended Particulate Matter (SPM) deposit on the surface of leaves and affect the output of plants. The pollutants released from vehicles affect the stomatal performance hence disrupt the gaseous exchange process. Most frequent effects reported are necrosis and chlorosis. (Wagh, N. D., Shukla, P. V., Tambe, S. B. and Ingle, S. T. 2006) , (Joshi, P. C. and Abhishek, S. 2007)

##### Mitigation Measures:

- Monitoring of avenue plantation along the expressway to be done for 5 years as per Green Highway policy. Dead sapling shall be replaced and survival rate of 90% shall be maintained. Saplings shall be provided with tree guards to protect from

cattle grazing.

- Regular watering of plants to be done in dry season.
- Weeding to be done biannually to remove exotic species.
- Dumping of waste along the expressway shall be strictly prohibited. Contingency plans to be followed to deal with spills or leaks on the expressway.
- Regarding vehicular emission, there is a need of a proper monitoring system and strengthening of the laws on environmental protection to ensure the reduction of roadside pollution that affect the animals, plants but also the human population. Vehicular emissions are of particular concern since these are ground level sources and therefore, have the maximum impact on the population of the surroundings. Use of clean fuel (public transport and private vehicles) and encourage electric vehicle are some of the measure to deter vehicular pollution.
- Compensatory Afforestation (CA) plan prepared by Forest Department in lieu of Forest land diversion is for 10 years. As per Compensatory afforestation notification 7<sup>th</sup> November, 2017, the requirement is 1000 plants per ha of Forestland diverted. Therefore the plantation required under CA for diversion of **191.5894 ha** forestland shall be **1,91,589 plants**. However, this shall be finalized by the Forest Department.
- Maintenance of avenue plantation and compensatory afforestation facilitate in restoring the ecology of the area and also provide aesthetic value for the travellers

## 4.7 FAUNA

### 4.7.1 Construction Phase

#### Impacts:

The alignment of the expressway traverses through the forest area. Forests are important for sustaining the population of wildlife. The forests are surrounded by agricultural land and settlements and shrinking from border due to deforestation, encroachments and illicit cutting. There are schedule species as per Wildlife Protection Act and threatened species as per IUCN in the forest area. Schedule-I and threatened species such as *Panthera pardus*, *Felis chaus*, *Tragulus meminna*, *Axis axis*, *Sus scrofa*, *Accipiter badius*, *Muntiacus muntjak*, *Gyps bengalensis*, *Haliaeetus leucogaster* etc. are dwelling in the region. The development of the project will have significant adverse impact on the fauna of the project area.

- Diversion of 191.5894 ha forest land shall directly cause loss of habitat for wildlife. The wildlife dwelling in the forest will be forced to move to other locations and compete for space and food.
- *Panthera pardus* (Panther) is one of the important and protected species dwelling in the area. Panther move outside forest area in dry summer season in search of food and water in nearby villages. There are several incidences of wildlife conflict in the area. The diversion of forestland and construction activity will further increase the conflicts with shrinking area for wildlife.
- Clearing of land and felling of trees will directly cause loss of habitat, shortage of fruits and seeds to avifauna and animals.
- Disturbance from road construction activity will affect wildlife behavior. Behavioral

responses of wildlife consist of avoidance of the area associated with regular or constant disturbance. The construction activities and noise will cause stress and disturbance to wildlife. It may cause change in their movement, feeding, breeding and resting. Noisy activity will be intermittent and short term reversible impact. Some animals may migrate to other locations.

- The labour population in the project area may enter nearby forest areas for collecting fire wood .The work force may poach wildlife. The labours may hurt wildlife observed at site during construction period.
- Domestic fauna in the area will also face problem in movement due to construction activity as the people
- Increase in incidences of mam- animal conflicts.

### **Mitigation Measures**

Wildlife can survive if the landscapes and habitats remain intact. The diversion of forestland, clearing of land and felling of trees will directly cause loss of habitat to avifauna and wildlife dwelling in the area. Conservation and awareness measures need to be followed to avoid / minimize / compensate potential adverse impacts.

- Construction activity shall be planned in such a manner to minimize impact on fauna. Trees outside ROW will not be felled.
- Wildlife awareness & environmental protection training shall be provided to the work force by the Contractor / PIU. The workers shall be made aware of the location, value and sensitivity of the natural resources in the area. The program shall be conducted before starting of construction activity. All staff of PIU, engineers, support staff and construction labour will attend the awareness program. Budget of **Rs.12,00,000/- (Twelve Lakh)** has been proposed for training in the EMP budget. The awareness and training shall be provided construction package wise before initiation of construction activity.
- Noise level will be kept under control as per the guidelines of CPCB and noisy activities shall be prohibited near forest areas during night time. No honking board shall be placed near the forest areas.
- Construction camps shall be located at least 1 km away from forest areas.
- Prohibitory sign boards shall be placed to prevent trespassing in the forest area. Movement of labour force shall be monitored by the Contractor and watch tower / check post may be established near forest area in consultation with concerned Forest Department, if required.
- Poaching shall be strictly banned and any incidence of wildlife poaching by workforce shall be reported to the Forest Department by the Contractor / PIU.
- Construction debris shall not be disposed in forest areas.
- Implementing sediment and erosion controls during construction will minimize adverse Impacts of water bodies and aquatic life. Construction activity will be avoided near rivers during rainy season.
- Drainage structures are designed to ensure continuous flow thus preventing ponding and flooding
- Plantation of fruit bearing species near forests will support the future demand of the fauna dwelling in the area. Plantation will provide habitat to avifauna dwelling in the area.



- The expressway will reduce the area of natural habitat. Loss of habitat shall be permanent within the ROW. Overall the impact on fauna can be mitigated / minimized by strict implementation of above provided measures and monitoring during construction stage.

#### 4.7.2 Operation Phase

##### **Impacts:**

- The expressway may hinder the movement of wildlife and increase incidents of road kills and injuries. Collision of vehicles with wildlife crossing the expressway is envisaged, as traffic volume increases. Mortalities are expected to be high; the number of animals likely to be repelled shall also increase in future. Road-related mortality and reduced wildlife movements will have significant impact on wildlife populations over the long term.
- NH-48 (old NH-8) is running on the right hand side (RHS) of the proposed VME. Wildlife kills are reported along the old NH-8 by the Forest Department. Panther (Leopard) kill due to road accident was reported near Village Kotbicha pada, Dahanu division on 19-02-2019 (source: mahaforest.gov.in)
- The old NH-8 is already linearly dissecting the region and construction of VME may further dissect the habitats and cause obstruction in movement of wildlife.
- Disturbance caused by traffic noise shall escalate with time and discourage wildlife movement.
- Impact on aquatic fauna shall be in case of accidental oil spill & toxic chemical release which find its way into the water bodies.

##### **Mitigation Measures:**

- Expressway act as barriers for wildlife movement hence bridges, culverts and wildlife / cattle underpass are important structures in the design of the expressway. 8 major bridges and 29 minor bridges, 133 culverts 51 cattle underpasses (size 7m x 4m) have been proposed along the expressway. In addition to above, the box culverts of size 6m x 4m and 5m x 4m will act as cattle underpass / animal crossings during summer season. Maintenance of the culverts will be required during operation phase of the expressway.
- Monitoring of animal crossing along the expressway should be done during operation stage. Incidences of wildlife injuries / kill while crossing expressway to be documented, if any.
- Fencing / wall has been proposed along the ROW boundary of the entire expressway.
- Protection of avenue plantation for 5 years and maintenance of 90% survival rate will support avifauna in future.
- Compensatory Afforestation by the Forest Department include 10 years plan and implemented by Forest Department, will enhance the wildlife habitat.
- Immediate cleaning up of oil spills, fuel and toxic chemicals in the event of accidents shall be dealt as per the contingency / emergency plan.
- Contingency plan to be followed immediately in case of oil spills / chemical spill etc.

- Above mentioned mitigation measures and awareness among the people shall facilitate the wildlife movement however the loss of habitat shall be irreversible and the fauna will be stressed and further at risk due to the proposed project.

## 4.8 PROTECTED AREA

### 4.8.1 Construction Phase

- The proposed expressway **does not pass through** any National Park, Wildlife Sanctuary, Conservation Reserve and Community Reserve. However the proposed expressway falls within 10 km of the Tungareshwar Wildlife Sanctuary (TWLS) and Dadar and Nagar Haveli Wildlife Sanctuary (DNHWLS). The proposed alignment is **neither fragmenting nor diverting land** of the TWLS and DNHWLS. The nearest distance of Tungareshwar Wildlife Sanctuary from expressway is **1.28 km**. near the start poin. The DNH WLS is located at **4.57 km** away from the end point of the expressway. Further, the expressway does not passing through the notified ESZ boundary of Tungareshwar Wildlife Sanctuary and Dadar and Nagar Haveli Wildlife Sanctuary. **There will be no direct impact on** Tungareshwar Wildlife Sanctuary and Dadar and Nagar Haveli Wildlife Sanctuary.
- From chainage 68+455 to 96+200 (27.745 km) of the proposed expressway is passes through **Dahanu Taluka**. Central Government, in consultation with the Government of Maharashtra, declared Dahanu Taluka as Ecologically Sensitive Area (DTESA) on 20<sup>th</sup> June, 1991. Approx. 106.532 ha forest land is proposed to be diverted in Dahanu Taluka.
- NH-48 (old NH-8) is running on the right hand side (RHS) of the proposed expressway. The start point of the expressway is about 1.8 km away from old NH-8 and moves away to about 11.6 Km at Km 66+0 before narrowing the distance to 10.0 km along Dahanu – Kasa Khurd Road (SH 30). After that the alignment moves close to NH-8 (2 km apart by Km 85+200) and then runs parallel to it before crossing at Km 104+700 at lbhadpada village of Talasari Taluka. Old NH-8 is an existing National Highway, wildlife kills are reported along the Highway by the Forest department. The incidence of wildlife killed in accident along old NH-8) is given in the **Table 4-23** and shown in **Figure 4-19**. After development of VME the movement of wildlife may be further obstructed.

**Table 4-23 Wild Animals killed in road accident along NH-48 (old NH-8) (within Study Area)**

Year	Animals Killed	Date	Location	Cause of death
2006	Panther	09.05.2006	NH8 Kolhi	Accident
2007	Panther	14.07.2007	NH8 Baphane	Accident
	Panther	21.07.2007	NH8 Baphane	Accident
2008	-	-	-	-
2009	-	-	-	-
2010	Panther	26.10.2010	Bapane-Juchandra Road	Accident
2011	Panther	1.12.2011	NH8 near Chinchoti C.N. 1096	Accident

Year	Animals Killed	Date	Location	Cause of death
2012	-	-	-	-
2013	Panther	21.02.2103	NH8 Sasunavghar	Accident
	Panther	15.05.2013	NH8 Maljipada	Accident
	Panther	08.06.2013	Chandrapada S.N. 556	Accident
2014	-	-	-	-
2015	Panther	13.01.2015	NH8 Sativali Khind	Accident

Source: Management Plan for Tungeshwar Wildlife Sanctuary 2018/19 to 2027/28

- The construction work will involve influx of labours in the area. Movement of man and construction machinery will produce noise and frighten away birds and wildlife dwelling in the vicinity. Incidences of human and wildlife conflicts will be more and may cause loss of life / injury to wildlife or persons at construction site.
- Social and cultural conflicts as the habitants in the project area are tribals.
- Use of community water resources by labour force.
- Dumping of waste will degrade the surrounding area.
- Waste from construction camps will be discharged into nearby water body.





### **Mitigation Measures:**

- As per the ESA notification of Dahanu Taluka and no new industries and expansion of existing polluting industries shall be permitted in the notified area. Construction of Road does not fall under the polluting industry category i.e. Red Category as per direction of Central Pollution Control Board, dated March 07, 2016. Construction of New Highway is classified as “Orange” Category. Construction of new roads / expressway fall under regulated activities and shall be done with mitigation measures, as per applicable laws, rules and regulation and available guidelines.
- The wildlife kills reported by Tungeshwar Wildlife Sanctuary (TWLS) shows that all the incidence of vehicle kill occurred towards south–east side and away from the proposed start point of expressway. The start point of the expressway is about 1.8 km away from NH-48. The TWLS is on further right side of NH-48.
- **NH-48 (old NH-8) is acting as a barrier for the movement of wild animals** from eastern side of the proposed expressway. **There is no report of wildlife killed in the stretch of NH-48 parallel or closed to the proposed expressway.** Further, the density of forest is more towards western side of the proposed expressway in comparison to the eastern side. Therefore, the possibility of accident of wild animal in the proposed expressway is expected to be nominal. Further, fencing / wall has been proposed along the ROW boundary of the entire expressway.
- Monitoring of wild animals should be done during construction phase and any incidence of sighting should be immediately reported to Forest Department. Watch tower may be installed in consultation with the Forest Department, if required during construction phase.
- Felling of trees on the Forest or Government or revenue or private lands shall be done after obtaining permission from competent authority.
- Mining of minor minerals, stone quarrying and crushing units shall be prohibited within the 1 km boundary of the protected areas.
- Open fire will not be permitted at construction site. Dos and Don'ts at the work place shall be displayed such as no smoking, waste disposal, personal protective equipment, etc.
- The construction and demolition waste management shall be carried out as per the provisions of the Construction and Demolition Waste Management Rules, 2016 published by the Government of India in the Ministry of Environment, Forest and Climate Change vide notification number G.S.R. 317(E), dated the 29<sup>th</sup> March, 2016, as amended from time to time
- Mitigation measures recommended during Environment & CRZ Clearance, DTEPA clearance and Forest Clearance shall be complied with by the Project Proponent. Monitoring and progress report of implementation of EMP and recommendations by various authorities shall be submitted as per the schedule.

#### **4.8.2 Operation Phase**

Though, roads are the vital features of human development, they pose severe threat to forest and wildlife. The major impacts on animal population include road-kills, limiting population, road avoidance causing modification of movement pattern etc. During



operation phase the impact will be due to traffic movement.

- Collision of wild animals with traffic causing injuries and mortality
- Emission from vehicles will impact the Air Quality.
- Honking and Traffic noise will cause disturbance behavioral change in wild animals.
- Leakages and spills from vehicle will pollute the land and water bodies
- Solid waste disposal by travellers

#### **Mitigation Measures:**

- Monitoring of Wildlife movement and identify accident prone areas or hot spots for wildlife kill. Fencing has been proposed along the ROW boundary of the entire expressway.
- Boards depicting wildlife awareness instructions and cautions should be placed near forest areas and at start and end point of the expressway.
- Animal feeding along the expressway will not be permitted and clearly conveyed through sign boards.
- Recommendations provided during EC shall be strictly adhered to and monitored by the concerned authorities.
- Measure for pollution control and waste management provided in the concerned sections. Speedy cleaning up of oil spills, fuel and toxic chemicals in the event of accidents shall be dealt as per the contingency / emergency plan.
- Structures (bridges, culverts, underpasses) to be maintained to facilitate movement of wildlife.
- Maintenance of plantation, implementation of CA activities and EC & FC compliance will facilitate in amelioration of environmental parameters.

#### **4.9 SOLID WASTE MANAGEMENT**

- Earth material generated from cutting : 62,98,413 Cum
- Earth requirement for filling : 1,35,52,116 Cum

##### Domestic Waste

Description	Occupancy	Per capita Generation (kg/day)	Quantity of Solid Waste Generated (kg/day)
Workers	150	0.500	75
Total Solid waste from each Construction Camp during the construction period of 24 months			<b>54 Ton</b>

Approx. 75 kg/day solid waste will be generated by the construction workers out of which biodegradable waste is estimated to be 30 kg/day and remaining 45 kg/day is non-biodegradable waste. There will be "Refuse Containers" at site for the management of domestic waste generated by the construction laborers and these containers shall be emptied at least once daily and will be disposed of as per SWM Rules, 2016 in consultation with the local authority.

### Construction waste

The part of the cut material shall be used in fill and further possibility of using the cut material in other road works shall be examined based on its suitability during the construction phase. The balance cut material, if any, shall be disposed off according to the Construction and Demolition Waste Management Rules, 2016.

As the proposed project is a greenfield expressway, the debris generated due to the dismantling of the structures within the RoW, existing road like cross roads etc. will be suitably reused in the proposed construction, subject to the suitability of the materials and approval of the Authority Engineer as follows:

- The sub grade of the existing pavement shall be used as embankment fill material.
- The existing base and sub-base material shall be recycled as sub-base of the haul road or access roads, if any
- The existing bitumen surface may be utilized for the paving of cross roads, access roads and paving works in construction sites and campus, temporary traffic diversions, haulage routes etc.

### Impact:

- Waste generated during construction may impact soil, agriculture and water quality
- Waste generated from workers' camps may impact surface and ground water quality and agriculture
- Impact due to oil spillage/leakage from machines and vehicles

Problems could arise from dumping of construction spoils (Concrete, bricks), waste materials (from contractor camps) etc. causing surface and ground water pollution. The other construction material such as steel, bricks, etc. will be housed in a fenced yard. The balance material from these yards will be removed for use/disposal. Mitigation measures include careful planning, cleaning redressing, landscaping and re-vegetation. Municipal waste from labor camps can lead to land pollution. Pollution risks may also arise from accidental leakage and spillage of oil or fuel, which may contaminate soil. Therefore adequate mitigation measures shall be developed to negate the overall impact of waste disposal during construction phase.

### Mitigation Measures:

#### Contamination of Soil

- Reuse of construction waste: Construction waste will be reused in the construction to the extent possible.
- Unutilized debris/ spoils or other material unsuitable for reuse shall be disposed off through filling up of borrow areas located in wasteland or at approved disposal locations protected by berms
- Storage of construction material in accordance with the IRC norms.
- Avoiding work during periods of heavy rainfall.
- Conservation of topsoil for reuse in planting pits and rehabilitation of borrow areas, sodding /grass turfing and implementation of soil erosion control plan.
- Disposal of domestic waste from Labour camps as per SWM Rules, 2016

#### Degradation of Water quality

- Use of sediment traps, silt fencing, sodding / grass turfing etc. for minimization of soil movement;
- The campsites will be provided with proper drainage and connected to local disposal system.
- No solid waste will be dumped near the water bodies or rivers.
- Garbage bins will be provided in the camps and ensured that these are regularly emptied and disposed off in a hygienic manner as per SWM Rules, 2016
- Vehicle maintenance will be carried out in a confined area, away from water sources, and it will be ensured that used oil or lubricants are not disposed to watercourses.
- Construction laborers` camps shall be located away from the habitation and from major water bodies.

#### Health Problem to workers

- Construction camp will be organized in a planned manner. Workers shall be provided proper sanitation facilities including toilets.
- There will be "Refuse Containers" at site for the management of domestic waste generated by the construction labourers and these containers shall be emptied at least once daily and will be disposed of as per SWM Rules, 2016.
- Wastes shall be collected, stored and taken to approve disposal sites in consultation with local authorities.

### **4.10 EMPLOYMENT & TRADING OPPORTUNITIES**

It is estimated that a substantial construction personnel including skilled, semi-skilled and unskilled labourers employed by various contractors will work at site during the peak period of construction phase. Since most of sizeable labour force will be drawn from neighbourhood, no change in demographic profile is anticipated. Only for a few skilled personnel, brought to site from outside the locality, proper housing/ accommodation would be provided in the construction camps. Due to employment opportunities, some competition for workers during construction phase is therefore anticipated.

The construction materials like stone chips and sand will be procured locally from identified quarry sites. The other important materials like cement, steel will be procured through various local sources. Thus there is a possibility of generation of local trading opportunities, though temporary.

#### **Mitigation Measures:**

- Most of the unskilled construction labourers will be recruited from the local areas to create some employment opportunities and sense of wellbeing among local people. This will also reduce social tension of migration.
- Some of the construction materials like stone chips & sand will be procured locally. Thus there is a possibility of generation of local trading opportunities, though temporary.

#### 4.11 CONSTRUCTION CAMP

##### Impacts:

- Influx of construction work-force & supplier who are likely to construct temporary tents in the vicinity
- Likely sanitation & health hazards & other impacts on the surrounding environment due to inflow of construction labourers
- Generation of solid and liquid waste from construction camp

##### Mitigation Measures:

- Temporary construction camps at designated & demarcated sites with adequate sanitation, drinking water supply & primary health facilities.
- Proper accommodation will be provided in the locality for the migrant construction engineers & officers.
- It will be ensured that the contractor's workers are provided with adequate amenities, health & sanitation facilities in the camp by the contractor. Guidelines for Siting and Layout of Construction Camp is given in **Annex-9.2**
- It is recommended to install Packaged Wastewater Treatment Plant in the construction camp. Guideline for the same is given in **Annex-9.6**
- A comprehensive waste management plan shall be prepared by the contractor prior to initiation of any works. Guideline for preparation of Comprehensive Waste Management Plan is given in **Annex-9.8**.

#### 4.12 OCCUPATIONAL HEALTH & SAFETY

##### Impacts:

- Health & safety related problems to construction workers due to inadequate health & safety measures

##### Mitigation Measures:

- Adequate safety measures complying with the occupational safety manuals will be adopted by the contractor to prevent accidents/hazards to the construction workers
- A road safety, traffic management and accident management plan is to be prepared by the Contractor prior to the start of the construction activity
- Periodic health check-up of construction workers will be done by the contractor
- Personal protective equipment will be provided to the construction workers (**Annex-9.10**)

## 4.13 ROAD SAFETY

### 4.13.1 Construction Phase

#### Impacts:

- Increase on incidence of accidents due to disruptions caused in existing traffic movements

#### Mitigation Measures:

- The proposed project is a greenfield alignment and there is no normal operating traffic as in the case of existing highways. Therefore, there is no specific standard requirement for traffic management plan during construction phase. It is normally the construction vehicles, which will be plying on temporary roads for the construction works. Wherever the proposed expressway is crossing any existing road, during construction phase, the Contractor shall provide and maintain a passage for traffic either along a part of the proposed RoW or along a temporary diversion constructed close to the crossing. The Contractor shall take prior approval of the Authority Engineer (AE) regarding traffic arrangements during construction. Guideline for Preparing of Traffic Management Plan is given in **Annex-9.9**.
- Reduction of speed through construction zones

### 4.13.2 Operation Phase

#### Impacts:

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

#### Mitigation Measures:

- To improve the safety of such high speed corridor, Thrie beam metal crash barriers shall be provided in entire length on both sides of each main carriageway (i.e. on median and on earthen shoulder of both carriageway), Loops and Ramps excluding stretches covered by bridges and RE wall structures, where concrete barriers to be provided.
- In addition to safety barrier, safety features like road marking, traffic sign, boundary stones, kilometer stones and hectometer stones, pavement marking and lighting has been proposed. Advanced Traffic Management System (ATMS) for entire expressway have been proposed to facilitate the road users, which will include mobile communication system, meteorological data system, automatic traffic counter and vehicle classification, video surveillance system, video incident detection system. To improve antiglare, hedge plantation on median have been proposed.

The engineering design of the expressway has also considered IRC codal provisions related to road safety such as:



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

#### **4.14 MIGRATION**

From the view point of employment of migrant skilled workers the project is small. Therefore no social tension is expected due to very small number migrant skilled workers. As the construction phase has a very short time span in comparison to the operation phase, it would not have any long term effect. Moreover the different groups of people engaged in different construction activities will leave the place after specified time span.

#### **4.15 Positive & Beneficial Impacts**

##### **4.15.1 Construction Phase**

- Employment opportunities due to recruitment of local labourers
- Trading opportunities due to procurement of some construction materials locally
- Clean up operations, landscaping and plantations

##### **4.15.2 Operation Phase**

- Increase in traffic & transportation activities due to faster accessibility
- Time saving due to faster movement of traffic
- Fuel saving due to faster movement of traffic
- Reduction of number of accidents
- Reduction of vehicle operating cost
- Better facilities to road users

## CHAPTER-5: ANALYSIS OF ALTERNATIVES

### 5.1 INTRODUCTION

The proposed green field alignment of Vadodara - Mumbai Expressway (VME) is in continuation of Ahmedabad-Vadodara Expressway which is in operation. It has been planned to take up construction of this proposed expressway under NHDP Phase VI.

The identification of the route alignment of this expressway was initially taken up in the early 1990s by the Ministry of Road Transport & Highways from a Technical Assistance Program of Asian Development Bank. The alignment was finalized by M/s Wilbur Smith consultants. Based on this alignment the Government of Gujarat has frozen a corridor of 600m width.

NHAI in the year 2008 awarded the task of finalization of VME alignment to M/s SECON through a desk study. As per the terms of the study SECON was to study Wilbur-Smith's alignment on satellite imagery and modify it based on the present site conditions by carrying out a desktop study.

In the current consultancy assignment, the Consultant was given the alignment as was finalized by M/s SECON to follow. It was stipulated that the consultant might review the alignment based on existing conditions at site if it passes through problematic area and propose alternate solution.

### 5.2 ALIGNMENT SELECTION

As discussed above, the following alignments have been studied by the Consultant for review and finalization of the expressway alignment:

- Step 1 – Desk study of the SECON's alignment on satellite Imagery / Google imagery and proposing tentative deviations where it is passing through habitation areas or through other obstructions.
- Step 2 – Taking up reconnaissance work at site along the alignment finalized by the M/s SECON. The observations made in Step-1 were confirmed at site and an alignment prepared for topographic survey.
- Step 3 – Fixing of GPS primary reference control stations (at approx. 2 km interval) along the proposed alignment firmed up in Step-2.
- Step 4 – Detailed topographic survey of the alignment has been carried out. It was observed during survey that at some places, the alignment was crossing habitations. The alignment was suitably modified to avoid the habitations incorporated in the alignment plan.
- Step 5 – Environmental reconnaissance of the whole area was undertaken so as to identify whether the alignment is passing through wild life area or reserved forest

area. Efforts were made to minimize its length in reserve forest area and to avoid wild life area.

- Step 6 – In certain sections, it was observed that SECON's alignment was along the gas pipeline, such that eventually the pipeline will be under the road embankment for a long length. The alignment was shifted to avoid any complications keeping in view safety concerns of both the highways as well as gas authorities.
- Step 8 – The alignment crosses major rivers having waterways more than 300 m. The most suitable site of bridges on these rivers were selected in the vicinity of the alignment of SECON, based on technical considerations and adopted. These required minor modifications in the alignment in approaches.

Following the above steps, SECON's alignment was modified and the modified alignment marked on satellite imagery was submitted to NHA for approval.

The Maharashtra PWD has also conducted detailed study during 1997-98 for the Mumbai - Talasari Expressway. Even after lot of persuasion - both from the Consultants and NHA, the Maharashtra PWD has refused to share the information. Therefore, the consultant has followed a combination of SECON's and Wilbur Smith alignment according to the ground conditions. A comparison of the recommended alignment with these two alignments is given in **Table 5.1**

**Table 5.1 Comparison of Recommended Alignment**

Sl. No.	Design Chainage		Length (km)	Remark
	From	To		
1	26.320	27.000	0.680	The alignment follow the corridor provided in the development plans of MBMC & CIDCO with slight modifications based on ground conditions.
2	27.000	52.000	25.000	The alignment follows SECON's alignment for better crossing of Vaitarna river. Wilbur Smith alignment is closer to the flood plain of Surya River and hence has not been followed.
3	52.000	68.500	16.500	The alignment follows Wilbur Smith's alignment to improve the geometry and keep the alignment relatively straight.
4	68.500	73.500	5.000	The alignment matches with both SECON's and Wilbur Smith alignment.
5	73.500	83.000	9.500	SECON's alignment runs deep into a reserved forest from 75.500 to 76.500 and then goes over built-up area at the crossing of SH-30 where an interchange is proposed. Hence the recommended alignment follows Wilbur Smith corridor.
6	83.000	88.000	5.000	The alignment generally matches with both SECON's and Wilbur Smith alignment
7	88.000	96.000	8.000	There is a gas line running in the middle of Wilbur Smith corridor in this section. The SECON's alignment runs very close to gas line in some length and then

Sl. No.	Design Chainage		Length (km)	Remark
	From	To		
				goes over a built-up land belonging to a charitable trust at the crossing of the road at km 92.400. Hence the recommended alignment is west of Wilbur Smith corridor to keep it sufficiently away from gas line for safety.
8	96.000	103.000	7.000	The recommended alignment follows Wilbur Smiths corridor. SECON's alignment runs over a gas line at the crossing of NH-8 and runs over it twice.
9	103.000	104.700	1.700	The recommended alignment deviates from both SECON's and Wilbur Smith alignment due to the change in the location of the interchange at NH-8. The change is necessitated as an underpass is being built on NH-8 under the ongoing six laning project at the same locations where the SECON's and Wilbur Smith alignment is crossing NH-8

**Approval of Alignment:** After a series of presentations in NHAI headquarters in front of senior NHAI officials, approval has been granted to the VME alignment vide letter No. NHAI/V-M Expressway/DM/2008/30 dated 8<sup>th</sup> February 2010.

### 5.3 “WITH” AND “WITHOUT” PROJECT SCENARIO

In this section, analysis of alternatives has been carried out ‘With Project’ and ‘Without Project’ scenarios in terms of potential environmental impacts.

The Phase II of proposed Vadodara-Mumbai Expressway occupies a strategic position and is meant not only for the development of surrounding area but also for the smooth movement of traffic and linking it with other parts of the country. The proposed expressway passes through 51 villages and 4 talukas of Palghar district in the State of Maharashtra and proposed ROW is 100 m to 120 m except at interchanges, toll booth, highway amenities and truck lay byes.

**Without Project Scenario:** the Mumbai–Ahmedabad Corridor in the western part of the country is one of the important transport corridors of the country. On one side of this corridor is Mumbai which is the financial capital of the country and on the other side is Vadodara, an important commercial and business city. Many industries like, textile, gems & jewelries, petrochemical & fertilizer etc. have been established along this corridor. This corridor also serves SEZ areas and ports. NH-8 is of great significance for transportation in this corridor starting from the country’s administrative capital of Delhi to financial capital of Mumbai. Present condition and steps taken to develop its speed and safety are as follows:

At present, the average journey speed in majority part of Mumbai-Vadodara section of NH 8 was found to be in the range of 50-60 km/hour and Vehicle Damage Factor (VDF) as assessed on NH8 varies from 2.04 to 5.86 for 2 axle vehicles and 19.48 to 25.69 for 6 axle vehicles. NH8 has been widened to 6 lane but many of the sections have already reached nearly the capacity volume (LOS E) of 6 lane NH (120,000 PCU) in the year

2015. Even with six laning or further widening, segregation of long distance and local and / or slow traffic is hard to achieve. Further, NH-8 is not an access controlled highway and is passing through many settlements where land availability and displacement of people would be a major concern for further widening. With rapid economic development taking place in the States of Gujarat and Maharashtra, there is a need to develop an expressway wherein the movement of large volumes of passenger and goods vehicles can take place at a fast pace.

**With Project Scenario:** the proposed expressway will link Ahmedabad Vadodara Expressway to Mumbai Pune Expressway thus providing Expressway Connectivity from Ahmedabad to Pune for a length of about 650 km and will reduce travel time from Vadodara to Mumbai to within 4 hours instead of 6 to 7 hours through NH-8. The Expressway will be linking big industrial cities like Vadodara, Surat, Bharuch, Ankleshwar and Mumbai. Thus, implementation of the project will achieve an all-round development of the economy and progress of the region. There will be short term increase in the pollution level (dust, emission from construction equipment & vehicle, construction camp etc.) of the surrounding area during the construction period. However, in long term there will be reduction in the levels of particulate matter and emission from vehicles using a surfaced road during operation phase. Land use pattern will be changed permanently while hydrological impact will be minimized by providing major & minor bridges and adequate number of culverts. Ecological impacts will be minimized through compensatory afforestation, avenue plantation and implementation of the compliance conditions, which will be provided by the Forest Department.

Hence the “With” project scenario with some reversible impacts is an acceptable option rather than the “Without” project scenario (**Table 5-2**).

**Table 5-2 “With” and “Without” Project Scenario**

With Project		Without Project	
Impacts		Impacts	
Positive	Negatives	Positive	Negative
<ul style="list-style-type: none"> <li>• Proposed expressway will provide fast uninterrupted free flow of traffic and thus minimize fuel consumption and emissions from the vehicles, eventually improve air quality of the region</li> <li>• It will link Ahmedabad Vadodara Expressway to Mumbai Pune Expressway thus providing expressway connectivity from Ahmedabad to Pune for a length of about 650km.</li> <li>• Reduction in accident rate and VOC</li> <li>• Reduction in travel and transportation costs</li> <li>• Enhancement / Protection of Community property</li> </ul>	<ul style="list-style-type: none"> <li>▪ Permanent changes in land use pattern</li> <li>▪ Loss of few properties and livelihood</li> <li>▪ Impact on vegetation</li> <li>▪ Diversion of forest land</li> <li>▪ Short-term reversible impact on air quality &amp; noise level</li> <li>▪ Possibility of short-term reversible impact on surface water bodies</li> </ul>	<p>Nil</p>	<ul style="list-style-type: none"> <li>▪ average journey speed 50-60 km/hour - increase in travel time</li> <li>▪ Increase in fuel consumptions</li> <li>▪ Vehicle Damage Factor (VDF) on NH8 varies from 2.04 to 5.86 for 2 axle vehicles and 19.48 to 25.69 for 6 axle vehicles</li> <li>▪ Increased Vehicle Operation Cost (VOC)</li> <li>▪ NH-8 already reached the capacity volume of 6 lane in the year 2015,</li> <li>▪ Further widening will involve large scale demolition of structures and displacement of people</li> <li>▪ Increase in dust pollution &amp; vehicular emission</li> </ul>



With Project		Without Project	
Impacts		Impacts	
Positive	Negatives	Positive	Negative
<ul style="list-style-type: none"> <li>• Improvement in ecology through compensatory afforestation and avenue plantation in long run</li> <li>• Enhanced trade and commerce.</li> <li>• The dust clouds associated with vehicles movement on existing highways will be reduced</li> <li>• Improved riding quality and smooth traffic flow.</li> <li>• Increased access to industrial cities like Ankleshwar, Mumbai, Vadodara etc.</li> <li>• New employment opportunities</li> <li>• Employment to local workers during the Construction Phase</li> <li>• Better access to health care centers and other social services</li> <li>• Improved quality of life</li> <li>• Strengthening of local economies and local industries.</li> </ul>			<ul style="list-style-type: none"> <li>▪ Increase in accident rate</li> <li>▪ Overall economy of the State will be affected.</li> <li>▪ Reduced employment/ economic opportunities</li> <li>▪ Arrest of possible significant enhancement and economic development of the region</li> <li>▪ In absence of the project, it will be difficult for the state to finance such a massive improvement of the road infrastructure from its own resources.</li> </ul>

By looking at the comparison it can be concluded that “With” project scenario, with positive & negative impacts will enhance social & economic development of the region and improve the surrounding environment in long run, while the “Without” project scenario will further deteriorate the existing environment and quality of life.

## CHAPTER-6: ENVIRONMENTAL MONITORING PROGRAM

### 6.1 INTRODUCTION

The purpose of the environmental monitoring program is to ensure that the envisaged purpose of the project is achieved and results in desired benefits to the target population. To ensure the effective implementation of the EMP, it is essential that an effective monitoring program be designed and carried out. The broad objectives are:

- to evaluate the performance of mitigation measures proposed
- to evaluate the adequacy of Environmental Impact Assessment
- to suggest improvements in management plan, if required
- to enhance environmental quality
- to satisfy the legal and community obligations

### 6.2 PERFORMANCE INDICATORS

The physical, biological and social components identified to be particularly significant in affecting the environment at critical locations have been suggested as Performance Indicators. The Performance Indicators shall be evaluated under three heads as:

- a) Environmental condition indicators to determine efficiency of environmental management measures in control of air, noise, water and soil pollution.
- b) Environmental management indicators to determine compliance with the suggested environmental management measures
- c) Operational performance indicators that have been devised to determine efficiency and utility of the proposed mitigation measures

The Performance Indicators and monitoring plans prepared are presented in **Table 6-1**.

**Table 6-1 Performance Indicators**

S.N.	Details	Indicators	Stage	Responsibility
<b>A. Pre-Construction Stage: Environmental Management Indicators and Monitoring Plan</b>				
1.	Location of construction camps have to be identified and parameters indicative of environment in the area has to be reported.	Construction camp	Pre-construction	Contractor
2.	Location of borrow areas have to be finalized and parameters indicative of environment in the area has to be reported.	Borrow areas	Pre-construction	Contractor
3.	Location of Quarry and Stone Crusher sites have to be finalized and parameters indicative of environment in the area has to be reported.	Quarry and Stone Crusher sites	Pre-construction	Contractor
4.	Locations for Debris Disposal Site have to be identified and parameters indicative of environment in the area has to be reported.	Debris Disposal Site	Pre-construction	Contractor
5.	Progress of tree removal marked for cutting is to be reported	Site clearing	Pre-construction	Contractor
<b>B. Construction Stage: Environmental Condition Indicators and Monitoring Plan</b>				
1.	The parameters to be monitored as per	Air quality	Construction	Contractor through

S.N.	Details	Indicators	Stage	Responsibility
	frequency, duration & locations of monitoring specified in the Environmental Monitoring Program prepared (Refer <b>Table 6-2</b> below)			NABL approved monitoring agency
		Noise level	Construction	Contractor through NABL approved monitoring agency
		Ground Water quality	Construction	Contractor through NABL approved monitoring agency
		Surface Water quality	Construction	Contractor through NABL approved monitoring agency
		Soil quality	Construction	Contractor through NABL approved monitoring agency
2.	Progress of measures suggested as part of the strategy is to be reported	Tree plantation	Construction	Contractor
3.	Contractor shall report implementation of the measures suggested for topsoil conservation to Sr. Environmental Specialist of Authority Engineer (AE)	Top Soil Conservation	Construction	Contractor
4.	Contractor shall report implementation of the measures suggested for slope stabilization and sediment control to Sr. Environmental Specialist of AE	Slope Stabilization and Sediment Control	Construction	Contractor
5.	Contractor shall report implementation of the measures suggested for waste management to Sr. Environmental Specialist of AE	Waste Management Plan	Construction	Contractor
6.	Contractor shall report implementation of the guideline to ensure worker's safety during construction to Sr. Environmental Specialist of AE	Worker's Safety during Construction	Construction	Contractor
<b>C. Operation Stage: Management &amp; Operational Performance Indicators</b>				
1.	The number of trees surviving during each visit will be compared with the number of saplings planted	Survival rates of trees	Operation	Sr. Environmental Specialist of Authority Engineer (AE) up to construction period, and then Environmental Cell of Project Implementation Unit (PIU) / NHAI over a period of 5 years
2.	Sr. Environmental Specialist of AE and NHAI (PIU) will undertake joint site visit with the Contractor to determine whether the Borrow areas, Quarry areas, Debris disposal site have been rehabilitated in line with Guidelines	Rehabilitation of Borrow areas, Quarry area, Debris Disposal site	Operation	Sr. Environmental Specialist of AE and PIU / NHAI
3.	The PIU will visit sensitive locations along with the environmental monitoring agency (responsible for monitoring of noise levels during operation stage) to check the efficiency of the noise barriers	Utility of noise barriers for sensitive receptors	Operation	PIU / NHAI

### 6.3 MONITORING SCHEDULE

The detail monitoring schedule during construction and operation stages are presented in **Table 6-2**. For each of the environmental condition indicator, the monitoring program specifies:

- Parameters to be monitored
- Location of the monitoring sites
- Frequency and duration of monitoring
- Institutional responsibilities for implementation and supervision

**Table 6-2 Environmental Monitoring Program**

Environment Component	Project Stage#	Environmental Monitoring Program			Institutional Responsibility	
		Parameters	Location	Frequency	Implementation	Supervision
Air Quality	Construction	PM <sub>10</sub> , PM <sub>2.5</sub> , SO <sub>2</sub> , NO <sub>2</sub> , CO, HC	At 2 locations: Wherever the contractor decides to locate the Batching & Asphalt Mixing Plants, Hot Mix Plant, Crushers, DG sets locations for each construction packages  No. of Construction Packages = 3  Total locations = 3 x 2 = 6	Twice in a season at one day interval for 3 seasons (except monsoon)  Construction work should be in full swing during monitoring  <u>Duration:</u> 24 hours	Contractor through NABL approved monitoring agency	AE / PIU, NHAI
		PM <sub>10</sub> , PM <sub>2.5</sub> , SO <sub>2</sub> , NO <sub>2</sub> , CO,	At 9 locations: <u>Construction Package-XIII:</u> 1. Khardi Village 2. Pargaon Village 3. Dhuktan village  <u>Construction Package-XII:</u> 4. Nagzari village 5. Kirat Village 6. Dhabon Village  <u>Construction Package-XI:</u> 7. Navnath Village 8. Vankas Village 9. Vadavali Village	Twice in a season at one day interval for 3 seasons (except monsoon)  Construction work should be in full swing during monitoring  <u>Duration:</u> 24 hours		

Environment Component	Project Stage#	Environmental Monitoring Program			Institutional Responsibility	
		Parameters	Location	Frequency	Implementation	Supervision
	Operation	PM <sub>10</sub> , PM <sub>2.5</sub> , SO <sub>2</sub> , NO <sub>2</sub> , CO,	At <b>6</b> locations: 1. Khardi Village 2. Dhuktan village 3. Nagzari village 4. Dhabon Village 5. Vankas Village 6. Vadavali Village	Once in a season for 3 seasons (except monsoon)  <u>Duration:</u> 24 hours	PIU through NABL approved monitoring agency	PIU, NHAI
Noise Level	Construction	Noise level in dB(A)	At 2 locations: Equipment Yard and Stone Crusher Unit for each construction packages  No. of Construction Packages = 3  Total locations = 3 x 2 = 6	4 times a year (in each season)  <u>Duration:</u> 24 hours	Contractor through NABL approved monitoring agency	AE / PIU, NHAI
		Noise level in dB(A)	At <b>9</b> locations: <u>Construction Package-XIII:</u> 1. Khardi Village 2. Pargaon Village 3. Dhuktan village <u>Construction Package-XII:</u> 4. Nagzari village 5. Kirat Village 6. Dhabon Village <u>Construction Package-XI:</u> 7. Navnath Village 8. Vankas Village 9. Vadavali Village	4 times a year (in each season)  <u>Duration:</u> 24 hours	Contractor through NABL approved monitoring agency	AE / PIU, NHAI
	Operation	Noise level in dB(A)	At <b>6</b> locations: 1. Khardi Village 2. Dhuktan village 3. Nagzari village 4. Dhabon Village 5. Vankas Village 6. Vadavali Village	Once in every three years  <u>Duration:</u> 24 hours	PIU through NABL approved monitoring agency	PIU, NHAI
Ground Water Quality	Construction	Physical, Chemical & Biological parameters as per IS 10500:2012  However, IE may include additional parameters	At <b>9</b> locations: <u>Construction Package-XIII:</u> 1. Khardi Village 2. Pargaon Village 3. Dhuktan village <u>Construction Package-XII:</u> 4. Nagzari village 5. Kirat Village 6. Dhabon Village <u>Construction Package-XI:</u> 7. Navnath Village 8. Vankas Village 9. Vadavali Village	4 times a year (in each season)	Contractor through NABL approved monitoring agency	AE / PIU, NHAI



Environment Component	Project Stage#	Environmental Monitoring Program			Institutional Responsibility	
		Parameters	Location	Frequency	Implementation	Supervision
	Operation	Physical, Chemical & Biological parameters as per IS 10500:2012	At <b>6</b> locations: 1. Khardi Village 2. Dhuktan village 3. Nagzari village 4. Dhabon Village 5. Vankas Village 6. Vadavali Village	Twice in every three years (Pre-monsoon & post-monsoon)	PIU through NABL approved monitoring agency	PIU, NHAI
Surface Water Quality	Construction	Physical, Chemical & Biological parameters as per IS:2296	At <b>11</b> locations: <u>Construction Package-XIII:</u> At <b>4</b> locations: Vaitaran River at Chainage 31+400, 35+700 & 45+040 Canal at Chainage 43+725  <u>Construction Package-XII:</u> At <b>3</b> locations: Canal at Ch. 65+134 Surya River at Ch. 68+400 Suseri Nalla at Ch. 72+190  <u>Construction Package-XI:</u> At <b>4</b> locations: Jogani Nadi at Ch. 89+600 Vadvali River at Ch. 96+200 Kangan Nala at Ch. 99+955 Pond at Ch. 103+400	4 times a year (in each season)	Contractor through NABL approved monitoring agency	AE / PIU, NHAI
	Operation	Physical, Chemical & Biological parameters as per IS:2296	At <b>8</b> locations: Vaitaran River at Ch. 31+400, 35+700 & 45+040 Surya River at Ch. 68+400 Suseri Nalla at Ch. 72+190 Jogani Nadi at Ch. 89+600 Vadvali River at Ch. 96+200 Kangan Nala at Ch. 99+955	Twice in every three years (Pre-monsoon & post-monsoon)	PIU through NABL approved monitoring agency	PIU, NHAI
Soil	Construction	pH, EC, Organic matter, N, P, Na, K, Pb	3 locations: wherever the contractor will decides to locate the Hot Mix Plant, agricultural area and forest area for each construction packages  No. of Construction Packages = 3  Total locations = 3 x 3 = <b>9</b>	Once in a year	Contractor through NABL approved monitoring agency	AE / PIU, NHAI
	Operation	pH, EC, Organic matter, N, P, Na, K, Pb	Total <b>6</b> locations: (3 agricultural area and 3 forest area)	Once in every three years	PIU through NABL approved monitoring agency	PIU, NHAI

Environment Component	Project Stage#	Environmental Monitoring Program			Institutional Responsibility	
		Parameters	Location	Frequency	Implementation	Supervision
Soil Erosion	Construction	Visual observation & turbidity test	Visual observation at high embankments sites such as bridge location, culvert locations, embankment area etc.	Pre-monsoon and post-monsoon season	Environmental Specialist, Hydrologist, and Material Specialist of Contractor	AE / PIU, NHAI
Haul Road	Construction	Maintenance of haul roads, generation of dust.	Haul roads & hauling mode	At least twice a day i.e. midday and evening	Contractor	AE / PIU, NHAI
Avenue Plantation	Construction	Plantation	- Side of the carriageway and median - Other specific locations suggested in the EMP	Once in fortnightly;  Comparison should be done for every six months	Contractor in association with State Forest Department	AE / PIU, NHAI
	Operation	Growth of plantation	- Side of the carriageway and median - Other specific locations suggested in the EMP	Assess growth every year for initial five years	PIU, NHAI	NHAI

# Project Stage 1) Construction period is 30 months  
2) Monitoring in Operation Phase will be conducted every 3 years for 15 years.

Note: Maharashtra has the following four seasons in the year:

- Winter Season : December to February
- Summer Season : March to May
- Monsoon Season : June to September
- Post-monsoon : October to November

## 6.4 REPORTING SYSTEM

Reporting system for the suggested monitoring program operates at two levels:

- Reporting of environmental management indicators
- Reporting for operational performance indicators at the PIU level

Environmental monitoring involves regular checking of the environmental management issues detailed in the EMP and to ascertain whether the mitigation measures are achieving their objectives, according to the EMP, with the progress of the works. It provides the necessary feedback for project management to keep the program on schedule and to achieve the desired outcomes.

The contractor, Authority Engineer (AE) and Project Implementation Unit (PIU) of NHAI are three components of the reporting system for environmental conditions and management indicators. The reporting system to be followed in construction phase is presented in **Table 6-3**.

- The reporting system will start with the Contractor who is the main executor of the implementation activities. The contractor will report to the Sr. Environmental Specialist of AE who in turn shall report to the PIU. The Contractor will submit monthly and quarterly environmental compliance reports to the AE.
- The AE will submit separate quarterly environmental monitoring reports to PIU in addition to submission of the summary of the activities of the month in the formal monthly report including any deviations and corrective actions.
- PIU will be responsible for preparation of the targets for identified non-compliances
- A full record of construction activities will be kept as a part of normal contract monitoring system. Reporting and Monitoring Systems for various stages of construction and related activities have been proposed are to ensure timely and effective implementation of the EMP.

During the operation phase, the overall supervision will lie with the Environmental Cell of PIU of NHAI.

**Table 6-3 Reporting System during Construction Phase**

Item	Contractor (implementation)	Authority Engineer		PIU to oversee compliance monitoring
		Supervision	Reporting to PIU	
Establishment of construction Camp	Before start of Work	Regular	Regular	Regular
Tree removal marked for cutting	Weekly	Weekly	Monthly	Quarterly
Location of Borrow Area / Quarry Area / Stone Crusher	Regular	Weekly	Monthly	Quarterly
Location of Debris Disposal Site	Weekly	Weekly	Monthly	Quarterly
Top Soil Conservation, Slope Stabilization & Sediment Control	Weekly	Weekly	Monthly	Quarterly
Environmental Monitoring	As per Environmental Monitoring Program	As per the Schedule	Quarterly	Quarterly
Monitoring of Enhancement Activities as per EMP	Regular	Regular	Monthly	Quarterly
Avenue Plantation	Monthly	Monthly	Monthly	Quarterly
Waste Management	Monthly	Monthly	Monthly	Quarterly
Worker's safety during construction	Monthly	Monthly	Monthly	Quarterly

## CHAPTER-7: ADDITIONAL STUDIES

### 7.1 INTRODUCTION

In order to ensure the comprehensive and effective EIA, it is necessary to conduct various project specific studies, which will help in identifying the anticipated impacts on local population and to propose appropriate measures during design phase to successfully mitigate the envisaged impacts. This Chapter describes the

- A. Social Impact Assessment of the proposed development including Rehabilitation and Resettlement Action Plan (RAP) prepared for the project
- B. Risk Assessment and Disaster Management Plan

### 7.2 SOCIAL IMPACT ASSESSMENT

The social impact assessment and resettlement study is meant to determine the magnitude of potential impact on the population due to construction of proposed expressway with the objective to ensure the social considerations be given adequate weightage in the selection and design of proposed expressway.

As per findings of Joint Measurement Survey (JMS) of affected land and non-land assets, the project impacts can be broadly classified as (i) impacts on private land, (ii) impacts on private structures and (iii) loss of common property resources. From the analysis of impacts, it is noted that altogether 2393 land units/plots (all private land units) and 895 structures including 717 private structures will be affected due to the project. As per the JMS survey, total 3110 households will be affected in the project. The summary of project impacts is presented in the **Table 7-1**.

**Table 7 - 1 Summary of Project Impacts (Phase-II of Main Alignment)**

Sl. No.	Impact Summary	Number / Area
1	Total private / government land acquisition requirement (in ha tentative)	710.3247
2	Total number of private land units / plots affected (No.)	2393
3	Fully displaced land owner (15% of affected land owners) (No.)	359
4	Total number of structures affected of all categories (Including Private, Government, and Religious)	895
5	Total number of affected private structures	717
6	Number of Fully displaced structure owner (15% of affected structure owners)	108
7	Total number of affected Households Including Land & Structures	3110
8	Total number of Govt. /Communities properties	175
9	Total number of religious properties	3

Source: Field Survey

### 7.2.1 Scope of Land Acquisition

Due to construction of greenfield expressway, the scope of land acquisition is quite significant. Land acquisition is under process and few villages have been compensated by executive agency. The tentative private land need to be acquired for the project is 664.19 ha. The Greenfield expressway traverses through 51 villages of four Talukas in Palghar district of Maharashtra state.

The land required for construction of proposed expressway is tentatively **901.9141 ha**, which includes forest land 191.5894 ha forest land and 710.3247 ha private / government land. Joint measurement of both private and forest land is ongoing and the above data may revise based on the final survey results.

### 7.2.2 Ownership of Land being acquired for the Project

The land acquisition for the project has been calculated considering the proposed ROW for Greenfield expressway. The tentative area of land to be acquired is around 664.19 ha. The affected private land area is calculated and quantified as per available records. The private land which needs to be acquired and number of tentative affected plots is referred in **Table 7-2**.

**Table 7 - 2 Details of Private Land being acquired for the Project**

Sl. No.	Type of Land	No of Affected Plots	Area (in Ha)
1	Private / government	2393	710.3247
<b>Total</b>		<b>2393</b>	<b>710.3247</b>

Source: Field Survey

### 7.2.3 Properties to be affected

The properties to be affected by the proposed expressway include houses, shops, religious establishments, community halls or any other structure. The survey team attempted to get the details of various structures that are located within the proposed RoW of the project alignment.

The census survey carries out to enumerate the properties, falling within proposed ROW. The finding of the study revealed that a significant numbers of structures, i.e., a total of **895** structures are going to be affected within the proposed right of way, out of which **717** private structures are affected. Total structures include the private properties, religious properties, community properties, government properties.

### 7.2.4 Total Affected Households

Due to loss of structures and land many people will be losing their properties / livelihoods and will be adversely affected. As per the data received from compensation award list and JMS survey, 2,393 land owners are affected as per the available compensation award data, and 717 private structures owners will be affected in the



proposed alignment. The data reveals that a total number of 3110 households are getting affected due to the project. The details for the same are shown in **Table 7-3**.

**Table 7 - 3 Number of Affected Households**

SI. No.	Affected Livelihoods	Category of AHs	Total	%age
1	Land Owner	Owner	2393	76.95
2	Structures Only	Owner	717	23.05
<b>Total</b>			<b>3110</b>	<b>100</b>

Source: Field Survey

### 7.2.5 Ownership of the Properties to be Affected

The total numbers of affected properties under different categories in terms of its uses, such as private, religious, public/ government and communities structures by JMS survey tentatively are **895**. The private properties are (**80.11%**) majority in number, followed by Government/ CPRs properties (**19.55%**), and religious properties (**0.34%**). The ownership details of total affected properties are tabulated in **Table 74**.

**Table 7 - 4 Ownership of Properties to be affected**

SI. No.	Type of Properties	Total	Percentage
1	Private	717	80.11
2	Religious	3	0.34
3	Government/CPRs	175	19.55
<b>Total</b>		<b>895</b>	<b>100.00</b>

Source: Field Survey

### 7.2.6 Type of Construction of the Structures

As per details of JMS survey (97.77%) structures are Pucca, followed by Kutcha (2.23%). The details of type of constructions of the structures are summarized in the **Table 7-5**.

**Table 7 - 5 Type of Construction of Private Structures**

SI. No.	Type of Construction	Total	Percentage
1	Pucca	701	97.77
2	Semi-Pucca	0	0.00
3	Kutcha	16	2.23
<b>Total</b>		<b>717</b>	<b>100</b>

Source: Field Survey

### 7.2.7 Legal Status of the Ownership of the Properties/ Structures

Due to loss of structures and land many people will be losing their properties/ livelihoods and will be economically affected. As per the JMS survey of affected structures and land plots details, tentatively 3110 households will be losing their properties/ livelihood due to

loss of structures and land under titleholders' category. The details of the affected households are shown in **Table 7-6**

**Table 7 - 6 Entitlement of Properties**

Sl. No.	Category of Affected Households	Description	Number of Affected Households (AHs)	Total AHs
1	Title Holders	Structures only	717	3110
		Land Owner	2393	
2	Non- titleholders	Squatters	0	0
		Encroachers	0	
3	Tenants	Commercial	0	0
4	Employees	Commercial	0	0
<b>Total</b>			<b>3,110</b>	<b>3110</b>

Source: Field Survey

### 7.2.8 Level of impact on Affected Private Structures

The level of impact has been considered under two categories namely, partial displaced and fully displaced. The structures, which are getting partially affected and remaining part of the structures are usable, are (85.00%), whereas (15.00%) structures are fully impacted and leads to physical displacement, detailed are tabulated in **Table 7-7**.

**Table 7 - 7 Impact Level on Structures**

Sl. No.	Percentage of Impact on (Structure Owners)	No. of Households (Structure Owners)	Impact Level	Percentage
1	Up to 10%	0	609 Partially Displacement	85.00%
2	10% to 20%	0		
3	20% to 30%	609		
4	30% to 40%	0	108 Fully Displacement	15.00%
5	40% to 50%	0		
6	50% to 60%	0		
7	60% to 70%	0		
8	70% to 80%	108		
9	80% to 90%	0		
10	90% to 100%	0		
11	NA/NR	0		
<b>Total</b>		<b>717</b>	<b>717</b>	<b>100%</b>

Source: Field Survey

### 7.2.9 Level of impact on Affected Land Holders

The level of impact has been considered under two categories namely, partial impact and fully impact. The land holders, which are getting partially affected are (85.00%), whereas (15.00%) land holders are fully impacted and leads to physical displacement,

detailed in **Table 7-8**

**Table 7 - 8 Impact Level on Land**

Sl. No.	Percentage of Impact on (Land Owners)	No. of Households (Land Owners)	Impact Level	Percentage
1	Up to 10%	0	2034 Partially Displacement	85.00%
2	10% to 20%	0		
3	20% to 30%	2034		
4	30% to 40%	0	359 Fully Displacement	15.00%
5	40% to 50%	0		
6	50% to 60%	0		
7	60% to 70%	0		
8	70% to 80%	359		
9	80% to 90%	0		
10	90% to 100%	0		
11	NA/NR	0		
<b>Total</b>		<b>2393</b>	<b>2393</b>	<b>100%</b>

Source: Field Survey

#### 7.2.10 Government Properties and other CPRs to be affected

The JMS survey data reveals that tentatively 175 government/ CPRs properties are to be affected due to the Greenfield expressway. Details of such properties are tabulated in **Table 7-9**.

**Table 7 - 9 Type of Government Properties and other CPRs to be affected**

Sl. No.	Type of Government Properties and other CPRs	No. of Structures	Percentage
1	Water Closet	32	18.29
2	Water Tank	14	8.00
3	Pump House	11	6.29
4	Compound	11	6.29
5	Hand Pump	7	4.00
6	Bore well	52	29.71
7	Well	39	22.29
8	Toilet	9	5.14
<b>Total</b>		<b>175</b>	<b>100</b>

Source: Field Survey

#### 7.2.11 Religious Properties to be affected along the alignment

The impacts on religious structures are generally considered as an area of concern due to its association with the religious sentiments of the people. The total numbers of

religious properties to be affected due to this project are 3, which includes only Temple. The details of religious properties are tabulated in **Table 7-10**.

**Table 7 - 10 Number of Religious Affected**

SI. No.	Type of Religious Properties	No. of Structures	Percentage
1	Temple	3	100%
	<b>Total</b>	<b>3</b>	<b>100%</b>

## 7.3 RISK ASSESSMENT AND DISASTER MANAGEMENT PLAN

### 7.3.1 Introduction

The proposed project is the development of Vadodara Mumbai Expressway (Phase-II), which is an 8 lane access-controlled green-field expressway. The expressway starts at proposed chainage 26+582 (at Koshimb village of Vasai Taluka) and ends at proposed chainage 104+700 (km 390+864 of NH-8) at Ibhadpada village of Talasari Taluka in the state of Maharashtra. Total length of expressway (Phase-II) is 78.118 km. The terrain is generally plain/ undulating.

In the start point, the alignment runs through Vaitarna River valley and then starts rising. The Section is thinly populated, under developed and where subsistence agriculture is common occupation. The alignment crosses Vaitarna River thrice – at km 31+300, km 35+725 and km 45+040. The alignment of proposed expressway runs parallel to and/ or very near to Rivers Vaitarna, Surya and Suseri between Km 30+000 and km 72+200. The proposed expressway traversing through eco-fragile area of Dahanu Taluka between km 68+455 to Km 96+200.



**Figure 7-1 Risk of Flood & threat to Bridge RCC Components  
 Location Km 30.500 to Km 32.000**

**Civil construction:** The quantum of civil construction work proposed in Phase II is indicated in **Table 7-11**

**Table 7 - 11 Civil Construction Work Proposed in Phase II**

Type of Civil Construction Work	VME - Phase-II
▪ Length of the expressway	78.118 km
▪ No. of Fly Over	4

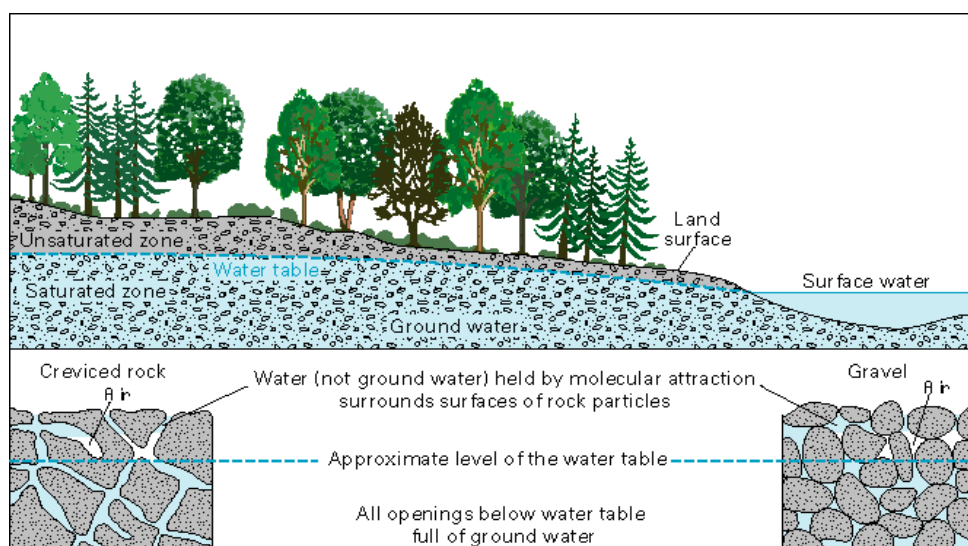


Type of Civil Construction Work	VME - Phase-II
▪ No. of Major Bridges	8
▪ No. of Minor Bridges	29
▪ No. of Culverts	133
▪ No. of Vehicular Underpasses	8
▪ No. of Vehicular Overpasses	3
▪ No. of Light and Small Vehicular Underpasses	21
▪ No. of Cattle Underpasses	51
▪ No. of Interchange	1
▪ No. of Toll Plaza	1
▪ Way side Amenities (Type-A)	2
▪ Way side Amenities (Type-B)	4
▪ Truck Parking	2
▪ Pavement Type	Rigid pavement

Source: DPR Prepared by the ICT Pvt. Ltd.

### 7.3.2 Environmental Risk of Green Field Project

- A) Aquifers: Disturbance to Underground Water: Groundwater is one of the most valuable resources, most of the void spaces in the rocks below the water table are filled with water. But rocks have different porosity and permeability characteristics, which mean that water does not move around the same way in all rocks below ground. It can be seen in the diagram (**Figure-7.2**), how the ground below the water table (the blue area) is saturated with water. The "unsaturated zone" above the water table (the greenish area) still contains water (after all, plants' roots live in this area), but it is not totally saturated with water. Further, the two drawings at the bottom of the diagram; show a close-up of how water is stored in between underground rock particles.



**Figure 7-2 Natural Underground Water Movement**

Sometimes the porous rock layers become tilted in the earth. There might be a confining

layer of less porous rock both above and below the porous layer. This is an example of a confined aquifer. In this case, the rocks surrounding the aquifer confined the pressure in the porous rock. Water movement in aquifers is highly dependent of the permeability of the aquifer material. Permeable material contains interconnected cracks or spaces that are both numerous enough and large enough to allow water to move freely.

The proposed expressway alignment is located in the coastal plain of the Palghar district and runs parallel to and/ or very near to Rivers Vaitarna, Surya and Suseri between Km 30+000 and km 72+200. Vertical profile of the proposed expressway shall, therefore, be governed by the HFL of these major Rivers along the entire stretches. Rocks were only visible in the beds of rivers (at NH8 crossing points) namely Surya (Km 68+420), Suseri (Km 72+190) and Vadvali (Km 96+208). As per the CGWA classification, all the Talukas, through which the proposed expressway is passing, fall under safe category. Further, the proposed expressway doesn't involve tunneling. Therefore, **possibility of exposure of aquifers rock deposits due to excavation during construction phase is negligible.**

- B) Loss of fertile top soil for due to change in land use: Detail study and quantification of loss of fertile top soil due to change in land use is discussed in Section-3.7 of Chapter-3.
- C) Habitat Fragmentation and Increased Animal Mortality: The proposed expressway traversing through eco-fragile area of Dahanu Taluka between km 68+455 to Km 96+200. The expressway will act as barriers or filters to animal / cattle movement and lead to habitat fragmentation. Many species may not cross the open space created by a expressway due to the threat of predation and expressway also cause increased animal mortality from traffic. To minimize the risk of habitat fragmentation, **51 cattle underpass** has been proposed.

The wildlife kills reported by Tungeshwar Wildlife Sanctuary (TWLS) shows that all the incidence of vehicle kill occurred towards south-east side from the proposed start point of VME. NH-8 is approximately 1.8 km on right side of proposed start point. The TWLS is further right side of NH-8. Hence, NH -8 is acting as a barrier for the movement of wild animals from TWLS to the proposed expressway.



Likely damage to flora, fauna and forest is discussed in detail in Chapter-4 of the EIA Report.

- D) Tropical Rain Water Storages Disturbance: Due to leveling operation, natural seasonal ponds may be affected, which is water source to wild life/ birds / Cattle grazing location.

Details of such impact are discussed in Chapter-4 of the EIA Report.

- E) Risk of Flood: Construction may cause disturbance of river and nallas, may cause unbalanced pouring water into main stream cause risk of flood situation near bridge locations.

### 7.3.3 Assessment of Risk

There are various risks in each project stage. From the viewpoint of project management, it is essential to qualitatively analyze the risks and conduct the risk management. However, in reality, the data for the analysis is usually very limited being green field project.

**Table 7 - 12 Qualitative Risk Assessment: Construction Activities**

Sl. No	Activity	Hazards	Likelihood / Consequence A - Remote B - Unlikely C - Likely D - Highly likely E - Near certainty	Control Measures
1	Stone crusher-coarse aggregate and fine aggregate	1) Fine dust inhalation. 2) High level Noise 3) Eye injury 4) Body Injury during stone handling 5) Accident Truck loading/unloading	D D C C C	1) Work as per Safe operating Procedures 2) Use of PPE / PPA 3) Avoid Manual operation 4) Safety supervision/communication
2	Transportation from Crusher unit to site	1) Road accidents 2) Dust evolution 3) Spillage on road	C D D	1) Follow strict Motor Vehicle Rules 2) PPE / PPA / First aid Box / Communication 3) Proper planning for avoiding Traffic congestion 4) Authorized & Trained Driver 5) During unloading using fluorescent coloured high visibility apparel. 6) Truck / tipper floor checks 7) Visual and auditory contact of the road worker
3	Unloading / spreading / leveling	1) Fetal accident 2) Body injury	C D	1) Permanent right-of-way to provide room for materials 2) Use of PPE /PPA / Barricade / Safety sign / display on Road / Caution board Display
4	Site Clearance /Borrow Pits / Quarrying using (a)Wheeled and crawler tractors, loaders and dozers; (b) Motor graders and scrapers; (c) Self-propelled rollers and compactors	1) Fetal accident - Operators may be died in machine roll-overs	B	1) Roll-over protective structure and a seatbelt to restrain the operator 2) Provide a supplementary steering system 3) Valid approval for operating nuclear gauge from the appropriate authority 4) use non-nuclear based equipment

Sl. No	Activity	Hazards	Likelihood / Consequence A - Remote B - Unlikely C - Likely D - Highly likely E - Near certainty	Control Measures
5	Earth work	1) Falling or sliding material or article from any bank or side of such excavation	D	1) Provide adequate piling and bracing against such bank or side 2) provide adequate shoring 3) Excavated material is not stored at least 0.65 m from the edge of an open excavation or trench 4) Provide metal ladders and staircases or ramps are provided
6	Movement of trucks	1) Fall over Tip Head	C	1) A protective beam or timber Baulk should be used. 2) Back under the control of a signalman
7	Bulldozers	1) Fetal accident 2) Injuries 3) Dusty environment 4) High noise hazards	C	1) Avoid side hill travel 2) Avoid obstacles 3) Avoid overhanging material to fall due to vibration /load 4) Do not work alone in deep water
8	Excavators	1) Fetal accident 2) Injuries 3) Dusty environment 4) High noise hazards	C	1) When excavating trenches, place the excavated material at least 600 mm clear of the edge 2) Avoid swinging your boom downhill any further than necessary 3) Maintain Stability , Watch boom clearance when travelling, Avoid jerky swings or sudden braking
9	Backhoe loader	1) Fetal accident 2) Injuries 3) Dusty environment 4) High noise hazards	C	1) Operate the backhoe from the correct area, never from the ground. 2) When operating on a slope, swing load uphill to dump 3) Select a level site While Parking 4) Lower bucket and backhoe to ground and block wheels 5) Engage parking brake, remove ignition key (parking)
10	Motor Grader	1) Fetal Accident 2) Topped down 3) Physical Injury	C	1) Give the right-of-way to loaded vehicles 2) Drive at a slow speed in congested areas 3) Remove ignition key when leaving grader. 4) Ground the blade when leaving grader unattended. 5) Use colored flags at each end of moldboard when blading. 6) Shift blade to center and lock it when parking.
11	Smooth wheeled tandem roller	1) Fetal accident 2) Injuries 3) Dusty environment	C	1) Examine edges for soft spots before starting work. 2) Avoid gear changes on steep

Sl. No	Activity	Hazards	Likelihood / Consequence A - Remote B - Unlikely C - Likely D - Highly likely E - Near certainty	Control Measures
		4) High noise hazards		sections 3) Park on the flat
12	Vibratory Roller	1) Fetal accident 2) Injuries 3) Dusty environment 4) High Noise hazards	C	1) Use Rollover Protection safety when the machine is operated over unsafe ground 2) Use a three-point approach when entering or exiting the roller.
13	Surface courses	1) Accident. 2) Fire, severe burns ,eye Injury, 3) Inhalation of toxic gases	C	1) Use proper safety equipment 2) Avoid wear rings, wristwatches, jewelry, loose or hanging apparel 3) Keep away from the machine's articulation area when the engine is running.
<b>Fly Over / Bridge Construction</b>				
14	Palletised Bricks, Stacking on Scaffolds	1) Falling loose bricks 2) Stacks collapsing or sinking 3) Obstruction to vehicles 4) Untrained forklift drivers 5) Danger to Workman's children	C D C B C	1) Plan stacking area 2) Fit brick guards to scaffold 3) Do not overload scaffold Stack neatly 4) Only trained forklift drivers to drive 5) Construction Health , Safety & Welfare Regulations 6) Use of PPE /PPA, such as safety helmet, safety footwear, gloves
15	Block Laying – High Density	1) Manual handling 2) Back injuries 3) Trapping fingers 4) Strain on arms, wrists 5) Falls from heights 6) Falling materials	C	1) Use good lifting procedures 2) Ensure hop-ups are adjusted to suit 3) Ensure scaffolds are complete and toe boards are in position 4) Use additional personnel to lift over 25 kg
16	Cement Mixing, Silo Operation, Ready Mix	1) Manual handling, Skin contact with dry and wet cement 2) Dust and noise	D	1) Keep hands away from moving parts 2) Use barrier cream 3) Wash frequently 4) Close safety gates
17	Concrete – Scabbling	1) Noise, dust, working from scaffolds 2) Manual handling 3) Flying particles 4) Dropping equipment	D	1) Only trained operatives to be used 2) Check scaffolds are properly constructed 3) Ensure personal protective equipment is worn 4) Use anti-vibrating equipment and carry out assessment
18	Lifting Loads with Cranes	1) Overhead electrical services 2) Underground services 3) Slings of loads	D	1) Documentation must be inspected prior to lifting i.e. Certificate of Past Inspection 2) Use of PPE / PPA 3) Provide Work permit system 4) Safety Supervision 5) The Banksman must be able to signal to the crane drivers by hand

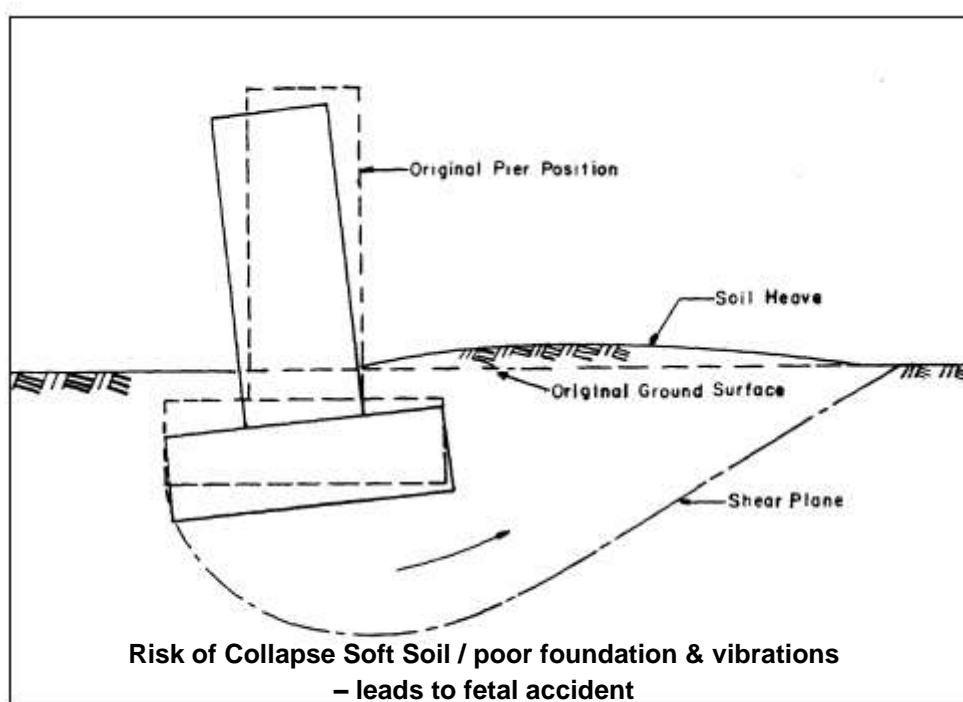


Sl. No	Activity	Hazards	Likelihood / Consequence A - Remote B - Unlikely C - Likely D - Highly likely E - Near certainty	Control Measures
				signals or radio link
19	Demolition	1) Flammable materials – dust, fumes etc. 2) Toxic wastes Asbestos, lead, lead paint 3) Falls from heights 4) Struck by falling materials 5) Noise, collapse of structures	D	1) Only trained and experienced operatives to be employed 2) Fence off area and display warning notices 3) Install temporary shoring as required 4) Provide suitable edge protection as required 5) Use PPE / PPA
20	Electric Arc Welding	1) Inhalation of fumes 2) Weld flash, Radiation burns 3) Hot sparks, fire, burns from hot metal 4) Electric shock	C	1) Only trained operatives to use 2) Ensure local exhaust ventilation is working 3) Wear recommended personal protection 4) Keep area clear of combustible materials 5) Use flash screens
21	Operation of Elevated Work Platform	1) Fall from platform 2) Fall of materials 3) Crushing from overhead obstructions 4) Uneven ground and drain covers 5) Injuries to other contractors, public	D	1) Only trained and experienced personnel to operate the machine 2) Harness should be secured 3) Keep work platform clean 4) Ensure hand tools are prevented from falling 5) Fence off work area and post warning notices
22	Forklift side Loader	1) Striking against operative 2) Overturning forklift 3) Hazardous stacking 3) Noise	D	1) Only trained and certificated operatives to drive 2) Ensure adequate lighting 3) Regular maintenance of machines
23	Work from Ladders	1) Falls from heights 2) Falling materials 3) Carrying materials 4) Ladder slipping	C	1) Use only ladders without defects 2) Ladder should extend 3'6" above the work platform 3) Safe angle of use 1:4 Secure at top or bottom Foot ladder
24	Laying slabs and kerbs	1) Manual handling 2) Trapping fingers 3) Trapping toes 4) Dust from cutting disc 5) Noise	D	1) Lift correctly 2) Seek help for very heavy slabs or kerbs 3) Use personal protection provided 4) Keep materials close to the job
25	Environmental improvements	1) Road transport and vehicles 2) Air & Noise Pollution	D	1) Set up traffic management system 2) Fence off work areas and excavations 3) Implementation of EMP 4) Safety helmet, hi visibility clothing, ear defenders, safety footwear, goggles, Dust masks, foul weather clothing may also be required

### A) Risk due to collapse of structure:

The top part of abutments, piers, and bents is called the cap. The structural members rest on raised, pedestal-like areas on top of the cap called the bridge seats. The devices that are used to connect the structural members to the bridge seats are called shoes or bearings.

Abutments, bents, and piers are typically built on spread footings. Spread footings are large blocks of reinforced concrete that provide a solid base for the substructure and anchor the substructure against lateral movements. Footings also serve to transmit loads borne by the substructure to the underlying foundation material. When the soils beneath a footing are not capable of supporting the weight of the structure above the soil, bearing failure occurs. The foundation shifts or sinks under the load, causing structure movement and damage.



### B) Potential Hazards during the handling of Bitumen

At ambient temperatures bitumen is solid and therefore does not pose a health hazard. But to handle bitumen it must be heated to temperatures above 100°C, which gives rise to the main hazard of heat burns. Also, there are other possible hazards associated with inhalation of fumes and low temperature skin contact with materials mixed with bitumen which could be toxic, such as cutters, emulsifying agents, adhesion agents, etc.

### C) Toxicity of Bitumen

Bitumen is complex hydrocarbon materials containing high molecular weight components, a low percentage of which are polycyclic aromatic hydrocarbons (PCAs).

The toxicity of these components needs to be considered in view of their known carcinogenicity. In experimental animal studies polycyclic aromatics with 3 to 7 (usually 4 to 6) fused rings, with molecular weights in the range 200 to 450, have been shown to be biologically active carcinogens. In particular benzo(a)pyrene and benz(a)anthracene are considered to be powerful carcinogens. However, the concentrations of these carcinogens in bitumen are extremely low, as indicated in the table below. The presence of carcinogens in bitumen does not necessarily constitute a risk to health in practice, but the information is vital so that appropriate precautions can be taken by personnel handling the product.

#### **D) Potential hazards during the handling of Bitumen Emulsions**

Bitumen emulsions are usually handled at ambient temperature, however some new high bitumen content emulsions are handled at elevated temperatures (40–80°C) and appropriate hot liquid handling precautions must be employed. Bitumen emulsions can be stored over a relatively long period, provided appropriate procedures are observed:

- Never allow the bitumen emulsion to freeze as it will break in the storage tank;
- Whenever possible choose tall vertical storage tanks to minimize the exposure of the bitumen emulsion surface to air;
- Fill / empty the storage tanks from the bottom to ensure that the bitumen skin that forms on the top of the emulsion is not broken;
- Gently circulate the product if long term storage is envisaged to counter the natural settling tendency of the emulsion. Once again do not break the skin that forms on top of the emulsion.

Bitumen emulsions can be handled and transported safely by following a few simple rules, which include:

- Never load bitumen emulsion on top of the remainder of a hot bitumen load;
- Never mix emulsion types i.e. anionic and cationic, in the same tank or pipeline as the emulsion will break into its two components;
- Ensure that the approved product tanker switch loading procedure is carried out whenever changing emulsion types or changing between loads of hot bitumen and emulsion. Follow the suppliers Material Safety Data Sheet advice at all times.

The main considerations therefore involved in handling bitumen are:

- The high handling temperature and the need to minimize the temperature wherever practical,
- The need for purpose-designed vessels which are insulated to retain heat and prevent contact of personnel with hot surfaces,
- The need to safeguard the health of personnel by provision of suitable protective clothing, serious burns can be caused by bitumen coming in contact with the skin.
- The training of personnel,
- The prevention of contact of water with hot bitumen,
- Flammability

### Protection against skin burns

- Eye and face protection (face shield)
- Heat resistant material overalls, close-fitting at the cuffs and overlapping the boots
- Heat resistant gloves with close-fitting cuffs
- Safety boots
- First aid for skin burns

Accidental contact with hot bitumen to the skin or eye should be immediately dealt with by immersing the affected area in clean cool running water for at least 10 minutes or until thoroughly cooled.

- For this reason, water showers and eye bath facilities should be available at fixed installations such as depots etc., at strategic locations.
- For other work locations, consideration must be given to where and how this safeguard would be accommodated.
- Once the bitumen has cooled, no immediate attempt should be made to remove it until admission to hospital and only at the direction of a burns specialist.
- All bitumen burns should receive proper medical attention without delay and burns to the eye should be referred urgently to hospital.
- Bitumen encircling a limb or finger can produce a tourniquet effect as it cools. This should be relieved under medical supervision.
- “Bituminous Materials SOP” and good practice would have all personnel aware of the available at all work locations including in the cabin of bituminous product vehicles.

### **E) Fly Ash**

When coal ash is used in concrete for building roads and bridges, its constituents—such as heavy metals—are bound (encapsulated) in the matrix of the concrete and are very stable. Leaching of these constituents for all practical purposes does not occur. Occupational issues associated with coal ash use in concrete include the handling of dry coal ash prior to or during its inclusion in a concrete mix or exposures during demolition of concrete structures. In these cases work inhalation and skin contact precautions should be observed.

Inhalation and Skin Contact: Water and air are the two media most likely to be affected by coal ash or coal ash constituents. Ingestion, inhalation, and skin contact are the ways that humans and other living things could be exposed to coal ash.

Other issues that may need to be addressed are leaching of elements such as mercury and metals into ground water contamination of vegetation and the impact of other elements on the food chain, and air-borne dust. In most cases, however, the way that coal ash is used, the engineering requirements for that use, and the handling and management methods applied minimizes exposure to the ash.

### 7.3.4 Disaster Scenarios of Expressway

Various scenarios that are anticipated to cause major emergencies on the Expressway are fire, explosion, toxic release and natural calamities like cyclone, flood, earthquake etc. All these scenarios are discussed in brief in the following text.



**Natural Disaster may affect Expressway evacuation management due to limited assess**

**A) Fire Hazard:** The fire is a process of burning that produces heat, light and often smokes and flames. The effect of fire on the people takes the form of skin burn on exposure to thermal radiation.

Radiation Level (kW/m <sup>2</sup> )	Observed Effect
37.5	Sufficient to cause damage to process equipment
25	Minimum energy required to ignite wood at indefinitely long exposures (non-piloted)
12.5	Minimum energy required for piloted ignition of wood, melting of plastic tubing
9.5	Pain threshold reached after 8s; second degree burns after 20s
4	Sufficient to cause pain to personnel if unable to reach cover within 20s; however blistering of the skin (second degree burns) is likely; 0: lethality
1.6	Will cause no discomfort for long exposure

**Flash Fire:** A flash fire occurs when a cloud of flammable gas and air is ignited accidentally.

**Jet Fire:** A jet fire occurs when a flammable liquid or gas is ignited after its release from a pressurized, punctured vessel or pipe (8kg/s – 35 m).

An accidental escape of flammable material to form a cloud and obtained delayed ignition.





## B) Hazards associated with NG Pipelines

Proposed alignment of the expressway crosses gas pipeline at chainage 103+998 and it requires additional protection safety signage. Natural Gas is highly flammable substance, transported through cross country pipelines at high pressure often close to centres of high population or through areas of high environmental sensitivity pose severe hazard problems for human being and property in the vicinity. Provision of protective measures is essential for safe operation of NG Pipeline system. The requirements based on

- Hazardous properties of Natural Gas
- Quantity of Natural Gas, which could be released and its effect

### Safety Aspects of NG Pipelines - Construction

- **Pipeline Cover:**

SN	Locations	Minimum Cover (In Mtr)
i)	Area of agricultural, horticultural activity, limited or no human activity, industrial commercial and residential area	1.0
ii)	Rocky terrain	1.0
iii)	Drainage, ditches at roads/railway crossing	1.0
iv)	Minor river crossings/canal/drain/nala/ditches	1.5
v)	Major river crossing (below scour level)	2.5
vi)	River with rocky bed (below scour level)	1.5
vii)	Area under influence of tides	1.5
viii)	Cased/Uncased road crossing	1.2
ix)	Cased railway crossing	1.7

### Safety Aspects of NG Pipelines – Operation & Maintenance

- **Right of Way for Inspection and Maintenance:**
  - Road and Highway Crossing – Once in a 3 months.
  - River Crossing – Twice in a year (Before and after Monsoon)



The depth of cover and right-of-way width may vary

**Safety Aspect of Gas pipeline**

### C) Transportation of Hazards Chemical / Materials

Palghar district has many industrial pockets on Western Railway track and highway. The main industrial activities are located at MIDC Tarapur area near Boisar Station, and other industrial estates and scattered industries along the existing highway and railway lines at **Palghar, Vasai**, Virar, Wada, **Dahanu** etc. These industrial activities mainly include small, medium and large scale chemical, steel, fine chemicals, textile and other allied industries. Tarapur Atomic power station (TAPS) and Thermal Power Station is also located in this area. As on today there are 26 MAH (Major Accident Hazardous) factories, 722 Hazardous Factories, 307 Chemical Factories and about 2522 other Factories. These units have hazardous / toxic / flammable chemicals like Ethylene Oxide, Propylene Oxide, Oleum, Liquefied Petroleum Gas (LPG), Chlorine, Ammonia etc. There are also other chemical factories handling / storing inflammable solvents like Toluene, Methanol, Isopropyl Alcohol, Hexane, and Monomer. Apart from storage of these hazardous, flammable, toxic chemicals in the factories, these chemicals are transported in Tankers by road. After construction of the expressway, there will be movement of tankers containing these chemicals, which has potential hazard like leakage, fire, BLAVE (Boiling Liquid Expanding Vapour Explosion), Vapour cloud, explosion and toxic release. This may cause risk to the property, human life and environment. The On-Site Emergency plans have been prepared by the industries.

#### 7.3.5 Disaster Management Plan

##### 7.3.5.1 Introduction

Disaster Management (or Emergency Management) is the discipline of dealing with and avoiding risks. It is a discipline that involves preparing, supporting and rebuilding when natural or human made disasters occur. The actions (efforts to avoid or ameliorate the impact) taken depends in part on the perceptions of the risk. In any event, an effective emergency management system will rely on the emergency plans available.



Figure 7-3 Cycle of Disaster Management

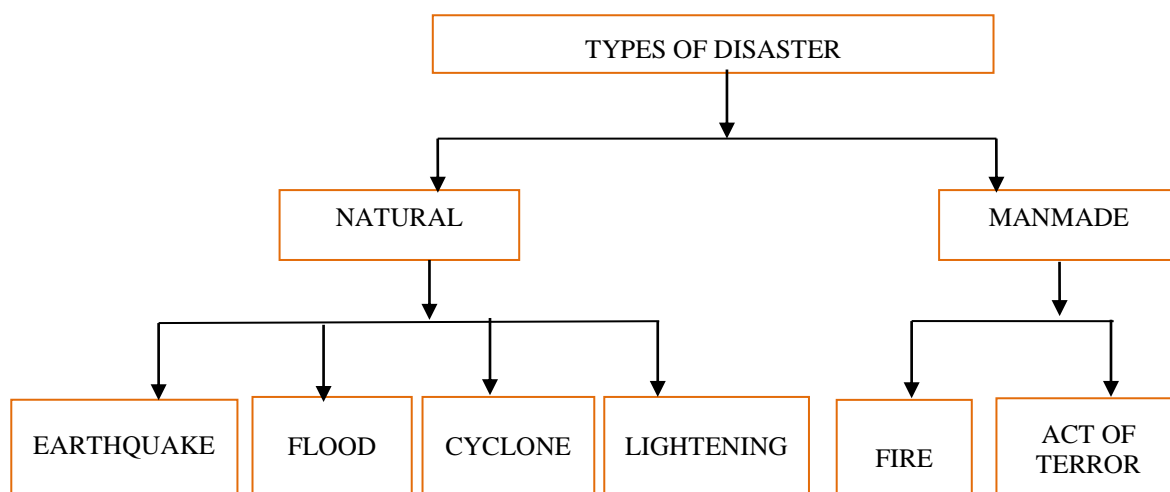
##### 7.3.5.2 Scope of DMP

DMP discuss planning, roll and responsibility and action to be taken by employees,

workman, security staff and local aid for prompt rescue, evacuation, rehabilitation and communication. During construction activities at the site will need to have a round-the-clock duty team to manage disaster. The duty team will include several functions and members depending on size of the organization and would be headed by a technically qualified as well as a trained individual to cope up emergency situation during natural and manmade disasters.

### 7.3.5.3 Objective of DMP

- Controlling the disaster, localizing the disaster and eliminating the hazard,
- Welfare of person managing the disaster,
- Head count and rescue operations,
- Treatment of injured,
- Safeguarding others by timely evacuation,
- Minimizing damage to property and environment,
- Informing and assisting relatives,
- Informing and collaborating with statutory authorities,
- Informing the news media,
- Preserving records and organizing investigations,
- Ensuring safety of the works before personnel reenters and resume work,
- Investigating and taking steps to prevent recurrence,
- Resorting normalcy



### 7.3.5.4 Planning Factor

The following parameters have kept in view in the formulation of this plan:

- Control and Direction over all the two zones to rest with local crisis management of Vasai – Virar and Tarapur – Talasari region
- Decentralization of operational control to each zone to be exercised by the respective crisis management group
- Each to be self-sufficient in first response capability within a specified time in

emergency service

- All concern should have very close linkage to ensure integrated approach to emergency
- All MAH industries in a zone should have formulated mutual aid agreement covering firefighting and medical services
- Instant alarm system to alert the people in danger zone
- Quick response by radio communication network, Mobile Phones and other available resources of communication
- Identification of alternative routes for transport of Hazardous Chemicals during emergency situation

#### **7.3.5.5 Onsite Disaster Management Plan**

- a) Site Disaster Manager to take charge and give guidance over public address system
  - Project Manager will take charge and give guidance over public address system
  - Assembly point shall be identified and marked. Mega phone shall be used to address the emergency to employees.
- b) Call for outside assistance of Fire Brigade, Hospital, Ambulance
  - Accounts & Administration In-charge will call for outside assistance of Fire Brigade, Hospital, Ambulance
  - In absence of Accounts & Administration In-charge, manager will call outside for assistance
- c) Network with State, District and Ward level control rooms
  - Ward level details are provided below in operation phase
- d) Ensure adequate warning before switching off power
  - All announcements will be done with good quality equipment
  - EHS In-charge of the Contractor will ensure with Safety Supervisor that all worker are stopped working and shut downed the machines & equipment before switching off emergency control switch
  - The emergency electrical switch during construction phase will be placed near the site office.
- e) Assure workers of continuous communication and take all measures to keep up their morale
  - Project manager will do continuous announcements by various methods to keep up workers morale
- f) Guide workers on the steps being taken for evacuation in a systematic manner
  - This requirement will be handled by dedicated trained staff/volunteers.
- g) Take steps to reduce/ eliminate panic
  - Periodical training to internal Volunteers & Officers
  - Periodical mock drills to all Workers, Officers, volunteers and staff in every three

months

- h) Liaise with Law & order Machinery
  - Project manager will liaise
- i) Preventive Maintenance
  - Preventive maintenance of construction equipment, lifting tackles, cranes, hot mix Plants, batching plants, stone quarry, fire protection system of POL storage area is advisable.
- j) Regular maintenance of Equipment & Systems
  - Periodical maintenance will be carried by certified, competent and skilled person employed by the Contractor at regular intervals.
- k) Warning System
  - Security will do the announcement by fan horn or reflex horn speaker in the guidance of Safety In-Charge
  - Provision of fire alarm switch at security room
- l) Organize extensive training for disaster managers and assistants
  - Quarterly training will be arranged by the Contractor for disaster managers and assistants during construction stage
- m) Prepare Inventory of Resources - rescue equipment, medical equipment for emergencies, ambulances, hospitals, NGOs and disaster management related material and personnel. Only OHSAS 18000 Certified Contractor will undertake work having
  - DMP policy
  - Standard Operation Procedures (SOP)
  - Emergency rescue equipment and resources
  - Provision of stretcher at appropriate location
  - Implementation of Work Permit system
  - All emergency contact details is to be maintained in register

#### **ROLES AND RESPONSIBILITIES**

<b>Position</b>	<b>Role &amp; Responsibility</b>
<b>Project Manager (Chief Site Controller)</b>	<ul style="list-style-type: none"><li>▪ Ensure that site management teams are adequately staffed by suitably trained and experienced personnel</li><li>▪ Advising the site management of their specific responsibilities and duties for health and safety</li><li>▪ Promoting an interest and enthusiasm for health and safety and emergency evacuation during crisis</li><li>▪ Conducting regular safety meeting with site management</li></ul>
<b>EHS General Manager (Asst. Site Controller )</b>	<ul style="list-style-type: none"><li>▪ Monitoring the implementation and operation of the safety plan</li><li>▪ Responsible to the head safety on day to day basis</li></ul>



Position	Role & Responsibility
	<ul style="list-style-type: none"> <li>▪ Verifying the correct reporting procedures for accidents, dangerous occurrences</li> <li>▪ Day-to- Day scrutiny of operations on site with regard to safe system of work</li> <li>▪ Investigation of accident and dangerous occurrences, reporting and recommending corrective actions</li> <li>▪ Ensure that all accident and dangerous occurrences are reported and any necessary remedial actions are taken</li> <li>▪ Manage the site safety condition and relation with client in proper compartment</li> </ul>
<b>Construction Head - (site Controller)</b>	<ul style="list-style-type: none"> <li>▪ Ensure Contractor's Safety Procedures are followed on site</li> <li>▪ Ensure that all statutory posters and notices are displayed together with the policy document</li> <li>▪ Carry out formal weekly site inspection and inform in writing to the senior safety executive of any necessary improvement to ensure the activities are undertaken in a safe manner</li> <li>▪ Daily inspection will be carried out and any dangerous condition reported</li> <li>▪ Ensure that an adequate supply of protective clothing and equipment is available and issued to operatives</li> <li>▪ Ensure that operatives are aware of their responsibilities regarding the wearing of such equipment</li> <li>▪ Ensure that fire extinguishers are located in correct place and are fully charged. Provide weekly reports and monthly status</li> </ul>
<b>Safety Supervisor (Member)</b>	<ul style="list-style-type: none"> <li>▪ Regular safety inspection for slings, chain ropes, fire extinguishers, housekeeping, scaffolds, ladders etc.</li> <li>▪ Correcting unsafe work practices on site</li> <li>▪ Enforcing use of personal protective equipment</li> <li>▪ Conducting safety inductions and safety tool box talks</li> <li>▪ Training of banks men / signalmen</li> <li>▪ Ensure that the location of medical facilities is made known to all employees</li> <li>▪ Daily site safety inspection and reporting</li> <li>▪ Ensure that an adequate supply of protective clothing and equipment is available and issued to operatives</li> <li>▪ Ensure that operatives are aware of their responsibilities regarding the wearing of such equipment</li> </ul>
<b>Construction Workers</b>	<ul style="list-style-type: none"> <li>▪ To take reasonable care to safeguard their own health and safety and of other workers who may be affected by their work</li> <li>▪ Never misuse anything provided in the interest of health and safety</li> <li>▪ To use correct tools and equipment for the job</li> <li>▪ Use personal protective equipment as required</li> <li>▪ To warn new man to know hazard at work</li> </ul>

**Response Plan:** The Contractor will allot a Project Manager for handling disaster by keeping in view of his knowledge of local language, fire safety exposure, communication skill and his contact with public and local NGO's. The Project Manager will handle disaster with his safety team with clearly enumerated functions during construction phase.

**Control Room:** The Contractor will earmark a specific area to function as control room for disaster management during construction phase. the Control Room shall be operated round the clock. Security Control Room during Construction phase should be at the main entry gate. The traffic in the area comprises:

- Regular workers
- Vendors
- Visitors to the Working staff
- Representatives of public bodies, couriers companies etc.
- The traffic could be mobile or pedestrian

#### 7.3.5.6 **Off-site Disaster Management Plan**

District authority Palghar will play major roll during off site emergency situations

#### **DIRECTION AND CONTROL: (at PALGHAR DIVISION)**

Organization Roles & Responsibilities (Crisis Management Group-CMG)

This is the apex body for crisis management and is headed by the SDM, Dahanu-Talasari / SDM, Vasai / SDM Jawhar –Mokhada / SDM Wada- Vikramgad. The SDM is assisted by members as under:-

- Police Authority S.P. Palghar
- Principal Medical Officer Civil Surgeon at Civil Hospital, Palghar.
- Joint Director, Industrial Safety & Health, Vasai, District - Palghar.
- Fire officer Fire Station MIDC, Tarapur, Fire Station, Palghar, Fire Station, Dahanu and Fire Station Navghar Manickpur, Vasai-Virar Municipal Corporation.
- Deputy Controller, Civil Defense, Palghar
- Public Relation Officer
- Sub Regional Officer, Pollution Control Board, Palghar
- Representative of the concerned Industrial Unit
- City Engineer, Vasai-Virar Municipal Corporation and Executive Engineer
- PWD, Thane
- Public Health Officer Palghar and Vasai
- Co-coordinator Mutual Aid and Response Group TIMA
- Dy. RTO, Virar, Palghar
- District Information Officer

#### **Incident Discovery:**

- In case of emergency, dial S. P. Palghar -- give your name, location and a concise description of the emergency (e.g fire, personal injury, and toxic gas release)

- Notify / alert the personnel in the immediate area of danger
- If personal safety and health is not assured, do not attempt to enter the site till the emergency response team / NDRF / Fire Brigade / Police will reach the site

#### **Tasks of the CMG**

- To exercise board control over emergency operations
- To give guidance on matter of basic policy
- To provide official information and instruction to the public
- During normal times review the operational preparedness and take appropriate measures to rectify the defects
- To co-ordinate inter zone emergency response.

### **ROLES AND RESPONSIBILITIES**

<b>Position</b>	<b>Role &amp; Responsibility</b>
<b>Police Authority: SP Palghar</b>	<ul style="list-style-type: none"> <li>▪ Maintain Law and Order</li> <li>▪ Regulate Traffic</li> <li>▪ Control entry to the emergency area</li> <li>▪ Security arrangements at each industrial unit</li> <li>▪ Protect vital installations</li> <li>▪ Assist in warning public about the emergency</li> <li>▪ Assist in evacuating and sheltering</li> <li>▪ Protect evacuated area</li> <li>▪ Assist emergency services in the performance of their duties</li> </ul>
<b>Chief Medical officer / Civil Surgeon, Palghar</b>	<ul style="list-style-type: none"> <li>▪ First Aid arrangement and availability of On-Site requirements of Industries</li> <li>▪ Set up Mobile First Aid Posts at Assembly points</li> <li>▪ Mobilization of emergency medical and health service at causality clearance centers and base hospitals</li> <li>▪ Public Health Service at reception centers</li> <li>▪ Medical supply of antidotes, special medicines and lifesaving drugs</li> <li>▪ Corpse disposal service</li> <li>▪ Co-opt voluntary organization like Rotary Clubs and Lions Clubs.</li> <li>▪ Prepare plan for health and medical</li> <li>▪ Training to medical team and Hospital Staff for emergency response</li> </ul>
<b>Joint Director Industrial Safety and Health - Vasai</b>	<ul style="list-style-type: none"> <li>▪ Undertake safety audit of hazardous industries situated near VME Phase II</li> <li>▪ Visit Industries to see that safety norms are being followed</li> <li>▪ Ensure development of On-Site Plans. Examination of risk evaluation study and safety audit</li> <li>▪ Ensure frequency of Safety Audit and Mock Drills (Fire)</li> <li>▪ Assist the Municipal Commissioner in developing off-site scenarios</li> <li>▪ Ensure Safety Education, Safety Awareness, and Discussion along with Mutual Aid and Response Group (MARG).</li> </ul>

Position	Role & Responsibility
	<ul style="list-style-type: none"> <li>▪ Pre-emergency &amp; Post emergency Task</li> <li>▪ Member Secretary of the DCG Palghar</li> </ul>
<b>Joint Director Industrial Safety and Health, Vasai</b>	<ul style="list-style-type: none"> <li>▪ Ensure On-Site Plans of Industries are vetted and approved as per Act</li> <li>▪ Visit Industries to see that safety norms are being followed</li> <li>▪ Ensure development of On-Site Plans. Examination of risk evaluation</li> <li>▪ Study and safety audit</li> <li>▪ Ensure frequency of Safety Audit and Mock Drills (Fire)</li> <li>▪ Assist the Municipal Commissioner in developing off-site scenarios</li> <li>▪ Ensure Safety Education, Safety Awareness, and Discussion along with MARG.</li> <li>▪ Pre-emergency &amp; Post emergency Task</li> <li>▪ Member Secretary of the DCG Palghar</li> </ul>
<b>City Engineer, Vasai Virar Muncipal Corporation, Virar and Exe.Eng.PWD</b>	<ul style="list-style-type: none"> <li>▪ Organization Reception Centre at Assembly Points.</li> <li>▪ Co-ordinate resource of voluntary organization.</li> <li>▪ Prepare Plan for the Public Work.</li> <li>▪ Assist to prepare Plan to Regional Officer Maharashtra Pollution Control Board of containment and cleanup.</li> </ul>
<b>Fire Officer, Fire Station Vasai-Virar Municipal Corporation</b>	<ul style="list-style-type: none"> <li>▪ Mobilization of all firefighting units from various sources</li> <li>▪ Training of fire service personnel in chemical disaster operations</li> <li>▪ Stocking of special firefighting agents and equipment</li> <li>▪ Adequacy of firefighting / control measure at each industrial location</li> <li>▪ Work out Mutual Aid arrangement in the cluster</li> <li>▪ Prepare Plan for Human service required for the emergency response</li> <li>▪ Formulation chain of command among the Fire Fighters</li> <li>▪ Prepare Plan for response personal safety</li> <li>▪ Prepare Plan for Fire &amp; Rescue</li> <li>▪ List of tasks of the Fire Fighters</li> </ul>
<b>Deputy Controller, Civil Defense, Palghar</b>	<ul style="list-style-type: none"> <li>▪ Function as operations officer</li> <li>▪ Assist District Emergency Authorities in evacuation, medical, rescue activities</li> </ul>
<b>Public Relation officer</b>	<ul style="list-style-type: none"> <li>▪ Spokesperson for media, news on behalf of the Administration of Corporation</li> <li>▪ Responsible for dissemination of information to public</li> <li>▪ Established Media Center</li> <li>▪ Ensure pre-emergency education / information to public at large</li> </ul>
<b>Sub Regional Officer, Maharashtra Pollution Control Board</b>	<ul style="list-style-type: none"> <li>▪ Monitor extent and quantum of pollution during the crisis</li> <li>▪ Declare hazardous are safe for re-occupation by public</li> <li>▪ Prepare plan for the containment &amp; Clean-up</li> <li>▪ Prepare plan for on-going incident assessment</li> </ul>

Position	Role & Responsibility
<b>Regional Transport Officer, Palghar</b>	<ul style="list-style-type: none"> <li>▪ Ensure strict enforcement of regulations laid down to improve safety in transportation of hazardous substance</li> <li>▪ Organize transportation arrangement for evacuation.</li> <li>▪ Ensure TREMCARD is available in the tankers transporting hazardous chemicals</li> <li>▪ Divert tankers transporting hazardous chemicals in association with Traffic Police in case of disaster, Ganesh Chaturthi or any other festivals or mass gathering to safer transport route</li> <li>▪ Train tanker drivers in respect of the hazardous during the chemicals transportation in consultation with MARG.</li> </ul>
<b>Incident Commander</b>	<p>The Incident Commander is responsible for incident activities including the development and implementation of strategic decisions and for approving the ordering and releasing of resources.</p> <ul style="list-style-type: none"> <li>▪ Obtain incident briefing from prior incident commander</li> <li>▪ Assess incident situation</li> <li>▪ Conduct initial briefing</li> <li>▪ Activate elements of the incident command system</li> <li>▪ Brief command staff and section chiefs</li> <li>▪ Ensure planning meetings are conducted</li> <li>▪ Approve &amp; Authorize implementation of incident action plan</li> <li>▪ Determine information needs and inform command personnel of needs</li> <li>▪ Co-ordinate staff activity</li> <li>▪ Manage incident operations</li> <li>▪ Approve requests for additional resources and requests for release of resources</li> <li>▪ Approve the use of trainees on the incident</li> <li>▪ Authorize release of information to new media</li> </ul>
<b>District Information Officer</b>	<p>The information officer, a member of the command staff is responsible for the formulation and release of information about the incident to the news media and other appropriate agencies and organizations</p> <ul style="list-style-type: none"> <li>▪ Obtain briefing from incident commander</li> <li>▪ Contact the jurisdiction agency to co-ordinate public information activities</li> <li>▪ Establish single incident information centre whenever possible</li> <li>▪ Arrange for necessary work space, materials, telephones and staffing</li> <li>▪ Prepare initial information summary as soon as possible after arrival</li> <li>▪ Observe constrains on the release of information imposed by incident commander</li> <li>▪ Obtain approval for release from incident commander</li> <li>▪ Release news to news media and post information in command post and other appropriate locations</li> </ul>



Position	Role & Responsibility
	<ul style="list-style-type: none"> <li>▪ Attend meetings to update information release</li> <li>▪ Arrange for meetings between media and incident personnel</li> <li>▪ Provide escort service to the media and VIP's</li> <li>▪ Provide fire retardant clothing for media and VIPs</li> <li>▪ Respond to special requests for information</li> <li>▪ Maintain and Submit all records and logs.</li> </ul>
<b>Assistant to SDM (Administration)</b>	<ul style="list-style-type: none"> <li>▪ Act as an Alternate Leader, Liaison Officer, and Agency Chief in disaster</li> <li>▪ Check in at the incident command post. Ensure that all agency resources have completed check-in</li> <li>▪ Obtain briefing from liaison officer or incident commander</li> <li>▪ Establish working location. Advise agency personnel on the incident that the agency representative position has been filled</li> <li>▪ Attend planning meetings as required</li> <li>▪ Provide input on use of agency resources if no resources use advisors are assigned</li> <li>▪ Co-operative fully with incident commander and general staff on agency's involvement at the incident</li> <li>▪ Observe the wellbeing and safety of agency personnel assigned to incident</li> <li>▪ Advise liaison officer if any special agency needs or requirements</li> <li>▪ Determine, if any special reports or documents are required.</li> <li>▪ Report to agency dispatch or headquarters on prearranged schedule.</li> <li>▪ Ensure that all agency personnel and/or equipment is properly accounted for and released prior to your departure</li> <li>▪ Ensure that all required agency forms, reports and documents are completed prior to your departure from the incident</li> <li>▪ Have debriefing session with liaison officer incident commander prior to departure</li> </ul>
<b>Station Master Western Railway, Vasai Road / Virar / Saphale / Palghar/ Boisar / Dahanu</b>	<ul style="list-style-type: none"> <li>▪ Ensure availability of local trains in case of evacuations</li> </ul>
<b>Depot Manager MSRTC Palghar / Boisar / Vasai</b>	<ul style="list-style-type: none"> <li>▪ Ensure availability of Buses in case of evacuations</li> </ul>
<b>Execute Engineer MSEDCL, Vasai, Dy. Execute Engineer Vasai /Palghar /Dahanu</b>	<ul style="list-style-type: none"> <li>▪ Ensure electricity supply to expressway, streets; Police Stations, Fire Brigades, Emergency Control Centre and other Offices of emergency Response Personnel</li> </ul>
<b>District Supply Officer, Palghar</b>	<ul style="list-style-type: none"> <li>▪ He is responsible for determining feeding requirements at all incident facilities, menu planning, determining cooking facilities required and general maintenance of the food service areas</li> </ul>
<b>District Collector,</b>	<ul style="list-style-type: none"> <li>▪ Co-ordination of all Local Crisis Groups of the District</li> </ul>

Position	Role & Responsibility
Palghar	<ul style="list-style-type: none"> <li>▪ Act as Chief Controlling Authority of District Emergency Plan.</li> <li>▪ Mobilize / Requisition / pulling together resources to tackle emergencies</li> <li>▪ Establish relationship between District Emergency Plan (Crisis Group) and State Crisis Group</li> <li>▪ To requisite the resource available from the public works departments</li> </ul>

**Warning System:** A good warning system is one of the important pre-requisite of the emergency management system to save lives, Prevent injuries and mitigate losses. As soon as incident commander determines that it is necessary to warn people of a threat to public safety, a strategy appropriate to the situation will be developed and immediately implemented to ensure coverage of the affected area.

**Communication among Responders:** During emergency in VME Phase II contact numbers as under:

**Control Room:** 02525-297474/ Toll Free 1077  
District Disaster Management Palghar

#### Initial Notification of Response Agencies

I	24 Hours LCG Control Room	02528-222231
II	VMC to Notify Area Public Official & Other Response personnel, SDM Dahanu/ Palghar / Vasai	02528-222231
III	DCG Control Room Palghar	022-25381886

Source: Off-Site Disaster Management Plan, Palghar District

#### EMERGENCY ASSISTANCE TELEPHONE ROSTER

Inform to	Telephone No.
POLICE CONTROL ROOM	100
FIRE BRIGADE	101
<b>Police Palghar</b>	
Police Superintendent Palghar	02525 251100
SDPO Palghar	02525 251903
SDPO Dahanu	02528 222433
SDPO Vasai	0250 2332614
<b>Collectorate Palghar</b>	
Collector Palghar	022-25344041
Collector Office ( Control Room)	022-25381886
SDM, Dahanu	02528-222231

<b>Inform to</b>	<b>Telephone No.</b>
SDM Palghar	02525-216224
SDM Vasai	0250-2320880
Tahisldar Talasari	2521-220018
Tahsildar Dahanu	2528-221182
Tahsildar, Palghar	2525-254930
Tahsildar, Vasai	259-2322007
<b>Hospitals (Palghar Area)</b>	
Dr. Tupkar Palghar Nursing Home	02525-253044
Dr. Kampati M.A –Palghar Nursing Home	02525-244855
Dr. Sushila Raut – Sharda Hospital	02525-252550
Dr. Abhay Pagadhare – Philia Hospital	02525-252820
Dr. Kamble, Surgeon – Gen. Sai Krupa Hospital	02525-252897
<b>Ambulance Support</b>	
Tarapur General Hospital	02525-2784444
Rotary Club Tarapur	08087202270 / 9323187571
Rotary Club of Boisar	9823147247 / 9323486777
<b>Fire Protection &amp; Safety Equipment</b>	
Axon Safety and Fire Service	02525-276949
Usha Fire and Safety Equipment	022-65161609

Source: Off-Site Disaster Management Plan, Palghar District

#### Other Important Telephone Numbers

<b>Sl. No.</b>	<b>Name of the Office</b>	<b>Telephone</b>	<b>Email</b>
I	Chief Executive Officer, Zilla Parishad Palghar	02525-250800	<a href="mailto:ceo.zp.palghar@maharashtra.gov.in">ceo.zp.palghar@maharashtra.gov.in</a>
II	District Health Officer Palghar	02525-252257	
III	District Surgeon, District Hospital, Palghar	02525-256488	<a href="mailto:cspalghar@gmail.com">cspalghar@gmail.com</a>
IV	Regional Officer, Maharashtra Pollution Control Board Thane	022-25802272	<a href="mailto:rothane@mpcb.gov.in">rothane@mpcb.gov.in</a>
V	Regional Officer, Maharashtra Pollution Control Board Palghar	-	<a href="mailto:rothane@mpcb.gov.in">rothane@mpcb.gov.in</a>
VI	Palghar Municipal Council, Palghar	09892539034	<a href="mailto:palgharhagarparishad@gmail.com">palgharhagarparishad@gmail.com</a>
VII	A Municipal branch office, Palghar	02525-257385	<a href="mailto:tppalghar@rediffmail.com">tppalghar@rediffmail.com</a>
VIII	Executive Engineer, (Water Supply), District Palghar	02525/252097 922129039	
IX	Deputy Conservator of Forest, Dahanu	02528-222337/ 9420856033	

Source: <https://palghar.gov.in/important-telephone-numbers>

## **CHAPTER-8: PROJECT BENEFIT**

### **8.1 GENERAL**

The proposed expressways will be constructed to higher design standards than a customary on ordinary highways. The features include separation of highway and railway grades, elimination of unnecessary stoppage except for fuel, full lanes of pavement in each direction separated by a medial safety zone, easy grades, sweeping curves and adequate shoulders. On an expressway of this type, it will be possible to obtain a high average speed in comparison with the top speed. It will provide the facility for movement of men and material at a faster pace, establishing linkages between distant cities and towns and improve earning and thereby enhancing the quality of life. This in turn enhances the demand for transport. This two-way interaction works through a host of inter-sectoral forward and backward linkages effects and dynamic externalities, tend to relocate industries, services and labour and thus helps to shape the economic geography of the region. The developments of expressways have also resulted in the development of the entire region located all along the stretch. In a way, the proposed expressways will become symbols of growth and prosperity.

The benefits of proposed Vadodara Mumbai Expressway may also be seen from a different angle, viz., the local benefit and the wider regional or national level benefit. The entire regional and national economy lying beyond this neighborhood will also be benefited from the development. Such effect may be called as the regional or national level benefits. Further the benefit may be direct or indirect in nature.

All these should have a bearing on the level of wellbeing of the households; although some of them may not themselves necessarily use more of the Expressway facility created. These would in turn lead to changes in the level of well-being and human development, through their benefit on consumption level, educational attainment, health status, etc.

### **8.2 DIRECT BENEFITS**

The proposed Vadodara Mumbai Expressway will have following direct benefits.

#### **8.2.1 Fast Connectivity**

- The expressway will link Ahmedabad Vadodara Expressway to Mumbai Pune Expressway thus providing Expressway Connectivity from Ahmedabad to Pune for a length of about 650 km.
- The Expressway will reduce travel time from Vadodara to Mumbai to under 4 hours from the present 6 to 7 hours on NH-8
- The expressway along with SPUR will provide connectivity to Dahej Port and Jawahar Lal Nehru Port (JNPT) thus facilitating imports and exports from these two ports.
- The expressway alignment is passing through the proposed Delhi – Mumbai

Industrial Corridor (DMIC) and hence will facilitate the Investments in the Mega Project.

- The Expressway will be linking big industrial cities like Vadodara, Surat, Bharuch, Ankleshwar, Mumbai thus will immensely benefit the economy of these cities.
- The expressway has been designed to best of International Standards and will thus facilitate safe travel at high speeds with State of the art Automated Traffic Management system, Access Control, World class way- side amenities such as truck parking / servicing areas, fuel stations etc.
- The Proposed Vadodara Mumbai Expressway will provide short, fast, uninterrupted, fully access controlled connectivity between important cities of Vadodara, Surat, Bharuch, Vapi, Silvassa, Ankleshwar etc.

### **8.2.2 Reductions in Vehicle Operating Cost & Travel Time**

The proposed expressway and the existing NH8 shall be competing facilities. With the expressway facility of eight lane configuration, it is expected that there will not be high savings in the operating costs. However since the expressway will offer higher speeds there will be considerable **time related savings**. Therefore as is expected under the project scenario the proposed expressway is economically viable with time savings only.

### **8.2.3 Reductions in Accidents, Morbidity and Mortality**

The existing NH 8 is passing through settlements, has poor road geometrics and is infamous for road fatalities. Vadodara Mumbai Expressway will help in controlling the road fatalities by virtue of segregation of fast and slow moving traffic and fully access controlled expressway. More over many sections of NH-8 has reached the traffic carrying capacity and others will reach soon.

### **8.2.4 Benefit to Local Trade and Economy**

Palghar is a vibrant industrial destination and has 5757 small registered Industries, 1883 temporary small registered industries and 427 large / medium industries. It houses the largest MIDC (Maharashtra Industrial Development Corporation) in the state. The MIDC at Tarapur is home to over 1300 operating industrial units, including renowned global corporations like TATA Steel, JSW Steel and Raymond. Palghar is a self-sustaining employment hub, with a working population exceeding 1.5 lakh persons. Palghar has India's first atomic power plant located at Tarapur. Additionally, a new shipping terminal is planned in Dahanu. Maharashtra's biggest fishing center, Satpati, is located around 8 km from Palghar railway station

This region sources their raw materials as well as transports their finished goods to various parts of the country. The expressway will provide efficient access to various markets by ensuring smooth flow of goods and services. The expressway will support the local businesses and economy along the project corridor. It will also facilitate small-scale industries by streamlining transport of raw and finished material.



## **8.2 INDIRECT BENEFITS**

### **8.2.1 Employment Opportunity**

The proposed expressway is expected to generate employment during construction phase. It is estimated that ~500 direct employees will be required per day during construction phase. Further due to ecosystem which will be created during construction phase, the expressway will also create considerable indirect employment opportunities in form of transportation of construction materials, greenbelt development, ancillary facilities like canteens, dhabas etc.

During operations phase, the expressway will largely have indirect employment benefits in form of highway amenities and through economic & social hubs developed around the expressway. Efficient reach and connectivity to distant markets will further enhance economy of the district and create employment opportunities.

### **8.2.2 Development of Agriculture**

The construction of the expressway will help the farmers in getting good prices of their produce by way of quick and fast transportation of perishable goods to the market places. The expressway connectivity will also help in import of new techniques of agriculture to the backward areas.

## CHAPTER-9: ENVIRONMENTAL MANAGEMENT PLAN

### 9.1 INTRODUCTION

Environmental Management Plan (EMP) is the key to ensure a safe and clean environment. The desired results from the environmental mitigation measures proposed in the project may not be obtained without a management plan to assure its proper implementation & function. The EMP envisages the plans for the proper implementation of management measures to reduce the adverse impacts arising out of the project activities.

### 9.2 STAGE WISE ENVIRONMENTAL MANAGEMENT MEASURES

The EMP includes a list of all project-related activities at different stages of project (design & pre-construction stage, construction stage and operation & maintenance stage), remedial measures, reference to laws/ guidelines, monitoring indicators & performance target and a clear reporting schedule. The EMP sets a time frame to all proposed mitigation and monitoring actions with specific responsibility assigned to the proponents, the contractors and the regulatory agencies to implement the project and follow-up actions defined. Stage wise management measures are tabulated below:

**Table 9-1 Stage Wise Environmental Management Plan**

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
<b>A. DESIGN AND PRE-CONSTRUCTION STAGE</b>							
<b>1. Alignment</b>							
1.1 Pavement damage and drainage provisions	<ul style="list-style-type: none"> <li>▪ Rigid pavement has been proposed</li> <li>▪ Design CBR value of sub grade is recommended to be 8 %.</li> <li>▪ Overloading to be checked</li> <li>▪ Raised embankment and provision of shoulder drain to prevent damage to pavement due to water logging on the expressway</li> <li>▪ Provision of adequate no. of cross drainage structures.</li> </ul>	Design requirement  IRC:37-2012 IRC: 58-2015	Entire stretch of proposed expressway;  Roadside drains shall be provided on both sides of the carriageway and embankment. The drains have been proposed as	MI: Design and number of bridges, culverts and length of drain,  PT: Design and numbers are in accordance with site needs	Review of detail design documents & drawings and comparison with site conditions	Design Consultant	NHAI

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	<ul style="list-style-type: none"> <li>▪ <b>8 nos. of major bridges, 29 nos. of minor bridges and 133 nos. of culverts have been proposed</b></li> <li>▪ Adequate drainage system including surface and subsurface drains and median drainage system in super elevation section shall be provided</li> <li>▪ Lined drain has been proposed for the expressway.</li> <li>▪ Length of shoulder drain is <b>141.234 km</b> (70.617 km in each side)</li> <li>▪ Length of toe drain is 134.445 km (67.223 km in each side)</li> </ul>		<p>open and trapezoidal with 2(H):1(V) side slope as per IRC: SP: 73-2015 (Clause 6.2.4).</p> <p>For list of bridges and culverts, Please refer Section 2.4.2 and Section 2.4.3 of Chapter-2 of EIA Report</p>				
1.2 Safety along the proposed alignment	<ul style="list-style-type: none"> <li>▪ Thrie beam metal crash barriers shall be provided in entire length on both sides of each main carriageway (i.e. on median and on earthen shoulder of both carriageway), Loops and Ramps excluding stretches covered by bridges and RE wall structures, where concrete barriers to be provided</li> <li>▪ Highway lightings will be provided at stretches along Expressway from start to end of approaches of all service areas, toll plaza, wayside amenities, interchange, flyover, truck parking, underpass, overpass</li> <li>▪ Yellow flashing lights will be provided to alert the drivers</li> <li>▪ Traffic signs and marking will be provided in accordance to IRC Specification</li> <li>▪ Horizontal and vertical geometry</li> </ul>	<p>Design requirement</p> <p>Vertical geometry will be based on IRC-SP:73-2015</p> <p>IRC:SP:84-2014</p> <p>IRC SP 87 2013</p> <p>IRC: 37-2012</p>	<p>Entire stretch of proposed expressway;</p> <p><u>Total length of embankment is 70.617 km</u></p> <p><u>Total length of structures is 7.501 km</u></p>	<p>MI: number and location of safety barriers, warning sign boards, traffic sign as per Schedule of Bid Document</p> <p>PT: numbers and location are in accordance with site needs ; additional location as directed by AE/ NHAH shall be identified and provided in accordance to IRC specification</p>	Review of design documents and drawings and comparison with site conditions	Design Consultant	NHAH

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	as per IRC Specification						
<b>2. Natural Hazards</b>							
2.1 Flooding / Water-Logging	<ul style="list-style-type: none"> <li>▪ Provision of adequate number of CD structures has been proposed.</li> <li>▪ All CD structures designed for 50year HFL return period and bridges designed for 100 year HFL return period</li> <li>▪ Adequate water ways for bridges and culverts have been proposed.</li> <li>▪ Adequate drainage system including surface and subsurface drains and median drainage system in super elevation section shall be provided</li> <li>▪ Average height of embankment is more than 4 m</li> </ul>	Design requirement	Entire stretch of proposed expressway	<p><u>MI</u>: Design and numbers of cross drainage structures, No. of bridges, location of roadside drain, embankment height</p> <p><u>PT</u>: Design and numbers are in accordance with site needs</p>	Review of design documents and drawings and comparison with site conditions	Design Consultant	NHAI
<b>3. Loss of Land and Assets</b>							
3.1 livelihood loss to affected persons	<ul style="list-style-type: none"> <li>▪ Social Impact Assessment and Resettlement Plan have been prepared as per National Policy, NHAI Policy and requirement of MoEFCC.</li> <li>▪ Complete all necessary land and property acquisition procedures prior to the commencement of civil work.</li> <li>▪ Adhere to the Land Acquisition procedures in accordance to Entitlement Framework.</li> <li>▪ Compensation and assistance as per project Resettlement Action Plan (RAP)</li> <li>▪ Income restoration</li> <li>▪ Preference in employment and</li> </ul>	<p>The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.</p> <p>and</p> <p>National Highways (NH) Act 1956</p>	Entire stretch of proposed expressway	<p><u>MI</u>: Payment of compensation and assistance to PAFs</p> <p>Number of complaints / grievances related to compensation and resettlement</p> <p><u>PT</u>: Minimal number of complaints / grievances. All cases of resettlement and rehabilitation if any</p>	<p>Check LA records; design drawings vs land plans; JMR</p> <p>Interview with affected persons</p> <p>Check status of employment given to local people during construction</p>	NHAI & implementing NGO	NHAI

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	petty contracts during construction to affected persons <ul style="list-style-type: none"> <li>Constitute Grievance Redressal Cell (GRC)</li> </ul>			are resolved at GRC level. No case referred to arbitrator or court.			
<b>4. Felling of Trees and Diversion of Forest Land</b>							
4.1 Loss of trees 4.2 Loss of habitat of avifauna	<ul style="list-style-type: none"> <li>Tree felling within proposed ROW</li> <li>Trees to be felled shall be clearly marked.</li> <li>Obtain tree felling permission from State Forest Department</li> <li>Tree felling is to proceed only after all the legal requirements including attaining of In-principle and Formal Clearances from the State Forest Department are completed and subsequently a written order is issued to the Contractor.</li> <li>Stacking, transport and storage of the wood will be done as per the relevant norms. Systematic corridor level documentation for the trees to be felled and those saved will be maintained by the PIU.</li> </ul>	<ul style="list-style-type: none"> <li>Forest (Conservation) Act, 1980</li> <li>Forest (Conservation) Second Amendment Rules, 2014</li> <li>Maharashtra Felling of Trees (Regulation) Act, 1964 and its amendments</li> </ul>	Entire stretch of proposed expressway	MI: Number and location where trees can be further saved within PROW, budget allocated for greenbelt development  PT: Unnecessary tree felling within PROW avoided; Budget allocation is adequate	Review final design. Check budget provision for plantation.	- Design Consultant, NHA & Forest Department - Forest Department	NHA & Forest Department
4.3 Diversion of Forest Land	<ul style="list-style-type: none"> <li>Forest area proposed to be diverted is to be marked on ground through a joint inspection with Forest Officials.</li> <li>FRA Certificate under the Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006.</li> </ul> <p><b>Working Permission:</b> To facilitate speedy execution of projects involving linear diversion of</p>	<ul style="list-style-type: none"> <li>Forest (Conservation) Act, 1980</li> </ul> <p><u>CA land for linear projects:</u> in double degraded land involving RF &amp; PF in case of Central Government projects executed by Central Government PSU</p>	For location of forest land along the expressway, please refer Forest Clearance Proposal No. FP/MH/ROAD/36560/2018  Forest land proposed to be diverted : <b>≅191.5894 ha</b>	MI: adjustments made in detailed design to avoid forestland, budget amount for diversion of forest land,  PT: Unnecessary tree felling on forest land avoided.	Review final design. Check budget provision for compensatory afforestation and additional plantation, training & awareness program	- Design Consultant, NHA & Forest Department - Forest Department	NHA & Forest Department



Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	<p>forest land, in-principle (Stage-I) approval issued by the Central Government may be deemed as the working permission for tree cutting and commencement of work, if the required funds for CA, NPV, Wildlife Conservation Plan, Plantation of dwarf species of medicinal plants and all such other compensatory levies specified in the in-principle approval are realized from the User Agency, and where necessary, for CA, transfer and mutation of non-forest / revenue forest land in favour of the State Forest Department is complete.</p> <p>Thereafter, a senior officer of the State Government (not below the rank of DFO) having jurisdiction over the forest land proposed to be diverted; shall <b>pass an order for tree cutting and commencement of work of a linear project in forest land</b></p>		<i>Area of forest land proposed to be diverted may get change during Forest Clearance process</i>	Budget allocation is adequate,			
<b>5. Shifting of Utilities</b>							
5.1 Disruption of utility services to local community	<ul style="list-style-type: none"> <li>▪ All telephone and electrical poles / wires and underground cables (if any) should be shifted before start of construction</li> <li>▪ Bore wells, water supply pipelines and hand pumps located within the proposed RoW should be shifted before start of construction</li> <li>▪ Necessary permission and payments should be made to</li> </ul>	Project requirement	Entire stretch of proposed expressway	<p><u>MI</u>: Number of complaints from local people, number, timing and type of notifications issued to local people, time taken to shift utilities</p> <p><u>PT</u>: No. of complaints should</p>	Interaction with concerned utility authorities and local public	Contractor/ NHAI / Utility Company	NHAI / AE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	relevant utility service agencies to allow quick shifting and restoration of utility services <ul style="list-style-type: none"> <li>Local people must be informed through appropriate means about the time of shifting of utility structures and potential disruption of services if any</li> </ul>			be 0. Effective and timely notification. Minimal time for utility shifting			
<b>B. CONSTRUCTION STAGE</b>							
<b>1. Air Quality</b>							
1.1 Dust Generation due to construction activities and transport, storage and handling of construction materials	<ul style="list-style-type: none"> <li>Transport, loading and unloading of loose and fine materials through covered vehicles.</li> <li>Paved approach roads.</li> <li>Storage areas to be located downwind of the habitation area.</li> <li>Water spraying on the unpaved haulage roads and other dust prone areas.</li> <li>Provision of PPEs to workers.</li> </ul>	<ul style="list-style-type: none"> <li>MORT&amp;H Specifications for Road and Bridge works</li> <li>The Air (Prevention and Control of Pollution) Act, 1981 and</li> <li>Central Motor and Vehicle Act 1988</li> </ul>	Entire stretch of proposed expressway	<u>MI</u> : PM <sub>10</sub> level measurements Complaints from locals due to dust  <u>PT</u> : PM <sub>10</sub> level < 100 µg/m <sup>3</sup> ; Number of complaints should be zero.	Standards CPCB methods; Observations; Public consultation; Review of monitoring data maintained by the Contractor	Contractor	NHAI / AE
1.2 Emission of air pollutants (HC, SO <sub>2</sub> , NO <sub>2</sub> , CO etc.) from vehicles and use of equipment and machinery	<ul style="list-style-type: none"> <li>Regular maintenance of machinery and equipment.</li> <li>Contractor to submit PUC certificates for all vehicles / equipment / machinery used for the project and maintain a record of the same during the contract period.</li> <li>Batching, WMM, HMP and crushers at downwind (1km) direction from the nearest settlement.</li> <li>These plants shall be used after obtaining consent to establish &amp; consent to operate from MPCB</li> </ul>	The Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules 1982;	Batching & Asphalt Mixing Plants, Hot Mix Plant, Crushers, DG sets locations	<u>MI</u> : Levels of HC, SO <sub>2</sub> , NO <sub>2</sub> , and CO. Status of PUC certificates  <u>PT</u> : To keep SO <sub>2</sub> and NO <sub>2</sub> levels less than 80 µg/m <sup>3</sup> . PUC certificate of equipment and machinery is up to date	Standards CPCB methods  Review of monitoring data maintained by the Contractor	Contractor	NHAI / AE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	<ul style="list-style-type: none"> <li>▪ Only Crushers licensed by the MPCB shall be used</li> <li>▪ Hot mix plant should be fitted with dust extraction unit</li> <li>▪ SPM value at a distance of 40 m from a unit located in a cluster should be less than 500 g/m<sup>3</sup>. The monitoring is to be conducted as per the monitoring plan.</li> <li>▪ DG sets with stacks of adequate height and use of low sulphur diesel as fuel.</li> <li>▪ LPG should be used as fuel source in construction camps instead of wood</li> <li>▪ Air quality monitoring as per Environmental Monitoring Program</li> <li>▪ Contractor to prepare traffic management and dust suppression plan duly approved by AE &amp; PIU</li> </ul>						
<b>2. Noise</b>							
2.1 Disturbance to local residents and sensitive receptors due to excessive noise from construction activities and operation of equipment and machinery	<ul style="list-style-type: none"> <li>▪ All equipment to be timely serviced and properly maintained.</li> <li>▪ Construction equipment and machinery to be fitted with silencers and maintained properly.</li> <li>▪ Only IS approved equipment shall be used for construction activities.</li> <li>▪ Near school, noisy construction activities shall be carried out after closing of school and in the weekends / holidays only</li> <li>▪ Carry out noisy operations intermittently to reduce the total</li> </ul>	Legal requirement Noise Pollution (Regulation & Control) Rules, 2003 and amended in 2010;	Identified Sensitive locations; Interchange; Fly-Overs and Way Side Amenity	<p><u>MI</u>: day and night Noise levels. Number of complaints from local people</p> <p><u>PT</u>: Zero complaints or no repeated complaints by local people. Average day and night time noise levels are within permissible limits for work zone</p>	<p>Consultation with local people</p> <p>Review of noise level monitoring data maintained by the Contractor</p> <p>Observation of construction site</p>	Contractor	NHAI / AE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	noise generated <ul style="list-style-type: none"> <li>▪ Restrict construction near residential and built up areas to daylight hours.</li> <li>▪ Construction of <b>noise barrier</b> at sensitive receptors as suggested in the Chapter-4 of EIA Report; Interchange- 600m on each side on outer edge; Fly-Overs-200m on each side on outer edge; Truck parking- 500m on one side on outer edge; Way Side Amenity (Type A) - 500m on one side on outer edge and Way Side Amenity (Type B) - 150m on one side on outer edge</li> <li>▪ Plantation to serve as mitigation option for operation phase</li> <li>▪ Honking restrictions near sensitive areas</li> <li>▪ Noise limits for construction equipment such as compactors, rollers, front loaders, concrete mixers, cranes (moveable) etc. shall not exceed 75 dB(A) at a distance of 11 m from its source</li> <li>▪ PPEs to workers</li> <li>▪ Noise monitoring as per Environmental Monitoring Program</li> </ul>			areas			
<b>3. Land &amp; Soil</b>							
3.1 Land use Change and Loss of productive / topsoil	<ul style="list-style-type: none"> <li>▪ Non-agricultural areas to be used as borrow areas to the extent possible.</li> <li>▪ If using agricultural land, top soil to be preserved and laid over either on</li> </ul>	Project requirement  Annex-9.1 Guidelines on Top Soil Conservation and Reuse	Entire stretch of proposed expressway;  Land identified for construction camp,	<u>MI</u> : Location of Construction Camp, Storage Areas, Hot-mix Plant, Batching Plant	Visit of construction camp, plant sites; review of the reports submitted by	Contractor	NHAI / AE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	the embankment slope for growing vegetation to protect soil erosion. <ul style="list-style-type: none"> <li>▪ Guideline on Top Soil Conservation and Reuse is given in <b>Annex-9.1</b></li> <li>▪ Hot-mix plants, batching plants, construction camps shall be located at least 500m away from habitation and 1000 m away from forest area</li> <li>▪ Land for temporary facilities like construction camp, storage areas etc. shall be brought back to its original land use</li> <li>▪ Detailed site selection criteria for Construction Camp given in <b>Annex-9.2</b> should be followed.</li> <li>▪ Details of sites identified for Construction Camp should be reported to the Sr. Environmental Specialist of AE for approval in the format as given in Annex-9.2 and format for setting up Construction Camp is given in Annex-9.2</li> </ul>	Annex-9.2 Guidelines for Siting and Layout of Construction Camp	storage areas, hot-mix plant, batching plant etc.	Top soil storage area  PT: Zero complaints or disputes registered against contractor by land owner	the Contractor		
3.2 Slope failure and Soil erosion due to Construction activities, earthwork, and cut and fill, stockpiles etc.	<ul style="list-style-type: none"> <li>▪ Bio-turfing of embankments to protect slopes.</li> <li>▪ Slope protection by providing frames, dry stone pitching, masonry retaining walls, planting of grass and trees.</li> <li>▪ Side slopes of all cut and fill areas will be graded and covered with stone pitching / Coir Geo-Textile, grass (Vetiver grass). Care should be taken that the slope gradient shall not be greater than 2:1.</li> <li>▪ The earth stock piles to be provided</li> </ul>	IRC: 56 -1974 recommended practice for treatment of embankment slopes for erosion control Clause No. 306 and 305.2.2 MORT&H	Entire stretch of proposed expressway	MI: Occurrence of slope failure or erosion issues  PT: No slope failures. Minimal erosion issues	Review of design documents and site observation	Contractor	NHAI / AE



Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	with gentle slopes to soil erosion						
3.3 Borrow Area Management	<ul style="list-style-type: none"> <li>▪ Obtain EC from SEIAA before opening any new borrow area.</li> <li>▪ Comply to EC conditions</li> <li>▪ Non-productive, barren lands, upland shall be used for borrowing earth with the necessary permissions /consents.</li> <li>▪ Follow IRC recommended practice for borrow area (IRC:SP:108:2015) for identification of location, its operation and rehabilitation</li> <li>▪ Borrow areas not to be dug continuously.</li> <li>▪ To the extent borrow areas shall be sited away from habitated areas.</li> <li>▪ Depths of borrow pits to be regulated and sides not steeper than 25%.</li> <li>▪ Topsoil to be stockpiled and protected for use at the rehabilitation stage.</li> <li>▪ At least 10% of the acquired area shall be kept for stockpiling of fertile topsoil. The piles shall be covered with gunny bags / tarpaulin.</li> <li>▪ Slope of stockpile shall not exceed 1:2 (V:H) and edge of pile shall be protected by silt fencing</li> <li>▪ Transportation of earth materials through covered vehicles.</li> <li>▪ Borrow areas shall be leveled with salvaged material or other filling materials which do not pose contamination of soil. Else, it shall</li> </ul>	<p>IRC Guidelines on Borrow Areas; Environmental Protection Act and Rules,1986; Water Act 1974; Air Act 1981</p> <p>Annex-9.3 Guidelines on Siting, Operation and Re-development of Borrow Area</p>	Borrow sites location	<p><b>MI:</b> Existence of borrow areas in inappropriate unauthorized locations. Poor borrow area management practices. Number of accidents. Complaints from local people.</p> <p><b>PT:</b> No case of non-compliance to conditions stipulated by SEIAA in clearance letter. Zero accidents. Zero complaints.</p>	<p>Review of design documents and site observations</p> <p>Compare site conditions with EC conditions by SEIAA</p>	Design Consultant and Contractor	NHAI / AE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	be converted into fish pond. ▪ Detailed site selection criteria, operation of borrow area and redevelopment plan given in <b>Annex-9.3</b> . ▪ Details of identified sites should be reported to the Sr. Environmental Specialist of AE for approval in the <b>Format</b> given in <b>Annex-9.3</b> and reporting format for establishment of borrow area given in Annex-9.3						
3.4 Quarry Operations	▪ Aggregates will be sourced from existing licensed quarries. ▪ Copies of consent / approval / rehabilitation plan for a new quarry or use of existing source will be submitted to AE & PIU. ▪ The contractor will develop a Quarry Redevelopment plan, as per the Mining Rules of the State and submit a copy of the approval to EA. ▪ Obtain environmental clearance from SEIAA in case of opening new quarry ▪ Quarrying shall be done only after obtaining proper permit or license from the Department of Mining and quarrying operation shall comply with the requirements of the Maharashtra Pollution Control Board. ▪ Detailed site selection criteria, operation of quarry area and redevelopment plan given in <b>Annex-9.4</b> .	IRC Guidelines on Quarry Areas; Environmental Protection Act and Rules,1986; Water Act 1974; Air Act 1981 Annex-8.5 Guidelines on Siting, Operation and Re-development of Quarry Area	Quarry area locations	<u>MI</u> : Existence of licenses for all quarry areas from which materials are being sourced  Existence of a Quarry Redevelopment Plan  <u>PT</u> : Quarry license is valid; No case of non-compliance to consent /permit conditions and \ Air quality meets the prescribed limit	Review of design documents, contractor documents and site observation; Compliance to EC conditions in case of opening new quarries	Contractor	NHAI / AE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	<ul style="list-style-type: none"> <li>Details of identified sites should be reported to the Sr. Environmental Specialist of AE for approval in the <b>Format</b> given in <b>Annex-9.4</b></li> </ul>						
3.5 Compaction of soil and impact on quarry haul roads due to movement of vehicles and equipment	<ul style="list-style-type: none"> <li>Construction vehicles, machinery, and equipment to be stationed in the designated ROW to avoid compaction.</li> <li>Approach roads / haulage roads shall be designed along the barren and hard soil area to reduce the compaction.</li> <li>Transportation of quarry material to the dumping site through heavy vehicles shall be done through existing major roads to the extent possible to restrict wear and tear to the village /minor roads.</li> <li>Land taken for construction camp and other temporary facility shall be restored to its original conditions</li> </ul>	Design requirement	Parking areas, Haulage roads and construction yards.	<p><u>MI</u>: Location of approach and haulage roads; Presence of destroyed / compacted agricultural land or land which has not be restored to its original Condition</p> <p><u>PT</u>: Zero occurrence of destroyed / compacted land and undestroyed land</p>	Site observation	Contractor	NHAI / AE
3.6 Contamination of soil due to leakage / spillage of oil, bituminous and non-bituminous debris generated from demolition and road construction	<ul style="list-style-type: none"> <li>Construction vehicles and equipment will be maintained and refueled in such a fashion that oil / diesel spillage does not contaminate the soil.</li> <li>Fuel storage and refueling sites to be kept away from drainage channels.</li> <li>To avoid soil contamination <b>Oil-Interceptors</b> shall be provided at wash down and refueling areas.</li> <li>Waste oil and oil soaked cotton / cloth shall be stored in containers</li> </ul>	Design requirement	Fuelling station, construction sites, and construction camps and disposal location.	<p><u>MI</u>: Quality of soil near storage area Presence of spilled oil or bitumen in project area</p> <p><u>PT</u>: Soil test conforming to no – contamination;</p> <p>No sighting of spilled oil or bitumen in construction site or camp site</p>	Site observation	Contractor	NHAI / AE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	labeled 'Waste Oil' and 'Hazardous' sold off to MPCB authorized vendors <ul style="list-style-type: none"> <li>Non-bituminous wastes to be dumped in borrow pits with the concurrence of landowner and covered with a layer of topsoil conserved from opening the pit.</li> </ul>						
3.7 Utilization of Fly Ash in construction of expressway and chances of ground water contamination	<ul style="list-style-type: none"> <li>Use of fly ash in road embankment has been designed as per IRC:SP:58-2001</li> <li>Fly ash samples have been collected from two sources namely Nani Naroli (GIPCL, Surat) and Ukai (GETPC, Ukai). Fly ash sample from Nani Naroli exhibits a CBR of 175% and the other one from Ukai exhibits a CBR of 5 %. Tests were repeated to confirm the high CBR from Nani Naroli, which may be due to its chemical composition. Owing to the good CBR and reasonably low dry density and specific gravity, the fly ash can be considered as good embankment material.</li> <li>Fly ash shall be transported to the site in covered dumper</li> <li>The leaching problem can be minimised by controlling the amount of water, which infiltrates into fly ash embankment</li> <li>Sides and top of the embankment will be protected using less permeable good earth. This will prevent the seepage the water from the pavement to the embankment.</li> <li>Surface of the stockpile will be</li> </ul>	MoEF&CC Notification S.O. 763 (E), 1999; S.O. 979 (E), 2003; S.O. 2804 (E), 2009; S.O. 254 (E) 2016;  IRC:SP:58-2001	As per design	MI: Checking the fulfillment of requirement as per IRC:SP: 58-2001  PT: Regular checking of ground compacting, handling & transportation of fly ash, spreading & compaction process	Site observation	Contractor	NHAI / AE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	covered with tarpaulins ▪ Monitoring Format for utilization of Fly Ash during construction of the expressway is given in <b>Annex-9.5</b> . it should be submitted to AE on monthly basis						
<b>4. Water Resources</b>							
4.1 Sourcing of water during construction	<ul style="list-style-type: none"> <li>▪ Requisite permission shall be obtained for abstraction of groundwater from Central Ground Water Authority and State Ground Water Board</li> <li>▪ Where surface water sources are to be tapped, arrangements shall be made by contractor that the water availability and supply to nearby communities remain unaffected.</li> <li>▪ The possible sources could be abandoned quarry filled with rainwater, river, tanks or wells, specially created tanks nearby perennial rivers subject to approval of village &amp; local administration.</li> <li>▪ Water intensive activities not to be undertaken during summer season.</li> </ul>	CGWA Guidelines	Entire stretch of proposed expressway	<u>MI</u> : Approval from competent authority; Complaints from local people on water availability  <u>PT</u> : Valid approval from Competent Authority. Zero complaints from local people.	Checking of documentation; Talk to local people	Contractor	NHAI / AE
4.2 Disposal of water during construction	<ul style="list-style-type: none"> <li>▪ Provisions shall be made to connect drains with existing nearby natural drains.</li> </ul>	Design requirement	Entire stretch of proposed expressway	<u>MI</u> : Condition of drainage system in construction site; Presence / absence of water logging in project area.  <u>PT</u> : Existence of proper drainage system. No water	Standards methods; Site observation and review of documents	Contractor	NHAI / AE



Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
				logging in project area			
4.3 Alteration in Surface Water Hydrology	<ul style="list-style-type: none"> <li>▪ Provision of adequate no. of cross drainage structures.</li> <li>▪ 8 nos. of major bridges, 29 nos. of minor bridges and 133 nos. of culverts have been proposed</li> <li>▪ All CD structures designed for 50year HFL return period and bridges designed for 100 year HFL return period</li> <li>▪ Construction of cross drainage structures shall be undertaken during lean flow period.</li> </ul>	Design requirement,	Near all drainage channels, River / Nallah crossings etc.	<p><u>MI</u>: Proper flow of water in Rivers, Streams and Nallah</p> <p><u>PT</u>: No complain of water shortage by downstream communities. No record of overtopping / water logging</p>	<p>Review of design documents</p> <p>Site observation</p>	Contractor	NHAI / AE
4.4 Siltation in Water Bodies due to construction activities / earthwork	<ul style="list-style-type: none"> <li>▪ Embankment slopes to be modified suitably to restrict the soil, debris entering water bodies.</li> <li>▪ Silt fencing shall be provided along water bodies within the direct impact zone intercepting expressway to prevent siltation in water bodies.</li> <li>▪ Sediment / silt should be collected and stockpiled for possible reuse as surfacing of slopes where they have to be re-vegetated.</li> <li>▪ Earthworks and stone works to be prevented from impeding natural flow of rivers, streams and water canals or existing drainage system.</li> <li>▪ <b>Guideline for Sediment Control</b> is given in <b>Annex-9.6</b></li> </ul>	Design requirement; Worldwide Best Practices; Annex-9.5 Guideline for Sediment Control	Near all water bodies/ waterway	<p><u>MI</u>: Presence/absence of siltation in rivers, streams, nallah, ponds and other water bodies in project area; water quality monitoring</p> <p><u>PT</u>: No records of siltation due to project activities. Surface water quality tests confirm to turbidity and TSS limit</p>	Field observation	Contractor	NHAI / AE
4.5 Deterioration in Surface water	<ul style="list-style-type: none"> <li>▪ No vehicles or equipment should be parked or refueled near water-</li> </ul>	The Water (Prevention and	Water bodies; refueling stations;	<u>MI</u> : Water quality of river, stream,	Water quality tests as per the	Contractor	NHAI / AE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
quality due to leakage from vehicles and equipment and waste from construction camps.	<p>bodies, so as to avoid contamination from fuel and lubricants.</p> <ul style="list-style-type: none"> <li>▪ Oil and grease traps and fuelling platforms to be provided at re-fuelling locations.</li> <li>▪ All chemicals and oil shall be stored away from water and concreted platform with catchment pit for spills collection.</li> <li>▪ All equipment operators, drivers, and warehouse personnel will be trained in immediate response for spill containment and eventual clean-up. Readily available, simple to understand and preferably written in the local language emergency response procedure, including reporting, will be provided by the contractors</li> <li>▪ Construction camp to be sited away from water bodies.</li> <li>▪ Solid wastes must be collected, stored and taken to identified disposal site only.</li> <li>▪ Packaged Wastewater Treatment Plant is to be installed in the Construction Camp. <b>Guideline for Wastewater Treatment in Construction Camp</b> is given in <b>Annex-9.7</b></li> <li>▪ Water quality shall be monitored</li> </ul>	Control of Pollution) Act, 1974 and amendments thereof; Annex-9.6 Guideline for Wastewater Treatment in Construction Camp	construction camps.	<p>ponds and other water bodies in project area; Presence of oil floating in water bodies in project area</p> <p><u>PT</u>: Surface water quality meets water quality standards (IS:2296)</p>	Environmental Monitoring Plan Field observation		

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
<b>5. Flora and Fauna</b>							
5.1 Vegetation loss due to site preparation and construction activities	<ul style="list-style-type: none"> <li>▪ Vegetation clearing shall be done within PROW; it will be ensured that trees falling outside PROW will not be felled. Efforts will be made to save trees outside formation width standing on edge of the PROW</li> <li>▪ Compensatory afforestation as per recommendations of competent authority</li> <li>▪ <b>90,899 trees</b> shall be planted on both sides of the expressway and <b>49,408 hedges</b> shall be planted in the median of the expressway</li> <li>▪ Additional plantation near sensitive receptors, river banks to minimize noise &amp; air pollution and to check erosion.</li> <li>▪ Saplings of horticultural trees may be distributed to farmers in affected villages and nearby schools freely as part of Corporate Environmental Responsibility (CER) to compensate the loss of horticultural trees in the area</li> <li>▪ Development of herbal garden and it's maintenance for 3 years</li> <li>▪ Local villagers to be employed for plantation activities and development of herbal garden.</li> <li>▪ Regular maintenance of all trees planted / herbal garden</li> <li>▪ Provision of LPG in construction camp as fuel source to avoid tree cutting.</li> </ul>	Forest Conservation Act 1980;  IRCSP:21-2009	Entire stretch of proposed expressway except major and minor bridge locations;  Additional Plantation near Sensitive receptors, river banks, borrow areas, quarry area etc.  Location of herbal garden as identified by the Forest Department	MI: ROW width; Number of trees for felling; Compensatory afforestation plan and number of trees replanted. Development of nursery for herbal garden  PT: Additional compensatory afforestation done by contractor; Number of trees planted; Tree survival rate should be 90%; Survival rate of species in herbal garden should be 90%.	Review of relevant documents; Tree cutting permission; Compensatory afforestation plan; Meeting with villagers & Forest Officials; Field Observations	Contractor & Forest Department	NHAI / AE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	<ul style="list-style-type: none"> <li>Controlled use of pesticides / fertilizers</li> </ul>						
<b>6. Construction Camp</b>							
6.1 Impact associated with location	<ul style="list-style-type: none"> <li>All camps should be established with prior permission from MPCB. Camps to maintain minimum distance from following:                             <ul style="list-style-type: none"> <li># 500 m from habitation,</li> <li># 1000 m from forest areas,</li> <li># 500 m from water bodies,</li> </ul> </li> </ul>	Design Requirement The Water (Prevention and Control of Pollution) Act, 1974 and its amendments thereof Annex-9.2 Guidelines for Siting and Layout of Construction Camp	All construction camps	<p><u>MI</u>: Location of camp sites and distance from habitation, forest areas and water bodies</p> <p><u>PT</u>: Distance of camp site is less than 500m from listed locations</p>	<p>On site observation</p> <p>Interaction with workers and local community</p>	Contractor	NHAI / AE
6.2 Worker's Health in construction camp	<ul style="list-style-type: none"> <li>The location, layout and basic facility provision of each camp will be submitted to AE and approved by the Sr. Env. Specialist of AE.</li> <li>The contractor will maintain necessary living accommodation and ancillary facilities in functional and hygienic manner.</li> <li>Adequate water supply and Packaged Wastewater Treatment Plant shall be provided.</li> <li>Contractor to provide a full-fledged dispensary. The number of beds shall be as per the requirement of the labour license</li> <li>Contractor to conduct workshop on HIV / AIDS for all his laborers at all his camps at least once in a quarter</li> <li>Contractor shall conduct monthly health check-ups of all his laborers in his camps through registered medical</li> </ul>	<p>The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 and</p> <p>The Contract Labour (Regulation &amp; Abolition) Act, 1970</p> <p>The Water (Prevention and Control of Pollution) Act, 1974 and amendments thereof</p> <p>Provision of ISO:14001:2004</p>	All construction camps	<p><u>MI</u>: Camp health records. Existence of proper first aid kit in camp site. Complaints from workers.</p> <p><u>PT</u>: No record of illness due to unhygienic conditions or vectors. Zero cases of STD. Clean and tidy camp site conditions.</p>	<p>Camp records</p> <p>Site observation</p> <p>Consultation with contractor workers and local people living nearby</p>	Contractor	NHAI / AE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	practitioner <ul style="list-style-type: none"> <li>▪ Waste disposal facilities such as dust bins must be provided in the camps and regular disposal of waste must be carried out.</li> <li>▪ The Contractor will take all precautions to protect the workers from insect and pest to reduce the risk to health. This includes the use of insecticides which should comply with local regulations.</li> </ul>						
<b>7. Management of Construction Waste / Debris</b>							
7.1 Selection of Debris Disposal Sites	<ul style="list-style-type: none"> <li>▪ Unproductive / wastelands shall be selected for dumping sites away from residential areas and water bodies</li> <li>▪ Dumping sites must be having adequate capacity equal to the amount of debris generated.</li> <li>▪ Public perception and consent from the village Panchayats has to be obtained before finalizing the location.</li> <li>▪ Guideline for Siting and Management of Debris Disposal Site is given in <b>Annex-9.8</b></li> <li>▪ Details of identified debris disposal site should be reported to the AE for approval in the Format given in <b>Annex-9.8</b></li> </ul>	Design Requirement; Annex-9.7: Guideline for Siting and Management of Debris Disposal Site,	At all Dumping Sites	<u>MI</u> : Location of dumping sites Number of public complaints.  <u>PT</u> : No public complaints. Consent letters for all dumping sites available with contractor	Field survey and interaction with local people.  Review of consent letter	Contractor	NHAI / AE
7.2 Reuse and disposal of construction and dismantled waste	<ul style="list-style-type: none"> <li>▪ All excavated materials will be used for backfilling of embankments</li> <li>▪ Unusable materials should be suitably disposed-off with approval of</li> </ul>	Design Requirement; Annex-9.8: Guideline for Preparing	Entire stretch of proposed expressway	<u>MI</u> : Percentage of reuse of existing surface material; Method and location	Contractor records  Field	Contractor	NHAI / AE



Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	the concerned authority. ▪ Guideline for Preparing Comprehensive Waste Management Plan is given in <b>Annex-9.9</b>	Comprehensive Waste Management Plan		of disposal site of construction debris  <u>PT</u> : No public complaint and consent letters for all dumping sites available with contractor or AE	observation  Interaction with local people		
<b>8. Traffic Management and Safety</b>							
8.1 Management of existing traffic and safety	<ul style="list-style-type: none"> <li>▪ Temporary traffic diversion shall be planned by the contractor and approved by the 'Engineer'.</li> <li>▪ The traffic control plans shall contain details of diversions; traffic safety arrangements during construction; safety measures for night time traffic and precautions for transportation of hazardous materials. Traffic control plans shall be prepared in line with requirements of IRC's SP 55 document'.</li> <li>▪ The Contractor will ensure that the diversion / detour are always maintained in running condition, particularly during the monsoon to avoid disruption to traffic flow.</li> <li>▪ On stretches where it is not possible to pass the traffic on the part width of existing carriageway, temporary paved diversions will be constructed.</li> <li>▪ Restriction of construction activity to only one side of the existing road.</li> <li>▪ The contractor shall inform local community of changes to traffic</li> </ul>	Design requirement and IRC: SP: 27 -1984;  IRC:SP: 32 -1988 Road Safety for Children (5-12 Years Old);  IRC:SP: 44 -1994 Highway Safety Code document'.  IRC: SP: 55 -2001; Guidelines for Safety in Construction Zones;  IRC:53:2012 Road Accident recording  The Building and other Construction workers Act 1996 and Factories Act 1948  Annex-9.9 Guideline for Preparing of Traffic Management Plan	Entire stretch of proposed expressway specially at location of Interchanges, Flyovers, Vehicular Underpasses, Vehicular Overpasses	<u>MI</u> : Traffic Management Plan. Presence/ absence of safety signs, clear traffic demarcations, flag men etc. on site. Complaints from road users. Number of traffic accidents  <u>PT</u> : No complaints. No accidents due to poor traffic management. Traffic signs, demarcation lines etc. present in appropriate locations on site	Review Traffic Management Plan;  Field observation of traffic management and safety system  Interaction with people in vehicles using the road	Contractor	NHAI / AE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	routes, and pedestrian access arrangements with assistance from "Engineer". <ul style="list-style-type: none"> <li>▪ Use of adequate signage to ensure traffic management and safety. Conduct of regular safety audit on safety measures.</li> <li>▪ Guideline for Preparing of Traffic Management Plan is given in <b>Annex-9.10</b></li> </ul>						
8.2 Pedestrians, animal movement	<ul style="list-style-type: none"> <li>▪ Temporary access and diversion, with proper drainage facilities.</li> <li>▪ Access to the educational institutions, religious places and other public places must be maintained when construction takes place near them.</li> <li>▪ All structures having vertical clearance above 3m and not catering to perennial flow of water may serve as underpass for animals</li> </ul>	Same as Point No. 8.1	Near habitation area, Construction Sites, Haulage roads and diversion sites.	MI: Presence/ absence of access routes for pedestrians. Road signage. Number of complaints from local people  PT: Easy access to schools, temples and public places. Zero complaints	Field observation Interaction with local people	Contractor	NHAI / AE
8.3 Safety of Workers and accident risk from construction activities	<ul style="list-style-type: none"> <li>▪ Contractors to adopt and maintain safe working practices.</li> <li>▪ Usage of fluorescent and retro refractory signage, in local language at the construction sites</li> <li>▪ Training to workers on safety procedures and precautions.</li> <li>▪ Mandatory appointment of Safety Officer.</li> <li>▪ All regulations regarding safe scaffolding, ladders, working platforms, gangway, stairwells,</li> </ul>	Same as Point No. 8.1  Annex-9.10 Guideline to Ensure Worker's Safety during Construction  Annex-9.11 Guidelines for Storage, Handling, Use and Emergency Response for Hazardous Substances	Construction sites	MI: Availability of Safety gears to workers  Safety signage Training records on safety  Number of safety related accidents  PT: Zero fatal accidents. Zero or minor non-fatal	Site observation  Review records on safety training and accidents  Interact with construction workers	Contractor	NHAI / AE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	excavations, trenches and safe means of entry and egress shall be complied with. <ul style="list-style-type: none"> <li>▪ Provision of PPEs to workers.</li> <li>▪ Provision of a readily available first aid unit including an adequate supply of dressing materials.</li> <li>▪ The contractor will not employ any person below the age of 18 years</li> <li>▪ Use of hazardous material should be minimized and/or restricted.</li> <li>▪ Emergency plan (to be approved by engineer) shall be prepared to respond to any accidents or</li> <li>▪ Accident Prevention Officer must be appointed by the contractor.</li> <li>▪ Other provisions to ensure Worker's Safety during Construction should be followed as per <b>Annex-9.11</b>.</li> <li>▪ A guideline for Storage, Handling, Use and Emergency Response for Hazardous Substances is given in <b>Annex-9.12</b>.</li> <li>▪ The Safety Checklist given in <b>Annex-9.10</b> should be submitted to AE on monthly basis</li> <li>▪ Reporting format for road safety measures during Construction given in <b>Annex-9.11</b> should be submitted to AE before start of construction.</li> <li>▪ On occurrence of any accident or injury, the safety officer should submit an accident report to the AE as per the format given in IRC:53-2012 "Road Accident Reporting"</li> </ul>	Provision of ISO:14001:2004		accidents.			

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
8.4 Accident risk to local community	<ul style="list-style-type: none"> <li>▪ Restrict access to construction sites only to authorized personnel.</li> <li>▪ Physical separation must be provided for movement of vehicular and human traffic.</li> <li>▪ Adequate signage must be provided for safe traffic movement</li> <li>▪ Provision of temporary diversions and awareness to locals before opening new construction fronts.</li> </ul>	Same as Point No. 8.1	Construction sites	<p><u>MI</u>: Safety signs and their location; Incidents of accidents; Complaints from local people</p> <p><u>PT</u>: Zero incident of accidents. Zero complaints.</p>	Site inspection  Consultation with local people	Contractor	NHAI / AE
<b>9. Site Restoration and Rehabilitation</b>							
9.1 Clean-up Operations, Restoration and Rehabilitation	<ul style="list-style-type: none"> <li>• Contractor will prepare site restoration plans, which will be approved by the 'Engineer'.</li> <li>• The clean-up and restoration operations are to be implemented by the contractor prior to demobilization.</li> <li>• All construction zones including river-beds, culverts, road-side areas, camps, hot mix plant sites, crushers, batching plant sites and any other area used / affected by the project will be left clean and tidy to the satisfaction of the Sr. Environmental Specialist of AE</li> <li>• All the opened borrow areas will be rehabilitated</li> </ul>	Project requirement  Annex-9.2 Annex-9.3 Annex-9.4 Annex-9.8  Provision of ISO:14001:2004	Entire stretch of proposed expressway, construction camp sites and borrow areas	<p><u>MI</u>: Condition of camp sites, construction sites and borrow areas.</p> <p>Presence / absence of construction material / debris after completion of construction works on construction site.</p> <p><u>PT</u>: Clean and tidy sites. No trash or debris left on site. Site restored and leveled.</p>	Site observation  Interaction with locals; Issue completion certificate after restoration of all sites are found satisfactory	Contractor	NHAI / AE
<b>C. OPERATION AND MAINTENANCE STAGE</b>							
<b>1. Air Quality</b>							
2.1 Air pollution due to due to vehicular movement	<ul style="list-style-type: none"> <li>▪ Avenue plantations shall be maintained.</li> <li>▪ Regular maintenance of the expressway will be done to ensure</li> </ul>	Environmental Protection Act, 1986;  The Air (Prevention	Entire stretch of proposed expressway	<p><u>MI</u>: Air quality monitoring as per post project Environmental</p>	As per CPCB requirements	PIU / NABL approved Environmental Monitoring	NHAI

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	good surface condition ▪ Air quality monitoring. If monitored parameters exceeds prescribed limit, suitable control measures must be taken. ▪ Signages shall be provided reminding them to properly maintain their vehicles to economize on fuel consumption. ▪ Enforcement of vehicle emission rules in coordination with transport department or installing emission checking equipment	and Control of Pollution) Act, 1981		Monitoring Program  PT: Levels are equal to or below baseline levels given in the EIA report	Site inspection	Agency	
<b>2. Noise</b>							
2.1 Noise due to movement of traffic	<ul style="list-style-type: none"> <li>• Effective traffic management and good riding conditions shall be maintained</li> <li>• Speed limitation and honking restrictions near sensitive receptors</li> <li>• HORN PROHIBITED sign to be placed near educational institutions and medical facilities</li> <li>• Noise monitoring. If monitored value exceeds prescribed limit, suitable control measures must be taken.</li> <li>• Maintenance of noise barriers</li> <li>• The effectiveness of plantation should be monitored.</li> <li>• Create awareness amongst the residents about likely noise levels from expressway operation at different distances, the safe noise limits and easy to implement noise reduction measures while</li> </ul>	Noise Pollution (Regulation & Control) Rules, 2003 and amended in 2010	Sensitive receptors as identified in the EIA Report	MI: Noise monitoring as per post project Environmental Monitoring Program  PT: Levels are equal to or below baseline levels given in the EIA report	Noise monitoring as per noise rules , 2000  Discussion with people at sensitive receptor sites	PIU / NABL approved Environmental Monitoring Agency	NHAI



Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	constructing a building near expressway						
<b>3. Land &amp; Soil</b>							
3.1 Soil erosion at embankment during heavy rainfall.	<ul style="list-style-type: none"> <li>▪ Periodic checking to be carried to assess the effectiveness of the stabilization measures viz. turfing, stone pitching etc.</li> <li>▪ Soil quality monitoring. If monitored parameters exceeds prescribed limit, suitable control measures must be taken.</li> <li>▪ Necessary measures to be followed wherever there are failures</li> </ul>	Project requirement	At bridge locations and embankment slopes and other probable soil erosion areas.  <u>Total length of embankment is 70.617 km</u> Soil quality monitoring from different land use area along the expressway such as agricultural area, residential area and forest areas	<u>MI:</u> Existence of soil erosion sites; Number of soil erosion sites  soil quality monitoring as per post project Environmental Monitoring Program  <u>PT:</u> Zero or minimal occurrences of soil erosion	On site observation  As per CPCB requirements	PIU / NABL approved Environmental Monitoring Agency	NHAI
<b>4. Water Resources / Flooding and Inundation</b>							
4.1 Siltation	<ul style="list-style-type: none"> <li>▪ Regular checks shall be made for soil erosion and turfing conditions for its effective maintenance.</li> </ul>	Project requirement	Near surface Water bodies	<u>MI:</u> Water quality monitoring as per post project Environmental Monitoring Program  <u>PT:</u> No turbidity of surface water bodies due to the road	Site observation	PIU / NABL approved Environmental Monitoring Agency	NHAI
4.2 Water logging due to blockage of drains, culverts or streams	<ul style="list-style-type: none"> <li>▪ Regular visual checks and cleaning of drains shall be done along the alignment to ensure that flow of water is maintained through cross drains</li> </ul>	Project requirement	Near surface Water bodies	<u>MI:</u> Presence/ absence of water logging along the road	Site observation	PIU	NHAI

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	and other channels / streams. ▪ Monitoring of water borne diseases due to stagnant water bodies			PT: No record of overtopping/ Water logging			
<b>5. Flora</b>							
5.1 Vegetation	▪ Planted trees, shrubs and grasses to be properly maintained. ▪ The tree survival audit to be conducted at least once in a year to assess the effectiveness	Forest Conservation Act 1980	Avenue Plantation along expressway	MI: Tree survival rate  PT: 90% tree survival rate	Records and field observations.  Information from Forestry Department	Forest Department / PIU	NHAI
<b>6. Maintenance of Right of Way and Safety</b>							
6.1 Accident Risk due to uncontrolled growth of vegetation	▪ Efforts shall be made to make shoulder completely clear of vegetation. ▪ Regular maintenance of plantation along the expressway ▪ No invasive plantation near the expressway	Project requirement	Throughout the expressway	MI: Presence and extent of vegetation growth on either side of expressway. Number of accidents.  PT: No accidents due to vegetation growth	Visual inspection Check accident records	PIU	NHAI
6.2 Accident risks associated with traffic movement.	▪ Traffic control measures, including speed limits, will be forced strictly. ▪ Encroachment of squatters within the ROW will be prevented. ▪ No school or hospital will be allowed to be established beyond the stipulated planning line as per relevant local law ▪ Monitor / ensure that all safety provisions included in design and construction phase are properly	IRC:SP:55	Throughout the expressway	MI: Number of accidents Conditions and existence of safety signs, rumble strips etc. on the road  Presence/absence of sensitive receptor structures inside the stipulated planning line as per relevant	Review accident records  Site observations	PIU	NHAI

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	maintained <ul style="list-style-type: none"> <li>▪ Highway patrol unit (s) for round the clock patrolling. Phone booth for accidental reporting and ambulance services with minimum response time for rescue of any accident victims, if possible.</li> <li>▪ Tow-way facility for the breakdown vehicles</li> </ul>			local law  PT: Fatal and non-fatal accident rate is reduced after improvement			
6.3.Transport of Dangerous Goods	<ul style="list-style-type: none"> <li>▪ Existence of spill prevention and control and emergency responsive system</li> <li>▪ Emergency plan for vehicles carrying hazardous material</li> </ul>	Risk Assessment for the project  Off-Site Disaster Management Plan, Palghar District, Jan 2018	Throughout the expressway	MI: Status of emergency system – whether operational or not  PT: Fully functional emergency system	Review of spill prevention and emergency response plan Spill accident records	PIU	NHAI

IRC: Indian Road Congress, AE: Authority Engineer, NHAI: National Highways Authority of India, MPCB: Maharashtra Pollution Control Board,

### 9.3 GREENBELT DEVELOPMENT PLAN

Green areas not only improve the floral status, land use and the aesthetic look of an area, but also serve the purpose of filtering fugitive dust, help to abate noise effects through dampening and replenish oxygen and ameliorate the surrounding temperature. Median plantation will prevent glare from the headlights of incoming vehicles. Plantation works are site-specific activity and depend on various factors like choice of species, terrain, availability of area (Right of Way), soil type, climatic conditions etc.

#### 9.3.1 Avenue and Median Plantation

**Avenue plantation** has been planned in accordance with IRC-SP-21:2009 (Guidelines on Landscaping and Tree Plantation) and Green Highways Policy 2015. Multiple rows may be planted in staggered pattern. Development of green belt will include:

- Plantation on either side of the expressway in the space available for plantation beyond 1.0 m away from the toe of embankment
- Plantation in the median to enhance the aesthetic look & reduce headlight glare

Based on the space available for avenue plantation, following plantation arrangement has been proposed:

- a) 1<sup>st</sup> row will be 1.0 m away from the toe of embankment with a plant spacing of 3.0 m. Number of trees / km will be 333
- b) 2<sup>nd</sup> row will be 5.0 m away from 1<sup>st</sup> row with a plant spacing of 6.0 m. Number of trees / km will be 167
- c) 3<sup>rd</sup> row will be 5.0 m away from 2<sup>nd</sup> row with a plant spacing of 8.0 m. Number of trees / km will be 125

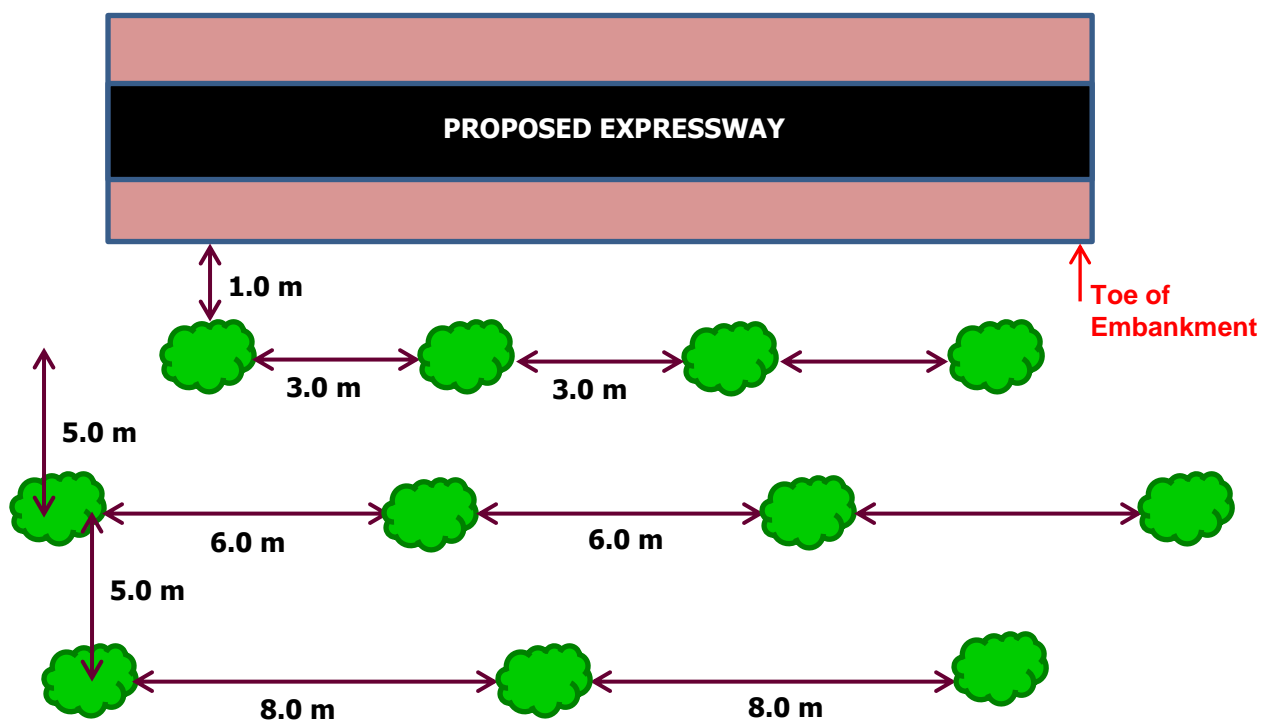


Figure 9-1 Pattern of Plantation (Number of Plants / row and row to row distance)

**Median Plantation:** Two rows of hedge / small ornamental trees with plant to plant spacing of 3.0 m have been proposed. Number of hedges will be of 666 per km.

Based on the above mentioned Guidelines and space available in different typical cross sections, number of trees and hedges to be planted has been calculated and presented in **Table 9-2** and **Table 9-3** respectively and greenbelt development plan has been shown in **Figure-9.2**. Avenue and median plantation has not been proposed in bridge section (3.563 km stretch) and toll plaza area (0.370 km stretch).

**Table 9-2 Typical Cross Section wise Number of Trees to be planted**

TCS Type	1st Row	2nd Row	3rd Row	1st Row	2nd Row	3rd Row	Trees/ Km	Length (Km)	Total Trees to be Planted
	Left Side			Right Side					
1	333	167	125	333	167	125	1,250	68.500	85,625
2	333	167	125	333	0	0	958	2.390	2,290
3	333	0	0	333	167	125	958	2.705	2,591
4	333	0	0	333	0	0	666	0.590	393
<b>Total</b>								<b>74.185</b>	<b>90,899</b>

**Table 9-3 Typical Cross Section wise Number of Hedges to be planted**

TCS Type	No. of Rows	Hedge/km/ row	Total Hedges / km	Length (Km)	Total Hedges to be Planted
1	2	333	666	68.500	45621
2	2	333	666	2.390	1592
3	2	333	666	2.705	1802
4	2	333	666	0.590	393
<b>Total</b>				<b>74.185</b>	<b>49,408</b>

### 9.3.2 Species Suggested for Plantation

Native tree species which are beneficial to avifauna and wildlife are suggested for plantation near forest area (**Table 9-4**) while evergreen, fast-growing ornamental tree and tolerant to air pollution are suggested in the stretches outside the forest area (**Table 9-5**). Plantation will be maintained upto 5 years and protected from cattle and illegal felling. Dead saplings will be replaced to maintain the survival percentage of 90%.

**Table 9-4 Tree Species Suggested for Plantation near Forest Area**

S. No	Species	Value	Visitors*
1.	<i>Tamarindus indica</i>	Nectar, Fruits	I,B,M
2.	<i>Terminalia elliptica</i>	Leaves, Bark , Fruits	I ,M
3.	<i>Butea monosperma</i>	Nectar, Dust & Pollution Control	I,B,M
4.	<i>Ficus microcarpa</i>	Fruit & Pollution Control	I,B,M
5.	<i>Ficus religiosa</i>	Dust & Pollution Control	IBM
6.	<i>Mangifera indica</i>	Nectar, Fruits & Pollution Control	I,B,M
7.	<i>Phoenix sylvestris</i>	Nectar, Fruits	I,B,M
8.	<i>Pongamia pinnata</i>	Nectar, Dust & Pollution Control	I,M
9.	<i>Bauhinia purpurea</i>	Nectar , local use (plates)	I, B,M



S. No	Species	Value	Visitors*
10.	<i>Syzygium cumini</i>	Nectar, Fruits	I,B,M
11.	<i>Ziziphus mauritiana</i>	Fruit	B,M
12.	<i>Madhuca indica</i>	Nectar, Leaves, flowers, fruits	I,M
13.	<i>Bombax ceiba</i>	Nectar,	I, B
14.	<i>Tectona grandis</i>	Leaves, Wood	I,M
15.	<i>Dillenia pentagyna</i>	Nectar, Fruits	I,B, M

\* I – Insects, B – Birds, M – Mammals

**Table 9-5 Tree Species Suggested for Plantation outside Forest Area**

S. No	Scientific name	Common Name	Remark
1	<i>Albizia lebeck</i>	Siris	Fast-growing tree, tolerant to air pollution
2	<i>Polylathia longifolia</i>	Ashok/ Devdar	Evergreen, ornamental, tolerant to air pollution
3	<i>Ficus infectoria</i>	Pilkhan	Evergreen tree with aerial roots, tolerant to air pollution
4	<i>Alstonia scholaris</i>	Saptparni	Evergreen native tree, tolerant to air pollution
5	<i>Azadirachta indica</i>	Neem	Good purifier of air
6	<i>Dalbergia sissoo</i>	Shisham	Used as a windbreak , tolerant to air pollution
7	<i>Cassia siamea</i>	Kasod	Fast growing, high crown, multipurpose tree
8	<i>Lagerstroemia speciosa</i>	Jarul	Evergreen tree, tolerant to air pollution
9	<i>Mimusup elengi</i>	Maulsari/ Bakuli	Evergreen tree, moderately tolerant to air pollution
10	<i>Saraca asoca</i>	Sita Ashok	Evergreen native, ornamental tree
11	<i>Cassia fistula</i>	Amaltas/ Bahava	Ornamental native species
12	<i>Ficus religiosa</i>	Pipal	Native, fast growing, tolerant to air pollution
13	<i>Bauhinia variegata</i>	Kachnar	Tolerant to air pollution
14	<i>Terminalia catappa</i>	Badam	Ornamental plant
15	<i>Pithecellobium dulce</i>	Jungle jalebi	Evergreen, tolerant to pollution

The species to be planted in median shall be of low or medium height with ornamental value to enhance the visual experience of the expressway corridor. It will also act as a screen to prevent glare from the incoming vehicles. The species recommended for median are mainly *Hibiscus rosa sinensis* (Gurhal), *Bougainvillea spectabilis* (Bougainvillea), *Jasminum grandiflorum* (Chameli), *Ixora coccinea* (Ixora), etc.

However, other species suitable and suggested by the Forest Department can be planted.

It is proposed to use the same species on either side of the expressway. This will ensure regularly grown avenues of the same form and type. Such avenues will mature at about the same time giving pleasant avenue appearance. Technical specification of avenue and median plantation is presented in **Table 9-6**.

**Table 9-6 Technical Specifications for Plantation**

Items	Tree	Hedge
No. of Rows	Please refer Table 9-2	Please refer Table 9-3
No. of trees per Km		
Spacing between the plant	First row : 3.0 m Second row : 6.0 m Third row : 8.0 m	3.0 m
Size of Pits	60 x 60 x 60 cm	20 X 20 X 20 cm
Height of Plant	Not less than 1.5 to 2m	Not less than 0.5 m
Age of Plant	Not less than 2 Years	Not less than 1 Year

### 9.3.3 Protection Measures

The fencing of single row plantations shall be done by using iron / brick / cement guards. Locally available bamboo guards or thorn fencing may also be used where protection can be ensured through these. The specifications for the iron guards shall be as per IRC-SP-21, 2009.

The fencing of multiple row plantations will be done preferably by barbed wire. A five strand barbed wire fencing, with cross strands, stretched on angle iron poles fixed at a distance of 4 meter from one another; is recommended. Bamboo fencing / thorn fencing may also be used where protection can be ensured through these. The specifications for barbed wire fencing are as per IRC-SP-21, 2009.

### 9.3.4 Precautionary Measures

- Plantation activity to be carried out in monsoon months
- The height of the plants should not be less than 1.5 m for trees and 0.5 m for and should be in polythene bags and are not to be removed till the time of planting
- All plants supplied must be planted within three days of removal from the nursery
- The contractor will be required to water the area in case of insufficient rains after planting
- 2 kg of compost /manure are suggested for each pit before plantation.
- To ensure better growth and survival of plants, surface should have sufficient layer of good quality soil (up to 45 cm)

### 9.3.5 Maintenance

Maintenance involves plant protection measures, tending operation, irrigation and fertilizer application at regular interval for 5 years. The survival percentage of plantation shall be maintained above 90% after raising the plantation at any stage with normal shape and size. The scope of maintenance shall be as per IRC-SP-21, 2009.

## 9.4 INSTITUTIONAL ARRANGEMENTS

Project Implementation Unit (PIU) of National Highways Authority of India (NHAI) is overall responsible for successful implementation of the project with assistance from the Contractor and Authority Engineer (AE).

Project Director will be heading the overall functioning of the PIU. The PIU will ensure that the statutory requirements are not violated during the pre-construction, construction and operation stages of the project. The Authority's Engineer serves as "Engineer of the Authority" for supervision of the project. Sr. Environmental Specialist of the AE will supervised all forestry and environmental related issues during construction phase of the project. The "Contractors" herein mean the agency hired for execution of the construction works for the project. The contractor will be responsible for actual implementation of the EMP in the field.

The reporting system will start with the Contractor who is the main executor of the implementation activities. The contractor will report to the Sr. Environmental Specialist of AE who in turn shall report to the PIU. The Contractor will submit monthly and quarterly environmental compliance reports to the AE. The AE will submit separate quarterly environmental monitoring reports to PIU in addition to submission of the monthly report in respect of its duties and functions as per the agreement with NHAI. The PIU will be responsible for preparation of the targets for identified non-compliances.

## 9.5 IMPLEMENTATION ARRANGEMENTS

The services of Authority Engineer will be procured to assist the PIU for successful implementation of project during construction and maintenance period. The AE will have a multi-disciplinary team including an environmental management team having intermittent input of a senior level Environmental Specialist supported by middle level full time Environmental Specialists. This team will ensure compliances of mitigation measures and all statutory requirements during implementation of the project.

### 9.5.1 Authority Engineer (AE)

The Environmental Specialist of the AE shall be the key personnel to supervise the implementation of EMP provisions through the Contractor. The EMP prepared for the Project road, needs to be followed during the implementation of the civil works.

#### Qualification and Responsibilities of Senior Environmental Specialist of AE:

##### Qualifications & Experience

- Postgraduate in Environmental Management / Environmental Science / Ecology / Environmental Planning / degree in Civil Engineering with PG / specialisation in environment.
- 15 years of total experience with a minimum of 10 years in the preparation and implementation of EMP of highway projects and an understanding of environmental, health and safety issues.
- Prior practical experience in Highways projects funded by Multilateral Agencies

### Roles & Responsibilities

- Supervise and monitor the implementation of EMP by the Contractor
- Update the PIU on the progress of environmental protection and / or enhancement works as envisaged in the EMP
- Review and approve site-specific environmental mitigation / enhancement designs worked out by the Contractor based on the EMP prepared during project preparation
- Review and recommend the Contractors' Implementation Plans for approval (with any changes that may be necessary) to ensure compliance with the environmental provisions of the Contract
- Supervise the progress of tree plantation and environmental monitoring programs
- Hold meetings with Contractor time to time and provide update to PIU regarding the progress of environmental works
- Finalized and submit Monthly, Quarterly, Semi-annual and Annual Environmental report to PIU
- Develop and organise environmental training programmes to upgrade the skills within the staff of the environmental cell and the Contractor
- Documentation of good practices during project implementation for wider dissemination
- Prepare and submit **Half-yearly Compliance Reports** in respect of the environmental clearance terms and conditions in soft copies to the regulatory authority concerned, on 1<sup>st</sup> June and 1<sup>st</sup> December of each calendar year.

The project will require continuous environmental supervision from the AE's side. Since the **Sr. Environmental Specialist of AE is to be deployed on intermittent basis**, it is required to have **fulltime Jr. Environmental Specialist** to assist the key specialist. Field Engineers supervising the construction works also needs to be trained on environmental aspects, who then shall apprise the Team Leader and the Sr. Environmental Specialist of any significant development on environment.

### Qualification and Responsibilities of Junior Environmental Specialist of AE (Sub Professional):

#### Qualifications & Experience

- Postgraduate in Environmental Management / Environmental Science / Ecology / Environmental Planning / Environmental Engineering
- 7 years of experience with a minimum of 3 years in the preparation and or implementation of EMP of highway projects and an understanding of environmental, health and safety issues
- Prior practical experience in multilateral funded projects in highways sector would be an advantage

### Roles & Responsibilities

- Update the Sr. Environmental Specialist & the Team Leader of AE on the progress of environmental protection and / or enhancement works as envisaged in the EMP
- Regularly supervise and monitor the implementation of EMP by the Contractor
- Verify the extent of environmental compliance of the Contractor regularly
- Monitor tree plantation programs and the periodic Environmental Monitoring Programs to ensure compliance with the statutory requirements and the EMP

- Interact & hold regular meetings with Contractor Environmental Officers in implementation of the EMP
- Prepare Monthly, Quarterly, Semi-annual and Annual Environmental reports and submit to the key specialist for finalization
- Assist the key specialist in documenting good practices during project implementation for wider dissemination
- Regularly monitor the approved site-specific environmental mitigation / enhancement designs based on the EMP prepared

### 9.5.2 Contractor

Execution of works will be the responsibility of the Contractor. The Contractors shall employ a **full time Environmental Officer** whose qualification and responsibilities shall be as stated below:

#### Qualification and Responsibilities of Environmental Officer (EO) of Contractor:

##### Qualifications & Experience

- Postgraduate in Environmental Management / Environmental Science / Zoology / Botany / Ecology / Environmental Planning / Environmental Engineering
- 5 years of experience with a minimum of 2 years in the implementation of EMP of highway projects and an understanding of environmental, health and safety issues
- Prior practical experience in multilateral funded projects in highways sector would be an advantage

##### Roles & Responsibilities

- The Environmental Officer shall report directly to the Resident Construction Manager / Project Manager of the Contractor so that the pertinent environmental issues that he / she raise are promptly dealt with.
- He / she shall also have a direct interaction with the Environmental Specialist of the AE.
- Implement measures laid out in the EMP and or as directed by the AE for the work executed both by petty contractors and the contractor.
- Implement tree plantation programs and conduct periodic Environmental Monitoring Programs to ensure compliance with the statutory requirements and the EMP
- Provide key inputs in the development of the Contractors' implementation plan for all construction activities, including haulage of material to site, adhering to the requirements of the EMP and getting approval of the AE on the same before start of works.
- Ensure that the regulatory permissions required for the construction equipment, vehicles and machinery (given in the EIA Report) have been obtained and are valid at all times during the execution of the project.
- Prepare / fill up the environmental and safety related compliances as per daily, weekly, fortnightly, monthly, quarterly, semi-annual checklists in the EMP
- Prepare Safety Plans, Debris & Waste disposal Plan, Emergency Response Plans and Quarry Management and other safety, health and environment related Plans for approval of the IE.
- Identify locations for siting construction camps and other plants, machinery, vehicles



and equipment, as well as locations for storage and disposal of wastes, both from the construction camps and from the site and obtain approval for the same from the AE.

- Detail out site-specific environmental mitigation and enhancement measures and obtain approval of the AE for the same
- Carry out the measurements of environmental mitigation and / or enhancement works and prepares bills for the same for approval and payment through the AE.
- Ensure that the safety of the workers and other site users is not compromised during construction
- Ensure that adequate monitoring facilities are available for collecting samples of all discharges from the Contractor's plants, equipment and camps
- Verify the extent of environmental compliance at sites from where the Contractor is procuring the material – Borrow Area, Quarries, Crushers or even sand and suggest appropriate mitigation measures, if required

#### **Penalty Clause:**

- For not employing a full time Environmental Officer (EO), the contractor shall be levied a **fine of Rs. 2,000/ every day** from his invoice
- The EO shall be approved by the NHAI
- In case of non-notified absence of the EO (absence to be notified to the authority in writing) for more than 15 days from site, a fine of Rs. 2,000 per day to be levied on the contractor. Eligibility of leave due to the EO shall be as per standard guidelines of the organization.

The environmental officer shall have an environmental, health and safety team to help him in implementing the EMP. These team members may / may not report to him / her directly but shall apprise him of all the incidents and mark a formal report of any incident having an impact on the Health, Environment and Safety issues.

- **Safety Officer (SO):** The safety officer shall on day to day basis interact and assist the EO in implementation of the safety features mentioned in the EMP. He shall also assist the EO in the preparation & submission of safety plans.
- **First Aider / Medical Officer (MO):** The first aider / medical officer shall interact and assist the EO in implementation of the health features mentioned in the EMP
- **Duty Officers (DO) /Supervisors:** The Duty Officers shall on day to day basis, take the necessary mitigation measures as per the directions of the EO, SO & MO and monitor the project facilities and report to the EO on activities that adversely affect the environment in the vicinity.
- **Plant Engineer:** The Plant Engineer has the responsibility of managing and controlling the hot mix plant, crusher unit and fleet of vehicles. He shall ensure that the environment is not degraded at his plant site. Even though the EO shall routinely monitor to detect any negative issues due to operations and bring it to the knowledge of Plant Engineer for taking rectification works. In case of emergency the Plant Engineer shall immediately notify the EO for necessary actions.

## 9.6 INSTITUTIONAL CAPACITY BUILDING

It is important to orient contractor's supervisory staff as well as key field staff towards environmental issues of highway project, implementation of mitigation measures, green construction technology etc. for successful implementation of the EMP. Project Implementation Unit and Authority Engineer are also responsible for the implementation of the EMP, need to be trained. To ensure the success of the proposed implementation set up, there is need for training and skill up-gradation. Hence, considering the requirement, the following training program is suggested.

### 9.6.1 Training Components

The environmental training should encompass the following:

- Understanding of the relevant environmental regulations and their application to the project;
- Environmental & Social Issues in Highway Projects
- Road Safety and Road Safety Audit for Highways
- Mainstreaming Biodiversity in Road Transportation Projects for Promoting Smart Green Infrastructure
- Eco friendly measures to mitigate impacts of linear infrastructure on wildlife
- Mitigation measures of noise generated from construction equipment
- Environmental Monitoring during Construction stage and Operation stage
- Green Highways & Green Infrastructure
- ISO 14001:2004 Environmental Management System

### 9.6.2 Training Program

A training program needs to be worked out incorporating the project needs as well as the intermediate-term capacity building needs of the PIU, AE and Contractor. The program should consist of a number of training modules specific to target groups. The training would cover the basic principles and postulates of environmental assessment, mitigation plans and program implementation techniques, monitoring and management methods and tools. Given below is a list of Training Institutes (**Table 9-7**) which can be contacted for providing training in various issues related to environmental management as identified in Section-9.6.1.

**Table 9-7 List of Training Institutes**

Sl. No.	Name of Training Institute
1.	<p><b>Wildlife Institute of India (WII)</b>                      Post Box # 18, Chandrabani, Dehadun 248 001 Uttarakhand                      Email: <a href="mailto:dwii@wii.gov.in">dwii@wii.gov.in</a>                      Phone: 0135-2640910, 0135-2640114, 0135 2646102                      Fax: 0135-2640117</p>
2.	<p><b>Central Road Research Institute (CRRI)</b>                      P.O. CRRI, Delhi-Mathura Institute, New Delhi – 110 025                      Shri. T. K. Amla, Chief Scientist, Head &amp; Course Organizer                      Phone: 011 26921939                      Email: <a href="mailto:tkamla.crri@nic.in">tkamla.crri@nic.in</a></p>

Sl. No.	Name of Training Institute
3.	<b>Indian Academy of Highway Engineers (IAHE)</b> (Ministry of Road Transport & Highways, Govt. of India) A-5, Institutional Area, Sector-62, NH-24 Bypass, NOIDA-201301 (UP) Telephone: 0120-2400085 - 86, 2405006 - 09, Course Coordinator: Shri. M. Riten Kumar Singh(Joint Director) Email: <a href="mailto:iahe.training@gmail.com">iahe.training@gmail.com</a>
4.	<b>National Environmental Engineering Research Institute (NEERI)</b> Nehru Marg, Nagpur – 440020, Maharashtra Phone: 0712 2249885-88; 2249970-72 URL: <a href="http://www.neeri.res.in">http://www.neeri.res.in</a>
5.	<b>Environment Protection Training and Research Institute (EPTRI)</b> 91/4, Gachibowli, Hyderabad – 500 032, Telangana Phone: +91-40-23180100; Fax: +91-40-23180135 Email: <a href="mailto:enquiry@eptri.com">enquiry@eptri.com</a> <a href="mailto:eptrihrd@gmail.com">eptrihrd@gmail.com</a> URL: <a href="http://www.eptri.com">www.eptri.com</a>
6.	<b>Enviro-tech Instruments Pvt. Ltd.</b> Manufacturers of Air Pollution Monitoring Instruments A-271,Okhla Industrial Area, Phase-1, New Delhi-110020 Phones: 011 26813887, 26814139 Fax: 011 26811833 Email: <a href="mailto:envirotech@vsnl.com">envirotech@vsnl.com</a>

## 9.7 ENVIRONMENTAL BUDGET

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

- Environmental Management Plan Works to be implemented by the Contractor under civil works contracts
- Cost of Compensatory Afforestation (CA ) and Net Present Value (NPV) to be paid by the NHAI as statutory fee

A capital cost provision of about **Rs. 66.42 Crore** has been kept towards implementation of environmental management plan. Summary of environmental budget is presented in **Table 9-8**.

### A. Green Belt Development Budget

Component	Stage	Item	Length (Km)	Unit	Quantity	Unit Cost# (Rs.)	Total Cost (Rs.)
Avenue Plantation	Construction	Typical Cross Section wise Number of Trees to be planted as detailed in <b>Table 9-2</b> & its maintenance for 5 years	74.185	No.	90,899	2,000	18,17,98,000
Median Plantation		Typical Cross Section wise Number of Hedge to be planted as detailed in <b>Table 9-3</b> & its maintenance for 5 years	74.185	No.	49,408	1,000	4,94,08,000
<b>Grand Total</b>							<b>23,12,06,000</b>

# basis of unit cost is the Consultant's past experience in similar projects

### B. Mitigation / Enhancement Budget

Component	Stage	Item	Unit	Quantity	Unit Cost# (Rs.)	Total Cost (Rs.)
Topography & Geology	Construction	Establishment of Construction Camp at 3 locations	Sq. ft	Area required = 100 Sq.ft/ labour; No. of labors: 150; No. of Camp: 3; Total area required = (100 x 150 x 3) = 45,000 sq. ft.	300	1,35,00,000
Soil	Construction	Slope stabilization	Covered under Engineering Cost			
Air	Construction	Dust suppression with sprinkling of water;	Trip	3 trips/day/Camp x 3 Camps x 300 days in a year for 2 years = 5,400 trips	500	27,00,000
Water	Construction	Provision of water supply facilities for the construction camps	Month	24 months x 3 Camps =72 months	30,000	21,60,000

Component	Stage	Item	Unit	Quantity	Unit Cost# (Rs.)	Total Cost (Rs.)
Water	Construction	Provision of sewage and sanitation facilities for the construction camps including maintenance for 2 years	Month	24 months x 3 Camps =72 months	15,000	10,80,000
Water	Construction	Provision of Wastewater Treatment Plant in the Construction Camp	Lump sum	3 Camps	22,50,000	67,50,000
Water	Construction	Provision for Oil Interception Chambers in construction yard near to 1) vehicle parking, fueling and washing area and 2) Hot Mix Plant	No.	2 units in a construction yard x 3 yards = 6	15,000	90,000
Water	Construction	Construction of Sedimentation Tanks in construction yard near to 1) Concrete mix plant and 2) Hot mix plant	No.	2 units in a construction yard x 3 yards = 6	50,000	3,00,000
Water	Construction	Silt fencing near surface water bodies	Meter	2,000	850	17,00,000
Water	Construction	Rainwater Harvesting Structures at Toll Plaza, Wayside Amenities etc.	No.	9	65,000	5,85,000
Noise	Construction	Construction of noise barrier at sensitive receptors; Interchange, Fly-Overs, Truck parking and Way Side Amenity	Covered under Engineering Cost			
Vegetation loss	Construction	Provision of fuel in the construction camp	No.	5 commercial LPG Cylinder per month in each camp x 3 Camps x 24 months = 360 cylinders	1,500	5,40,000
Solid Waste Management	Construction	Clearing garbage from construction camp and construction site	Month	24 months x 3 Camps =72 months	5,000	3,60,000
Safety of Workers	Construction	Providing PPE to the labours during the construction	Cost/ person	150 labors x 3 camps = 450	1,200	5,40,000
Health Checkup	Construction	Provision for biannual health checkups	No.	150 labors x 4 checkups x 3 Camps =1,800	2,000	36,00,000
<b>Total</b>						<b>3,39,05,000</b>

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

2) No. of Construction Packages = 3

3) No. of Construction Camps = 3

3) No. of labour in each Construction Camp = 150

# basis of unit cost is the Consultant's past experience in similar project



### C. Environmental Monitoring Budget

Parameters	Stage	Frequency	No. of Locations	No. of Samples	Unit Cost/ Sample# (Rs.)	Total Cost (Rs.)
Ambient Air Quality	Construction	Twice in a season for 3 seasons (except monsoon)	15	180	7,000	12,60,000
	Operation	Once in a season for 3 seasons (except monsoon)	6	90	7,000	6,30,000
Noise Level	Construction	4 times a year (in each season)	15	120	2,500	3,00,000
	Operation	Once in every three years	6	30	2,500	75,000
Ground Water Quality	Construction	4 times a year (in each season)	9	72	10,000	7,20,000
	Operation	Twice in every three years (Pre-monsoon & post-monsoon)	6	30	10,000	3,00,000
Surface Water Quality	Construction	4 times a year (in each season)	11	88	10,000	8,80,000
	Operation	Twice in every three years (Pre-monsoon & post-monsoon)	8	40	10,000	4,00,000
Soil Quality	Construction	Once in a year	9	18	6,500	1,17,000
	Operation	once in every three years	6	30	6,500	1,95,000
<b>Grand Total</b>						<b>48,77,000</b>

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

2) Monitoring in Operation Phase will be conducted every 3 years for 15 years.

# basis of unit cost is the Consultant's past experience in similar projects

### D. Training & Mobilization Budget

Component	Stage	Item	Unit	Quantity	Unit Cost # (Rs.)	Total Cost (Rs.)
Training	Construction & Operation	Training of Environmental staff of PIU involved in the project; staff of Authority Engineer; Contractor and collaborating Government agencies No. of persons = 24 No. of Training = 2	Training cost per person	48	25,000 per person per training	12,00,000
Facilities and Equipment	Construction & Operation	Infrastructure facility (such as computer, printer, scanner, internet etc.) for the team at PIU who will be responsible for monitoring of the implementation of EMP	Set	6	200,000	12,00,000
<b>Total</b>						<b>24,00,000</b>

# basis of unit cost is the Consultant's past experience in similar projects

### E. CA & NPV Budget

Item	Forest land to be diverted (ha)	Cost per ha (Rs.)	Total Cost (Rs.)#
CA & NPV for diversion of forest land	191.8405	20,00,000	<b>38,36,81,000</b>

Note: # tentative cost; final cost will be calculated by the Maharashtra Forest Department after Stage-I Forest Clearance

**Table 9-8 Summary of Environmental Budget**

Component	Description	To be implemented by	Amount (Rs.)
A.	Greenbelt Development	Contractor	23,12,06,000
B.	Mitigation / Enhancement		3,39,05,000
C.	Environmental Monitoring		48,77,000
D.	Training & Mobilization		24,00,000
E	<i>Subtotal (A+B+C+D)</i>		<i>27,23,88,000</i>
F	Contingency @3%		81,71,640
G	<b>Total (E + F)</b>		<b>28,05,59,640</b>
H	CA & NPV	NHAI	38,36,81,000
<b>Grand Total (G + H)</b>			<b>66,42,40,640</b>
			<b>Say Rs. 66.42 Crore</b>

## 9.8 CORPORATE ENVIRONMENT RESPONSIBILITY

The MoEFCC vide Office Memorandum dated 1<sup>st</sup> May 2018 has firmed up guidelines that will require every corporate seeking green clearance to set aside up to 0.25 % to 2.0% of its capital investment for Corporate Environment Responsibility (CER) and it is to be in addition to the cost for implementation of EMP (EMP budget). As per the MoEFCC Guideline, cost of CER has been calculated and presented in **Table 9-9**.

**Table 9-9 CER Provisions as per MoEFCC OM dated 1<sup>st</sup> May 2018**

Provision as per MoEFCC OM dated 1 <sup>st</sup> May 2018	Capital Investment as per Draft DPR (in Cr.)	% of Project Cost considered	Cost of CER in Cr.
Capital Investment >1,000 Cr. to ≤10,000 Cr. Greenfield Project – 0.5%	7,010	0.5%	<b>35.05</b>

Source: MoEFCC Office Memorandum dated 1<sup>st</sup> May 2018

**Community Composter:** No solid waste management facility available in the 51 affected villages of the project area. Therefore, it is proposed to introduce composting facilities in the villages on community basis for handling of household waste which is primarily biodegradable in nature. This biodegradable waste, when converted into organic compost provides excellent manure and can be used in agriculture and horticulture. Composting not only reduces the use of chemical fertilizers that results soil and water contamination but also avoids stockpile of waste in solid waste landfill. The Swachh Bharat Mission is also committed to ensuring that all organic waste is processed into making compost.

Community composter facilities organic composting in a hassle-free way and does not require electricity, dedicated staff to manage and hence has very low maintenance cost. Units of community composter are readily available in the market; such composter units may be provided on community basis (a unit per approx. 50 persons which may be increased later on depending on use and sustainability). Numbers of composter unit that may be provided in 51 affected villages of the project area are presented in **Table 9-10**.

**Table 9-10 Village wise Number of Composter Unit to be provided**

Sl. No.	Village	No of Unit	Sl. No.	Village	No of Unit
1	Koshimbe**	0	27	Kirat	34
2	Khardi	26	28	Borsheti	39
3	Doliv	14	29	Ravate	19
4	Wadhiv Saravali	29	30	Chinchare	18
5	Navghar	24	31	Dhabon	69
6	Ghatim	14	32	Aine	27
7	Penand	24	33	Rankol	58
8	Sonave	53	34	Chandwad	26
9	Pargaon	32	35	Navnath	35
10	Girale	19	36	Ganjad	39
11	Nagaze	11	37	Somnath	39
12	Navje	40	38	Ganeshbag	27
13	Sakhare	33	39	Awadhani	43
14	Dahisar T. Manor	51	40	Dhanivari	28
15	Khamlioli	31	41	Chinchale	29
16	Dhuktan	57	42	Talotha	11
17	Gowade	21	43	Punjave	9
18	Maswan	33	44	Bramhanwadi	17
19	Wandivali	11	45	Vankas	80
20	Wakadi	6	46	Vadavali	118
21	Wasaroli	5	47	Sawane	60
22	Katale	25	48	Kawad	63
23	Loware	22	49	Awarpada	31
24	Nihe	45	50	Talasari	87
25	Nagzari	36	51	Ibhadpada	25
26	Lalonde	30			0
<b>Sub total</b>		<b>692</b>	<b>Sub total</b>		<b>1031</b>
<b>Grand Total = 1,723</b>					

Note: As per PCA 2011, Population of Koshimbe village has been included in the Vasai-Virar City Municipal Corporation, hence not suggested

Community composting facility in the villages is proposed to be implemented in a phased manner in collaboration with Gram Panchayat (GP) and local administration. Self Help Groups (SHGs), other community groups, and private agency are also to be involved in the process. Following institutional arrangements may be required for implementation of the scheme:

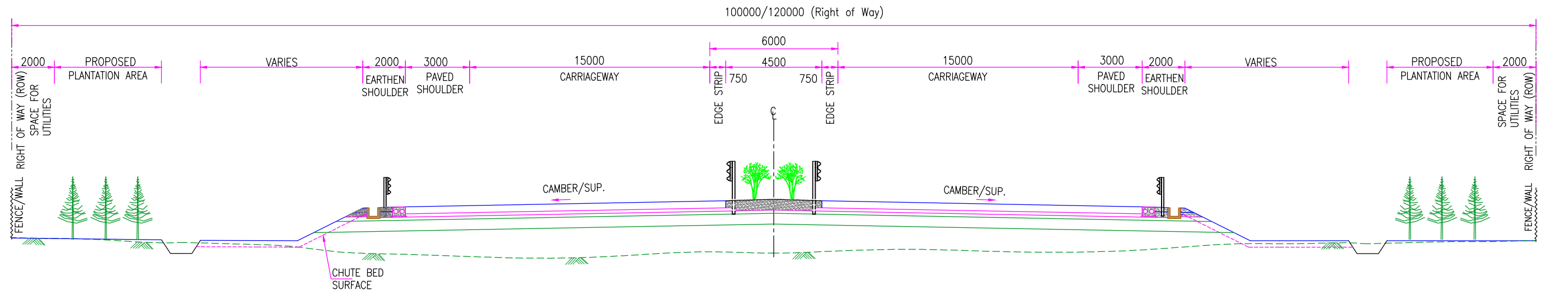
- Awareness and training of the villagers regarding requirement of community composter and its use
- Identification of qualified persons at GP level for operation and maintenance (O&M) of the community composter
- Development of basic monitoring / recording systems at GP level
- Availability of common space in and around the village

Cost of community composter, cost towards awareness, training and institutional arrangement for implementation of Community Composter as well as cost of other activities to be implemented under CER is presented in **Table 9-11**:

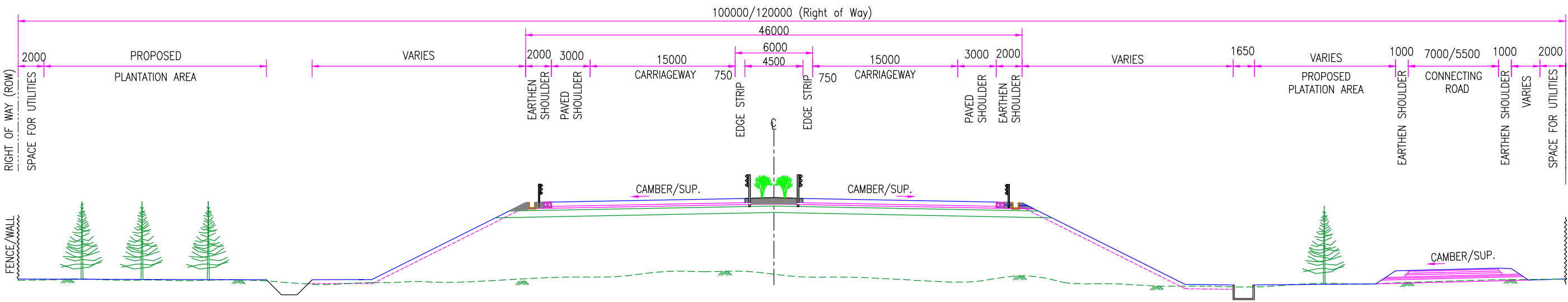
**Table 9-11 Budget for Corporate Environment Responsibility**

Sl. No.	Description	Quantity	Unit Cost# (Rs.)	Total Cost (Rs.)
1	Community Composter in the projected affected villages (Please refer Table 9-10)	1723 no.	55,000	9,47,65,000
2	Cost towards awareness, training and institutional arrangement for implementation of Community Composter in affected villages	50 villages	90,00,000	4,50,00,000
3	Development of herbal garden including 3 years maintenance by the Forest Department	-	Lump sum	60,00,000
4	Distribution of fruit bearing trees for plantation in community area and mangrove plantation	51 villages	5,00,000	2,55,00,000
5	Provision of fulfillment of Primary Health Centre (PHC) requirement in 7 villages as detailed in <b>Table 3-53</b> in Chapter-3	7 villages	1,00,00,000	7,00,00,000
6	Skill development of community in affected villages through National Skill Development Mission	51 villages	20,00,000	10,20,00,000
7	Miscellaneous expenditure	-	Lump sum	72,35,000
			<b>Total</b>	<b>35,05,00,000</b>
				<b>35.05 Cr.</b>

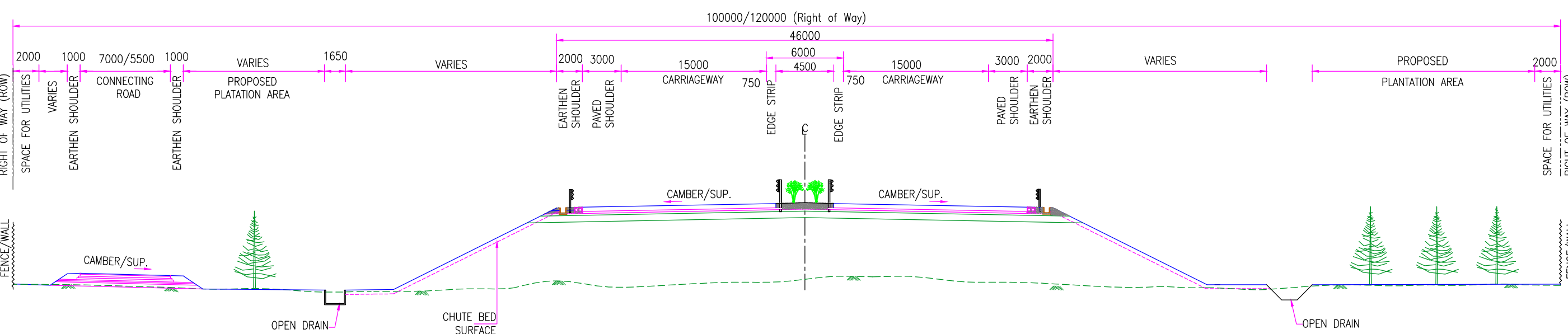
# basis of unit cost is the Consultant's past experience in similar projects



TYPICAL CROSS SECTION (1) OF EXPRESSWAY 8-LANE DIVIDED C/W WITHOUT CONNECTING ROAD



TYPICAL CROSS SECTION (2) OF EXPRESSWAY 8-LANE DIVIDED C/W WITH RIGHT SIDE CONNECTING ROAD



TYPICAL CROSS SECTION (3) OF EXPRESSWAY 8-LANE DIVIDED C/W WITH LEFT SIDE CONNECTING ROAD



## CHAPTER-10: SUMMARY AND CONCLUSION

**Need of the Project:** The Mumbai–Ahmedabad Corridor in the western part of the country is one of the important transport corridors of the country. On one side of this corridor is Mumbai which is the financial capital of the country and on the other side is Vadodara, an important commercial and business city. Many industries like, textile, gems & jewelries, petrochemical & fertilizer etc. have been established along this corridor. This corridor also serves SEZ areas and ports. NH-8 is of great significance for transportation in this corridor between Delhi to Mumbai.

NH48 (old NH-8) has been widened to 6 lane but many of the sections have already reached beyond the capacity volume of 6 lane with average journey speed of 50-60 km/hr with traffic more than 1 lakh PCUs.. Further widening of NH-48 is not feasible. With rapid economic development taking place in the States of Gujarat and Maharashtra, there is a need to develop an expressway wherein the movement of large volumes of passenger and goods vehicles can take place at a fast pace. Further, the Delhi – Vadodara Expressway is also connection the Vadodara – Mumbai Expressway (VME) which will complete the expressway corridor from Delhi to Mumbai.

The proposed project is the development of 8 lane access-controlled green-field Vadodara Mumbai Expressway (Phase-II) starting at Koshimb village of Vasai Taluka (proposed chainage 26+582) and terminating at Ibhaddpada village of Talasari Taluka (proposed chainage 104+700) in the state of Maharashtra. Total length of VME (Phase-II) is 78.118 km.

The proposed expressway will provide fast connectivity between Delhi - Ahmedabad – Mumbai to Pune. The proposed expressway will reduce the travel time, vehicle operating cost, no. of accidents, increase employment opportunity and improve economic development of the region.

**Environmental Impacts:** The proposed greenfield expressway will have impacts on the environment during construction and operation phase as summarized below:

- Blockage of natural surface water runoff due to construction embankment
- Permanent change of existing land use pattern due to acquisition of approx. 710.3247 ha private / government land
- Impact on ecology & biodiversity due to diversion of approx. 191.5894 ha forest land and felling of approx. 69,095 no. of trees
- Impact on surface water bodies (2 Ponds shall be fully affected and 2 partially)
- 2393 land units /plots (private & government) and 895 structures including 717 private structures will be affected due to the project.

**Mitigation Measures:** Conservation and ecosystem management has vital role to minimize the impact of expressway construction. Maintaining natural flows of rivers, streams, drainage network etc. without changing the gorge of flow at expressway site also contribute to conservation of ecosystem. Mitigation measures suggested to minimize the impacts is summarized below:

- To minimize the impact drainage network & hydrological flow, 8 major bridges, 29 minor bridges, 133 culverts are proposed to be constructed along the expressway
- All bridges have been designed for a return period of 100 years and culverts have been

designed for a return period of 50 years

- Coir Geotextile & Vetiver grasses have been proposed for slope stabilization, which is the only environment friendly and sustainable technology to control soil erosion and slope stabilization.
- Packaged Wastewater Treatment Plant has been recommended for the construction camp
- Silt fencing shall be provided to prevent sediments from the construction site entering into the nearby watercourses
- **90,899 no. of trees** and **49,408 no. of hedges** have been proposed to be planted under greenbelt development plan.
- Plantation suggested under Compensatory afforestation for diversion of 191.5894 ha forestland shall be 1,91,589 plants. However, this shall be finalized by the Forest Department.
- A budget of **Rs. 2.55 Crore** earmarked under CER for fruit sapling distribution and plantation of mangrove species.
- To compensate the loss of medicinal plants, development of herbal garden is proposed. Total budget of **Rs. 60 Lakhs** proposed for development of herbal garden by Forest Department under CER.
- 51 cattle underpasses have been proposed along the expressway. In addition to this, 133 box culverts will also act as cattle underpass during summer season.
- The proposed expressway **does not pass through** any National Park, Wildlife Sanctuary, Conservation Reserve and Community Reserve, hence no direct impact is envisaged
- The construction and demolition waste management shall be carried out as per the provisions of the Construction and Demolition Waste Management Rules, 2016.
- Disposal of domestic waste from Labour camps as per SWM Rules, 2016
- Mitigation measures recommended during Environment & CRZ Clearance, DTEPA Clearance and Forest Clearance shall be complied with by the Project Proponent. Monitoring and progress report of implementation of EMP and recommendations by various authorities shall be submitted as per the schedule.

### Environmental Management Plan

- A capital cost provision of about **Rs. 66.42 Crore** has been kept towards implementation of environmental management plan.
- A capital cost provision of about **Rs. 35.05 Crore** has been kept under Corporate Environment Responsibility (CER) for implementation of various activities for overall improvement of environmental and ecological conditions of the project area.

## CHAPTER-11: DISCLOSURE OF CONSULTANT

Declaration by Experts contributing to the Environment Impact Assessment Study “Development of Vadodara Mumbai Expressway (Phase-II) from km.26.320 to km.104.700 of Main Expressway in the State of Maharashtra”

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

Signature



Name of EIA Coordinator

: Tirthankar Banerjee

Date

: 08-11-2019






Period of involvement





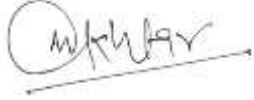

: July 2016 to till date



Contact information

: Intercontinental Consultants and Technocrats Pvt. Ltd.  
A-8, Green Park, New Delhi-110016

### Functional area experts:

S. No.	Functional areas	Name of the expert/s	Involvement (period and task**)	Signature and date
1	Air Pollution Monitoring, Prevention & Control (AP)	Tirthankar Banerjee Subhajit Mitra	<p>Period: July 2016 – till date</p> <ul style="list-style-type: none"> <li>• Identification of meteorology and air quality monitoring locations and supervision of monitoring at site</li> <li>• Review of monitoring results and analysis</li> <li>• Assessment of impact on air quality and mitigation measures for air pollution</li> <li>• Preparation of EMP</li> </ul>	 
2	Water Pollution Monitoring, Prevention and Control (WP)	Pawan Malik	<p>Period: July 2016 – till date</p> <ul style="list-style-type: none"> <li>• Identification of water sampling locations</li> <li>• Site visit, supervision of sampling</li> <li>• Counter checking of analysis of data by literature study and consultation with local people and concerned departments</li> <li>• Assessment of impact on water quality and mitigation measures for water pollution</li> </ul>	
3	Socio-Economics (SE)	Dr. S. K. Singh / Dibya Kumar Dash	<p>Period: July 2016 – till date</p> <ul style="list-style-type: none"> <li>• Reconnaissance study, transect walk</li> <li>• Evaluation of socio economic status of population in the study area</li> <li>• Assessment of social impact</li> <li>• Community participation, Mitigation plan</li> <li>• Preparation of resettlement plan</li> <li>• Stakeholder consultation</li> </ul>	 


S. No.	Functional areas	Name of the expert/s	Involvement (period and task**)	Signature and date
4	Ecology and Biodiversity  (EB)	Dr. Lakshmi Rawat	<u>Period:</u> July 2016 – till date <ul style="list-style-type: none"> <li>Visited site to identify the ecological condition of project area by direct field survey and consultation, identification of major floral and faunal species</li> <li>Assessment of impacts on ecology &amp; biodiversity and mitigation measures to minimize the impacts</li> </ul>	
5	Solid and Hazardous Waste Mgt.  (SHW)	Aruna Sharan	<u>Period:</u> Dec 2016 – till date <ul style="list-style-type: none"> <li>Estimated the waste generation quantity due to various construction activity</li> <li>Devising measures to minimize wastes; recycle and disposal</li> <li>Preparation of Comprehensive Waste Management Plan</li> </ul>	
6	Land Use  (LU)	Surjit Singh Saini	<u>Period:</u> Dec 2016 – till date <ul style="list-style-type: none"> <li>Identification and collection of satellite imageries</li> <li>Finalization of Land Use and Ground Survey Maps</li> <li>Ground verification</li> <li>Impact assessment of Land Use</li> <li>Mitigation measures for land Use</li> </ul>	
7	Soil Conservation  (SC)	Dr. R C Thakur	<u>Period:</u> Dec 2016 – till date <ul style="list-style-type: none"> <li>Identification of soil quality and soil type for establishing the baseline conditions</li> <li>Assessing the impact on soil due to various activities of the project</li> <li>Suggest mitigation measures to control the adverse impact</li> </ul>	
8	Meteorology, Air Quality Modeling & Prediction  (AQ)	Mohammad Akhtar	<u>Period:</u> Dec 2016 – till date <ul style="list-style-type: none"> <li>Analysis of air quality data, meteorological data, traffic data etc. as per the requirements of Pollution Dispersion model (CALINE4)</li> <li>Predict air quality using pollution dispersion model (CALINE 4)</li> <li>Finalization of report</li> </ul>	
9	Noise and Vibration  (NV)	Tirthankar Banerjee	<u>Period:</u> July 2016 – till date <ul style="list-style-type: none"> <li>Identification of noise monitoring locations and supervision of monitoring at site</li> <li>Review of monitoring results and analysis</li> <li>Assessment of impact on noise and mitigation measures for noise pollution</li> <li>Analysis of noise quality data, traffic data etc. as per the requirement of mathematical model (CRTN)</li> <li>Interpretation, analysis and presentation of predicted results</li> </ul>	

S. No.	Functional areas	Name of the expert/s	Involvement (period and task**)	Signature and date
10	Hydrology, Ground Water & Water Conservation (HG)	Joshua Anand	<u>Period:</u> Dec 2018 – till date <ul style="list-style-type: none"> <li>Review of Hydro- geological pattern of the study area</li> <li>Catchment Area and Drainage Network</li> <li>Assessment of impact on hydrology &amp; drainage pattern</li> <li>Mitigation measures</li> </ul>	
11	Risk Analysis and Hazard Management (RH)	Dr. Ravindra Kode	Dec 2016 – till date <ul style="list-style-type: none"> <li>Identification of the potentially hazardous material and events that might occur during various phases of the project</li> <li>Risk Assessment</li> <li>Preparation of Disaster Management Plan</li> </ul>	

S. N.	Name	Proposed Position	Mentor
1.	Pawan Malik	Team Member (RH)	Dr. Ravindra Kode
2.	Subhajit Mitra	Team Member (WP)	Pawan Malik
3.	Tirthankar Banerjee	Team Member (AQ)	Mohammad Akhtar
4.	Kiran Kumar Jadav	Team Member (LU)	Surjit Singh Saini

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

I, **Mr. Prashant Kapila**, hereby, confirm that the above mentioned experts prepared the EIA for the above mentioned project. I also confirm that the consultant organization shall be fully accountable for any mis-leading information mentioned in this statement.

Signature: 

Name: **Prashant Kapila**

Designation: **COO**

Name of the EIA consultant organization: **Intercontinental Consultants and Technocrats Pvt. Ltd.**

NABET Certificate No. & Issue Date: **NABET /EIA /1619 /RA 0089 dated April 12, 2018**