Supplemental Environmental Impact Assessment Report (Volume-II: Annexure)

for

Mumbai-Ahmedabad High Speed Railway Project

NHSRCL

National High Speed Rail Corporation Ltd

National High Speed Rail Corporation Limited

(A Joint Venture of Government of India and Participating State Governments)

Asia Bhawan, Plot No. 205, Sector-9,

Dwarka, New Delhi-110 077

SEPTEMBER 2018

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In Association with

Amaltas Enviro Industrial Consultants LLP.

(NABET Certificate No. NABET/EIA/1518/IA 0017)

SEPTEMBER 2018

CONTENT

CONTENT

Abbreviations

Abbreviations

Abbreviation	Meaning
ADB	: Asian Development Bank
AIDS	: Acquired Immune Deficiency Syndrome
ALT	: Alternative
APCCF	: Additional Principal Chief Conservator of Forests
APHA	: American Public Health Association
ASI	: Archaeological Survey of India
ATS	: Anti Terror Squad
ATP	: Auto Transformer Post
AWS	: Automatic Weather Station
AWWA	: American Water Works Association
BAU	: Business as Usual
BDI	: Biodiversity Index
BKC	: Bandra Kurla Complex
BOD	: Biochemical Oxygen Demand
CBR	: Crude Birth Rate
CBSE	: Central Board of Secondary Education
C&D	: Construction and Demolition
CDM	: Clean Development Mechanism
CDR	: Crude Death Rate
CEC	: Central Empowered Committee
CEL	: Centre for Environmental Law
CEPI	: Comprehensive Environmental Pollution Index
CEPT	: Centre for Environmental Planning & Technology
CFCs	: Chlorofluorocarbons
CGWA	: Central Ground Water Authority
CGWB	: Central Ground Water Board
CHC	: Community Health Centre
CISCE	: Council for the Indian School Certificate Examinations
CMP	: Conservation and Management Plan
CMR	: Child Mortality Rate
CPHEEO	: Central Public Health and Environmental Engineering Organisation
CPCB	: Central Pollution Control Boards
CRZ	: Coastal Regulation Zone
CTE	: Consent to Establish
CTO	: Consent to Operate
CUM	: Cubic meter
CWLW	: Chief Wildlife Warden
CWRA	: Central Wetland Regulatory Authority
CZMA	: Coastal Zone Management Authority
CZMP	: Coastal Zone Management Plans
DC	: District Collector
DFC	: Dedicated Freight Corridors
DFO	: Divisional Forest Officer
DGMS	: Director General of Mines and Safety
DNA	: Deoxyribonucleic Acid
DTEPA	: Dahanu Taluka Environment Protection Authority
DCF	: Deputy Conservator of Forests
DSS	: Distribution Substation

DyCCF	: Deputy Chief Conservator of Forests
ECR	: East Central Railway
EIA	: Environmental Impact Assessment
EMCBF	: Eastern Margin Cambay Basin Fault
EMCBF	: East Cambay Basin Boundary Faults
EMP	: Environmental Management Plan
EMoP	: Environmental Monitoring Plan
EPA	: Environment (Protection) Act
ERF	: Environment Relief Fund
ESA	: Eco Sensitive Area
ESCR	: Economic, Social, and Cultural Rights
ESM	: Enterprise Scheduling Management
ESZ	: Eco Sensitive Zone
FCA	: Forest Conservation Act
FEM	: Federal Equivalent Method
FRA	: French Railway Authority
FRM	: Federal Reference Method
FRU	: First Referral Unit
FS	: Feasibility Study
FSI	: Forest Survey of India
FTA	: Federal Transit Administration
GC	: General Consultants
GCZMA	: Gujarat Coastal Zone Management Authority
GHG	: Green House Gas
GPCB	: Gujarat Pollution Control Board
GRM	: Grievance Redressal Mechanism
GPSTPL	: GPS Technologies Pvt. Limited
GWP	: Global Warming Potential
HCFCs	: Hydrochlorofluorocarbons
HIV	: Human Immunodeficiency Virus
HSR	: High-Speed Railway
HSRC	: High Speed Rail Corporation Limited
HST	: High-Speed Train
HTL	: High Tide Line
IBA	: Important Bird Area
ICE	: Institutional Capacity Enhancement
ICESCR	: International Covenant on Economic, Cultural and Social Rights
IFC	: International Finance Corporation
ILO	: International Labour Organisation
IMD	: Indian Meteorological Department
IPP	: Indigenous Peoples Plan
ISR	: Institute of Seismological Research
ISRO	: Indian Space Research Organisation
JICA	: Japan International Cooperation Agency
JICC	: JIC Consortium
JBIC	: Japan Bank for International Cooperation
LEB	: Life Expectancy at Birth
LTL	: Low Tide Line
LU/LC	: Land Use / Land Classification
LPCD	: Liter Per Capita Per Day
MAHSR	: Mumbai-Ahmedabad High Speed Railway Project

MCZMA	: Maharashtra Coastal Zone Management Authority
MEEP	: Municipal Energy Efficiency Programme
MEMU	: Mainline Electric Multiple Unit
MF	: Membrane Filter
MMR	: Maternal Mortality Rate
MoEFCC	: Ministry of Environment, Forests and Climate Change
MoHFW	: Ministry of Health and Family Welfare
MoR	: Ministry of Railway
MPCB	: Maharashtra Pollution Control Board
MSI	: Mangrove Society of India
MSW	: Municipal Solid Waste
NAAAQS	: National Ambient Air Quality Standards
NABET	: National Accreditation Board for Education and Training
NABL	: National Accreditation Board for Testing and Calibration Laboratories
NACO	: National AIDS Control Organisation
NATM	: New Austrian Tunneling Method
NBWL	: National Board of Wildlife
NCZMA	: National Coastal Zone Management Authority
NDIR	: Non-dispersive Infra Red Absorption
NEP	: The National Environmental Policy
NFHS	: National Family Health Survey
NGO	: Non-Governmental Organization
NGT	: National Green Tribunal
NHSRCL	: National High Speed Rail Corporation Limited
NIC	: Nature Interpretation Centre
NIO	: National Institute of Oceanography
NMA	: National Monument Authority
NNM	: Neo-Natal Mortality
NNW	: North-North-West
NO	: Oxide of Nitrogen
NOC	: No Objection Certificate
NP	: National Park
NRHM	: National Rural Health Mission
NTU	: Nephelometric Turbidity Unit
NW	: North West
NWDA	: National Water Development Authority
ODS	: Ozone Depleting Substance
OHS	: Occupational Health and Safety
OP	: Operational Policy
PA	: Protected Area
PAP	: Project Affected Persons
PAS	: Public Address System
PCCF	: Principal Chief Conservator of Forests
PESA	: Panchayat Extent to Scheduled Area
PEL	: Permissible Exposure Limit
PF	: Protected Forest
PHC	: Primary Health Centre
PIU	: Project Implementation Unit
PMU	: Project Management Unit
PLHIV	: People living with HIV
PNNM	: Post Neo-Natal Mortality

PUC	: Pollution Under Control
PPE	: Personal Protective Equipment
PPP	: Public Private Partnership
PTFE	: Polytetrafluoroethylene
QCI	: Quality Council of India
RAC	: Resident Additional Collector
RAP	: Resettlement Action Plan
RCCF	: Regional Chief Conservator of Forest
RCS	: Replacement Cost Survey
RF	: Reserved Forest
RFO	: Range Forest Officer
RFP	: Request for Proposal
RO	: Regional Officer
ROR	: Records of Revenue
RoW	: Right of Way
RVNL	: Rail Vikas Nigam Limited
SAC	: Space Applications Centre
SADEC	: Station Area Development Expert Committee
SBWL	: State Board for Wildlife
SC	: Schedule Cast
SEM	: Social and Environmental Management Unit
SER	: Signaling and Telecommunication Equipment Room
SCZMA	: State Coastal Zone Management Authorities
SE	: Site Engineer
SIA	: Social Impact Assessment
S-EIA	: Supplemental Environmental Impact Assessment
SEMU	: Site Environment Management Unit
SGNP	: Sanjay Gandhi National Park
SHE	: Safety Health Environment
SHM	: Stakeholder Meeting
SP	: Sectioning Post
SPCB	: State Pollution Control Boards
SPL	: Sound Pressure Level
SPV	: Special Purpose Vehicle
SSA	: Sarva Shiksha Abhiyan
SSP	: Sub Sectioning Post
ST	: Schedule Tribe
STP	: Sewerage Treatment Plant
SWM	: Solid Waste Management
TBM	: Tunnel Boring Machine
TCLP	: Toxicity Characteristics Leaching Procedure
TCM	: Tetrachloromercurate
TCFS	: Thane Creek Flamingo Sanctuary
TDS	: Total Dissolved Solids
TERI	: Tata Energy Research Institute
TFR	: Total Fertility Rate
TO	: Tree Officer
TSDF	: Treatment, Storage & Disposal Facilities
TSS	: Total Suspended Solids
TSS	: Traction Substation
TWLS	: Tungareshwar Wildlife Sanctuary

UIC	: Union Internationale Des Chemins
ULB	: Urban Local Bodies
UMLC	: Unmanned Level Crossing
UNFCCC	: United Nations Framework Convention on Climate Change
USDA	: United States Department of Agriculture
VCTC	: Voluntary Counseling and Testing Centres
WB	: World Bank
WFF	: World Forum of Fish Harvesters and Fish Workers
WHO	: World Health Organization
WLS	: Wildlife Sanctuary
WMCBF	: West Cambay Basin Boundary Fault
WNW	: West-North-West
WPCF	: Water Pollution Control Federation
ZOI	: Zone of Influence
ZSI	: Zoological Survey of India

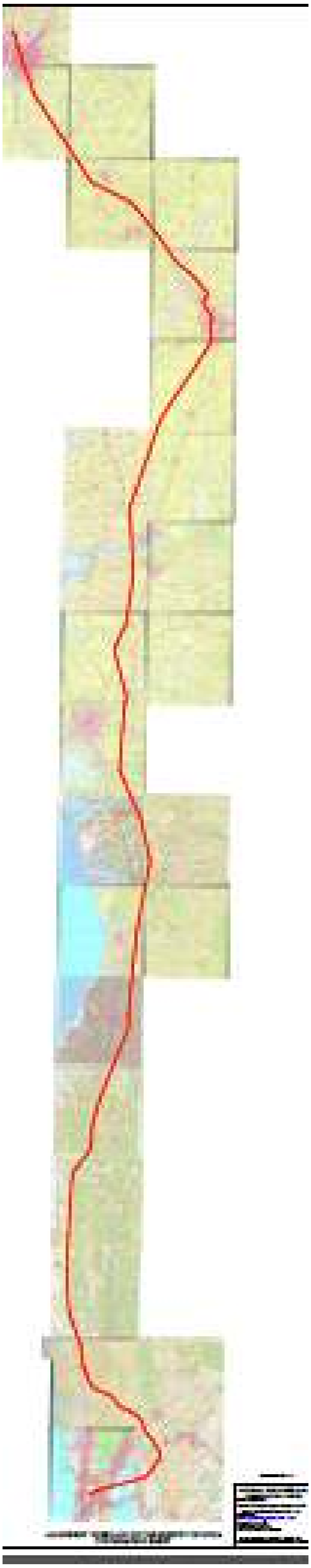
Symbols and Units of Measurement

Symbol	**Meaning**
$<$	: less than
$\leq$	: less than or equal to
$>$	: greater than
$\geq$	: greater than or equal to
%	: per cent
amsl	: above mean sea level
bgl	: below ground level
$Ca\ CO_3$	: calcium carbonate
CH_4	: methane
cm	: centimetre
CO	: carbon monoxide
CO_2	: carbon
Cu	: copper
dB	: decibel
dB(A)	: decibel A-weighted
$\mu g/m^3$	: micrograms per cubic metre
GHz	: gigahertz
ha	: hectare
hPa	: hectopascal
hr	: hour
Hz	: hertz
kg	: kilogram
KLD	: kilolitre per day
km	: kilometre
kmph	: kilometre per hour
km^2	: square kilometre
kV	: kilovolt
kV/h	: kilovolts per hour
kWh	: kilowatt hour
µm	: micrometre
m	: metre

m^2	: square metre
m^3	: cubic metre
m/s	: metre per second
mm	: millimetre
mm/s	: millimetre per second
min	: minutes
mbgl	: Meter below ground level
mg/kg	: Miligram Per Kilogram
ML	: Million Litre
MLD	: Million Litre Per Day
MW	: megawatt
N	: nitrogen
Ni	: nickel
NO	: nitrogen oxide
NO_2	: nitrogen dioxides
NOx	: oxides of nitrogen
O_2	: oxygen
PA	: per annum
Pb	: lead
PAX	: passenger unit
pH	: potential of hydrogen
pkm	: passenger kilometre
PM	: particulate matter
PM_{10}	: particulate matter >2.5μ and <10 μ
$PM_{2.5}$	: particulate matter <2.5μ
PPV	: peak particle velocity
PV	: photo voltic
SO_2	: sulphur dioxide
TJ	: trillion jules
T	: tonne
V	: volt
Zn	: zinc

Annexure 1.1

Alignment overlaid on the Survey of India Topographic Sheet



Annexure 1.2

【Document-1】 Validation of the launching method at the crossing point (PSC)

Launching erection method by jack pushing

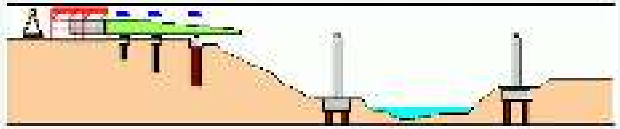
Applicability at crossing point

	applicability	remark
Road crossing	◯	/Necessary to divert or Stop cars
Railway crossing*	◯	/Necessary to block for track /once the girder is launched, the works over tracks will not be necessary.
River crossing	◯	

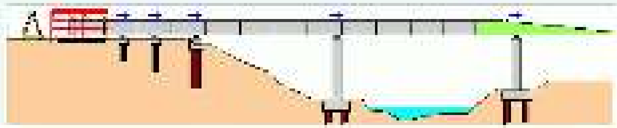
* In this project, PSC girder will not be used over the railway crossing.

【procedure】

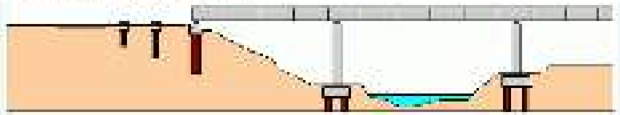
After framing launching nose,
1st main girder block is connected to launching girder by PS-bar.



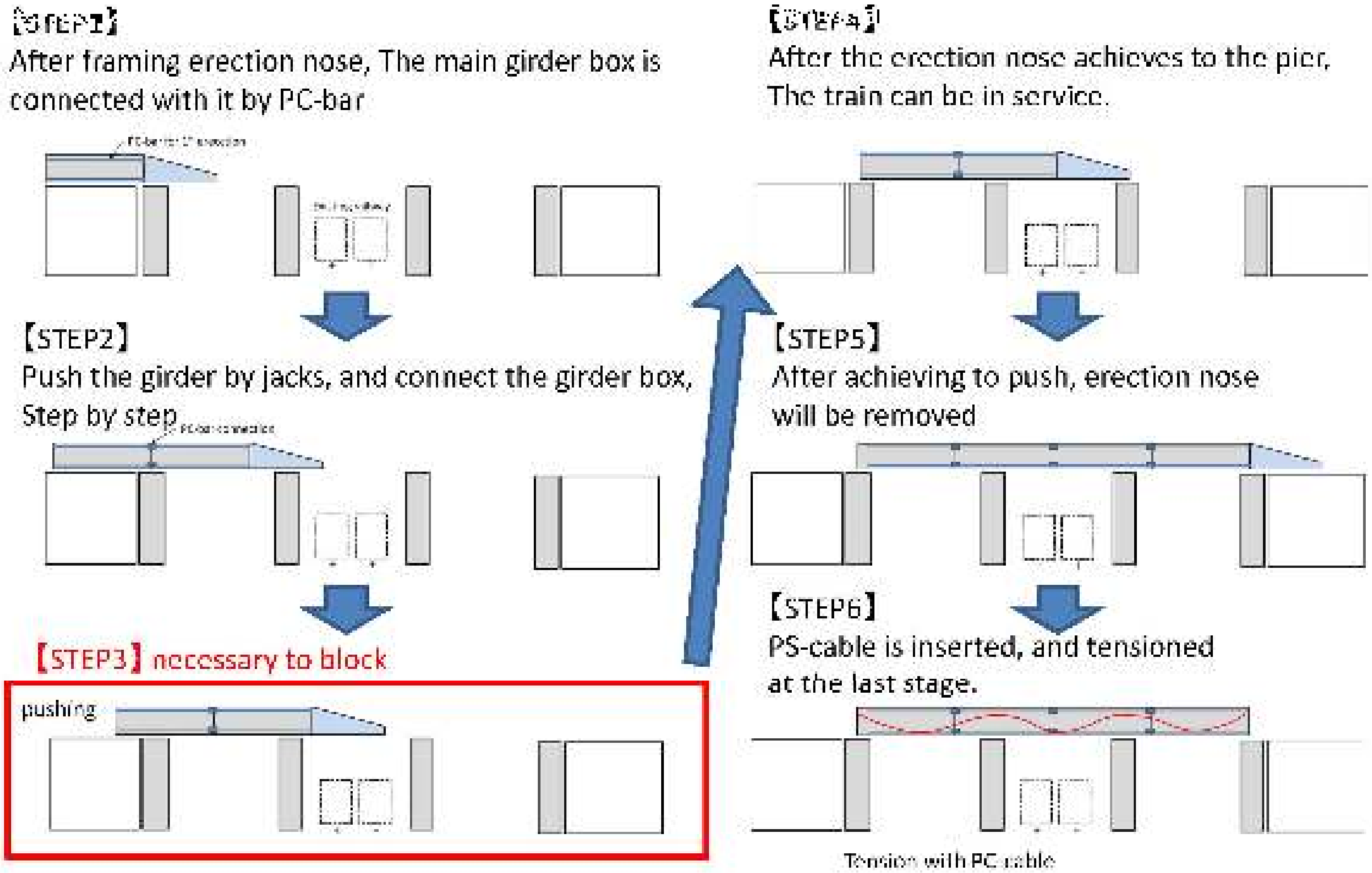
After pushing 1st main girder block, the next main girder block is constructed and pushed step by step.



After completing the pushing, the launching nose will be removed, shoes will be set, and the main girder is tensioned by PS cable.



Very safe!
Normally used
at railway crossing in Japan


【STEP1】
After framing erection nose, The main girder box is connected with it by PC-bar
【STEP2】
Push the girder by jacks, and connect the girder box, Step by step
【STEP3】necessary to block
pushing
【STEP4】
After the erection nose achieves to the pier, The train can be in service.
【STEP5】
After achieving to push, erection nose will be removed
【STEP6】
PS-cable is inserted, and tensioned at the last stage.
Tension with PC cable

【Document-1】 Validation of the launching method at the crossing point (PSC)

Erection girder Hanger-Type for Segment PSC girder

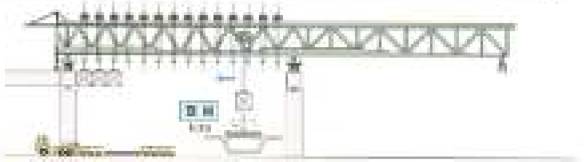
Applicability at crossing point

	applicability	remark
Road crossing	○	/Necessary to divert /protection facilities in order not to stop cars
Railway crossing*	×	/usually it is impossible to stop trains
River crossing	○	

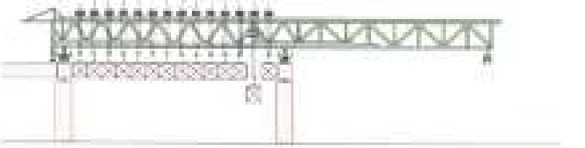
【procedure】

<STEP1> carrying the segment by the truck

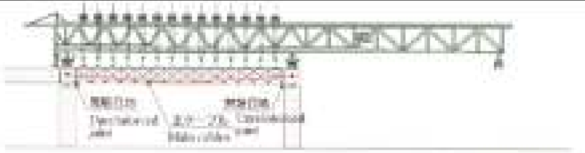
<STEP2> launching the segment by the erection girder



<STEP3> connecting segment after spreading epoxy-gel At the connection surface



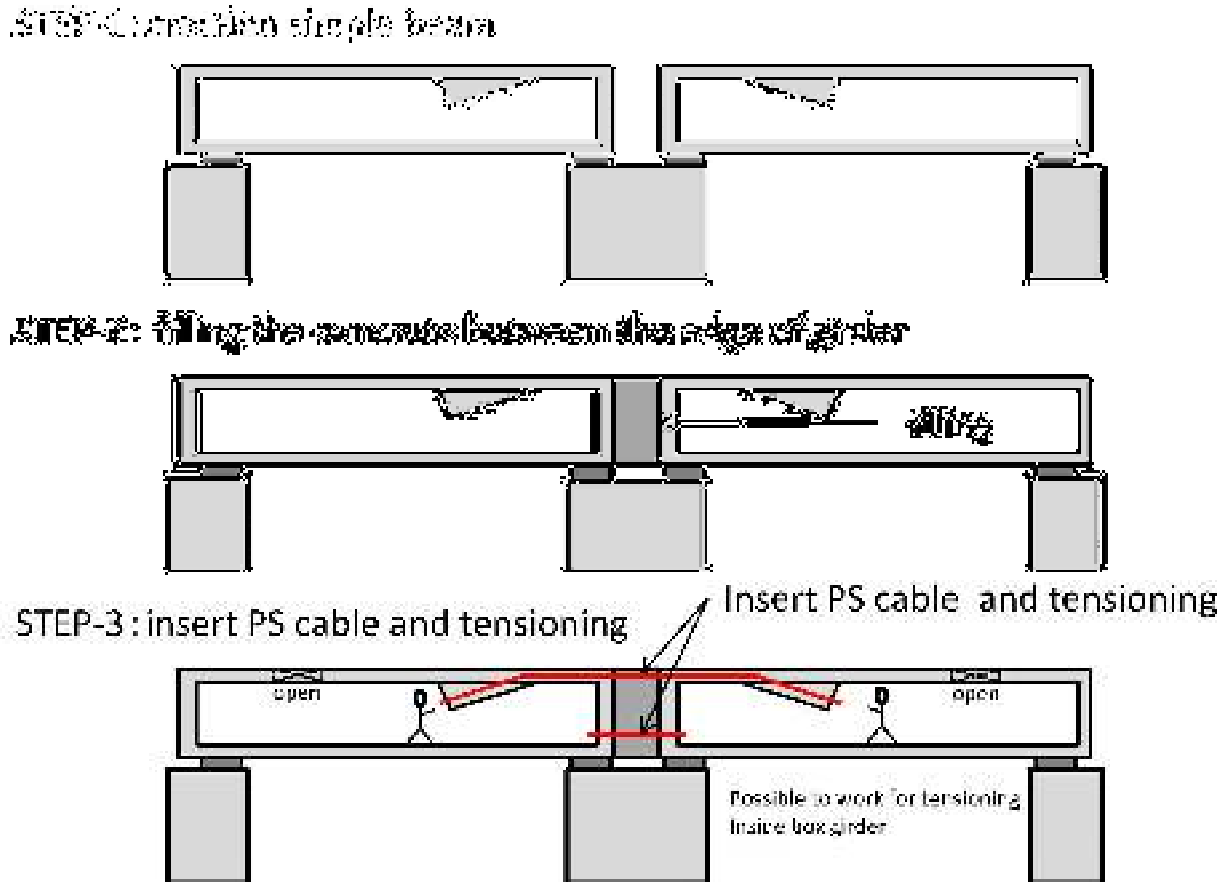
<STEP4> after filling the concrete at the edge of girder, insert PS cable, and cables are tensioned.



【Document-1】Validation of the launching method at the crossing point (PSC)

One of the methods to construct a continuous PC box girder from simple PC box girder

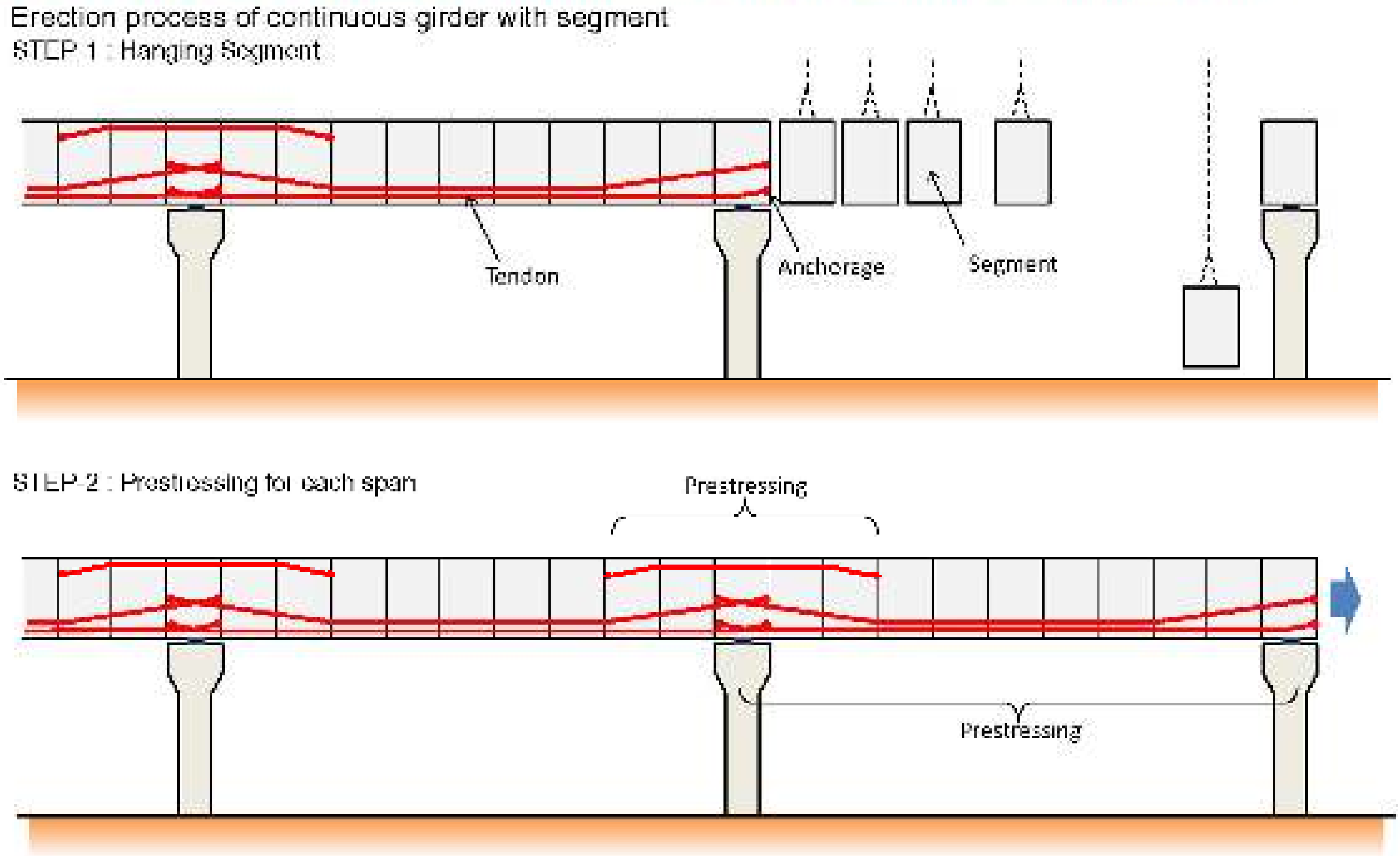
Case: after launching the girder as a simple beam, connection procedure for continuous girder



【Document-1】Validation of the launching method at the crossing point (PSC)

Erection girder Hanger-Type for Segment PSC girder

Case: after the pier top is cast in situ, the connection procedure for continuous girder



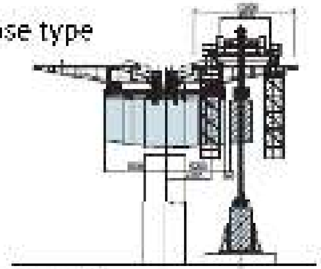
【Document-1】Validation of the launching method at the crossing point (PSC)

Cantilever Method

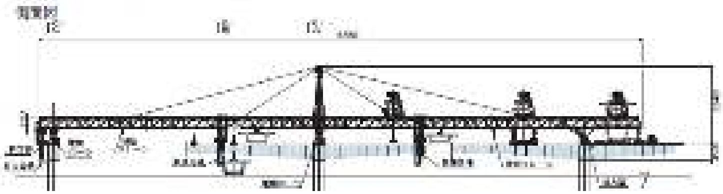
Applicability at crossing point

	applicability	remark
Road crossing	○	/Necessary to divert or To Stop cars
Railway crossing	○	/protection facilities necessary because of the work above the track
River crossing	○	

Erection nose type

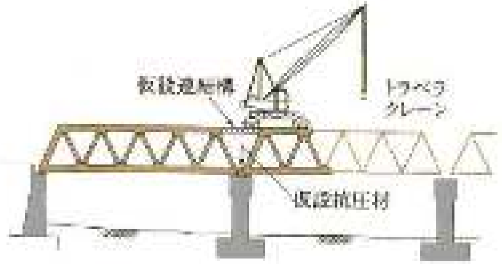


Erection girder type



【Document-1】Validation of the launching method at the crossing point (Truss)

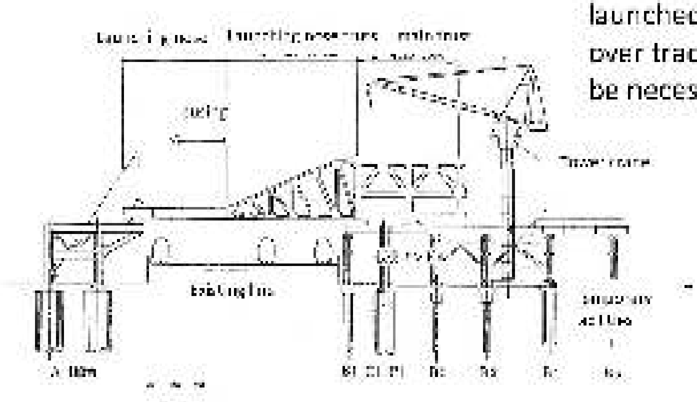
overhanging erection method by traveler crane



High Risk to fall members...

It is not suitable for railway and road cross section
(if divergent or being not in service is possible,
this method is available.)

Launching erection method by jack pushing



once the girder is launched, the works over tracks will not be necessary.

Very safe!

Normally used
at railway crossing in Japan

【Annex-1】Launching Method for Girders (PSC)

temporary facility method

Launching method by using track and crane

【Annex-2】Launching Method for Girders (PSC)

girder method

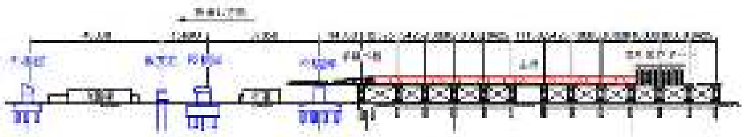
【Annex-3】

The Actual Results and The construction method of the uniform-section continuous girder

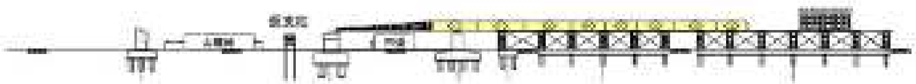
The procedure of launching erection method for PC continuous girder

Picture : sample for actual results

The actual results of Hokuriku Shinkansen Sanroku B

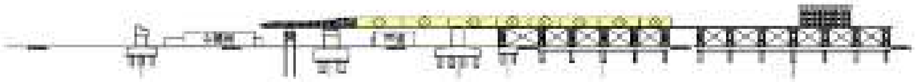


① (押出し距離27.000m) 手延べ桁先端をP2に到達



【STEP1】

② (押出し距離24.000m) 主桁先端をP3に到達

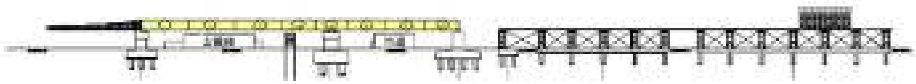


【STEP2】

③ (押出し距離33.000m) 手延べ桁先端をP1に到達

【STEP3】

④ (押出し距離28.000m) 押出し完了



【STEP4】

Annexure 1.3

No	Name		km	Depot,Shipway,Station,etc				TSS:Traction substation/ SP:Sectioning post/ SSP:Sub sectioning post			Temporary yard			Note 2017/07/06 R1
	Structure			L	B	n	m^2	L	B	m^2	L	B	m^2	
	Mumbai Station	(Cut and cover)	0.250											
	Cut & Cover	Mumbai St	0.500								0	0	210,000	Include Shaft1& Track
	Shaft1 construction	Thane T	0.700											
	Track Construction		0.500											Track
	THANE Tunnel		0.500											
	Shaft2 construction	Thane T	6.800										130,000	
	Shaft3 construction	Thane T	16.200								0	0	25,000	
	Inclined Shaft construction	Thane T	17.800								0	0	10,000	
	Tunnel construction	Thane T	21.150								0	0	10,000	Include Shaft1& Track
	Track Construction	0	21.150											Track
	Construction yard 1	Type A	27.000								100	200	20,000	Track construction
	Track Slab Concrete1		27.000								100	400	40,000	Track Slab Concrete1
	PSC Girder concrete1		27.000								100	400	40,000	PSC Girder concrete1
	Concrete Plant1		27.000								100	200	20,000	Concrete Plant
	Girder1	Truss yard	28.000								48	490	23,040	Truss yard1
	Girder2	Truss yard	28.100								48	470	22,600	Truss yard2
	Ballasted Track construction1	Thane Depot (Rolling stock) Maintenance Depot.	31.000								100	200	20,000	Ballasted Track construction
	PSC sleeper Concrete1		31.000								100	200	20,000	PSC sleeper Concrete
	Construction yard2	Type B	44.000								50	100	5,000	Track construction DP1
	PSC Girder concrete2		44.000								100	400	40,000	PSC Girder concrete2
	Concrete Plant2		44.000								100	200	20,000	Concrete Plant2
	Cutting1	Cut & Embankment	44.000								50	100	5,000	Cutting1
	Girder3	Truss yard	45.800								48	650	30,200	Truss yard3
	Girder4	Truss yard	48.800								150	550	82,500	Truss yard4 (L:550m B:150m)
	Tunnel construction	Tunnel	[illegible]										55,000	
	Construction yard3	Type B	61.000								100	200	20,000	Track construction DP5
	PSC Girder concrete3		64.000								100	400	40,000	PSC Girder concrete3
	Concrete Plant3		64.000								100	200	20,000	Concrete Plant3
	Tunnel construction	Tunnel	[illegible]								0	0	55,000	
	Girder5	Truss yard	65.800								150	600	90,000	Truss yard5 (L:600m B:150m)
	Embankment1	Cut & Embankment	69.800								50	100	5,000	Embankment1
	Girder6	Truss yard	68.800								150	520	78,000	Truss yard6 (L:520m B:150m)

No	Name		km	Depot,Stowage,Station,etc				PSS(Traction substation) SP(Sectioning post) SSP(Sub sectioning post)			Temporary yard			Note 20170306-11
	Structure			L	B	n	m²	L	B	m²	L	B	m²	
	Tunnel construction	Tunnel	63.538								0	0	55,000	
	Cutting2	Cut & Embankment	65.368								50	100	5000	Cutting2
	Embankment2	Cut & Embankment	67.800								50	100	5000	Embankment2
	Cutting3	Cut & Embankment	67.800								50	100	5000	Cutting3
	Tunnel construction	Tunnel	68.100								0	0	55,000	
	Construction yard4	Type-B	68.000								100	200	20,000	Track construction
	PSC Girder concrete4		68.000								100	400	40,000	PSC Girder concrete4
	Concrete Plant4		68.000								100	200	20,000	Concrete Plant4
	Girder2	Truss yard	71.335								48	440	21,120	Truss yard2
	Embankment3	Cut & Embankment	76.314								60	100	6000	Embankment3
	Tunnel construction	Tunnel	76.515								0	0	55,000	
	Tunnel construction	Tunnel	78.105								0	0	55,000	
	Girder3	Truss yard	82.600								150	560	########	Truss yard3 (L150m,B100m)
	Construction yard5	Type-B	87.000								100	200	20,000	Track construction
	PSC Girder concrete5		87.000								100	400	40,000	PSC Girder concrete5
	Concrete Plant5		87.000								100	200	20,000	Concrete Plant5
	Cutting4	Cut & Embankment	100.360								50	100	5000	Cutting4
	Construction yard6	Type-A	106.000								100	200	20,000	Track construction
	Track Slab Concrete1		106.000								100	400	40,000	Track Slab Concrete1
	PSC Girder concrete6		106.000								100	400	40,000	PSC Girder concrete6
	Concrete Plant6		106.000								100	200	20,000	Concrete Plant6
	Cutting5	Cut & Embankment	106.350								50	100	5000	Cutting5
	Embankment4	Cut & Embankment	110.200								60	100	6000	Embankment4
	Construction yard7	Type-B	116.000								50	100	5000	Track construction
	PSC Girder concrete7		116.000								100	400	40,000	PSC Girder concrete7
	Concrete Plant7		116.000								100	200	20,000	Concrete Plant7
	Cutting6	Cut & Embankment	121.200								50	100	5000	Cutting6
	Cutting7	Cut & Embankment	123.600								50	100	5000	Cutting7
	Cutting8	Cut & Embankment	125.500								50	100	5000	Cutting8
	Embankment5	Cut & Embankment	125.900								50	100	5000	Embankment5
	Construction yard8	Type-B	127.500								100	200	20,000	Track construction
	PSC Girder concrete8		127.500								100	400	40,000	PSC Girder concrete8
	Concrete Plant8		127.500								100	200	20,000	Concrete Plant8
	Tunnel construction	Tunnel	127.580								0	0	55,000	0
	Embankment6	Cut & Embankment	128.850								50	100	5000	Embankment6
	Tunnel construction	Tunnel	131.900								0	0	55,000	0

No	Name		km	Depot,Slipway,Stairs,etc				TSS(Traction sub station) SP(Sectioning post) SSP(Sub sectioning post)			Temporary yard			Note 2017/8/09-H1
	Structure			L	B	n	m²	L	B	m²	L	B	m²	
	Embankment7	Cut & Embankment	131.730								50	100	5000	Embankment7
	Cutting9	Cut & Embankment	132.160								50	100	5000	Cutting9
	Embankment8	Cut & Embankment	136.320								60	100	6000	Embankment8
	Cutting10	Cut & Embankment	144.790								60	100	6000	Cutting10
	Embankment9	Cut & Embankment	147.310								60	100	6000	Embankment9
	Embankment10	Cut & Embankment	147.650								50	100	5000	Embankment10
	Cutting11	Cut & Embankment	147.950								50	100	5000	Cutting11
	Embankment11	Cut & Embankment	148.350								60	100	6000	Embankment11
	Cutting12	Cut & Embankment	148.450								60	100	6000	Cutting12
	Cutting13	Cut & Embankment	148.400								60	100	6000	Cutting13
	Embankment12	Cut & Embankment	150.350								60	100	6000	Embankment12
	Construction yard9	Type-B	151.000								100	200	20,000	Track construction
	PSC Girder concrete9		151.000								100	100	10,000	PSC Girder concrete9
	Concrete Plant9		151.000								100	200	20,000	Concrete Plant9
	Embankment13	Cut & Embankment	162.450								60	100	6000	Embankment13
	Tunnel construction	Tunnel	167.000								0	0	66,000	0
	Construction yard10	Type-B	167.000								100	200	20,000	Track construction
	PSC Girder concrete10		167.000								100	100	10,000	PSC Girder concrete10
	Concrete Plant10		167.000								100	200	20,000	Concrete Plant10
	Construction yard11	Type-A	183.500								100	200	20,000	Track construction
	Track Slab Concrete5		183.500								100	400	40,000	Track Slab Concrete5
	PSC Girder concrete11		183.500								100	400	40,000	PSC Girder concrete11
	Concrete Plant11		183.500								100	200	20,000	Concrete Plant11
	Construction yard12	Type-B	195.000								50	100	5,000	construction
	PSC Girder concrete12		195.000								100	100	10,000	PSC Girder concrete12
	Concrete Plant12		195.000								100	200	20,000	Concrete Plant12
	Construction yard13	Type-B	208.000								100	200	20,000	Track construction
	PSC Girder concrete13		208.000								100	400	40,000	PSC Girder concrete13
	Concrete Plant13		208.000								100	200	20,000	Concrete Plant13
	Construction yard14	Type-B	220.000								100	200	20,000	Track construction
	PSC Girder concrete14		220.000								100	100	10,000	PSC Girder concrete14
	Concrete Plant14		220.000								100	200	20,000	Concrete Plant14
	Girder6	Truss yard	221.137								48	440	21,120	Truss yard2
	Construction yard15	Type-B	228.000								100	200	20,000	Track construction
	PSC Girder concrete15		228.000								100	400	40,000	PSC Girder concrete15
	Concrete Plant15		228.000								100	200	20,000	Concrete Plant15

No	Name		km	Depot,Subway,Station,etc				TSS(Traction substation) SP(Sectioning post) SSP(Sub sectioning post)			Temporary yard			Note 20170306-11
	Structure			L	B	n	m²	L	B	m²	L	B	m²	
	Construction yard16	Type B	248.000								100	200	20,000	Track construction
	PSC Girder concrete16		248.000								100	400	40,000	PSC Girder concrete16
	Concrete Plant16		248.000								100	200	20,000	Concrete Plant16
	Girder10	Truss yard	262.600								48	440	21,120	Truss yard10
	Construction yard17	Type A	262.500								100	200	20,000	Track construction
	Track Slab Concrete4		262.500								100	100	10,000	Track Slab Concrete4
	PSC Girder concrete17		262.500								100	100	10,000	PSC Girder concrete17
	Concrete Plant17		262.500								100	200	20,000	Concrete Plant17
	Construction yard18	Type-B	281.300								50	100	5,000	construction
	PSC Girder concrete18		281.300								100	400	40,000	PSC Girder concrete18
	Concrete Plant18		281.300								100	200	20,000	Concrete Plant18
	Girder11	Truss yard	[illegible]								48	420	[illegible]	Truss yard11
	Construction yard19	Type-B	291.800								100	200	20,000	Track construction
	PSC Girder concrete19		291.800								100	100	10,000	PSC Girder concrete19
	Concrete Plant19		291.800								100	200	20,000	Concrete Plant19
	Construction yard20	Type-B	306.000								100	200	20,000	Track construction
	PSC Girder concrete20		306.000								100	100	10,000	PSC Girder concrete20
	Concrete Plant20		306.000								100	200	20,000	Concrete Plant20
	Girder12	Truss yard	317.332								48	470	21,000	Truss yard12
	Construction yard21	Type-B	324.000								100	200	20,000	Track construction
	PSC Girder concrete21		324.000								100	400	40,000	PSC Girder concrete21
	Concrete Plant21		324.000								100	200	20,000	Concrete Plant21
	Girder13	Truss yard	337.338								150	550	82,500	Truss yard13 (L:550m B:150m)
	Girder14	Truss yard	337.428								150	520	78,000	Truss yard14 (L:520m B:150m)
	Construction yard22	Type A	345.000								100	200	20,000	Track construction
	Track Slab Concrete5		345.000								100	100	10,000	Track Slab Concrete5
	PSC Girder concrete22		345.000								100	100	10,000	PSC Girder concrete22
	Concrete Plant22		345.000								100	200	20,000	Concrete Plant22
	Construction yard23	Type-B	366.000								50	100	5,000	construction
	PSC Girder concrete23		366.000								100	400	40,000	PSC Girder concrete23
	Concrete Plant23		366.000								100	200	20,000	Concrete Plant23
	Construction yard24	Type B	367.500								100	200	20,000	Track construction
	PSC Girder concrete24		367.500								100	100	10,000	PSC Girder concrete24
	Concrete Plant24		367.500								100	200	20,000	Concrete Plant24

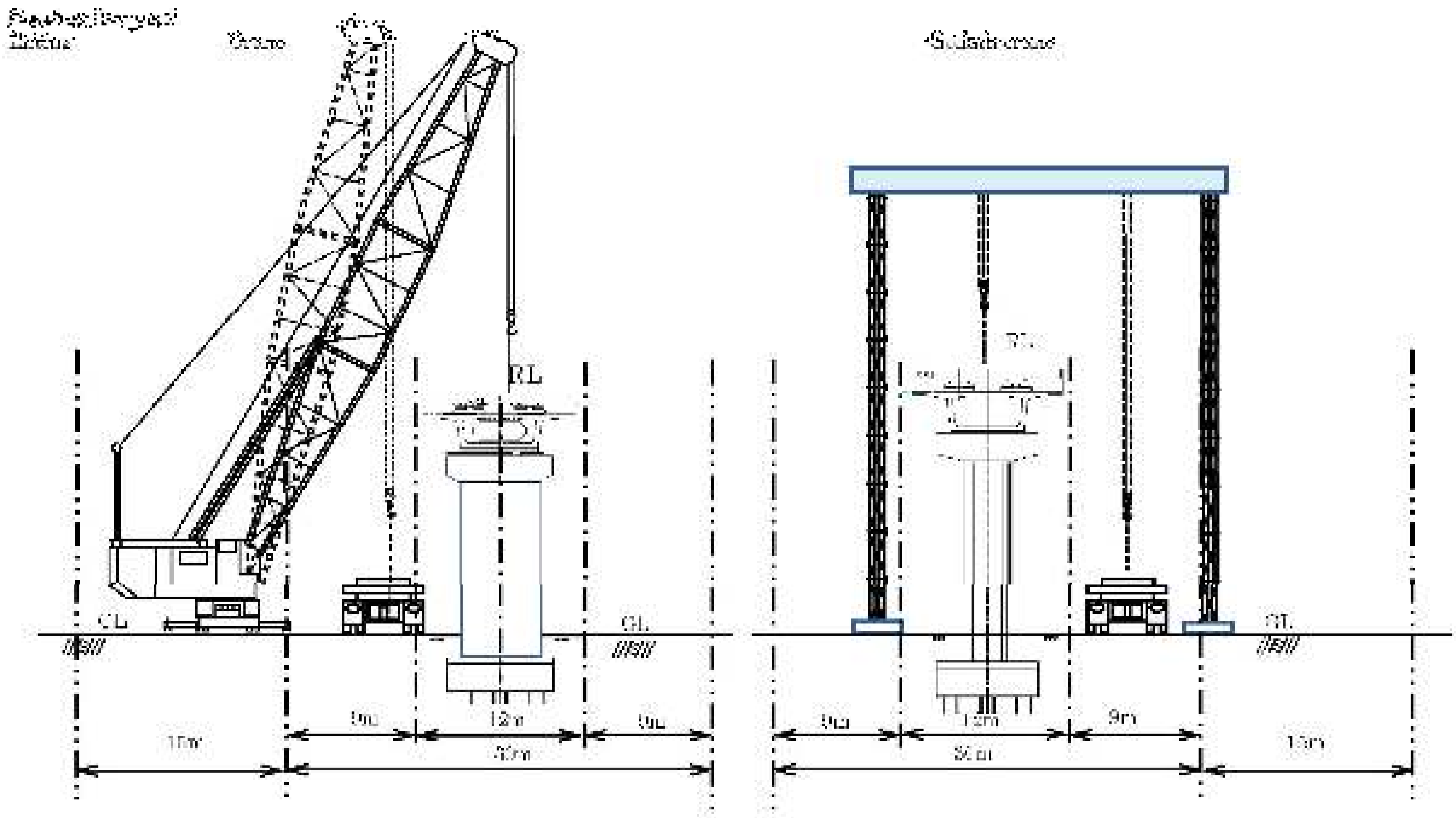
No	Name		km	Depot,Slipway,Stairs,etc				TSS(Traction substation) SP(Sectioning post) SSP(Sub sectioning post)			Temporary yard			Note 2017/03/09-H1
	Structure			L	B	H	m²	L	B	m²	L	B	m²	
	Construction yard25	Type-B	384.000								100	200	20,000	Track construction
	PSC Girder concrete26		384.000								100	400	40,000	PSC Girder concrete26
	Concrete Plant26		384.000								100	200	20,000	Concrete Plant26
	Girder15	Truss yard	383.000								48	440	21,120	Truss yard15
	Girder16	Truss yard	394.080								48	440	21,120	Truss yard16
	Girder17	Truss yard	397.500								48	680	32,640	Truss yard17
	Girder18	Truss yard	400.300								48	530	25,440	Truss yard18
	Girder19	Truss yard	401.450								48	560	26,880	Truss yard19
	Girder20	Truss yard	402.535								48	450	21,600	Truss yard20
	Construction yard26	Type-B	403.000								100	200	20,000	Track construction
	PSC Girder concrete26		403.000								100	400	40,000	PSC Girder concrete26
	Concrete Plant26		403.000								100	200	20,000	Concrete Plant26
	Construction yard27	Type-B	416.000								50	100	5,000	construction
	PSC Girder concrete27		416.000								100	400	40,000	PSC Girder concrete27
	Concrete Plant27		416.000								100	200	20,000	Concrete Plant27
	Construction yard28	Type-A	427.000								100	200	20,000	Track construction
	Track Slab Concrete6		427.000								100	400	40,000	Track Slab Concrete6
	PSC Girder concrete28		427.000								100	400	40,000	PSC Girder concrete28
	Concrete Plant28		427.000								100	200	20,000	Concrete Plant28
	Girder21	Truss yard	431.755								48	440	21,120	Truss yard21
	Construction yard29	Type-B	446.000								100	200	20,000	Track construction
	PSC Girder concrete29		446.000								100	400	40,000	PSC Girder concrete29
	Concrete Plant29		446.000								100	200	20,000	Concrete Plant29
	Girder22	Truss yard	446.630								48	480	23,040	Truss yard22
	Girder23	Truss yard	446.630								150	550	82,500	Truss yard23 (L=150m,B=550m)
	Girder24	Truss yard	455.180								48	440	21,120	Truss yard24
	Construction yard30	Type-A	465.000								100	200	20,000	Track construction
	Track Slab Concrete7		465.000								100	400	40,000	Track Slab Concrete7
	PSC Girder concrete30		465.000								100	100	40,000	PSC Girder concrete30
	Concrete Plant30		465.000								100	200	20,000	Concrete Plant30
	Construction yard31	Type-B	485.000								100	200	20,000	Track construction
	PSC Girder concrete31		485.000								100	400	40,000	PSC Girder concrete31
	Concrete Plant31		485.000								100	200	20,000	Concrete Plant31
	Construction yard32	Type-B	490.000								100	200	20,000	Track construction
	PSC Girder concrete32		490.000								100	100	40,000	PSC Girder concrete32
	Concrete Plant32		490.000								100	200	20,000	Concrete Plant32

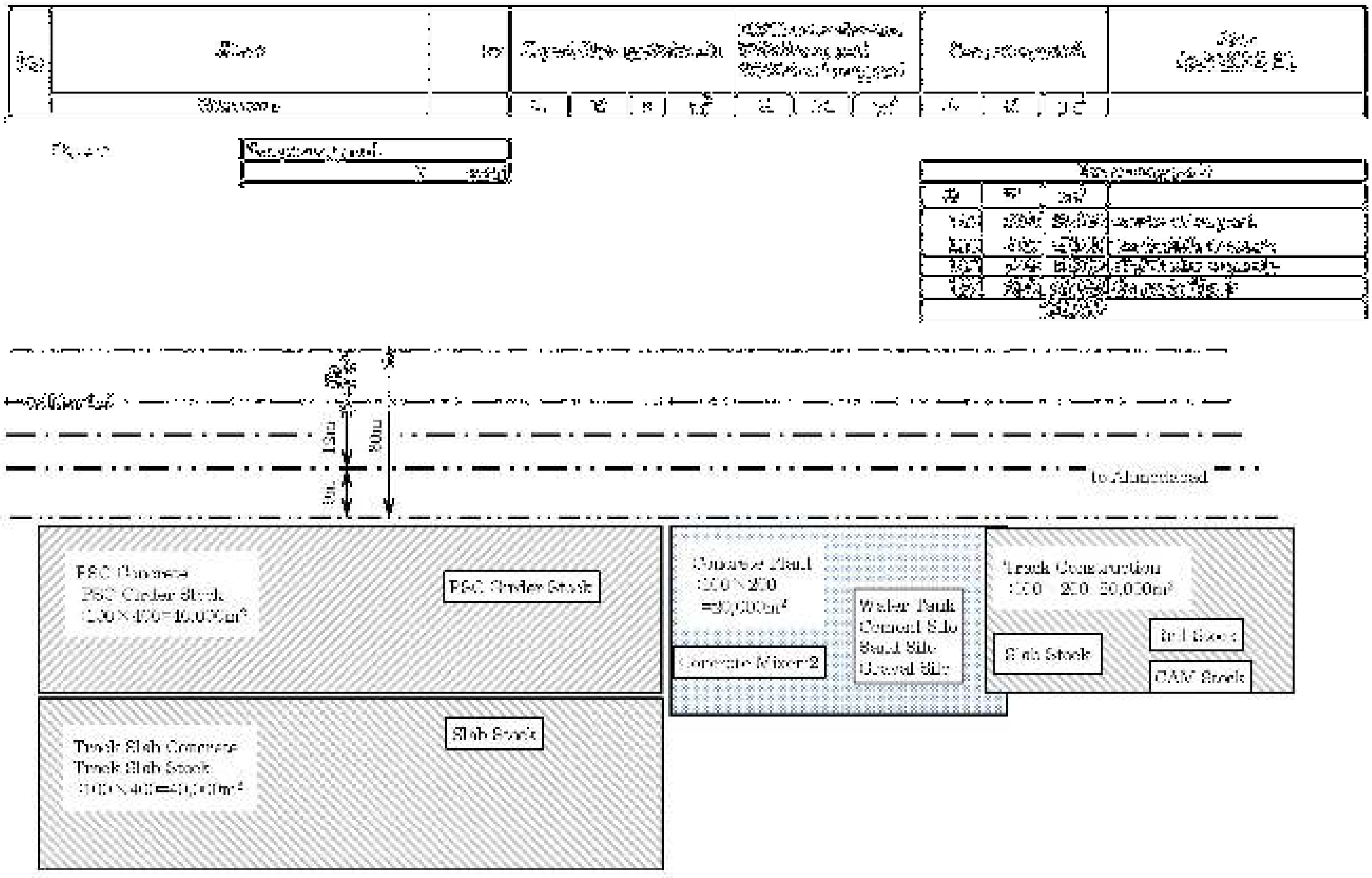
No	Name		km	Depot, Slipway, Stairs, etc				TSS(Traction substation) SP(Sectioning post) SSP(Sub sectioning post)			Temporary yard			Note 20170806-E1
	Structure			L	B	n	m^2	L	B	m^2	L	B	m^2	
	Girder25	Truss yard	[illegible]								48	680	32,640	Truss yard25
	Girder26	Truss yard	429.260								[illegible]	[illegible]	[illegible]	[illegible]
	Girder27	Truss yard	[illegible]								[illegible]	[illegible]	[illegible]	[illegible]
	Girder28	Truss yard	[illegible]								[illegible]	[illegible]	[illegible]	Truss yard28
	Girder29	Truss yard	301.17[illegible]								48	580	27,840	Truss yard29
	Girder30	Truss yard	[illegible]								48	[illegible]	[illegible]	Truss yard30
	Girder3[illegible]	Truss yard	[illegible]								48	[illegible]	[illegible]	Truss yard31
	Construction yard25	Type15	307.000								60	100	6,000	Type construction
	PSC Girder concrete36		307.000								100	400	40,000	PSC Girder concrete36
	Concrete Plant35		307.000								100	200	20,000	Concrete Plant35
	Ballast Track construction2	Sabarmati Depot (Sidhur road)	510.000								100	100	10,000	Ballast Track construction2
	PSC sleeper Concrete2	Maintenance Depot	510.000								100	200	20,000	PSC sleeper Concrete2
	Total										Total =		6,146,700	Temporary area

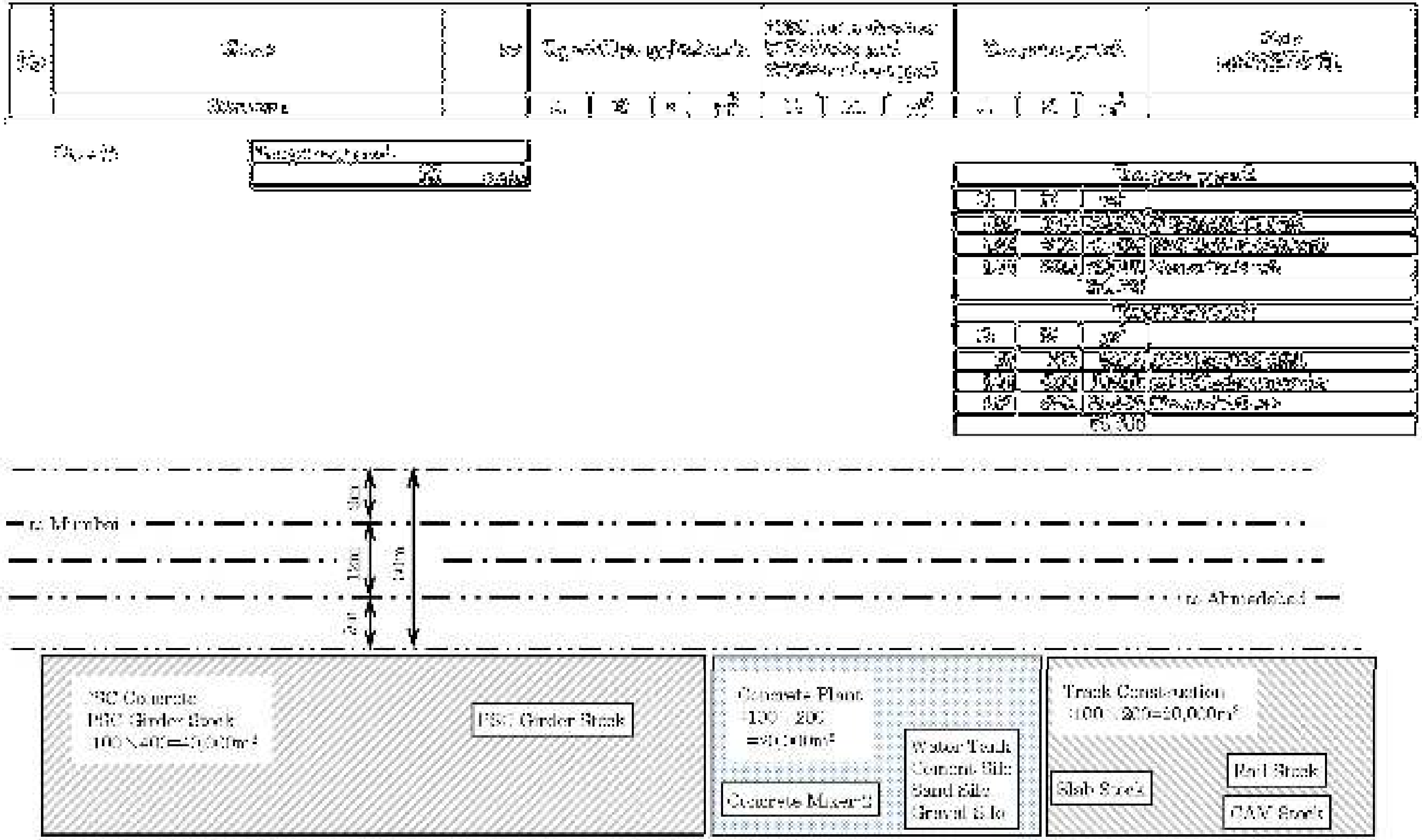
[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

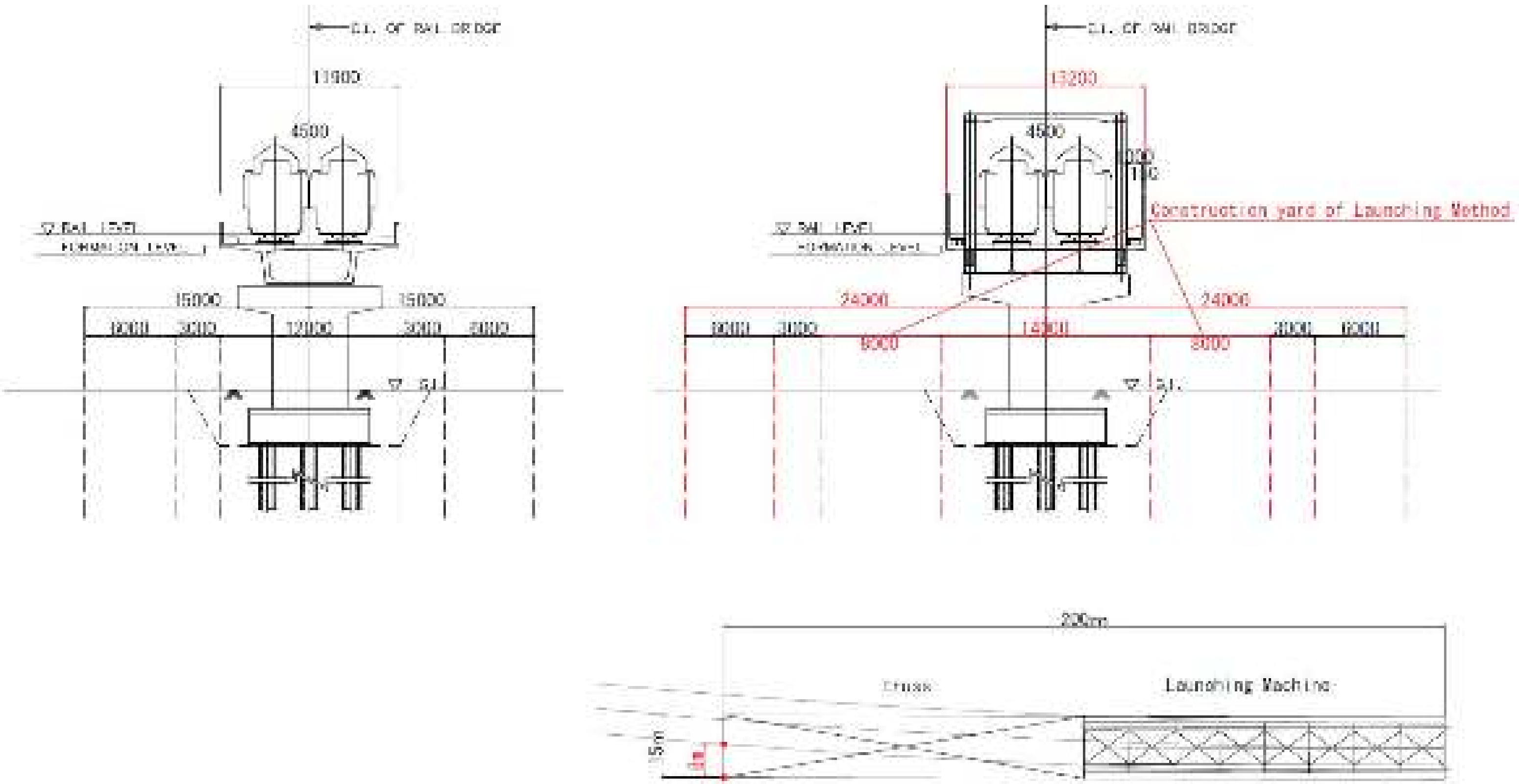
[illegible]	[illegible]	[illegible]	[illegible]				[illegible]			[illegible]			[illegible]
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	


RL
GL
GL
9m
12m
9m
15m
30m
RL
GL
9m
12m
9m
30m
15m


15m
30m
5m
to Ahmedabad
PSC Concrete
PSC Girder Stock
100×400=40,000m²
PSC Girder Stock
Concrete Plant
100×200
=20,000m²
Water Tank
Cement Silo
Sand Silo
Gravel Silo
Concrete Mixer 2
Track Construction
100×200=20,000m²
Slab Stock
CAM Stock
Track Slab Concrete
Track Slab Stock
100×400=40,000m²
Slab Stock


to Mumbai
to Ahmedabad
PSC Girder Stock
Concrete Plant
Water Tank
Cement Silo
Sand Silo
Gravel Silo
Track Construction
Slab Stock
Rail Stock
CAM Stock

Girder	Truss yard



Annexure – 2 (a)

www.indianrailways.gov.in/railwayboard/uploads/.../infra/.../Main_Report_Vol_I.pdf

Annexure 4.1

4.1 TOPOGRAPHY, PHYSIOGRAPHY AND DRAINAGE PATTERN

The topography of the entire study area along the proposed alignment can be bifurcated into two different regions. The first part towards Mumbai- having undulated and coastal area while the second one, falling in the Gujarat region having plain with minor undulation.

The alignment Starts Underground from BKC Station and enters into tunnel. A total of 8 tunnels have been proposed in the entire alignment with the longest tunnel of 20.375Km under sea at Thane Creek in Mumbai. The total Length of alignment is 508.17 Km out of which 26.203 Km is under tunnel and the rest alignment is on viaduct and bridges. The altitude of the entire study area varies from 1m above MSL to 151m above MSL leaving aside the creek and sea with elevation of 0 m above MSL. The lion's share of the proposed MAHSR alignment runs parallel to the Arabian Sea in Maharashtra as well as in Gujarat. The main rivers in the region cross the corridor, flowing generally east to west from the inland mountains to the sea; their tributaries flow generally north or south.

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 paddies, and generally land unsuitable for road construction. In this region, the rivers form marshy estuaries in the broad tidal flats. In some locations (but not within project corridor), 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. There are few forested areas in the Coastal Plain, except in the south.

Rolling Terrain Region

The Rolling Terrain Region is characterized by undulating landscape and soils with good constructability. Cross slopes of the land range between 10 and 25 percent. The project corridor in Thane and Palgarh is passing through rolling terrain.

Drainage System

Maharashtra

The Mumbai

Geographically, Mumbai is an island outside the mainland of Konkan in Maharashtra separated from the mainland by narrow Thane Creek and a somewhat wider Harbor Bay. At present, it covers the original island group of Mumbai, and most of the island of Salsette, with the former Trombay island appended to it in its Southeast. A small part in the north the Salsette island however, lies in Thane District. The Salsette-Mumbai island creek and the Thane Creek together separate it from the mainland. Thus the area of Greater Mumbai is surrounded on three sides by the seas; by the Arabian Sea to the west and the south, the Harbor Bay and the Thane Creek in the east-but the north, the district of Thane stretches along its boundary across the northern parts of Salsette. Its height is hardly 10 to 15 meters above sea level. At some places the height is just above the sea level. Part of Mumbai City district (Backbay and Bandra reclamation)is the major reclamation areas of Mumbai in the Arabian sea. The drainage pattern of Mumbai region is illustrated in Exhibit 4.1.2.

Exhibit 4.1.2: Drainage Map of Mumbai

Source: District profile of Mumbai, District Gazetteer

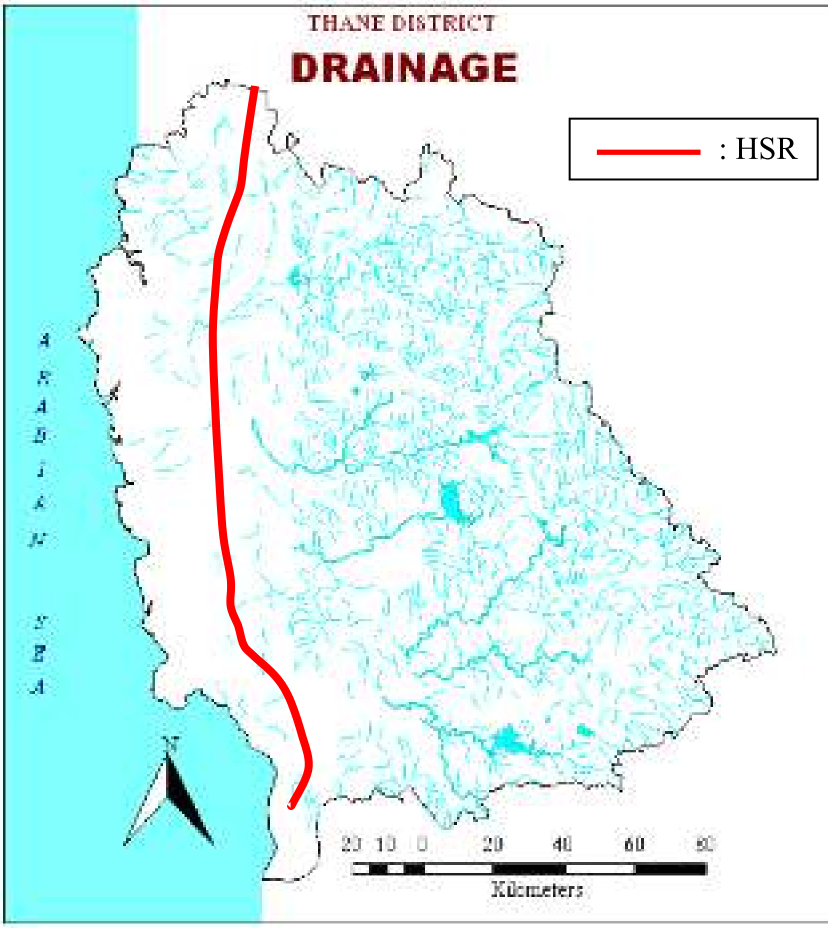
Thane

The drainage of this region is controlled by mainly two rivers streams of North Konkan, namely the Ulhas and the Vaitrana, both draining the rainy western slopes of Sahyadri that lie between the Bhor and the Thal Ghats. There is much similarity in their courses. The drainage pattern of Thane is shown in Exhibit 4.1.1.

Creeks

All along the coast many creeks are found, in which tidal water flood upstream and inundate much low ground; human interference in many cases has helped in converting them into mud flats. Of these, mention can be made of the Bhivandi, Chinchani, and Dahanu creeks. The Sopara creek in the bygone days was an important artery of sea-traffic bringing Arab dhows and Greek sailing vessels to the now forgotten Sopara that was a celebrated port. The Thane creek is not a creek in the true sense, but a depression engulfed by the sea. Its shallowest point is just south of Thane where a ridge of rocks affords the foundation for the railway bridge.

Exhibit 4.1.1: Drainage Map of Thane

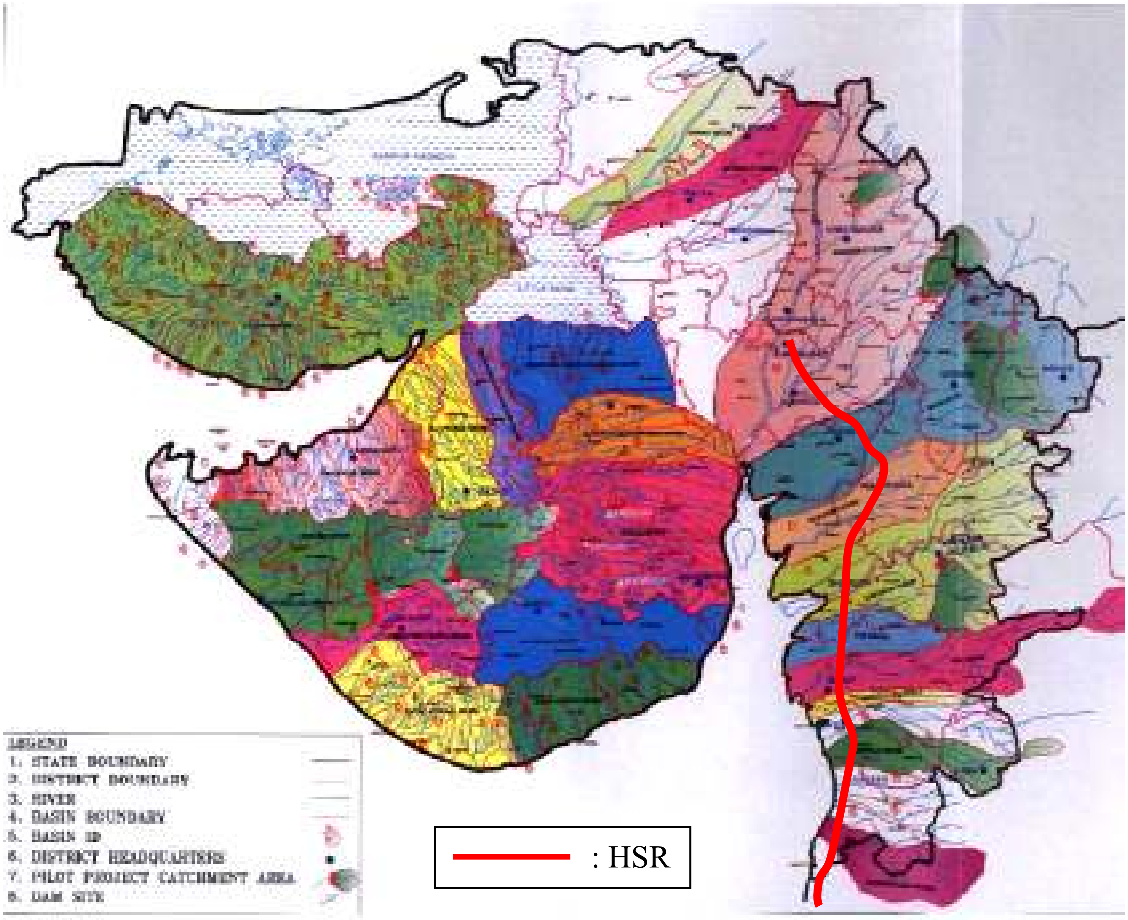


Source: District profile of Thane, District Gazetteer

Gujarat

Drainage of all five physiographical regions of Gujarat State is distinct with the prevailing topographical and physical characteristics of the rock formations. The flow direction of some of the major rivers is controlled by major tectonic activity. The drainage system of Gujarat is shown in Exhibit 4.1.3. Drainage of the Mainland Gujarat has been controlled by the factors of physiography, geology (tectonics) and climate (past as well as present). It shows two distinct sets of rivers. Rivers occurring in the northwestern part (Rupen, Saraswati and Banas) arise from Aravalli hills and flow into the Ranns of Kachchh. These rivers have courses of about 150 km lengths at the maximum and are more or less seasonal carrying water only during the monsoons. Interestingly, these rivers though shallow, have wide sandy channels in their lower reaches. The rivers draining the central and southern parts fall into the Gulf of Khambhat and the Arabian Sea. Major rivers are Sabarmati, Mahi, Narmada and Tapi. The Sabarmati river originates in the southwestern spurs of the Aravalli hills and traverses a distance of 416 km through the districts of Sabarkantha, Ahmedabad and Kheda before meeting the Gulf of Khambhat. Interestingly, the river has, in its upper reaches cliffy banks rising upto 50m. In its lower reaches, the river is seen to have frequently changed its course. The plains of Central Gujarat lying between Sabarmati and Mahi are drained by a number of tributaries of Sabarmati, viz., Khari, Shedhi, Mejan, Andheri, Meshwo and Vatrak, of these, Meshwo and Vatrak are the major ones. Meshwo originates in Dungarpur district of Rajasthan and meets the Vatrak river. The Vatrak also rises from the Dungarpur hills and meets Sabarmati at Vautha. The river Shedhi which forms the chief drainage of the alluvial plains between Sabarmati and Mahi originates from the eastern hills of Panchmahals district and meets Vatrak at Kheda.

Exhibit 4.1.3: Drainage Map of Gujarat



Source: www.gujarat.gov.in

The river Mahi, the third largest river of Gujarat after Narmada and Tapi, rise from about 556 m above sea-level in the Malwa region around Sardarpur in Madhya Pradesh. It flows for about 180 km in Gujarat before emptying into the Gulf of Khambhat. The lower course of the river for about 70 km is characterized by heavily gullied cliffy sand-banks and ravines. Towards south, the river Dhadhar rising from the Shivrajpur hills also flows into the Gulf of Khambhat. This river is met by a major tributary Visvamitri, 25 km SW of Vadodara. The river Narmada originating in the hills of Amarkantak in Madhya Pradesh, 1150 m above the sea-level, cuts through the hill range of Satpura and Vindhya before entering Gujarat, and as is well known, thisriver flows along a major geo fracture zone. Within the Gujarat State it has a 150 km long. course and finally falls into the Gulf of Khambhat near Bharuch. The Orsang river is a major tributary of Narmada, meets it on its right bank at Chandod on the left bank, river Karjan flows into Narmada at Rundh. Lower down its course between Shuklatirth and Bharuch, three smaller tributaries namely viz., Kaveri, Amravati and Bhukhi, join the main river. For almost 100km, the Narmada flows across the most fertile plains of Gujarat. Other rivers to the south of Narmada (Damanganga, Kolak, Par, Puma, Auranga, Ambica and Mindhola) of South Gujarat are comparatively smaller and rise within the boundaries of the state from the eastern trappean highlands. Tapi river, after flowing through Madhya Pradesh and Maharashtra, enters the trappean highlands of Gujarat and runs for about 100km before meeting the sea, 10 km west of Surat. As compared to Narmada, Tapi is a smaller river but the area drained by it in Gujarat is quite large. The lower Tapi valley is very fertile and covered with black cotton soil. The Kim river rises in the Rajpipla hills and flows into the Gulf of Khambhat. The river Mahi, the third largest river of Gujarat after Narmada and Tapi, rise from about 556 m above sea-level in the Malwa region around Sardarpur in Madhya Pradesh. It flows for about 180 km in Gujarat before emptying into the Gulf of Khambhat. The lower course of the river for about 70 km is characterized by heavily gullied cliffy sand-banks and ravines. In south, the river Dhadhar rising from the Shivrajpur hills also flows into the Gulf of Khambhat. This river is met by a major tributary Visvamitri, 25 km SW of Vadodara. The river Narmada originating in the hills of Amarkantak in Madhya Pradesh, 1150 m above the sea-level, cuts through the hill' range of Satpura and Vindhya.

Annexure 4.2

4.2 LANDSCAPE

Landscape of the project area can be bifurcated into two different types a) the area falling in the Maharashtra region and b) the area falling in the Gujarat region. The landscape of Maharashtra region is undulated with many hillocks with rich vegetation and coastal plains while the landscape falling in Gujarat is plain with minor undulation.

(1) Mumbai and Thane Region

In geographical terms the state of Maharashtra can be divided into three different regions Konkan Coastal Line, Deccan plateau and the Western Ghats. The landscape of the state varies from - deciduous forests, arid deserts, coastal regions, lush green forests to lofty hills. The typical landscape of Maharashtra is shown in Exhibit 4.2.1

Exhibit 4.2.1: Landscape of Maharashtra

Source: Wikipedia

The physiographic feature of Mumbai region is broad and flat terrain flanked by north - south trending hill ranges. The hill range forms almost parallel ridges in the eastern and western part of the area. The Powai - Kanheri hill ranges are the other hill extending in the eastern and central part running NNE-SSW. The maximum elevation of the area is 450 m above mean sea level (above MSL) at some of the peaks of hill ranges. Trombay island has north-south running hills with maximum elevation of 300 metre above mean sea level. Malbar, Colaba, Worli and Pali hills are the small isolated ridges trending north-south in the western part of the area. Geographically, Mumbai is an island outside the mainland of Konkan in Mahrashtra separated from the mainland by narrow Thane Creek and a somewhat wider Harbor Bay. At present, it covers the original island group of Mumbai, and most of the island of Salsette, with the former Trombay island appended to it in its Southeast. A small part in the north, the Salsette Island however, lies in Thane District. The Salsette-Mumbai island creek and the Thane creek together separate it from the mainland. The relief features of the region present the steep scarps of the Sahyadri in the east, the land of the district falls through a succession of plateaus in the north and centre of the district to the Ulhas valley in the south centre. These lowlands are separated from the coastal flats by a fairly well defined narrow ridge of hills that runs north-south to the east of the Thane creek, maintaining a remarkable parallelism to the shore at a distance of about six to ten kilometers from the shores. A number of isolated hills and spurs dot the entire district area, so much so that the district as a whole in its aspect is hilly.

The Sahyadri

The western steep slope of the Sahyadri, falling from the crestal plateaus and high peaks, as well as the foothills lie within the limits of the district.

Passes

From the northern limits, adjoining the Gujarat border, till reaching the Thal Ghat, the Sahyadri is subdued in relief, and nowhere, elevations exceed 600 meters. There is no well marked physical barrier between Nasik and Mokhada Taluka of this district and a number of ghat passes have been traditionally used as routes between villages in the plateau and this district.

Off-shoots

A number of spurs shoot off from the Sahyadri westwards into Thane lowlands and plateau. Most of them are narrow, rarely more than two kilometers wide, with steep slopes on either side and often rising to considerable levels, rather abruptly, above the floor level of the plateau. Many of them carry on their crests, small plateaus, often forest clad and of difficult access. This type of a hill, range country, with intervening deep gorges of stream valleys, is at its best seen in the central part of Wada and Jawhar Talukas it presents a memorable picturesque landscape clothed in green soon after the monsoon.

Coastal Ranges

The most rugged terrain of the district is a belt about 15-25 kilometers broad that runs parallel to the coast at a distance of 15-20 kilometers from the shore. In the south of these tracts are the hills of the Salsette Island that form the core and rise to the highest elevation of 462 kilometers at Kanheri and Avaghad and further north in Kamandurg and Tungar hills of Bassein.

Interior Hills

Further inland to the north east of the Manor is the semi-circular hill of Pola with its peaks Adkilla and Asheri. About thirteen kilometers south of Manor, across the Vaitarna from Keltan and Takmak stands the solitary fortified hill of Kohoj rising abruptly from the plains and visible over considerable distances from all around. Between this rugged terrain and the Sahyadri in the east, the country is comparatively level, broken by few hills. Of these, the western-most hill in Wada is Davja with its two spurs. Smaller hills in Wada are Kapri in the east, In Dagaon hills in the north-west, and Ikna and Domkavla hills in the south-east border. About seven kilometers north-east of Shahapur the long flat-topped mass of Mahuli (849 meters) rises like a great block of masonry. The sides of the hills are richly wooded but the laterite - capped top has only a poor stunted vegetation mostly of hirda (Terminalia chebula). North of this, Bhopatgad is crowned with a fort which overlooks Kurlod on the north of the Pinjal River and rises about 170 meters above the general level of the neighboring high country. From the east, the ascent is about 170 meters from the west; it is about 500 meters for its slopes form the face of the Mokhada tableland.

The Southern Hills

In the south, the country is far from level. On the west, the Parsik range runs from Panvel creek northwards and ends abruptly with a cliff face overlooking the Ulhas near Mumbra. Its highest elevation is Dophora peak (405 meters). The curved range of Chanderi stretches from the long level back of Matheran, west to the quaintly cut peaks Tavli and Bava Malang (791 meters) along southern limits of the district. About every twenty kilometers to the north-east, near Bablapur is Muldongri hills.

The Plateaus

Between the coastal range, the hills and Sahyadri scarp the whole country is a succession of plateaus descending from the Sahyadri, step by step and separated from the next lower down with a well-defined scarp face. In the north-east at an elevation of about 300-400 meters is the Jawahar - Mokhada plateau that descends down further west to the Wada plateau at an elevation of about 150-300 meters. The Wada plateau is separated from the coastal lowlands of Palghar and Dahanu by the double range of hills that runs about 15-25 kilometers from the coast, enclosing within it the Surya and the Vaitarna valleys. South-east of the Wada plateau is the Shahapur upland at an average elevation of 300 meters which in the west falls to the Bhiwandi lowland and in the south to the narrowly entrenched Bhatsai-Kalu valleys. In the south-east of the district is the Murbad plateau at an elevation of less than100 meters.The plateau country locally is dotted with low mounds and ladges that are best seen along the railway line from Kalyan to Kasara.

The Coast

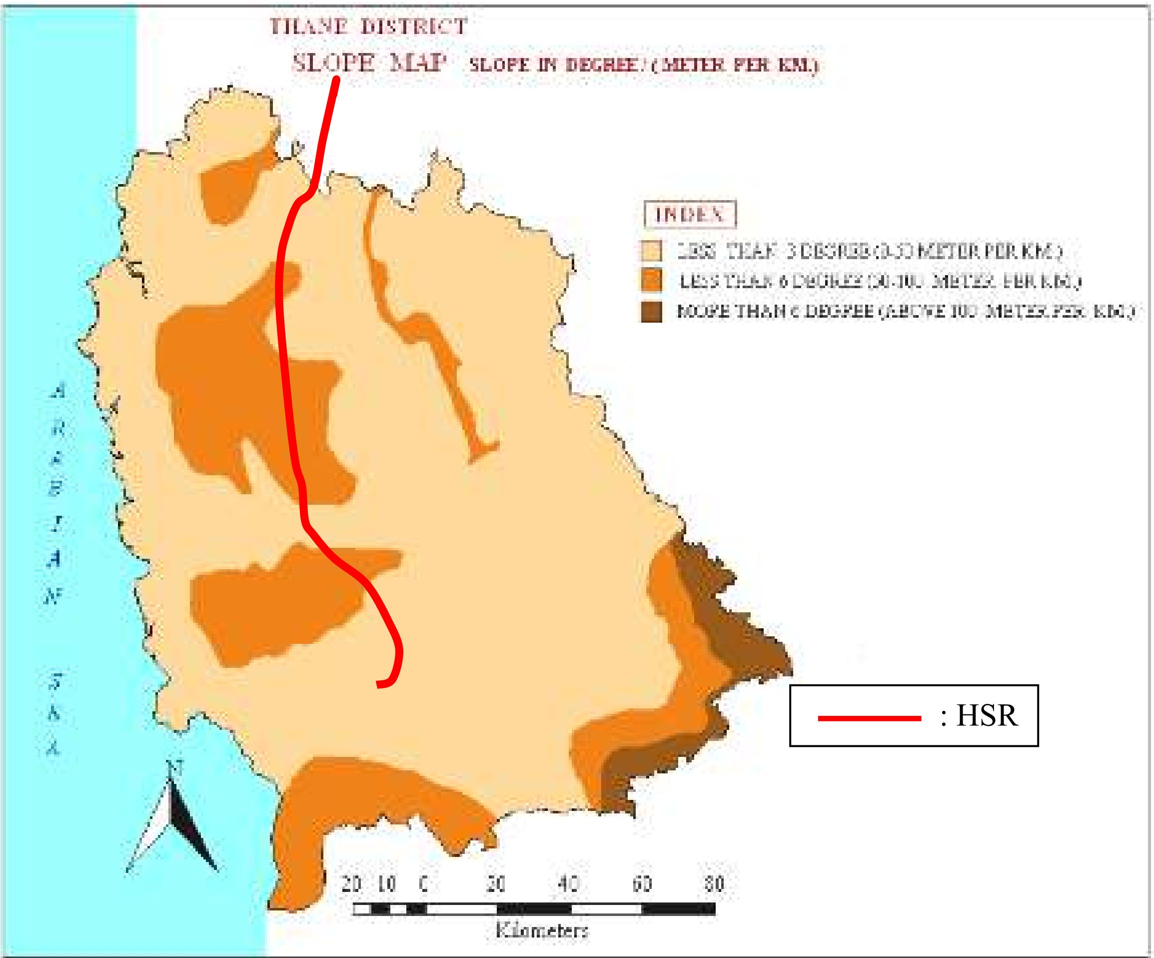
To the west, the district of Thane has a fair coast-line, about 100 kilometers long. The coast naturally falls into two sections to the north and south of Vaitarna estuary. Then the south, the great gulf that runs from the north of Kolaba to Bassein, must in recent time have stretched far further inland than it now stretches. Idrisi description of Thane (1153 A.D.) that it stands on a great gulf where vessels anchor and from which they set sail, may have been adequately deep when sea filled the marsh through which the Thane creek now runs towards Bhivandi and Kalyan and where the wide tracts are now half dry. As late as the beginning of the 19th century, Salsette comprised a number of islands. Within three to five kilometers of the Vaitarana estuary formed the islands of Bassein. The backwater that separated this strip of coast from the mainland opened south-westward into the Bassein creek forming the Sopari creek on which stood the celebrated fort of Sopara Ptolemy. In-between the Vaitarana and Ulhas mouths, island were formed once by the branches of the Bassein creek that ran up to Bhivandi. In the south, the Thane creek was once a broad belt of sea with a number of islands like the Gharapuri, Butcher islands and Karanja, dotting it. Many of these islands have now become a continuous mass of land extending as peninsulas from the mainlands. On the whole, the coast here presents the appearance of considerable submergence. However, geologically the coast is not without its variety. The present coast from Bandra to Dahanu is a constant alternation of bays and rocky headlands with sand spits, dunes and bars in protected reaches behind headlands. Along the coast, in the neighbourhood of Manori and further north, as far as Dahanu, raised beaches made of littoral concrete have been recognized, running north-south close to the present shores and not very high above the present sea level.

North of the Vaitarana estuary, the shores are flat, with long sandy beaches and spits running into muddy shallows; the creeks and streams are at best small inlets divided by wide wastes of salt marshes tracts of slightly rising ground in-between covered by palms, fruit orchards and casurina. This landscape stretches to the foot of the hills that live a few kilometers away and rise abruptly to sufficiently high elevations to mask off the flatness of the low ground. All along the coast, the dreary salt marshes are being steadily reclaimed as salt pans and rice flats.

Islands

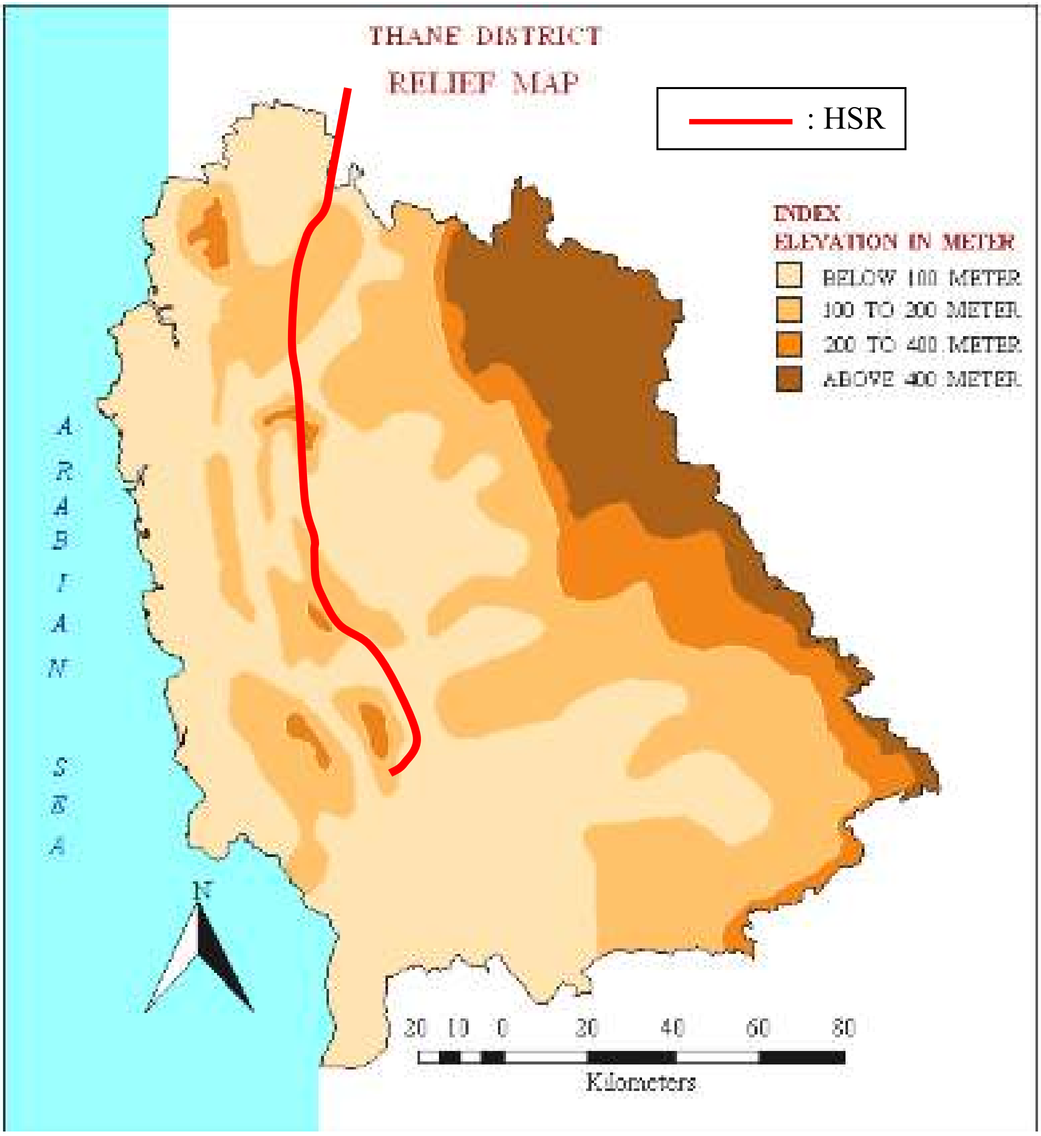
There are number of islands along the sea-margins of the district. The most important of these is the group of Mumbai islands, overlooking Uran and Panvel of Kolaba district on the mainland. In the Bassein tehsil, at the entrance to the Vaitarana estuary lies in the island of the Arnala containing a well-preserved fort. The slope map of Thane showing the change in grade is shown in Exhibit 4.2.2 and the relief feature of Thane is illustrated in Exhibit 4.2.3.

Exhibit 4.2.2: Slope Map of Thane



Source: District profile of Thane, District Gazetter

Exhibit 4.2.3: Relief Map of Thane



Source: District profile of Thane, District Gazetteer

(2) Gujarat Region

Gujarat is situated on the west coast of India. In the west there is Arabian Sea, in the north-west Pakistan, in the north Rajasthan, in the east Madhya Pradesh and in the south and south-east it shares boundary with Maharashtra. The state of Gujarat occupies the northern extremity of the western sea-board of India. It has the longest coast line of 1290 km. The state comprises of three geographical regions. The peninsula, traditionally known as Saurashtra, is essentially a hilly tract sprinkled with low mountains. Kutch on the north-east is barren and rocky and contains the famous Rann (desert) of Kutch, the big Rann in the north and the little Rann in the east. The mainland extending from the Rann of Kutch and the Aravalli Hills to the river Damanganga is on a level plain of alluvial soil. Gujarat's mountains are rich in scenic beauty and have been closely associated with religious and historical aspects of the people. A wide range of physiographic features are displayed within relief variations from sea level to 1000 m elevation. It has a 1600 km long coast line characterized by two gulfs (Gulf of Khambhat and Gulf of Kachchh) and several estuaries. The state strides the Tropic of Cancer in its northwestern part and forms a subtropical high-pressure region. As a result, the atmospheric conditions are influenced dominantly by the monsoon and to some extent by physiography, insularity and the Thar Desert. The proposed MAHSRC alignment passes through five different physiographic divisions of the Gujarat:

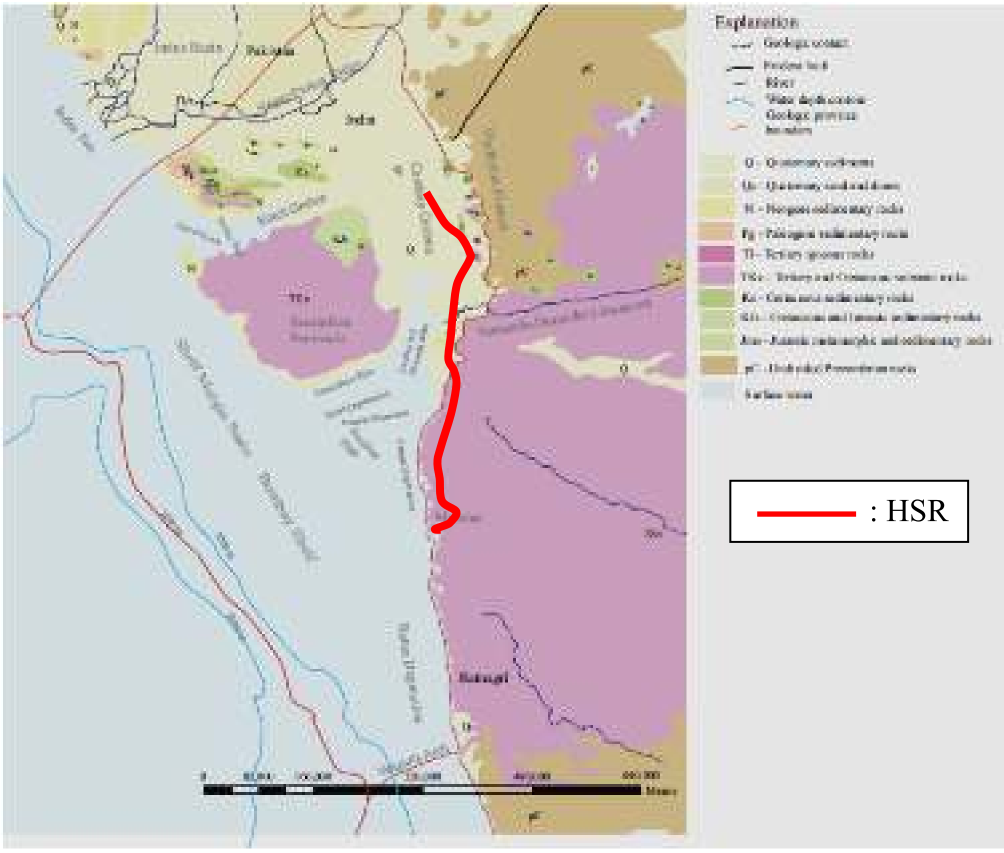
- North Rocky Highland- Panch Mahals
- Central Alluvial Plain-Vadodara, Kheda and Bharuch
- Northern Alluvial Plain-Ahmedabad
- Southern Rocky Highland-Valsad
- Coastal Zone of Gujarat- Surat

Annexure 4.3

4.3 GEOLOGY&SEISMIC CONSIDERATION

Geologically the entire alignment of MAHSRC can be divided into two segments-Alluvial plains of Gujarat and Paleogene sedimentary rocks of Maharashtra, Vindhyan formation. The general geomorphology of the entire stretch of High Speed Rail Corridor is shown in Exhibit 4.3.1.

Exhibit 4.3.1: General Geomorphology of the Entire of Proposed Alignment

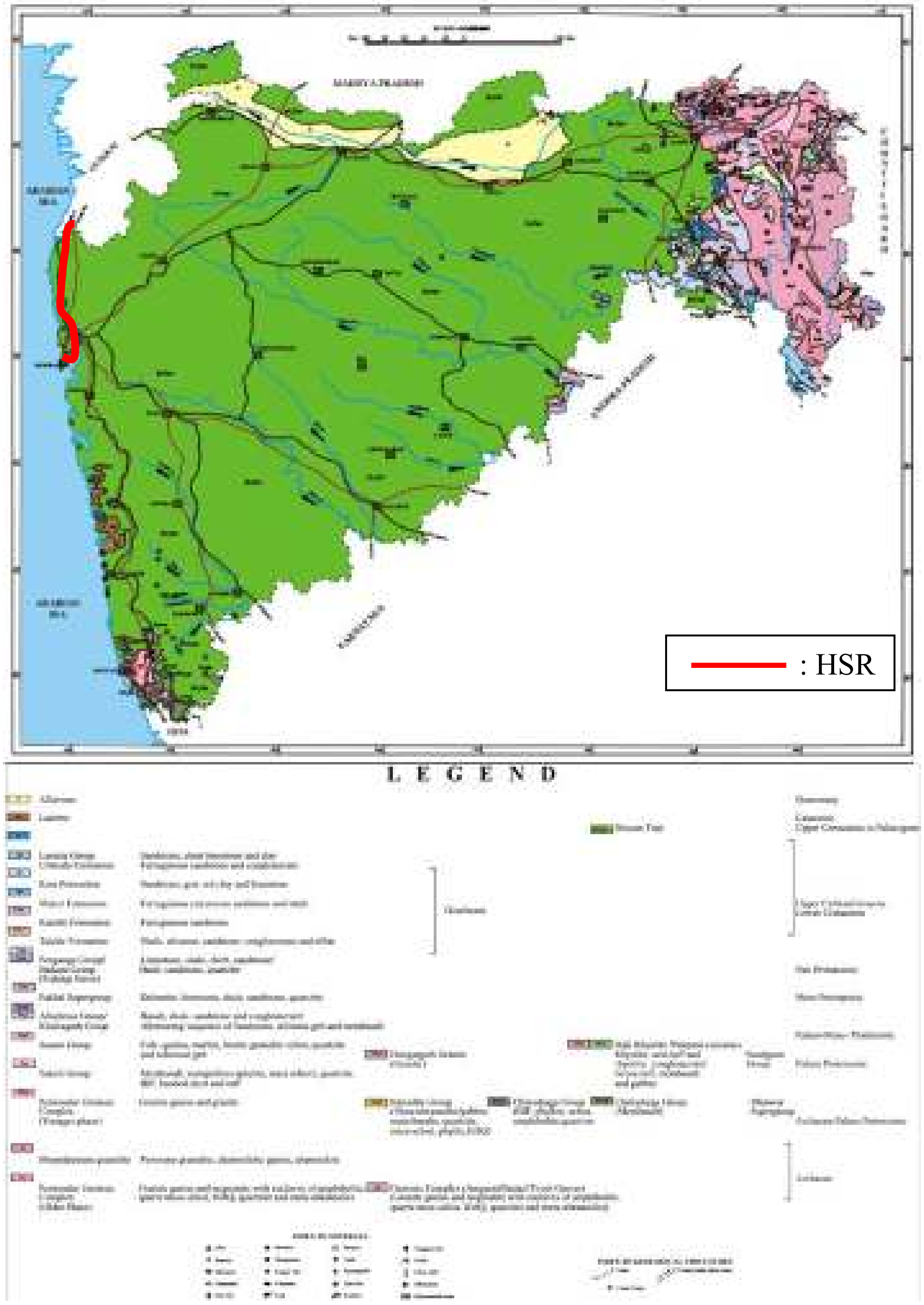


Source: www.portal.gsi.gov.in/

4.3.1 GEOLOGY OF MAHARASHTRA

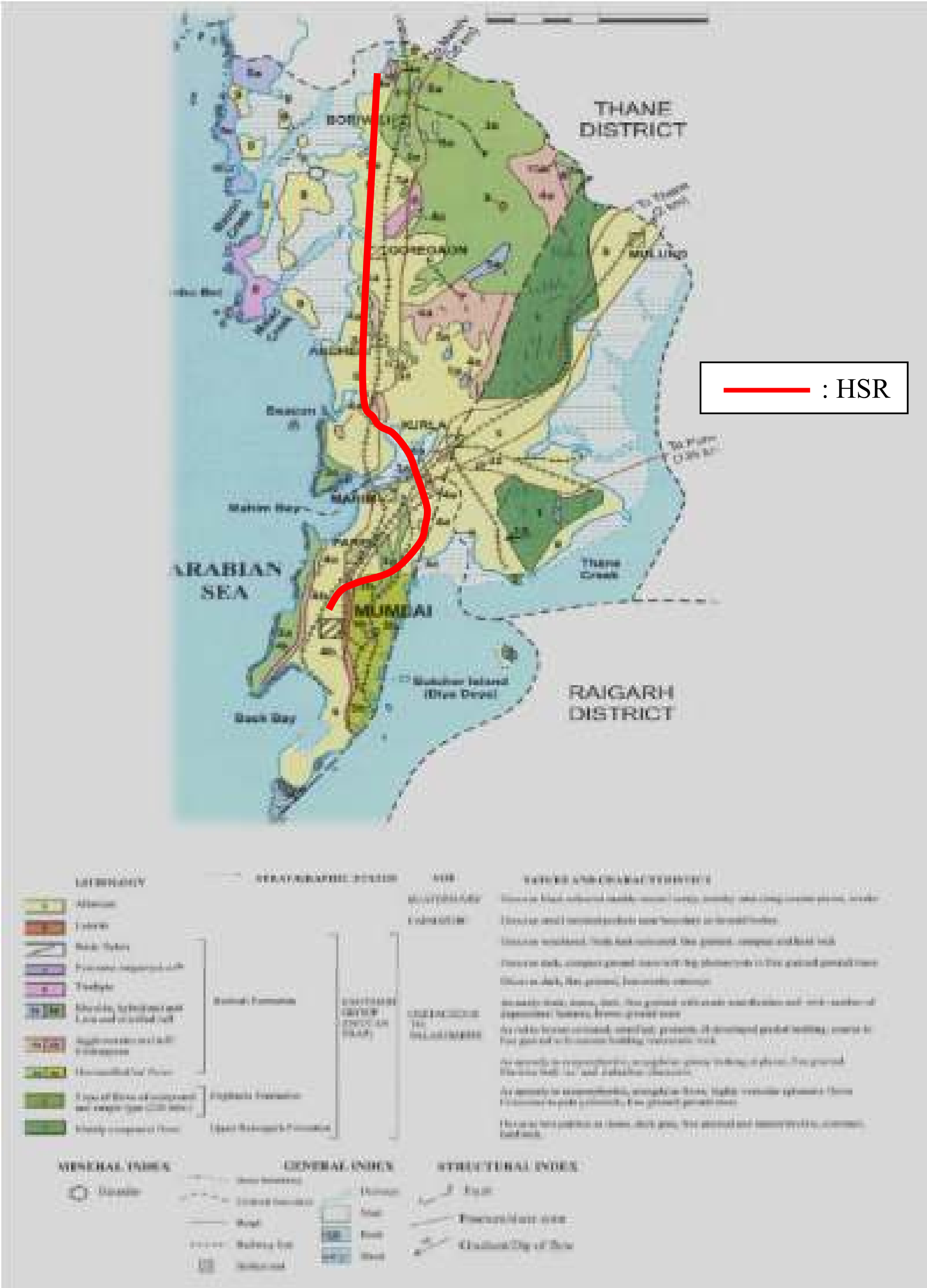
The entire district is underlain by basaltic lava flows of upper Cretaceous to lower Eocene age. The shallow Alluvium formation of recent age also occurs as narrow stretch along the major river flowing in the area. A map depicting the geological feature of Maharshtra is shown in Exhibit 4.3.2, geological feature of Mumbai is shown in Exhibit 4.3.3 and hydrogeological feature of the Mumbai is illustrated in Exhibit 4.3.4

Exhibit 4.3.2: Geological Map of Maharashtra



Source: www.portal.gsi.gov.in/

Exhibit 4.3.3: Geological Map of Mumbai



Source: www.portal.gsi.gov.in/

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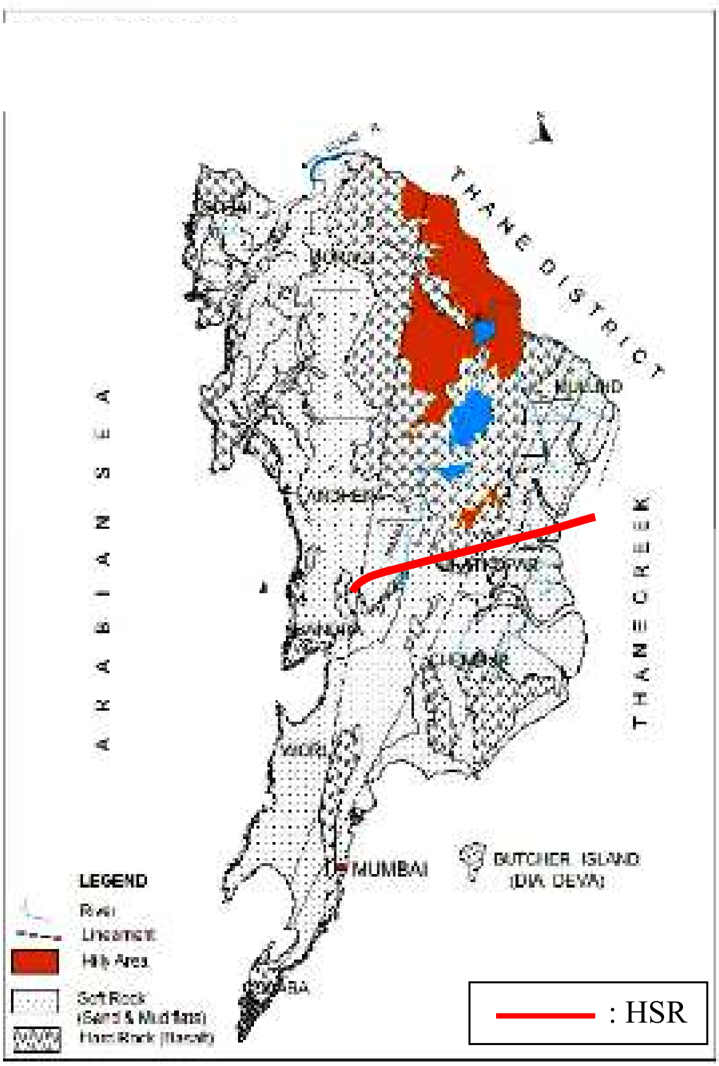
Exhibit 4.3.4: Geohydrological Map of Mumbai



Source: www.portal.gsi.gov.in/

Deccan Trap Basalt

The 'Pahoehoe' flows in the district consists of highly vesicular bottom layer having closely spaced horizontal joints but the thickness is generally less. The vesicles are generally filled with secondary minerals and green earths. In such cases, they do not serve as aquifer. However, such vesicular zones are weathered in most part of the area, thus, making them moderately permeable. But if, vesicles are not filled, they act as highly permeable aquifers. The simple and compound "Pahoehoe" flow comprises a basal vesicular zone, middle relatively massive portion followed by a vesicular top. The vesicles of "Pahoehoe" flows are generally not interconnected and thus there is a variation in water holding capacity from the base to the top of the flow.The ground water exists in fractures, joints, vesicles and in weathered zone of Basalt. The occurrence and circulation of ground water is controlled by vesicular unit of lava flows and through secondary porosity and permeability developed due to weathering, jointing, fracturing *etc.*, of Basalt. The ground water occurs under phreatic, semi confined and confined conditions. The leaky confined conditions are also observed in deeper aquifers. Generally,the phreatic aquifer range down to depth of 15 mbgl. The water bearing zone down to depth of 35m bgl forms the semi-confined aquifer and below this deeper aquifer down to depth of 60m bgl is observed. The yield of thedugwells varies from 10 to 1000 m^3/day, whereas that of borewells ranges between 50 and 1000 m3/day. It is expected that the potential of deeper aquifers would be much more limited as compared to the unconfined/phreatic aquifer.

Soft Rock Areas
River Alluvium patches along the course of rivers and Marine Alluvium in the coastal area, are highly potential aquifer but with limited areal extent. The ground water occurs under water table condition in sandy/gritty layers. The alluvial fill of low lying areas underlain by weathered basalt has relatively better ground water potential.

4.3.2 GEOLOGY OF THANE

The 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 Thane district which have positive relation with the geology of the area. 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.A general geological sequence is as follows:

- Shore sand- Recent,
- Laterite-Pleistocene
- Basalt-Eocene.

Deccan Traps
The Deccan trap has been divided into three major groups*, i.e.*upper, middle and lower. The Bombay basalt flows have been grouped into upper traps on the basis of the inter-trappean and ash beds present in them (Krishnan, 1968). Being in the contiguous area, the Deccan traps in the district can also be grouped with the upper flows.There are number of dyke's criss-crossing the area. The general trend is however, north-northwest south-southeast and north-northeast south-southwest, dipping steeply to the east. The thickness seldom exceeds six meters. The dykes send out offshoots of different sizes, at places enclosing lenticular wedges ofcountry rock. Chilled margins are seen along dykes' flow contact.The dykes vary from coarse dolerite to fine grained basalts. Most ofthe dykes are porphyritic of feldspars. (Refer Exhibit 4.3.5)

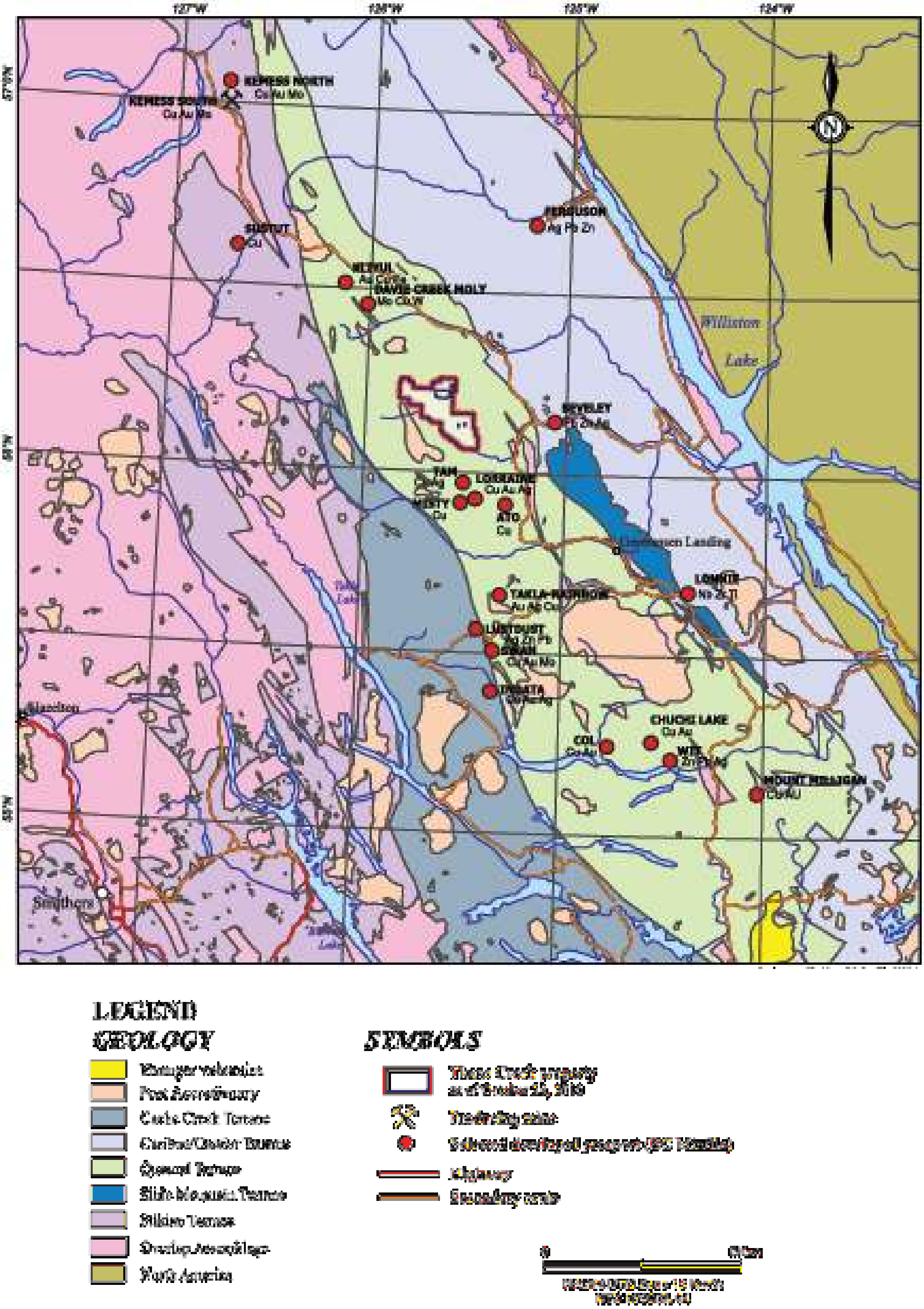
Laterite
Few high basalt plateaus of the district are capped bylaterites. These are Boundongri ($19^0$10'N-$75^0$57'E) and Bombassadongri ($19^0$11'N-$75^0$57'E) 430 meters, Kanheri ($19^0$13'N-$72^0$58'E) 510 meters, and Tungar ($19^0$26'N-$72^0$55'E) 665 metershills. The Kanheri and Tungar laterites have conspicuous development of bauxite.

Shore Sands
The sea coast of the district stretching severalkilometers along the western boundary is covered by sands.

Thermal Springs
There are about thirty-three hot springs whichare described under five groups based on their location.

Vajreshwari Group
i) Ganeshpuri area ($19^0$29'N-$73^0$01'E)-There are thermal springs, most of these occurring on medium tocoarse grained dykes.

Exhibit 4.3.5: Geological Map of the Thane Creek



ii) Akloli area ($19^0$29'N-$73^0$02'E)-There is linear cluster of six thermalsprings near the left bank of Tansa river. They occur at the easternmargins of fine grained dolerite dykes trending east.

Sativli Group: ($19^0$38'N-$72^0$55'E) There are about six springs inthis group. They occur at about a kilometer west of Sativli village, near Vadvali.

Haloli Group: ($19^0$40'30"N: $72^0$51'30"E) There are four hot springs at Haloli occurring in a paddy field 0.1 km west of the new highway.

Paduspada Spring: ($19^0$41'30"N: $72^0$55'30"E).The four springs in this group are seen in the soil covered left bank of Vaitarna river.

Most of the thermal springs are seen on the fringe of dykes.The temperatures of the spring vary from 30^0C to 70^0 C. Most of thesprings are rich in sodium chloride. These waters are proved to havetherapeutic values. Most of the springs give out gases from theorifice of the springs at periodic intervals.

Economic Mineral Deposits

i) Bauxite Deposits

Tungarplateau is the most promising of all the aluminous laterites reportedin the district. The plateau rises to an elevation of about 665 metersand is situated about 14.5 kilometers north-west of Bassein ($19^0$20'N-$72^0$48'E).

ii) Common Salt

Common salt is collected in artificial evaporationpans along the coast. It is thriving industry.

Geological Strata-Thane Creek

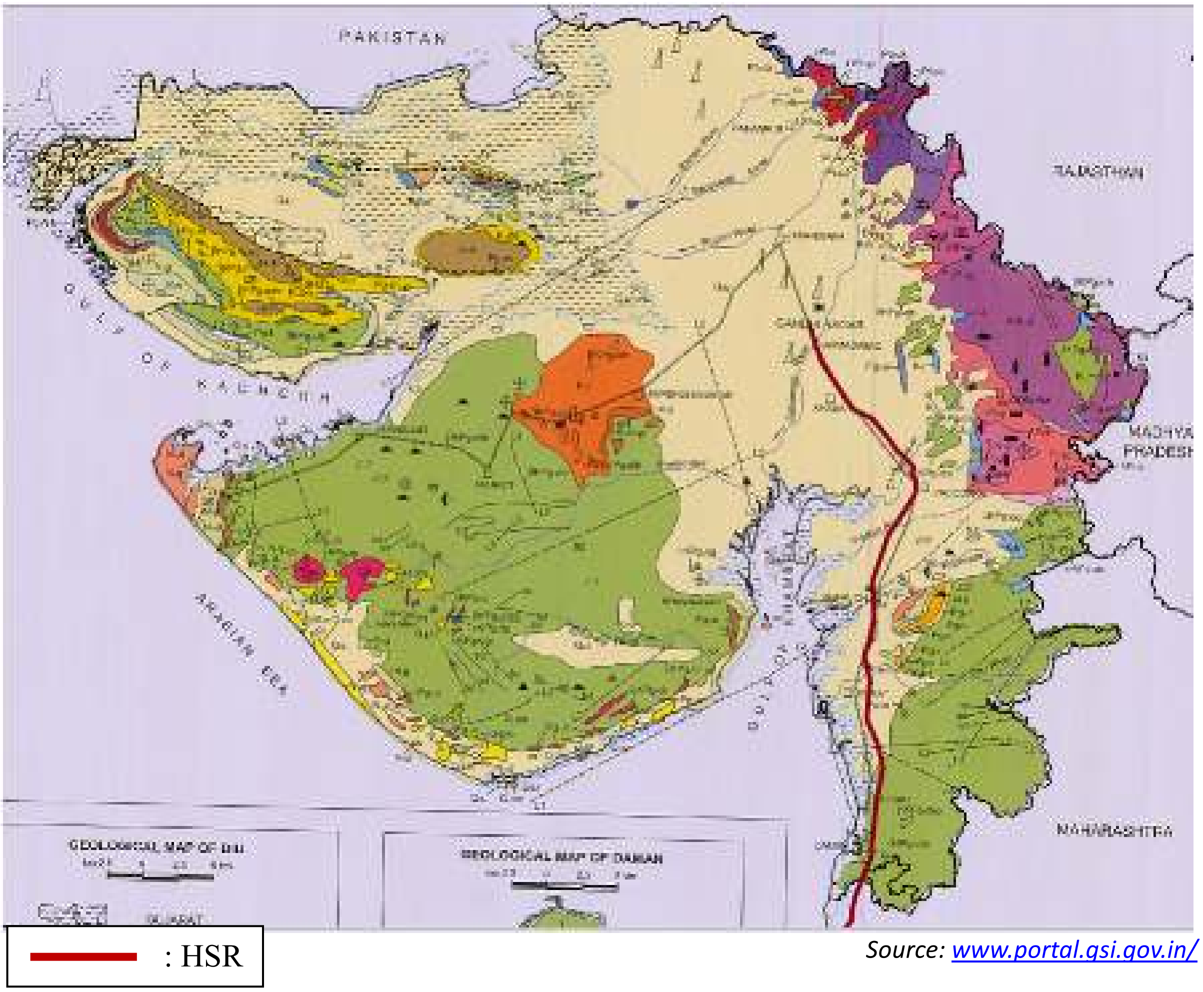
During the detailed design engineering stage, the geological exploration has been carried out in the Thane Creek area for the proposed undersea tunnel. The outcome of the exploration is briefly discussed in the succeeding sections.

To confirm the geological strata of Thane Creek, geological exploration has been carried out by RITES, FUGRO and IGS at 30 locations. A tunnel of 20.375 km length has been proposed in the Thane Creek about 40 m below the surface of the sea. Basaltic rock has been reported in the bore log data.

4.3.3 Geology of Gujarat

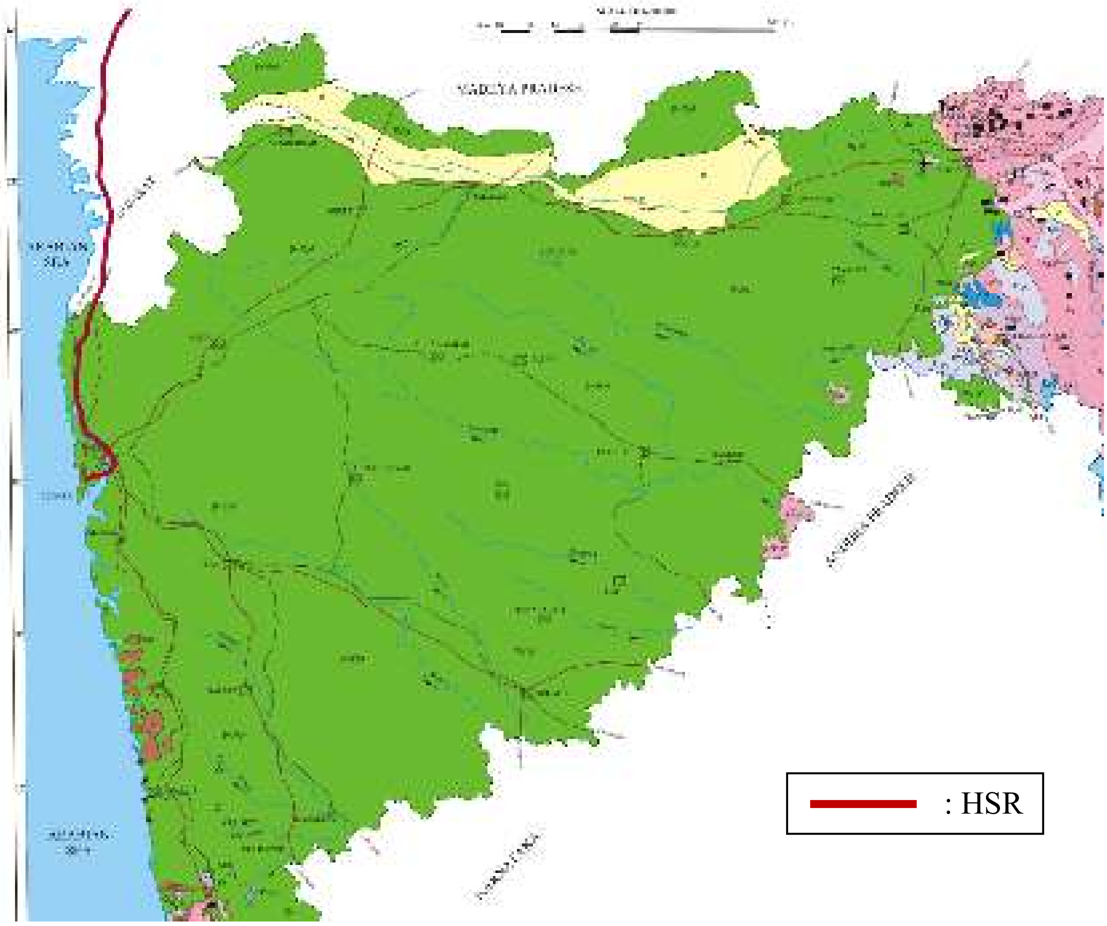
The Mainland Gujarat is further divisible into two well-defined zones: (i) the Eastern Rocky Highlands and (ii) the Western Alluvial Plains. The Eastern Rocky Highlands that show an altitude variation from 300 to 1,100m are the extensions of the major mountains of western India - the Aravalli, Satpura and the Sahyadri. The hilly areas of the north form the SW extremity of the Aravalli Mountain. The geological map of Gujarat is shown in Exhibit 4.3.1 and major geomorphic division of Gujarat is shown in Exhibit 4.3.2.The Aravalli hills within the Gujarat state do not show any well-defined directions, but regionally they conform to the NE-SW trends. The rocks belong to the Delhi and Aravalli Supergroups with associated intrusives. A majority of the hills fall within an altitude range of 300 to 600 m. The central part of the hilly terrain, lying between the Mahi and Narmada rivers, referred to as Vindhyan range provides an example of topography typical of Archean metamorphics and granitic rocks; specific trend is observed. The altitude ranges between 150 and 500 m, the average heights being -350 m. The rocky area to the south of Narmada is included in Sahyadri, and the area especially beyond Tapi River is characterized by E-W trending hill ranges of basalt: from north to south shows a progressive increase in altitude with a step-like topography. Elevationwise, a major part of the trappean highland shows an altitude variation from 150 to 300m.The Western Alluvial Plains are made up of a thick pile of unconsolidated sediments deposited by a combination of fluvial and aeolian agencies during the Quaternary period. Forming the western half of the Mainland Gujarat, the altitude variation of the plains ranges from 25 to 150m with a gradual seaward slope. These plains of North and Central Gujarat in their deepestparts are very thick and could be as deep as 500m or even more at places. Across these plains flow the major rivers of Gujarat.

Exhibit 4.3.1: The Geological Map of Gujarat



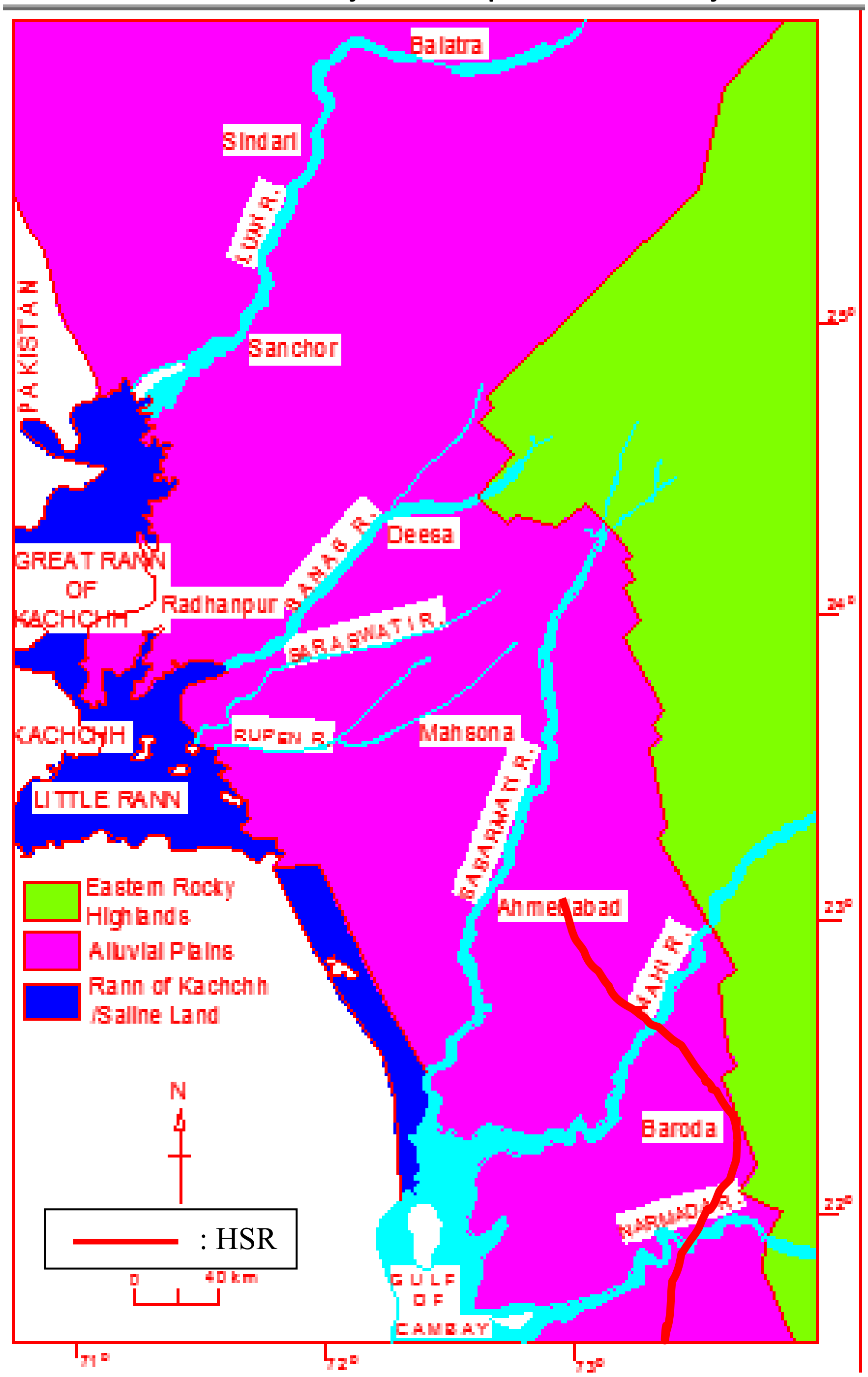
Source: www.portal.gsi.gov.in/

Exhibit 4.3.2: The Geological Map of Maharashtra



Source: www.portal.gsi.gov.in/

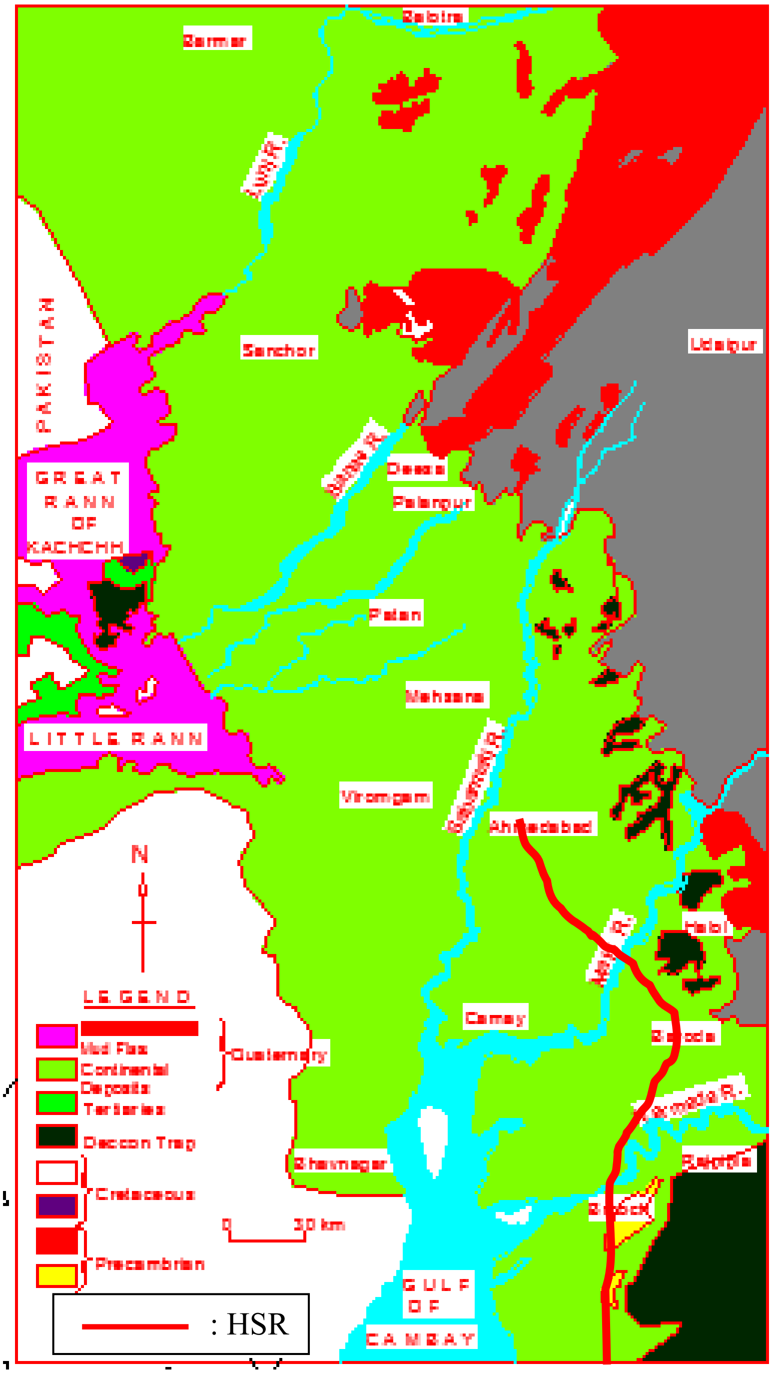
Exhibit 4.3.3: The Major Geomorphic Division of Gujarat



Source: www.portal.gsi.gov.in/

The geology of Gujarat comprises a Precambrian basement over which younger rocks commencing with Jurassic, continuing through Cretaceous, Tertiary and Quaternary have given rise to varying sequences in different parts. Thus, the rocks of Gujarat belong to formations ranging in age from the oldest Precambrian to Recent. A generalized geological map of Mainland Gujarat based on the work of Geological Survey of India is illustrated in Exhibit 4.3.3 and the stratigraphy of Mainland Gujarat is presented in Table 4.3.1.

Exhibit 4.3.4: The Generalized Geological Map of Mainland Gujarat



Source: www.portal.gsi.gov.in/

Table 4.3.1: Straitigraphy of Mainland Gujarat

Era	Period	Age	Group / Formation	Lithology
Cenozoic	Quaternary	Holocene	Gujarat Alluvium / Narmada FM	Sand, Silt, Clays With Gravel Beds
		PleistoceneU	Jambusar FM (Not Exposed)	
		L		Coarse, Sand, clays, Kankars
	Tertiary	Pliocene U	Bharuch FM (Not Exposed)	Claystone, Sandstone
		L	Jhagada FM	Conglomerate Sandstone
		Miocene U	Kand FM	Conglomerate, Fossil, Limestone, Calc, Sandstone,
		L	Babaguru FM	Conglomerate Sandstone
		Oligocene		
		Eocene U	Dinod FM	Fossil, Limestone, Marl
		L	Vagadkhol FM	Conglomerate Grit Sandstone, Clay, Siltstone
		Palaeocene U L	Laterite / Deccan Trap	Bauxite Bentonite / Tholeitte & Alkali Basalt
Mesozoic	Cretaceous	U	Decccan Trap / Lamenta	Flows & Intrusives / Limestone
		L	Bagh Beds / Nimar Sandstone	Limestone, Mari, Sandstone
	Jurassic	U		
		M		
		L		
Proterozoic	PostDelhiMagmatism		Malani Volcanic	Andesite Albitised Basalt
			Erinpura Granite	Potash Granite, Micro-Granite, Granite Porphyry
			Godhra Granite	Granite, Granite gneiss
			Post-Delhi Pre Erinpura Granite Phase	Meta-Gabbro Meta-Dolerite, Epidiorite
	DelhiSupergroup		Sirohi Group	Phyllite, Mica-Schist, Calc Schist
			Ambaji Granite	Granite Granodioritte Granite Gneiss
			Kumbhalgarh Group	Calc Schist, Calc Gneiss, Mica Schist, Marble
			Cogunda Group	Quartzite Slate, Calc Schist
	AravaliSuperGroup		Lunavada Group	Phyllite, Biotite Schist, Quartzite, Dolomite
			Rakhadev Ultramafic Suite	Talc-Serpentine Schist with Tremolite, Actinolite
			Jharol Group	Phyllite,Chlorite Schist, Quartzite Cryst, LST
	AgeUncertain		Basement	GraniteandGneiss

Source: www.portal.gsi.gov.in/

Geomorphology

The vast alluvial plains look uninteresting and monotonous but a careful and in-depth appraisal of the terrain with the help of topographical sheets, satellite images and field studies reveal very interesting details. They show an array of geomorphic features which are the reflections of the various tectonic, erosional and depositional processes of the late Quaternary.The Gujarat plains are situated in a geological setting flanked by Precambrian rocks in the east and by the Mesozoic rocks, comprising both sedimentaries aswell as volcanics, in the west and south. The overall topography is a product of a combination of numerous tectonic lineaments (faults, joints *etc.*) which mark the limits of the rocky highlands and also control the behaviour of most of the rivers.

Alluvial Plains

Commonly referred to as Gujarat Alluvial Plains, these form the median part of Mainland Gujarat extending from Narmada River in the south to the Luni river in the north. A generalised geomorphic map based on satellite images, topographic maps and field surveys show the landscape diversity of these plains

Tectonic Framework

Interaction between sedimentation and tectonics is now an established fact, though the phenomenon is not yet fully understood. However, the effectiveness of tectonic factor is implicit on two counts:

(i) A basin providing a site for the accumulation of sediments; and

(ii) An uplifted area from where sediments could be derived.

Tectonism has played an important role in the evolution of Gujarat plains at all stages. The control exercised by the various structural lineaments was quite effective and dominant all-throughout the Tertiary and Quaternary and the sediment accumulated in structural basins that developed at the close of Cretaceous. All along, especially during Quaternary, the factors of glacio-eustasy and palaeoclimate combined to sustain and control the deposition.

Tectonic History

The structural history of the depositional basin since its inception right upto almost Sub-Recent, can be chronologically arranged as under:

i) Post Mesozoic reactivation of N-S and NNW-SSE Precambrian faults and NarmadaGeofracture

This event gave rise to Cambay Basin a structural depression. This happened at the advent of the Cenozoic. Two regional faults that limited the down faulted block, have been (delineated by the ONGC) referred to as West Cambay Basin Boundary Fault (WMCBF) and East Cambay Basin Boundary Faults (EMCBF). Varying trend of these two bounding faults from south to north and even those of the Rajasthan basin, is a very clear manifestation of the combination of faults with different trends, following one or other directions of fracturing. Whereas smaller faults were responsible for the horst and graben topography of the Cambay Basin basement over which Tertiary sediments were deposited, somewhat larger faults trending NE-SW divided the main basin into 4 sub-basins. Several step faults east of and parallel to EMCBF, also simultaneously developed, thereby providing a wide expanse of low ground, which later on became the site of Quaternary deposition.

ii) Differential movement along the various faults all- throughout the Tertiary and Quaternary deposition

Thickness variation and lateral differences in lithofacies in the Tertiary sediments are attributed to this syn-depositional tectonism. Variable thickness of Quaternary deposits in the different structural blocks, indicate continued vertical movement during their accumulation. It however appears that the intensity of this tectonic activity gradually decreased so much so that during upper Pleistocene and Holocene, it practically died down or at least considerably reduced.

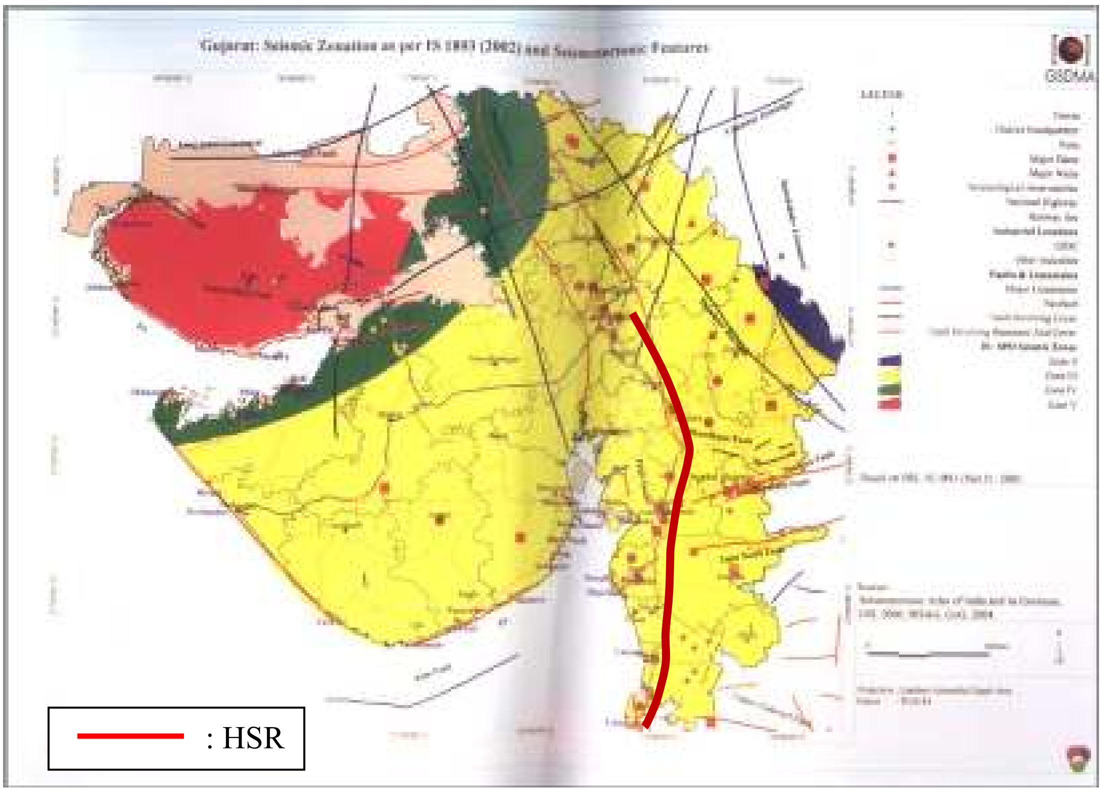
iii) During (Quaternary E- W to ENE-WSW fracture trends continued to be effective inthemanner that they provided preferred directions for the various rivers of the older drainage system

The older rivers flowing SW to W from the eastern rocky highland impinged into the basin, crossing successively the various step faults finally transected the EMCBF; depositing their debris such that the Quaternary sediments rested over Tertiaries. The older fluvial system (which now stands disrupted), points to a control exercised by the regional westward slope and the E-W to NE- SW fractures. Almost entire part of the sediment thickness (mostly fluvial) was the result of these ancient rivers. The process of fluvial aggradations came almost to a close with the onset of the Terminal Pleistocene aridity.

iv) Next and the last major phase of tectonic activity took place, sometime in early Holocene, after the aridity

During this tectonic event, numerous NNW-SSE trending fracture zones developed, and these dissected the earlier deposited continental sequence, disrupted the older rivers, deflected their courses, such that Sabarmati and Mahi started flowing along new channels and the Orsang river (relicts of which are seen as the Dhadhar river) instead of flowing towards W, swung anticlockwise towards Narmada. This phenomenon is very well reflected in the development of vertical cliffs and deeply cut ravines, sinuous channels of trunk stream as well as those of major tributaries. Cliffy channels of Sabarmati, Mahi and Narmada that flow in a *zig-zag* manner, simulating entrenched meanders, in fact reflect the influence of intersecting or en-echelon fractures that developed during this late tectonism. The rivers flowing along these fractures (mostly joints), in due course have given rise to loops and curves which resemble and behave and look to a certain extent like true meanders, making it difficult to recognize the tectonic control. All the rivers-Luni, Sukri, Banas, Sabarmati, Mahi and Narmada, show a gentle northwesterly tilt of the newly faulted blocks. As a result, there occur no tributaries on the respective right banks in each case and the smaller streams meet the main rivers along the left banks. Also, the areas to the west of the middle segment of Sabarmati and lower reaches of Mahi, are totally devoid of any drainage and represent uplifted terrains with a slight NW tilt. Subsurface information also indicates uplift. Obviously, the uplift and tilting were related to this Holocene fracturing.Seismic and tectonic map of Gujarat is shown in Exhibit4.3.5.

Exhibit 4.3.5: Seismic and Tectonic Map of Gujarat



Source: www.portal.gsi.gov.in/

Lithostratigraphy

The Quaternary continental deposits of the Mainland consist of a succession of layered sediments of marine, aeolian and fluvial origins. A total maximum thickness of over 800m of Quaternary sediments has been computed on the basis of exposed sequences and sub-surface borehole data. The nature of the base of Quaternary deposits however is not fully understood and little information is available to delineate the boundary between the Quaternary and the Tertiary. It may be pointed out that the lower part of the Quaternary sequence remains un-investigated and the only available information is that provided by Chandra and Chowdhary.

Narmada River Basin

Taking into account twelve well exposed lithounit sections along the Narmada River, a composite lithostratigraphic succession has been prepared. Three major stratigraphic formations *viz.* Tilakwada formation, Ambali formation and Bharuch formation have been recognized.

Tilakwada Formation

The Tilakwada formation marks the base of the total exposed Quaternary sediment succession in the Lower Narmada valley and comprises five major horizons- (i) bluish pedogenised and mottled clay, (ii) cobblyto bouldery gravel (Gms- facies/ Gravel-I), (iii) coarse reddish sand, (iv) laminated/stratified pedogenised silty mudand (v) cross-stratified gravel (Op-facies/Oravel-Il). The bluish pedogenised clay forms the base with an exposed thickness of 2 to 3m and is overlain by a poorly sorted 5 to 6m thick horizon of cobbly to bouldery gravel (G-I); it shows inverse grading at places. It is ideally exposed at Tilakwada and Rampura. The gravels are overlain by sand-sheets and trough cross-stratified beds of around 4m thickness; these at places are replaced by stratigraphic equivalent units of laminated mud. Above this horizon, cross- stratified gravel of about 5 to 6m in thickness (G-II) is encountered; this gravel at places shows planar cross-stratification.

Ambali Formation

The Ambali formation overlies the gravel (G-II) and ranges in thickness between 13 and 15m. It comprises four major units; (i) laminated pedogenised mud; (ii) sandy gravel (Gravel-III); (iii) silty sand and (iv) rubified silty sand. The pedogenised laminated mud, 4m thick, directly rests over Gravel-II and is devoid of any sedimentary structure. The mud is overlain, by 3m thick sandy gravel (G- III). Silty sand of about 2 to 2.5m thickness overlie this horizon, which at places is replaced by a stratigraphically equivalent unit of pedogenised mud. The topmost part of this formation is 3 to 4m thick silty sand which is brownish red in colour. More or less, structureless, this rubified unit is at places demarcated from the underlying silty sand horizon by a concentration of ca1cretic layers.

Bharuch Formation

This formation forms the upper portion of the Narmada succession, and has a thickness range of 10 to 12m. It is made up of five major units, viz.(i) weakly pedogenised laminated mud; (ii) pedogenised silty sand; (iii) pale yellow coloured silt(loess-like); (iv) pedogenised silt and (v) fine dunal sand. The weakly pedogenised laminated mud unit (1.5-2m) forms the base of the formation, and rests over the rubified horizon of the Ambali formation. This succession is finally capped by an aeolian sand horizon of 2 to 8m thickness, which has given rise to a characteristic typical dunal topography.

Location wise Description

Bharuch Section
This section is located on the right bank of Narmada, 25km upstream from the mouth.The exposed cliffs in this area range in height between 18 and 20m and show only the Bharuch formation which is represented by fluvial silts and the uppermost aeolian sand.

Nikora Section
This is located 10km upstream of Bharuch on the right bank of the Narmada. The section varies in thickness from 17 to 18m.The basal pedogenised clay is followed by the Ambali formation (l2m) and capped by, the laminated mud and dunal sand of Bharuch formation (3m). Tilakwada formation except the basal clay is absent at this location.

Kanjetha Section
This section is located 8km upstream of Nikora on the right bank. The section height varies between 28 and 30m. It begins withTilakwada formation (10m) and is overlain by Ambali formation (12m). The youngest is the Bharuch formation having 6m thickness.

Ambali Section
This section located 12km upstream of Kanjetha on the right bank of Narmada is 20 to 22m thick. The Tilakwada formation (7m) marks the base; in turn it is overlain by 8m thickAmbali formation. This unitis followed upwards by the Bharuch formation with 7m thickness.

Sankheda Section
The section is located 15km upstream of Chandod on the left bank of Orsang River. The cliff height here ranges between 12 and14m. The basal part is represented by 7mthick Tilakwada formation, Ambali formationis absent and the Bharuch formation (5m) directly overlies the Tilakwada formation.

Chandod Section
A more or less complete sequence is seenin this section, exposed on the left bank of the Orsang River at its confluence withthe Narmada. The cliff height is around 1·8m and the section comprises Tilakwada formation (7m), Ambali formation (6m) and Bharuch formation (9m).

Tilakwada Section
This section is exposed at the confluence of the rivers Men and Narmada. The 25m left bank section is represented by 20m thick Tilakwada formation overlain by 5m of Bharuch formation.

Rampura Section
Located upstream of Tilakwada on the leftbank of Narmada, the 19m section is made up of a lower 13m thick Tilakwada formation, followed upwards directly by 4m thick Bharuch formation represented by Aeolian sediments.

Mahi River Basin
The Mahi river provides very good sections all along its course, and on the basis of the exposed lithounits studied at 10 locations, a composite stratigraphy could be prepared. The exposed sequence resting over the basal clays, has been divided into three formations *viz*., Rayka, Shihora and Singrot.

Rayka Formation

The Rayka formation is seen to rest over the basal clays and shows an overall thickness of 10 to 11m. The formation is made up of two members:
(a) Vasad Member; and
(b) Poicha Member.

The Sabarmati River provides very good cliff sections revealing almost entire exposed sequence whereas the rivers further north show only the upper part of the succession. On the basis of a critical appraisal and synthesis of information obtained from a number of exposed sections in the Sabarmati, Rupen, Khari, Saraswati, Banas and Luni, supported by sub-surface borehole data, a composite stratigraphy for these northern rivers has been worked out.

SabarmatiRiverBasin

The Sabarmati river basin reflects an alluvial fan environment quite similar to that of the Narmada. The various horizons exposed in the river valley with their characteristic features point to a deposition in, a combination of fluvial and aeolian environment. The oldest exposed Quaternary horizon in the study area is the basal bluish clay, correlatable with the formations in Mahi and Narmada. This horizon comprises 70-75 % of clay and is rich in chlorite and montmorillonite. Subsequent to their deposition, these were exposed to sub-aerial weathering processes, during which they underwent pedogenisation. This is evidenced by the development of calcrete veins, strings and tubes. The high CaO content is also attributed to these phenomena.

Geology of Ahmedabad

Geologically the area consists of Quaternary alluvium. The south west area *viz.* Part of Barvada, Ranpur and Dhandhuka is made up of Basalt Rock, while rest area of the district consists of alluvial formation, made up of alternate beds of clay and sand. Geohydrologically, major parts of the district consist of alluvial formation. Alluvial formation is made up of sand, clay, *kankars*, silt and gravels. In this formation water is available under confined and unconfined conditions. Remaining area is made up of Basalt, which is very poor in ground water availability and yield. Sufficient discharge is available from alluvial formation. Thickness of Alluvium in north- west part of the area is more. Average depth of tube-well in eastern part ranges from 90-120m and in northwest part it is 350 to 400m.

Anand

Geologically the area is mostly comprised of Quaternary Alluvium (clay and sand). The alluvium formations consist of clay, sand, *kankars* and gravels. The sand and gravel beds are the water bearing formations. The ground water occurs under confined and semi-confined conditions. Generally, tube wells are drilled in the depth range of 60 to 150 meters in Anand, Umreth, Anklav, Borsad and Petlad talukas.

Bharuch

Geologically, the district is mainly divided in to two types of rocks. Western side taluka of Bharuch district such as Jambusar, Amod, Vagra, Bharuch, Ankleshwar and Hansot represent alluvial formation. The strata made up mainly of black and yellow clay and layers of different size of sand. The eastern side of Valia and southwest part of Zagadia taluka is made up of Basalt rocks. At places like east of Zagadia and south, south-west of Rajpardi, Lignite type of coal is available whereas in south-west of Zagadia, Agate stone also mined. Geohydrologically, the coastal area of Bharuch district falls in saline zone due to its location on the Coast of Arabian Sea. While the western part, away from coast, comprises of alluvial formation and yields potable water. Bores are drilled up to 90 to 120 m depths.

Valsad

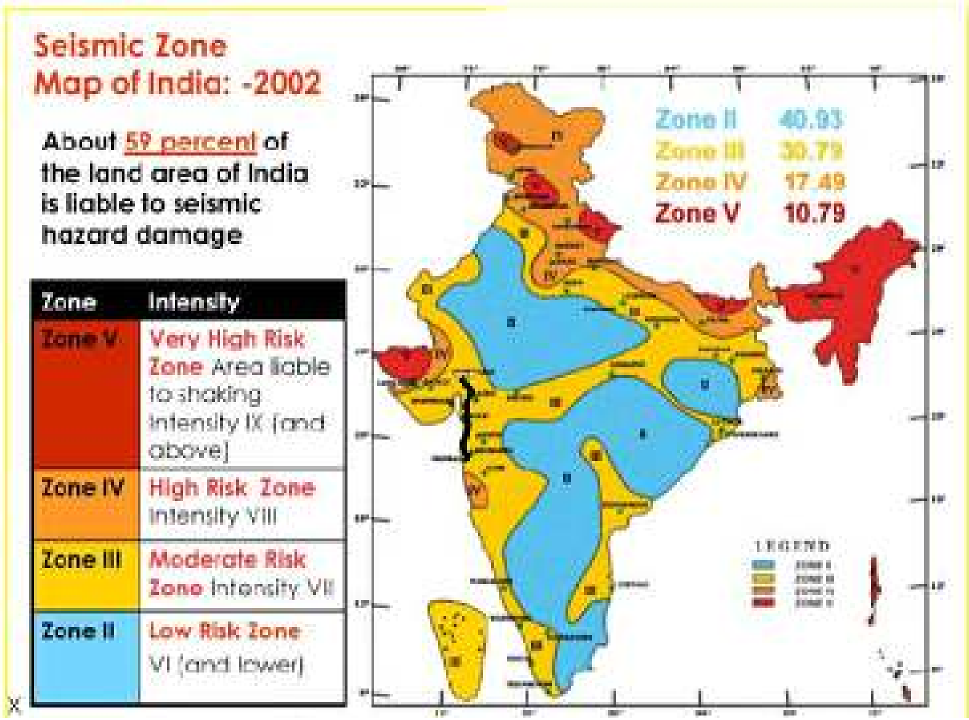
Geologically the area is composed of igneous rocks, mainly Deccan trap basalt and is overlain by thin layer of alluvium (clay, sand, silt andgravels) The Dharampur and Kaprda Taluka's are hilly and rocky. The Valsad, Pardi and Umargam Talukas are covered by Alluvium (Clay, Silt & Sand) and underlain by basalt. There is less overburden in the Dharampur and Kaprada taluka's. Recent alluvium formation contains sand silt, clay and gravels. Ground water occurs in weathered portion, cracks, fissures and joints. Excessive runoff causes soil erosion and less recharge.Valsad, Pardi and Umargam talukas contains Alluvium & Basalt, while Dharampur & Kaprada Talukas are rocky & hilly feasible for drilling of bores (60 to 90 m deep) by DTH Rig. Western part is feasible for drilling by DTH / MDR rig. Salinity prevails in the coastal area, as a result now; the area is covered under regional water supply schemes for supply of drinking water. In the Dharampur and Kaprada taluka rocks are fresh and massive as a result bores and wells become seasonal and dry up during summer.

4.3.4 SEISMIC CONSIDERATION

Seismic Zonation map of a country is a guide to the seismic status of a region and its susceptibility to earthquakes. India has been divided into five zones with respect to severity of earthquakes. Of these, Zone-V is seismically the most active where earthquakes of magnitude 8 on Richter scale or more could occur. Recent strong motion observations around the world have revolutionized thinking on the design of engineering structures, placing emphasis also on the characteristics of the structures themselves.It should be realized that in the case of shield type earthquakes, historic data are insufficient to define zones because recurrence intervals are much longer than the recorded human history.This may often give a false sense of security. Occurrence of the damaging earthquake at Latur, falling in Zone-I is a typical example of this situation.

On perusal of Seismic Zoning Map of India, 2002 (Exhibit 4.3.6), the entire stretch of the proposed MAHSR alignment falls in the intensity Zone-III as per IS 1893:2002. Zone –III represents area of moderate risk zone. However, all the structure of the station building and depots shall be designed taking care of the seismic intensity.

Exhibit 4.3.6: Seismic Zoning Map of India



Source: www.imd.gov.in

Cause of Earthquake

The earth's crust is a rocky layer of varying thickness ranging from a depth of about 10kilometers under the sea to 65 kilometers under the continents. The crust is not one piece but consists of portions called 'plates' which vary in size from a few hundred to thousands of kilometers. The 'theory of plate tectonics' holds that theplates ride up on the more mobile mantle,and are driven by some yet unconfirmed mechanisms, perhaps thermal convection currents. When these plates contact each other, stress arises in the crust. These stresses can be classified according to the type of movement along the plate's boundaries:

a) Pulling away from each other;

b) Pushing against one another; and

c) Sliding sideways relative to each other.

All these movements are associated with earthquakes.The areas of stress at plate boundaries which release accumulated energy by slipping or rupturing are known as 'faults'. The theory of 'elasticity' says that the crustis continuously stressed by the movement of the tectonic plates; it eventually reaches a point of maximum supportable strain. A rupture then occurs along the fault and the rock rebounds under its own elastic stresses until the strain is relieved. The fault rupture generates vibration called seismic (from the Greek 'seismos' meaning shock or earthquake) waves, which radiates from the focus in all directions. The point of rupture is called the 'focus' and may be located near the surface or deep below it. The point on the surface directly above the focus is termed as the 'epicenter' of the earthquake

Magnitude

It is a quantity to measure the size of an earthquake and is independent of the place of the observation.

Unit of Magnitude-Richter Scale

The local magnitude is defined as the logarithm of the maximum amplitude measured in microns on a seismogram written by Wood-Anderson seismograph with free period of 0.8 second, magnification of 2800, damping factor of 0.8 calculated to be at a distance of 100km. The relative size of events is calculated by comparison to a reference event of ML=0, using the formula, ML=log A-log A_o Where, A is the maximum trace amplitude in micrometer recorded on a standard seismograph and A_o is a standard value which is a function of epicentral distance (Δ) in kilometer.India has witnessed some of the most devastating earthquakes during the last century like the one in Kangra (1905), Bihar-Nepal (1934) and in Assam (1950). In the recent past, earthquakes have caused havoc in Uttarkashi (1991), Latur (1993), Jabalpur (1997), Chamoli (1999) and in Bhuj (2001).

The classification of magnitude of the earthquake is given in Table 4.3.2.

Table 4.3.2: Classification of Magnitude of Earthquakes

Category	Magnitude on Richter Scale
Slight	Upto 4.9
Moderate	5.0 to 6.9
Great	7.0 to 7.9
Very Great	8.0 and more

Source: www.imd.gov.in

Past Record of Earthquakes in India

On 26th January 2001, India experienced one of the worst earthquakes in recent times measuring 6.9 on the Richter scale.The earthquake caused incalculable damage not just to its epicenter Bhuj, but also to other towns of the district of Kutch and to about 500 villages out of the total of 900 villages. The reported damage to property in Gujarat was about Rs. 21,000crore and the number of human lives lost were about 20,000. Of these, more than 500 deaths were reported from Ahmedabad, situated at adistance of about 350km from Bhuj. In the same city, about 150 numbers of multi-storied buildings crumbled down. Cities far away from the epicenter, like Surat, too reported damage to property. Table 4.3.3lists some damaging earthquakes took place in India.

Table 4.3.3: Occurrence of Major Earthquakes in India

Year of Occurrence	Place of Occurrence	Magnitude on Richter Scale	Scale of Damage
1618	Bombay	Not known	2000 lives lost
1720	Delhi	6.5	Some lives lost
1737	Bengal	Not known	300,000 lives lost
1803	Mathura	6.5	The shock felt up to Calcutta.
1803	Kumaon	6.5	Killed 200-300 people.
1819	Kutch	8.0	Chief towns of Tera, Kathara and Mothala razed to the ground.
1828	Srinagar	6.0	1000 people killed.
1833	Bihar	7.7	Hundreds of people killed
1848	Mount Abu, Rajasthan	6.0	Few people killed
1869	Assam	7.5	Affected an area of 2,50,000 Sq. miles.

Year of Occurrence	Place of Occurrence	Magnitude on Richter Scale	Scale of Damage
1885	Srinagar	7.0	Kamiarary area destroyed.
1897	Shillong	8.7	Wide spread destruction in Shillong.
1905	Himachal Pradesh	8.0	Thousands of people killed.
1906	Himachal Pradesh	7.0	Heavy damage.
1916	Nepal	7.5	All houses collapsed at Dharchulla.
1918	Assam	7.6	Heavy damage.
1930	Dhubri, Meghalaya	7.1	Heavy damage in Dhubri.
1934	Bihar, Nepal	8.3	Large number of border area people killed.
1941	Andaman	8.1	Very heavy damage.
1947	Dibrugarh	7.8	Heavy damage.
1950	Assam	8.6	Heavy damage to life and property.
1952	NE India	7.5	Heavy damage.
1956	Bulandshahar, U.P.	6.7	Many people killed
1956	Anjar, Gujarat	7.0	Hundreds of people killed
1958	Kapkote, U.P.	6.3	Many people killed
1967	Koyna,	6.1	Koyna Nagar razed.
1969	Bhadrachalam	6.5	Heavy damage.
1986	Dharamshala (H.P)	5.7	Lots of damage.
1988	Assam	7.2	Few people killed
1988	Bihar- Nepal	6.5	Large number of people killed.
1991	Uttarkashi	6.6	Lots of damage to life and property.
1993	Latur	6.4	Heavy damage to life and property about, 000 people killed.
1997	Jabalpur	6.0	Lots of damage to property, about 39 lives lost.
1999	Chamoli	6.8	Lots of damage to property about 100 people lost lives.
2001	Bhuj	6.9	Huge devastation, about 20000 people lost lives
2009	Andaman & Nicobar Island	7.7	26 people lost their lives.
2011	Sikkim	6.9	Tremors felt across northern India. About 120 killed.
2012	Andaman & Nicobar Island	6.2	No loss of life. Damage to property.
2015	Bihar & Nepal	7.8	About 9000 people lost their lives in Nepal.

Source: www.imd.gov.in

Annexure 4.4

4.4 SOIL QUALITY

The entire stretch of the proposed alignment can be divided into two parts on the basis of the soil characteristics- the alignment falling in the Gujarat and second one the alignment falling in the Maharashtra, close to Mumbai and Thane.

Project area is a part of Gondwanaland. The rock formation of the area comprised of metamorphosed quartzite, slates and lime stones. The project area has four types of soils ranging from moderately well drained to poorly drain, acidic to slightly alkaline and medium to high textured. The soils are primarily belonging to deep black soil, coastal alluvial, medium black soil and grey brown soil. Alluvial soil is found along riverbed, which is used for agriculture. Sandy soil is also found in the riverbeds. The coastal plain of project area is composed of alluvial clays with a layer of black soil on the surface.

Thane and 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 Palgarh district which have positive relation with the geology of the area. 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 soil of Vadodara district belongs to shallow to deep soil depth class. In Vadodara district the soils are dominantly fine textured (clayey) followed by medium textured (loamy). Soil drainage in Vadodara district varies from well drained to moderate drained followed by somewhat excessive drained. The soils of Vadodara district towards western part ranges from slight to moderate saline.

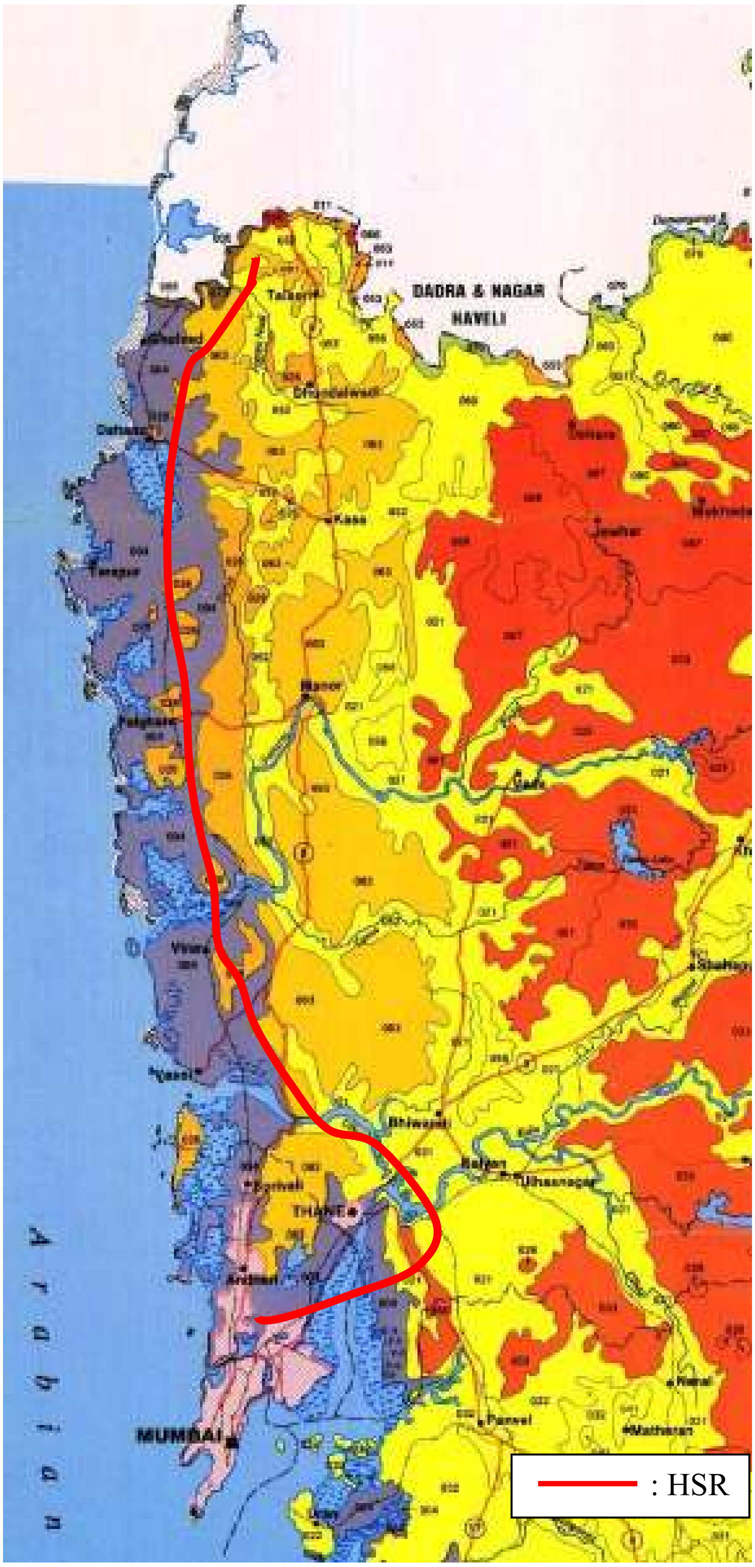
The soils in Surat district dominantly distributed to very deep soil depth class followed by shallow depth moderately deep soil are also observed. The soil is well drained and fine and medium textured. The soil of the area is of black cotton type upto 1.5 m followed by yellow soil and silt upto 10 m. Below 10 m depth, soft rocks are available. There is no signature of hard rock in the area. The Soil salinity in Surat belongs to slight to strong salinity class.

Dadra and Nagar Haveli are underlain by hard rock strata particularly by Deccan Basaltic flows [81% of the total area] with localized occurrences of sedimentary and alluvial formations.

(1) SOIL OF MAHARASHTRA REGION

The soil of Maharashtra is residual, derived from the underlying basalts. In the semi-dry plateau, the regur (black-cotton soil) is clayey, rich in iron and moisture-retentive, though poor in nitrogen and organic matter. When re-deposited along the river valleys, the kali soils are deeper and heavier, better suited for Rabi crops. Farther away, with a better mixture of lime, the morand soils form the ideal Kharif zone. The higher plateau areas have pather soils, which contain more gravel. The soil in the Deccan plateau is made up of black basalt soil. This type of soil is rich in humus. The soil is commonly known as the black cotton soil because it is best suited for the cultivation of cotton. The soil map of Marashtra and Mumbai Region with superimposed HSR alignment is shown in Exhibit 4.4.1. The volcanic action which had taken place in the Deccan region has given rise to the soil texture and composition. These igneous rocks break down into the black soil which is very fertile. The black soil is rich in N, P and K nutrients. By and large, the soils of Maharashtra are shallow and of somewhat poor quality. Soil cover in the city region is predominantly sandy due to its proximity to the sea. In the suburbs the soil cover is largely alluvial and loamy.

Exhibit 4.4.1: Soil Map of Study Area of Maharashtra



Source: European Soil Portal

LEGEND

001	Extremely shallow, somewhat excessively drained, loamy soils on moderately sloping lands with residual hills with severe erosion and strong stoniness; associated with extremely shallow, somewhat excessively drained, loamy soils on gently sloping lands with severe erosion and strong stoniness.	O Loamy-skeletal, mixed, isohyperthermic, Lithic Ustorthents O Loamy, mixed, isohyperthermic, Lithic Ustorthents
002	Very shallow, well drained, loamy soils on moderately sloping lands with residual hills with moderate erosion and moderate stoniness; associated with rock outcrops.	O Loamy, mixed, isohyperthermic, Lithic Ustorthents O Rock outcrops
003	Very shallow, well drained, loamy soils on moderately sloping lands with residual hills with severe erosion and slight stoniness; associated with moderately shallow, well drained, loamy soils on gently sloping lands with moderate erosion and slight stoniness.	O Loamy, mixed, isohyperthermic, Lithic Ustorthents O Loamy-skeletal, mixed, isohyperthermic, Udic Rhodustalfs
004	Slightly deep, poorly drained, fine soils on very gently sloping lands with residual hills with slight erosion and strong salinity; associated with moderately deep, well drained, fine soils on gently sloping lands with moderate erosion.	O Fine, montmorillonitic, calcareous, isohyperthermic, Vertic Halaquepts O Fine, montmorillonitic, calcareous, isohyperthermic, Entic Chromusterts
005	Very deep, moderately well drained, calcareous, fine soils on nearly level lands with residual hills with slight erosion, associated with very deep, moderately well drained, calcareous, very fine soils on very gently sloping lands with slight erosion.	O Fine, montmorillonitic, calcareous, isohyperthermic, Typic Chromusterts O Very fine, montmorillonitic, calcareous, isohyperthermic, Typic Chromusterts
006	Slightly deep, well drained, loamy soils on moderately sloping undulating lands with mesas and narrow valleys with moderate erosion and slight stoniness; associated with slightly deep, well drained, loamy soils on gently sloping lands with moderate erosion and slight stoniness.	O Fine-loamy, mixed, isohyperthermic, Udic Rhodustalfs O Loamy-skeletal, mixed, isohyperthermic, Typic Ustropepts
007	Moderately deep, well drained, loamy soils on moderately sloping undulating lands with mesas and narrow valleys with moderate erosion and moderate stoniness; associated with shallow, well drained, loamy soils with moderate erosion and strong stoniness.	O Fine-loamy, mixed isohyperthermic, Ultic Haplustalfs O Loamy, mixed, isohyperthermic, Lithic Ustropepts

Source: European Soil Portal

008	Very shallow, well drained, loamy soils on moderately sloping undulating lands with mesas and narrow valleys with severe erosion and moderate stoniness; associated with very shallow, well drained, loamy soils with severe erosion and strong stoniness.	o Loamy, mixed, isohyperthermic, Lithic Ustorthents o Loamy-skeletal, mixed, iso-hyperthermic, shallow, Typic Ustorthents
009	Very shallow, well drained, loamy soils on steeply sloping lands with mesas and narrow valleys with severe erosion; associated with well drained, loamy soils on moderately sloping lands with severe erosion.	o Loamy, mixed, isohyperthermic, Lithic Ustorthents o Loamy-skeletal, mixed iso-hyperthermic, Lithic Ustropepts
010	Shallow, somewhat excessively drained, loamy soils on moderately sloping undulating lands with mesas and narrow valleys with moderate erosion and moderate stoniness; associated with shallow, well drained loamy soils with moderate erosion and moderate stoniness.	o Loamy, mixed, isohyperthermic, Lithic Ustorthents o Loamy, mixed, isohyperthermic, Lithic Ustropepts
011	Moderately deep, well drained, fine soils on very gently sloping undulating lands with mesas and narrow valleys with moderate erosion and slight stoniness; associated with very deep, moderately well drained, fine soils with moderate erosion.	o Fine, montmorillonitic, isohyperthermic, Vertic Ustropepts o Fine, montmorillonitic, isohyperthermic, Typic Chromusterts
012	Shallow, well drained, loamy soils on moderately steeply sloping undulating lands with mesas and narrow valleys with severe erosion and slight stoniness; associated with very shallow, well drained, loamy soils on moderately sloping lands with severe erosion and slight stoniness.	o Loamy-skeletal, mixed, isohyperthermic, shallow, Typic Ustropepts o Loamy, mixed, isohyperthermic, Lithic Ustorthents
013	Slightly deep, well drained, loamy soils on moderately sloping undulating lands with mesas and narrow valleys with severe erosion and moderate stoniness; associated with shallow, well drained, loamy soils with severe erosion.	o Fine-loamy, mixed, isohyperthermic, shallow, Typic Ustropepts o Loamy, mixed, isohyperthermic, shallow, Typic Ustropepts
014	Deep, well drained, loamy soils on gently sloping undulating lands with mesas and narrow valleys with slight erosion.	o Fine-loamy, mixed, isohyperthermic, Typic Ustropepts
015	Moderately deep, well drained, loamy soils on gently sloping valley lands with moderate erosion; associated with deep, well drained clayey soils with moderate erosion.	o Fine-loamy, mixed, isohyperthermic, Ultic Haplustalfs o Fine, mixed, isohyperthermic, Typic Haplustalfs
016	Very shallow, well drained, loamy soils on gently sloping valley lands with moderate erosion and slight stoniness; associated with moderately deep, well drained, loamy soils on moderately sloping lands with severe erosion and slight stoniness.	o Loamy, mixed, isohyperthermic, Lithic Ustorthents o Fine-loamy, mixed, isohyperthermic, Udic Rhodustalfs

Source: European Soil Portal

017	Very shallow, somewhat excessively drained, loamy soils on steeply sloping lands with severe erosion; associated with shallow, somewhat excessively drained, loamy soils on moderately steeply sloping lands with severe erosion.	o Loamy, mixed, isohyperthermic, Lithic Ustorthents o Loamy, mixed, isohyperthermic, shallow Typic Ustropepts
018	Shallow, well drained, loamy soils on moderately sloping valley lands with severe erosion and slight stoniness; associated with moderately deep, well drained, loamy soils with moderate erosion.	o Loamy, mixed, isohyperthermic, shallow Typic Ustropets o Fine-loamy, mixed, isohyperthermic, Udic Rhodustalfs
019	Deep, well drained, clayey soils on gently sloping valley lands with slight erosion; associated with deep, well drained, loamy soils, with slight erosion.	o Fine, mixed, isohyperthermic, Typic Ustropepts o Fine-loamy, mixed, isohyperthermic, Typic Ustropepts
020	Deep, well drained, loamy soils on gently sloping valley lands with slight erosion and strong salinity; associated with deep, well drained, loamy soils with slight erosion.	o Fine-loamy, mixed, isohyperthermic, Typic Ustropepts o Fine, mixed, isohyperthermic, Typic Ustropepts
021	Extremely shallow, somewhat excessively drained, loamy soils on moderately steeply sloping undulating and rolling lands with severe erosion; associated with slightly deep, moderately well drained, loamy soils on very gently sloping lands with moderate erosion.	o Loamy-skeletal, mixed, isohyperthermic, Lithic Ustorthents o Fine-loamy, mixed, isohyperthermic, Typic Ustropepts
022	Very shallow, well drained, loamy soils on very gently sloping undulating and rolling lands with moderate erosion; associated with moderately deep, well drained, clayey soils on very steeply sloping lands with severe erosion and moderate stoniness.	o Loamy, mixed, isohyperthermic, Lithic Ustorthents o Clayey-skeletal, mixed, isohyperthermic, Typic Ustropepts
023	Very shallow, somewhat excessively drained, loamy soils on moderately steeply sloping elongated ridges with hills with severe erosion and strong stoniness; associated with rock outcrops.	o Loamy, mixed isohyperthermic, Lithic Ustorthents o Rock outcrops
024	Shallow, well drained, loamy soils on moderately sloping elongated ridges/hills with moderate erosion and strong stoniness; associated with rock outcrops.	o Loamy, mixed, isohyperthermic, Lithic Ustorthents o Rock outcrops
025	Very shallow, well drained, loamy soils on very steeply sloping elongated ridges/hills with very severe erosion; associated with shallow, moderately well drained, clayey soils on very gently sloping lands with moderate erosion.	o Loamy, mixed, isohyperthermic, Lithic Ustorthents o Clayey, montmorillonitic, isohyperthermic, shallow, Typic Ustorthents

Source: European Soil Portal

026	Moderately deep, moderately well drained, clayey soils on gently sloping elongated ridges/hills with moderate erosion; associated with very shallow, somewhat excessively drained, clayey soils on moderately steeply sloping lands with severe erosion and strong stoniness.	o Fine, montmorillonitic, isohyperthermic, Vertic Ustropepts o Clayey-skeletal, mixed, isohyperthermic, shallow, Typic Ustorthents
027	Shallow, well drained, clayey soils on steeply sloping elongated ridges with stoniness; associated with slightly deep, well drained clayey soils with severe erosion and strong stoniness.	o Clayey-skeletal, mixed, isohyperthermic, Typic Ustropepts o Clayey-skeletal, mixed, isohyperthermic, Typic Rhodustalfs
028	Moderately deep, well drained, loamy soils on gently sloping elongated ridges/hills with moderate erosion; associated with shallow, well drained, loamy soils with moderate erosion.	o Fine-loamy, mixed, isohyperthermic, Typic Ustropepts o Loamy, mixed, isohyperthermic, Lithic Ustropepts
029	Deep, well drained, clayey soils on moderately sloping uplands with narrow valleys with severe erosion; associated with slightly deep, well drained, loamy soils on moderately steeply sloping lands with severe erosion and slight stoniness.	o Fine, mixed, isohyperthermic, Udic Haplustalfs o Loamy-skeletal, mixed, isohyperthermic, Typic Ustropepts
030	Extremely shallow, somewhat excessively drained, loamy soils on gently sloping uplands with narrow valleys with moderate erosion; associated with rock outcrops.	o Loamy, mixed, isohyperthermic, Lithic Ustorthents o Rock outcrops
031	Moderately deep, well drained, clayey soils on steeply sloping uplands with narrow valleys with severe erosion; associated with shallow, well drained, loamy soils with severe erosion.	o Clayey-skeletal, mixed isohyperthermic, Typic Ustropepts o Loamy, mixed, isohyperthermic, Lithic Ustropepts
032	Very shallow, somewhat excessively drained, loamy soils on moderately steeply sloping dissected hills and intervening valleys with severe erosion; associated with moderately deep, moderately well drained, clayey soils on very gently sloping lands with moderate erosion.	o Loamy, mixed, isohyperthermic, Lithic Ustorthents o Fine, montmorillonitic, isohyperthermic, Vertic Ustropepts
033	Shallow, well drained, loamy soils on moderately steeply sloping dissected hills and intervening valleys with severe erosion; associated with very shallow, well drained, loamy soils on gently sloping lands with moderate erosion.	o Loamy, mixed, isohyperthermic, Typic Ustropepts o Loamy, mixed, isohyperthermic, Lithic Ustropepts
034	Shallow, well drained, loamy soils on moderately steeply sloping undulating western foothill slopes and narrow valleys with severe erosion and moderate stoniness; associated with shallow, well drained, loamy soils on very steeply sloping lands with very severe erosion and moderate stoniness.	o Loamy-skeletal, mixed, isohyperthermic, Lithic Ustorthents o Loamy-skeletal, mixed, isohyperthermic, shallow, Typic Ustropepts

Source: European Soil Portal

035	Very shallow, somewhat excessively drained, loamy soils on moderately steeply sloping undulating western foothill slopes and narrow valleys with severe erosion and strong stoniness; associated with shallow, somewhat excessively drained, loamy soils with severe erosion and strong stoniness.	O Loamy, mixed, isohyperthermic, Lithic Ustorthents Loamy, mixed, isohyperthermic, shallow Typic Ustropepts
036	Shallow, somewhat excessively drained, loamy soils on moderately steeply sloping undulating western foothill slopes and narrow valleys with severe erosion and strong stoniness; associated with very shallow, well drained, loamy soils with severe erosion and strong stoniness.	O Loamy-skeletal, mixed, isohyperthermic, shallow, Typic Ustropepts O Loamy-skeletal, mixed, isohyperthermic, Lithic Ustorthents
037	Shallow, moderately well drained, loamy soils on very gently sloping undulating western foothill slopes and narrow valleys with moderate erosion; associated with shallow, well drained, loamy soils on gently sloping lands with severe erosion.	O Fine-loamy, mixed, isohyperthermic, Typic Ustropepts O Loamy, mixed, isohyperthermic, Lithic Ustorthents
038	Moderately deep, well drained, loamy soils on moderately sloping spurs with severe erosion and moderate stoniness; associated with moderately deep, well drained, clayey soils on moderately steeply sloping spurs with severe erosion and moderate stoniness.	O Fine-loamy, mixed, isohyperthermic; Udic Rhodustalfs O Clayey-skeletal, mixed, isohyperthermic, Typic Ustropepts
039	Deep, somewhat excessively drained, fine soils on moderately steeply sloping spurs with moderate erosion and strong stoniness; associated with slightly deep, somewhat excessively drained, fine soils with severe erosion and strong stoniness.	O Fine, mixed, isohyperthermic, Udic Rhodustalfs O Fine, mixed, isohyperthermic, Typic Ustropepts
040	Shallow, well drained, loamy soils on moderately sloping spurs with severe erosion and strong stoniness; associated with slightly deep, loamy soils with severe erosion and strong stoniness.	O Loamy-skeletal, mixed, isohyperthermic, shallow, Udic Haplustalfs O Fine-loamy, mixed, isohyperthermic, Udic Rhodustalfs
041	Very shallow, somewhat excessively drained, loamy soils on moderately steeply sloping spurs of north Sahyadri with severe erosion and moderate stoniness; associated with rock outcrops.	O Loamy-skeletal, mixed isohyperthermic, Lithic Ustorthents O Rock outcrops.
042	Very shallow, somewhat excessively drained, loamy soils on moderately sloping spurs with moderate erosion and strong stoniness.	O Loamy, mixed, isohyperthermic, Lithic Ustropepts
043	Moderately deep, well drained, loamy soils on moderately sloping spurs with moderate erosion and strong stoniness; associated with deep, well drained, loamy soils with moderate erosion.	O Fine-loamy, mixed isohyperthermic, Typic Ustropepts O Fine-loamy, mixed, isohyperthermic, Udic Rhodustalfs

Source: European Soil Portal

044	Very deep, well drained, loamy soils on gently sloping eastern hill slopes and narrow valleys with moderate erosion; associated with shallow, well drained, loamy soils on steeply sloping lands with very severe erosion.	O Fine-loamy, mixed, isohyperthermic, Udic Rhodustalfs O Loamy-skeletal, montmorillonitic, isohyperthermic, shallow, Typic Ustropepts
045	Deep, well drained, loamy soils on moderately steeply sloping narrow valleys on eastern slopes of Sahyadri with severe erosion; associated with shallow, well drained, loamy soils with very severe erosion and moderate stoniness.	O Fine-loamy, mixed, isohyperthermic, Udic Rhodustalfs O Loamy-skeletal, mixed, isohyperthermic, shallow, Typic Ustropepts
046	Very deep, well drained, loamy soils on gently sloping narrow valleys with moderate erosion; associated with shallow, well drained, loamy soils on moderately sloping hill slopes and narrow valleys with very severe erosion and moderate stoniness.	O Fine-loamy, mixed, isohyperthermic, Udic Rhodustalfs O Loamy, mixed, isohyperthermic, shallow, Typic Ustropepts
047	Moderately shallow, well drained, loamy soils on moderately steeply sloping eastern slopes and narrow valleys with severe erosion and moderate stoniness; associated with moderately shallow, well drained, clayey soils with severe erosion and slight stoniness.	O Fine-loamy, mixed, isohyperthermic, Udic Rhodustalfs O Clayey-skeletal, mixed, isohyperthermic, Typic Ustropepts
048	Moderately deep, somewhat excessively drained, fine soils on moderately steeply sloping eastern slope and narrow valleys with severe erosion and strong stoniness.	O Fine, mixed, isohyperthermic, Udic Rhodustalfs
049	Shallow, well drained, loamy soils on moderately steeply sloping Sahyadri eastern slopes and narrow valleys with severe erosion; and strong stoniness; associated with shallow, somewhat excessively drained, loamy soils with severe erosion and strong stoniness.	O Loamy-skeletal, mixed, isohyperthermic, Lithic Ustorthents O Loamy, mixed, isohyperthermic, shallow, Typic Ustropepts
050	Very shallow, well drained, loamy soils on moderately steeply sloping Sahyadri eastern slopes with very severe erosion and strong stoniness; associated with rock outcrops.	O Loamy, mixed, isohyperthermic, Lithic Ustorthents O Rock outcrops.
051	Shallow, somewhat excessively drained, clayey soils on moderately sloping eastern slopes of highly dissected hill range with severe erosion and strong stoniness; associated with shallow, well drained clayey soils with moderate erosion and moderate stoniness.	O Clayey, mixed, isohyperthermic, Lithic Ustorthents O Clayey, mixed, isohyperthermic, shallow, Typic Ustropepts
052	Very shallow, moderately well drained, clayey soils on gently sloping narrow valleys with moderate erosion; associated with shallow, moderately well drained, clayey soils with moderate erosion.	O Clayey-skeletal, mixed, isohyperthermic, shallow, Typic Ustorthents O Clayey, mixed, isohyperthermic, shallow, Typic Ustropepts
053	Moderately deep, well drained, fine soils on very gently sloping foot hills with moderate erosion and slight stoniness; associated with very deep, moderately well drained, fine soils with moderate erosion.	O Fine, montmorillonitic, isohyperthermic, Vertic Ustropepts O Fine, montmorillonitic, isohyperthermic, Typic Chromusterts.
054	Shallow, excessively drained, clayey soils on moderately steeply sloping Sahyadri eastern slopes with severe erosion and strong stoniness.	O Clayey, montmorillonitic, isohyperthermic, shallow, Typic Ustropepts

055	Shallow, well drained, loamy soils on moderately steeply sloping dissected hills and narrow valleys with severe erosion and moderate stoniness; associated with shallow, well drained loamy soils with severe erosion and moderate stoniness.	○ Loamy, mixed, hyperthermic, Lithic Rhodustalfs ○ Loamy, mixed, hyperthermic, Lithic Ustochrepts
056	Very shallow, somewhat excessively drained, loamy soils on moderately steeply sloping dissected hills and narrow valleys with severe ercsion and strong stoniness; associated with rock outcrops.	○ Loamy-skeletal, mixed, isohyperthermic, Lithic Ustorthents ○ Rock outcrops
057	Shallow, somewhat excessively drained, loamy soils on moderately steeply sloping dissected hills and narrow valleys with severe erosion and strong stoniness; associated with shallow, somewhat excessively drained, loamy soils on moderately steeply sloping lands with severe erosion and strong stoniness.	○ Loamy-skeletal, mixed, isohyperthermic, Lithic Ustorthents ○ Loamy, mixed, isohyperthermic, Lithiç Ustorthents
058	Very shallow, well drained, loamy soils on steeply sloping elongated ridges of Sahyadri with severe erosion and moderate stoniness; associated with moderately deep, well drained, loamy soils with severe erosion and slight stoniness.	○ Loamy-skeletal, mixed, isohyperthermic, Lithic Ustorthents ○ Loamy-skeletal, mixed, isohyperthermic, Typic Ustropepts
059	Very shallow, somewhat excessively drained, loamy soils on gently sloping dissected hills/narrow valleys with severe erosion; associated with shallow, well drained, clayey soils with moderate erosion.	○ Loamy-skeletal, mixed, isohyperthermic, Lithic Ustorthents ○ Clayey, mixed, isohyperthermic, shallow, Typic Ustropepts
060	Extremely shallow, somewhat excessively drained, clayey soils on moderately steeply sloping dissected hills/narrow valleys with severe erosion and strong stoniness; associated with very shallow, somewhat excessively drained, clayey soils with severe erosion and moderate stoniness.	○ Clayey-skeletal, mixed, isohyperthermic, Lithic Ustorthents ○ Clayey-skeletal, mixed, isohyperthermic, shallow, Typic Ustorthents
061	Very shallow, well drained, loamy soils on very steeply sloping dissected hills/narrow valleys with very severe erosion; associated with very shallow, well drained, clayey soils with severe erosion.	○ Loamy, mixed, isohyperthermic, Lithic Ustorthents ○ Clayey, mixed, isohyperthermic, Lithic Ustorthents

Source: European Soil Portal

062	Very shallow, somewhat excessively drained, clayey soils on moderately steeply sloping dissected hills/ narrow valleys with severe erosion and moderate stoniness; associated with shallow, somewhat excessively drained, clayey soils with severe erosion and moderate stoniness.	o Clayey, mixed, isohyperthermic, Lithic Ustorthents o Clayey, mixed, isohyperthermic, shallow, Typic Ustorthents
063	Shallow, somewhat excessively drained, loamy soils on moderately steeply sloping dissected hills/narrow valleys with severe erosion and moderate stoniness; associated with very shallow, somewhat excessively drained, clayey soils with severe erosion and strong stoniness.	o Loamy-skeletal, mixed, isohyper-thermic, shallow, Typic Ustorthents o Clayey-skeletal, mixed, isohyper-thermic, shallow, Typic Ustorthents
064	Very shallow, well drained, clayey soils on moderately sloping dissected hills/narrow valleys with severe erosion and strong stoniness; associated with very shallow, well drained, clayey soils with severe erosion and strong stoniness.	o Clayey-skeletal, mixed, isohyper-thermic, shallow, Typic Ustorthents o Clayey, montmorillonitic, isohy-perthermic, Lithic Ustorthents
065	Shallow, somewhat excessively drained, loamy soils on moderately steeply sloping dissected hills/narrow valleys with severe erosion and strong stoniness; associated with moderately deep, somewhat excessively drained, loamy soils with severe erosion and strong stoniness.	o Loamy, mixed, isohyperthermic, Lithic Ustropepts o Fine-loamy, mixed, isohyper-thermic, Typic Ustropepts
066	Shallow, well drained, clayey soils on very gently sloping dissected hills/narrow valleys with moderate erosion and moderate stoniness; associated with deep well drained fine soils with moderate erosion and slight stoniness.	o Clayey, mixed, isohyperthermic, Lithic Ustropepts o Fine, montmorillonitic, isohyper-thermic, Vertic Ustropepts
067	Shallow, well drained, loamy soils on moderately sloping dissected hills/narrow valleys with moderate erosion; associated with extremely shallow, excessively drained, loamy soils with severe erosion and strong stoniness.	o Loamy, mixed, isohyperthermic, Typic Ustropepts o Loamy-skeletal, mixed, isohyper-thermic, Lithic Ustorthents
068	Moderately shallow, well drained, loamy soils on moderately sloping dissected hills/narrow valleys with moderate erosion; associated with shallow, well drained, loamy soils with moderate erosion.	o Fine-loamy, mixed, isohyper-thermic, Typic Ustropepts o Loamy, mixed; isohyperthermic, Lithic Ustropepts
069	Very shallow, somewhat excessively drained, loamy soils on moderately steep dissected hills/narrow valleys with severe erosion and moderate stoniness; associated with shallow well drained, loamy soils on moderately sloping lands with severe erosion and moderate stoniness.	o Loamy-skeletal, mixed, hyper-thermic, Lithic Ustochrepts o Loamy, mixed, hyperthermic, Lithic Ustochrepts

Source: European Soil Portal

070	Shallow, well drained, loamy soils on gently sloping dissected hills/narrow valleys with moderate erosion and moderate stoniness; associated with shallow well drained, clayey soils with moderate erosion and moderate stoniness.	○ Loamy, mixed, hyperthermic, Lithic Ustochrepts ○ Clayey, montmorillonitic, hyperthermic, Lithic Ustochrepts
071	Shallow, well drained, loamy soils on gently sloping dissected hills/narrow valleys with severe erosion and moderate stoniness; associated with shallow, well drained, clayey soils with moderate erosion and moderate stoniness.	○ Loamy, mixed, hyperthermic, Lithic Ustochrepts ○ Clayey, montmorillonitic, hyperthermic, Lithic Ustochrepts
072	Deep, well drained, fine soils on very gently sloping foothills with moderate erosion; associated with shallow, well drained, clayey soils on gently sloping lands with moderate erosion and slight stoniness.	○ Fine, montmorillonitic, hyperthermic, Vertic Ustochrepts ○ Clayey, montmorillonitic, hyperthermic, Lithic Ustochrepts

Source: European Soil Portal

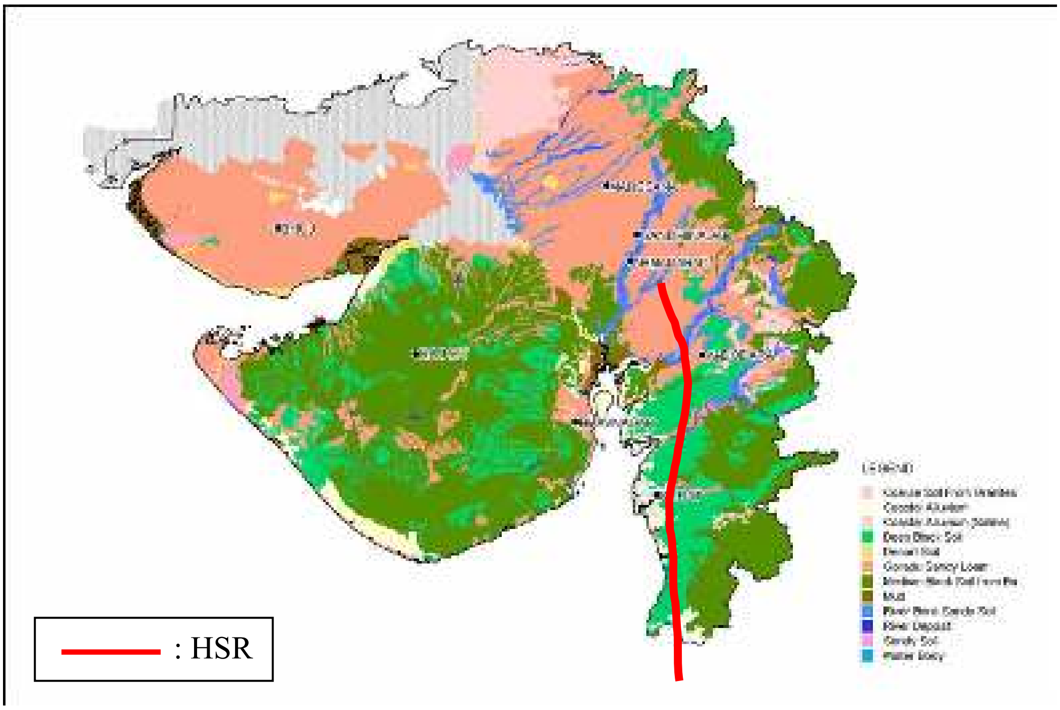
(2) SOIL OF GUJARAT REGION

Central Gujarat comprises Vadodara, Kheda, Anand, Dahod and Panchmahal district. The soil of central Gujarat varies from shallow to deep soil depth class. The deep and very deep soil depths are found in western part, where as shallow soil depth belongs to eastern part. The soils are fine to coarser and well to moderately drained in general and observed somewhat excessive drained also. The Soils are slight to moderate saline having slight sodicity. The distribution of district wise area mapped characteristic wise. The soils of Vadodara, Panchmahal and Dahod district belong to shallow to deep in soil depth class, whereas they vary from moderately deep to very deep in Anand and Kheda district. The soil map of Gujarat is shown in Exhibit 4.3.1. The Soils of Central Gujarat belongs to fine to coarser in general. The soils of Anand, Kheda, Panchmahal, Dahod districts are dominantly medium textured (Loamy) followed by fine textured (clayey).The soils adjoining to Anand, Kheda, Panchmahal and Dahod districts are coarser (Sandy). In Vadodara district the soils are dominantly fine textured (clayey) followed by medium textured (loamy) and towards adjoining Vadodara and Dahod district boundary the soils are coarser (sand).Soil drainage in Anand, Kheda and Panchmahal are well to moderately drained whereas in Vadodara and Dahod district varies from well drained to moderately drained followed by somewhat excessive drained. The soils of western parts of Anand districts are medium saline in nature and towards north slightly saline in nature. Towards Khambhat creek, the soils are moderately saline. The soil in Kheda district belong to slight to moderate saline and the soils of Vadodara district towards western part ranges from slight to moderate saline. The Soil Salinity in Vadodara, Anand, Kheda are slighter to moderately saline whereas in Panchmahal and Dahod the Soil Salinity belongs to moderately saline. The soil sodicity in general is slight sodic in all districts of Central Gujarat.

South Gujarat region comprises of Bharuch, Narmada, and Surat, Tapi, Navsari, Valsad and Dang districts. Dominantly the soils are very deep, well drained and fine and medium textured. They are slightly alkaline, slight to strong saline. Soil depth in South Gujarat is well distributed in two parts. The Soils in western side are dominantly very deep followed by moderately deep and in eastern part soils are dominantly shallow followed by moderately shallow. The soils in Bharuch, Surat, Navsari and Valsad districts dominantly distributed to very deep soil depth class followed by shallow depth moderately deep soil are also observed, whereas in Tapi basin the soil depth are dominantly shallow followed by very deep. In Dang district the soils are dominantly distributed in shallow soil depth class. Soil in south Gujarat in general varies from fine to medium textured (clayey to loamy clay), except in Dang District.

In Dang the soils are medium textured. Soil drainage in South Gujarat is well to moderately drain in general. In Dang district the soil drainage is well drained. Soil salinity in South Gujarat varies from slight to strong salinity class. In Bharuch District soil salinity belongs to slight to moderate and severe towards coastal. In Narmada basin, Tapi basin and Dang district soil salinity is moderate. The soil salinity in Surat, Navsari and Valsad belongs to slight to strong salinity class.

Exhibit 4.4.2: Soil Map of Gujarat



Source: www.gujarat.gov.in

The Soil Sodicity in South Gujarat in general belongs to slight sodicity class except in Navasari where soil sodicity varies from slight to moderate. Ahmedabad, along with Banaskantha, Patan, Mehasana, Sabarkantha, Gandhinagar, Surendranagar districts falls in the North Gujarat Region of Gujarat State. In this region, major area falls into 'very deep' soil. However, ‘deep’ soil is in major area of Surendranagar district and in few area of Ahmedabad and Patan district. There are 'moderately deep' soils in few areas of Surendranagar, Patan and Ahmedabad district and in North-East of Sabarkantha district.There are 'very shallow' to 'shallow' soil in North-East part (Sabarkantha district) and South West (Surendranagar district) part of the region. Rock outcrops are also found in some part of the region especially in North-East (Banaskantha and Sabarkantha district) and South - West (Surendranagar District) of the region. However, the rocks are not found in Ahmedabad area.A major texture of the soil in the region is 'Loamy'. However, in South-West part (in Ahmedabad and Surendranagar district) a soil texture in few areas is found to be 'Clayey'. It is also 'Sandy' soil in some area of the Northern part (Banaskantha district) of the region. Major area of the region is having 'Well’ drained soil. However, in some area of region especially in central part (adjoining area of Mehsana, Sabarkantha and Gandhinagar district) and eastern part of Banaskantha and Western part of Surendranagar district is representing 'Somewhat excessively' drained soil. A very few areas of southern part of the region (Adjoining area of Ahmedabad and Surendranagar district) and in Western part (Patan district) is showing 'moderately well' drained soil.

In few areas of middle part of Ahmedabad district and Eastern part of Surendranagar district is 'Slightly Saline'. A considerable area of Eastern part of Patan and Western part of Mehsana, a southern part of Ahmedabad district and North-West part of Banaskantha district is representing 'Moderate' salinity of the soil. 'Strongly' saline soil is observed in South-West part of Banaskantha and Western part of Patan district. Very few areas have 'Severe' saline soil in Southern part of Ahmedabad district.Slight sodicity is found in central part of the region (In Patan, Mehsana and Ahmedabad district) and in North-East part of Surendranagar district. In west part of the region (Banaskantha, Patan, Surendranagar and Ahmedabad district). 'Moderate' to 'strong' sodicity of the soil is found in the region.

Annexure 4.8

4.8 CLIMATOLOGY AND METEOROLOGY

The weather of a place represents the state of the atmospheric environment over a brief period of time. Integrated weather conditions over several years is generally referred to as climate or more specifically, as the ‘macro-climate’. An analysis of the climate of a particular region can help in assessing the seasons or periods during which a person may experience comfortable oruncomfortable conditions. It further helps in identifying the climatic elements, as well as theirseverity, that cause discomfort. The information helps a designer to build a house that filters out adverse climatic effects, while simultaneously allowing those that are beneficial. Discomfort and the corresponding energy demand for mechanical systems can be significantly reduced by comprehensive understanding of the climate.

The climatic conditions of the study area are strongly influenced by its geographical setting. The proposed MAHSR alignment almost runs parallel to the Arabian Sea particularly in the Maharashtra state and short stretch of Gujarat. The study area can be divided into two parts - (i) the alignment which falls in the State of Maharashtra and (ii) the stretch of alignment which falls in the State of Gujarat. The area falling in the mainland of Gujarat has different weather condition in comparison to the area of Deccan Trap of Maharashtra and coastal region in the vicinity of Mumbai and Thane. In the subsequent section the general climate of the study area has been discussed based on the long term normal. As per the Indian Meteorological Department, a year has been divided into following seasons in the Indian sub-continent:

Summer (Pre-monsoon)	:	March-to-May
Monsoon Season	:	June–to-September
Post-monsoon Season	:	October-November
Winter Season	:	December-to- February

4.8.1 PAST RECORDS

Climatological data for the period 1983 to 2005 of different meteorological observatories located in the study area like Dahanu, Ahmedabad, Surat, Bharuch, Vadodara, and Mumbai have been collected and used to bring out the synoptic features of the area (Table 4.8.1 to Table 4.8.6).

There are seven meteorological observatories established by the Indian Meteorological Department (IMD) operating in the study area. Apart from the observatories, IMD has also established permanent Automatic Weather Station (AWS) at several locations in India. The AWS and observatories located in the study area are given below -

- Ahmedabad
- Vadodara
- Surat
- Navsari *(Only AWS)*
- Bharuch
- Mumbai
- Mumbai (Santa Cruz)
- Dahanu (in Thane District)

THE CLIMATE - MAHARASHTRA REGION

The climate of the study area falling in the vicinity of Mumbai and Thane are more or less controlled by the coastal feature. As per the climatic zone classification of India by *Bansal et al (http://mnre.gov.in/solar-energy/ch2.pdf)*, this area is classified as warm and humid. The high humidity encourages abundant vegetation in these regions. The diffuse fraction of solar radiation is quite high due to cloud cover, and the radiation can be intense on clear days. The dissipation of the accumulated heat from the earth to the night sky is generally marginal due to the presence of clouds. Hence, the diurnal variation in temperature is quite low. In summer, temperatures can reach as high as 30 – 35 ºC during the day, and 25–30 ^{0}C at night. In winter, the maximum temperature is between 25 to 30 ºC during the day and 20 to 25 ^{0}C at night. Although the temperatures are not excessive, the high humidity causes discomfort. The climate is characterized by an oppressive summer, dampness in the atmosphere nearly throughout the year, and heavy southwest monsoon rainfall. The cold season from December to February is followed by the summer season March to June. The period from June to about the end of September constitutes the southwest monsoon season. October and November form the post monsoon season. In addition to these factors, a number of natural elements such as hills, valleys, water bodies, vegetation, etc. affect the climate locally. Buildings, cities and other man-made features also have an impact on the climate and is reflected in the long term normals.

The Rainfall

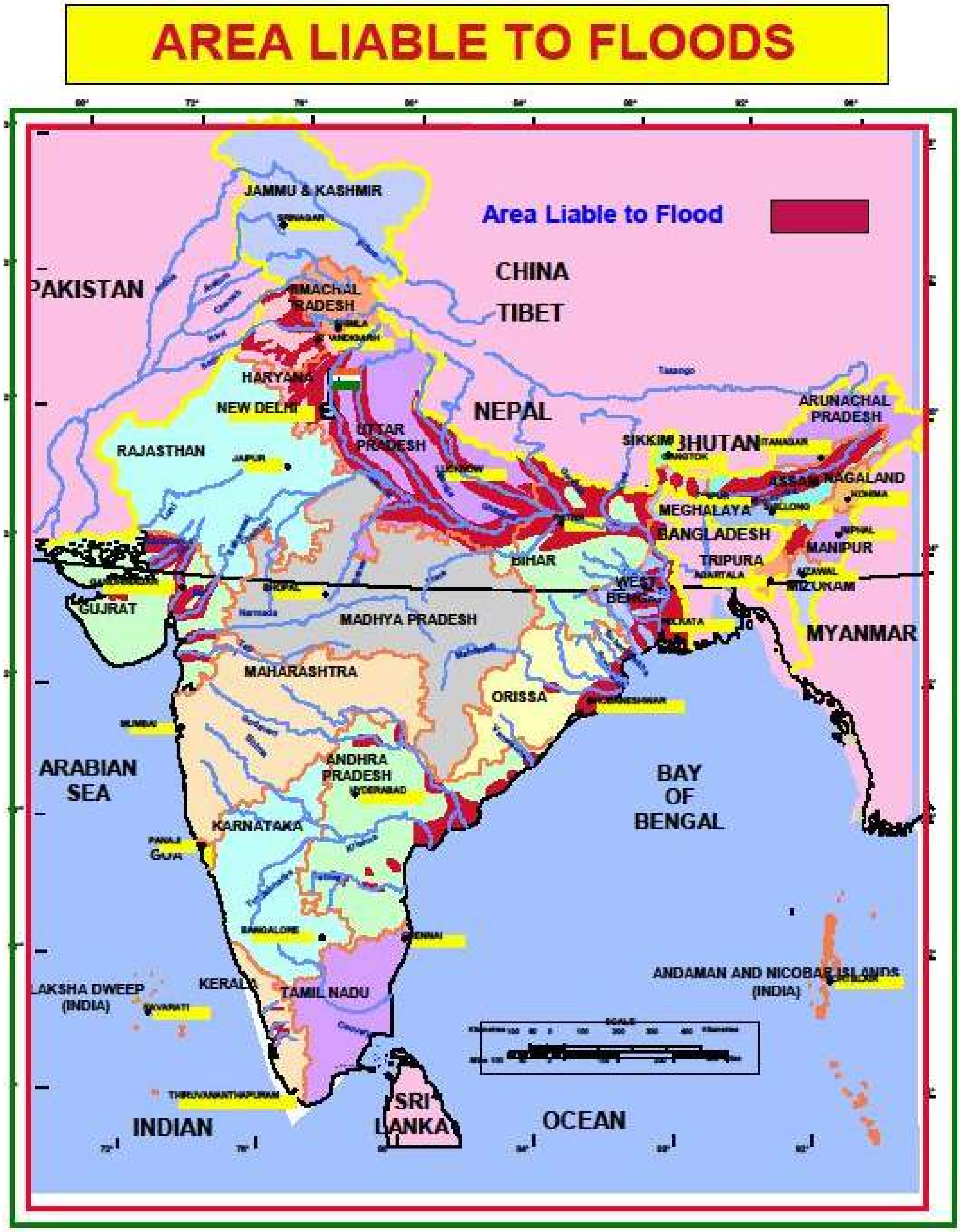
The area receives average annual rainfall of about 2000 mm. The variation in the rainfall from year to year is quite appreciable. The highest annual rainfall was recorded in 1917 and was 167% of the annual normal, whilst the lowest recorded was in 1905 and only 51% of the normal in 1905. About 94 per cent of the annual rainfall is received during the southwest monsoon from June to September. July is the rainiest month when about one third of the annual rainfall is received. Some rainfall mostly as thunder showers is also received during May and in the post-monsoon months. During the period December to April, there is very little rainfall. On an average there are 73 rainy days in a year (*i.e.* days with rainfall of 2.5 mm or more in a day).

On 26th July 2005, a 24-hour period saw **944 mm** of rain, which took a huge toll on the city. At least 450 lives were lost during the floods, and another 248 later, while 300,000 citizens required medical attention. The floods caused damage to 20,000 cars, 2,500 BEST buses, and countless number of two and three-wheelers. Around 200,000 tonnes of garbage — washed away or water-soaked furniture, foodstuffs, appliances — had to be cleared up. Furthermore, to prevent an epidemic of monsoon-related diseases, 24 metric tonnes of bleaching powder and 2 metric tonnes of disinfectant were used.

As against an annual rainfall average of 2258mm, Mumbai received 2334mm between the beginning of monsoon (June 12) till 8.30am on 30th August 2017. Moreover, 29th August 2017 rainfall resulted in the city recording its highest monthly rainfall **(941.1 mm)** for August since 2011. In August 2010, Mumbai had recorded 1036.5mm, which is the highest August total for the decade. Between 8.30am 29th August 2017 and 8.30am 30th August 2017, the Santacruz weather station, representative of the suburbs and Mumbai, recorded **331.4 mm** rain, which is the highest 24-hour August rain in a decade. During the same time Colaba recorded 111mm rain. Before Tuesday, the highest 24-hour August rain for the decade was recorded on August 29, 2011, when the city received **232.6 mm** rainfall. The highest 24-hour rain in August was recorded on August 23, 1997 as **346.2 mm**. On 29th August 2017, Mumbai was 15mm short of achieving the highest 24-hour August rain levels over the past two decades.

As per the National Disaster Management Authority (NDMA), the risk map of flood excludes Maharashtra from possibilities of flood hazard. However torrential rain cause havoc in Mumbai metropolitan region. The flood Hazard Map prepared by the NDMA is presented below in Exhibit 4.8.1.

Exhibit 4.8.1: Area Liable to Flood



The Temperature

The records of these observatories may be taken as fairly representative of the meteorological conditions in the area. In the interior parts of the district (Thane), temperatures are likely to be slightly lower in the cold season and higher in the hot season than at Dahanu. Being coastal district, the variation's in day temperature across the three seasons is not large. After February, temperature progressively increases till May which is the hottest month with the mean daily maximum temperature of 33.3^{0}C and minimum temperature of 26.9^{0}C. In the months preceding the monsoon, the day temperatures may reach up to 40 C. The oppressive heat on most days is, relieved by cool sea breezes particularly in the coastal regions. The onset of the southwest monsoon in June decreases the temperature and the weather becomes progressively cooler. At the end of the monsoon, day temperatures begin to increase and a secondary maximum in day temperature is reached in November. Nights, however, become progressively cooler after the withdrawal of the monsoon. After November, temperature decreases and in January which is the coldest month, the mean daily maximum temperature is 27.7^{0}C and the mean daily minimum 16.8^{0}C. The highest maximum temperature among the project districts of Maharashtra is recorded at Dahanu was 40.6^{0}C on 19th April 1955 and lowest minimum was 8.3^{0}C on 8th January 1945.

The Relative Humidity

An important characteristic of this region is the relative humidity, which is generally very high, about 70 – 90 % throughout the year. Precipitation is also high, being about 2000 mm per year, or even more. Hence, the provision for quick drainage of water is essential in this zone. The driest part of the year is the November to March period with relative humidity between 50 and 65 per cent.

The Sky Condition

Sky condition generally refers to the extent of cloud cover in the sky or the duration of sunshine. Under clear sky conditions, the intensity of solar radiation increases; whereas it reduces in monsoon due to cloud cover. The re-radiation losses from the external surfaces of buildings increase when facing clear skies than covered skies. The measurement of sky cover is expressed in oktas. For example, 3 oktas means that 3/8th of the visible sky is covered by clouds. During the monsoon months, the sky is generally overcast. Cloudiness decreases after the withdrawal of the monsoon towards the end of September. During December to March, normally clear or lightly clouded skies prevail.

The Winds

The wind is generally from one or two prevailing directions with speeds ranging from extremely low to very high. Winds are generally moderate with appreciable increase in force during the monsoon month. Winds during May and the monsoon season are mainly from directions between southwest and northwest (from the coast towards the land). For the rest of the year, winds blow from directions between north and east in the mornings and between west and north in the afternoons.

Special Weather Phenomena – Cyclones

During the pre and post-monsoon months, the area experiences very strong winds, sometimes reaching gale force particularly near the coast and heavy rain in association with cyclonic storms, which develop in the Arabian Sea and move in the close proximity to the coast. Thunderstorms are common in the post-monsoon months and the later part of the hot season.

THE CLIMATE - GUJARAT REGION

Gujarat, being located on the Tropic of Cancer, falls in the sub-tropical climatic zone having hot and dry weather and a large part of the State lies between 35^{0}C and 45^{0}C isotherms. The rainfall in the state is moderate as it forms a transitional zone between the heavy monsoon area of Konkan (Maharashtra) in the South and the arid areas of Rajasthan in the North. On the basis of climate, Gujarat is divisible into following five regions:

- Sub- humid South Gujarat (Surat, Valsad, Dangs);

- Moderately humid Central Gujarat (Bharuch, Vadodara, Panch Mahals, Sabarkantha and parts of Ahmedabad);
- Humid and sultry South-facing coastal region of Saurashtra;
- Semi-arid North Gujarat (parts of Sabarkantha and Ahmedabad and Gandhinagar); and
- Arid North Gujarat (Mehsana and Banaskantha)

The Rainfall

The rainfall gradually decreases northward; in the southernmost part (Valsad and Dangs) it is around 1200 mm, while in the extreme north it is as low as 300 mm. The relative humidity in all parts of the State is low, though in the coastal areas it is moderately high. The winds are generally light to moderate, increasing in intensity during the late summer and monsoon. Coastal areas experience stronger winds. The winds blow from W or SW during the monsoon and NE to NW from October to April. The rainfall pattern (continuity, intensity and frequency) is of great importance for the Gujarat plains, particularly as they are situated on the margins of the Thar Desert.

The Temperature

During the summer months, the mean daily maximum temperature is around 40^0C and mean daily minimum temperature around 25^0C, although temperatures touching peaks of $44\text{-}45^0$C are not uncommon. Clear skies, low humidity and light northeasterly, northerly and northwesterly winds characterizes the winter season. During the coldest month of January, the normal minimum temperature varies from 7^0C to 18^0C (mean around 14^0C); occasionally the mercury dips below to $3\text{-}4^0$C.

From the month of March onwards the temperature starts rising till it reaches the maximum in June, as high as 45°C, in some parts of the State. January is the coldest month with maximum temperature below 30^0C and the minimum temperature around 8°C to 10°C. The region receives much of its rainfall from the southwest monsoon between June and September.

Relative Humidity

Generally, the relative humidity is minimum in January, February and March. The relative humidity increases as the temperature moves upward and maximum in June, July and August. In the study area, in Gujarat region, the relative humidity varies from 37 per cent to 84 per cent. The maximum relative humidity 84 per cent was recorded at Bharuch in the month of July, at Surat in the month of July and August respectively.

The Sky Condition

The state of Gujarat receives more than 3000 to 3200 hours of bright sunshine in a year. As far as the availability of global solar radiation is concerned, more than 2000 kWh/m^2 -year are received over Gujarat. Because of the of global solar radiation, there is lot of potential for harnessing the solar energy for power generation along the proposed MAHSR project and will lead to curtailment in the Green House Gas Emission as well as captive production.

The Winds

The wind is generally from one or two prevailing directions with speeds ranging from extremely low to very high. Winds are generally moderate with appreciable increase in force during the monsoon month. Winds during May and the monsoon season are mainly from directions between southwest and northwest (from the coast towards the land). For the rest of the year, winds blow from directions between north and east in the mornings and between west and north in the afternoons.

Special Weather Phenomena – Cyclones and Tsunami

Owing to its geo-climatic, geological and physical features, Gujarat is vulnerable to all-major natural hazards (Drought, Flood, Cyclone, Earthquake, Tsunami *etc.*). Gujarat State Disaster Management Authority (GSDMA) has developed Gujarat Hazard Risk & Vulnerability Atlas. This is the first geographically explicit Level 1 assessment of its kind outside the United States.

Cyclones

- Gujarat falls in the region of tropical cyclone. With the longest coast line of 1600 km in the country, it is highly vulnerable to associated hazards such as floods, storm surges *etc*.
- Most of the cyclones affecting the State are generated in the Arabian Sea. They move North-East and hit the coast particularly the Southern Kutch and Southern Saurashtra and the Western part of Gujarat.
- Two cyclonic storm seasons are experienced in Gujarat: May to June (advancing southwest monsoon) and September to November (retreating monsoon).

The Hazard Risk and Vulnerability Atlas prepared by GSDMA is shown in Exhibit 4.8.2.

Tsunami / Floods

- Gujarat is prone to Tsunami risk due to its longest coastline and probability of occurrence of near and offshore submarine earthquakes in the Arabian Sea.
- Makran Subduction Zone (MSZ) -South West of Karachi is an active fault area which may cause a high magnitude earthquake under the sea leading to a tsunami.
- In past, Kandla coast was hit by a Tsunami of 12 mtrs height in 1945, due to an earthquake in the Makran fault line. Tsunami prone areas in the State include coastal villages of Kutch, Jamnagar, Rajkot, Porbandar, Bhavnagar, Anand, Ahmedabad, Bharuch, Surat, Navsari and Valsad districts.

The Hazard Risk and Vulnerability Atlas prepared by GSDMA shows (Exhibit 4.8.3a) the estimated inundation based on Probable Maximum Surge (PMS) at highest high tide level.

The Hazard Risk and Vulnerability Atlas prepared by GSDMA shows (Exhibit 4.8.3b) the estimate flooding.

Exhibit 4.8.2: The Hazard Risk and Vulnerability Atlas prepared by GSDMA for Cyclones

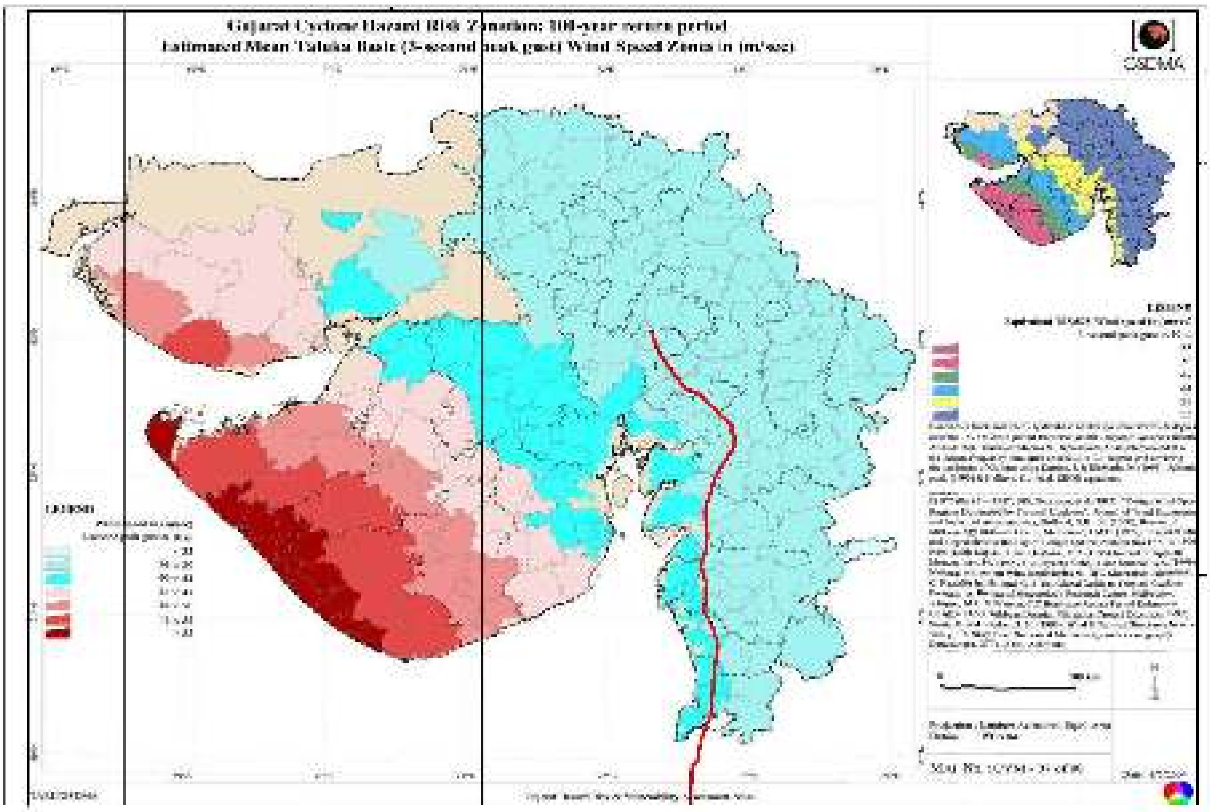


Exhibit 4.8.3a: The Hazard Risk and Vulnerability Atlas prepared by GSDMA for Tsunami

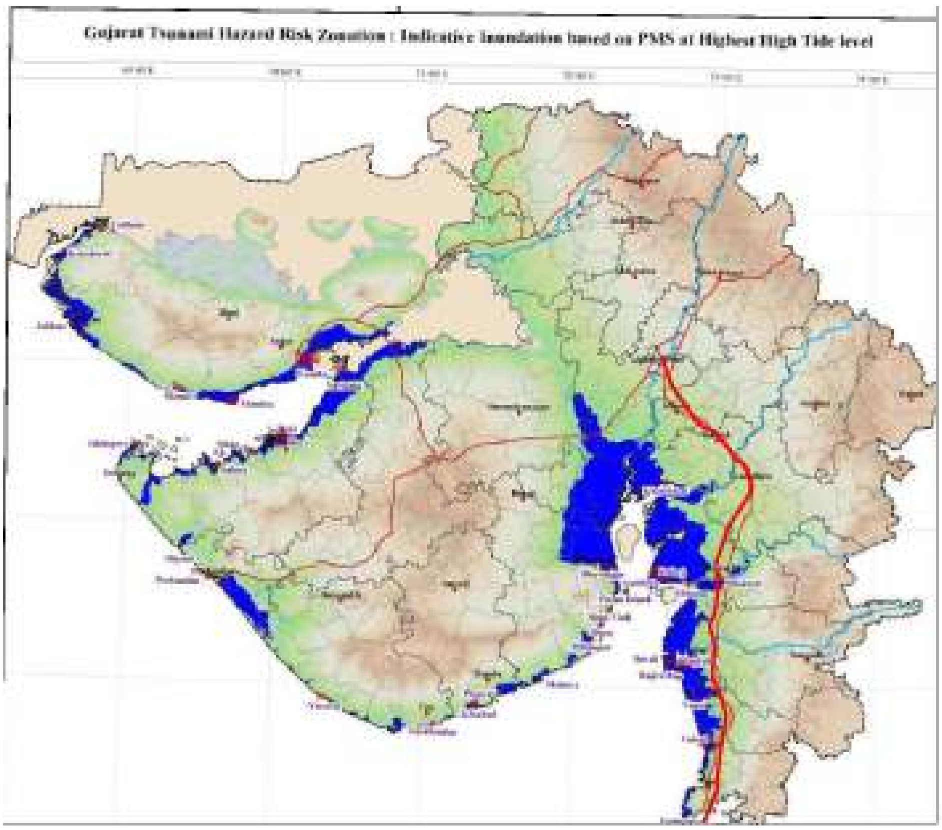
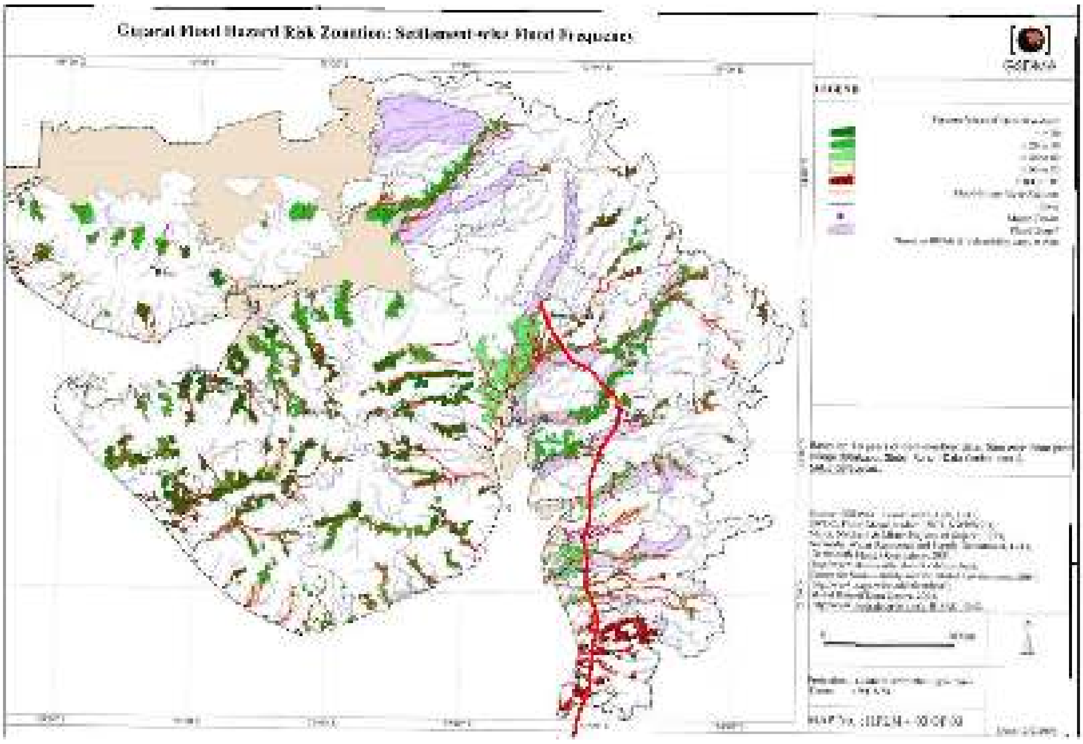


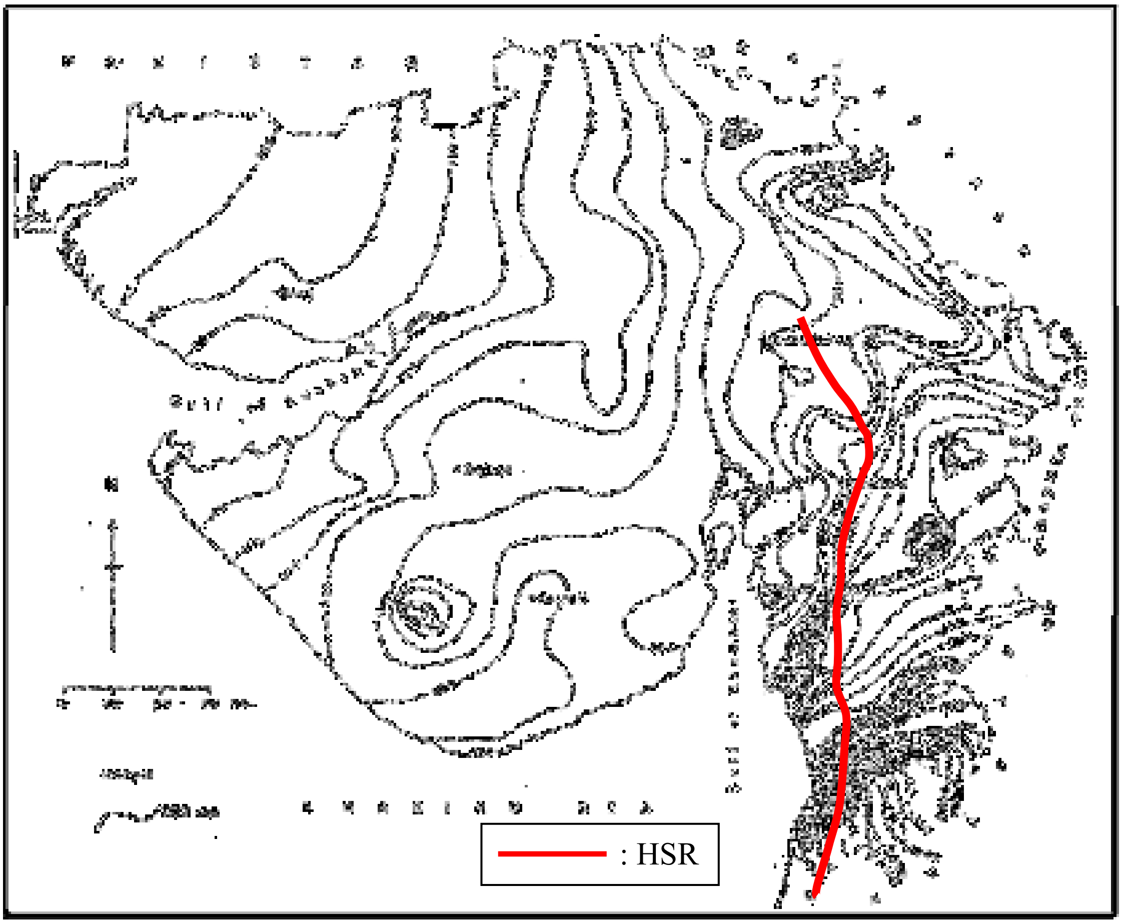
Exhibit 4.8.3b: The Hazard Risk and Vulnerability Atlas prepared by GSDMA for Floods



<u>STUDY AREA</u>

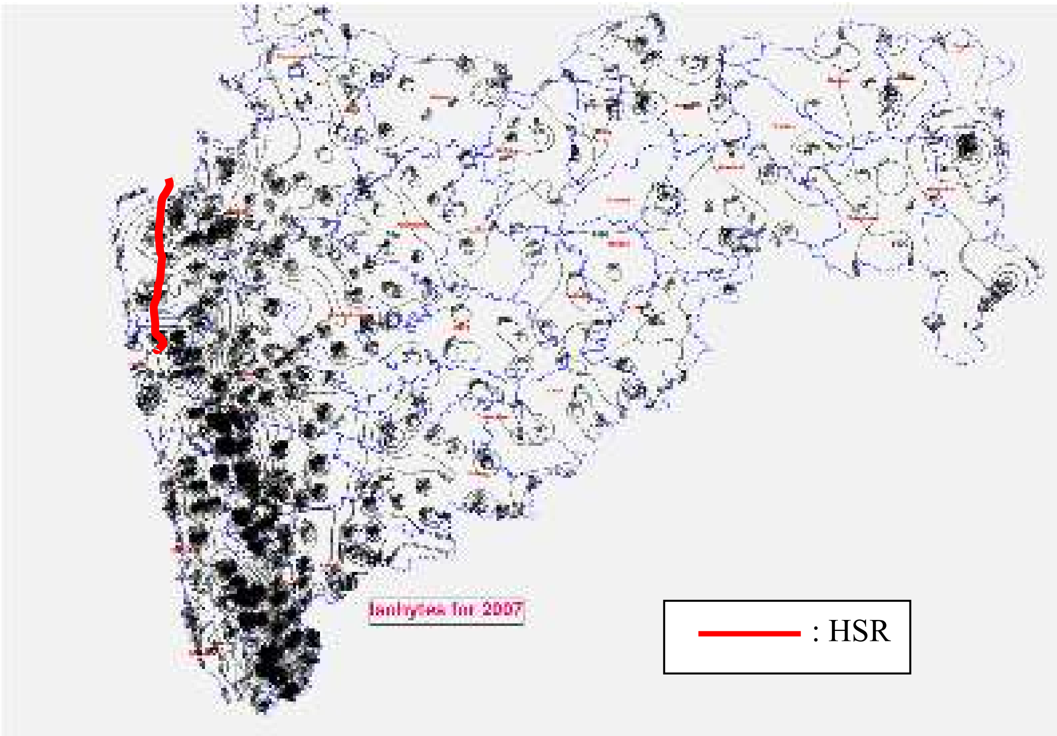
The data of all weather variables recorded at various meteorological observatories by the Indian Meteorological Department (IMD) and are also available in a number of books are presented in Table 4.8.1 to 4.8.6. The annual isohyte of Gujarat is depicted in Exhibit 4.8.4 The Isohyte map of Maharashtra for the year 2007 and 2008 are illustrated in Exhibit 4.8.5 and Exhibit 4.8.6.

Exhibit 4.8.4: Isohyte Map of Gujarat



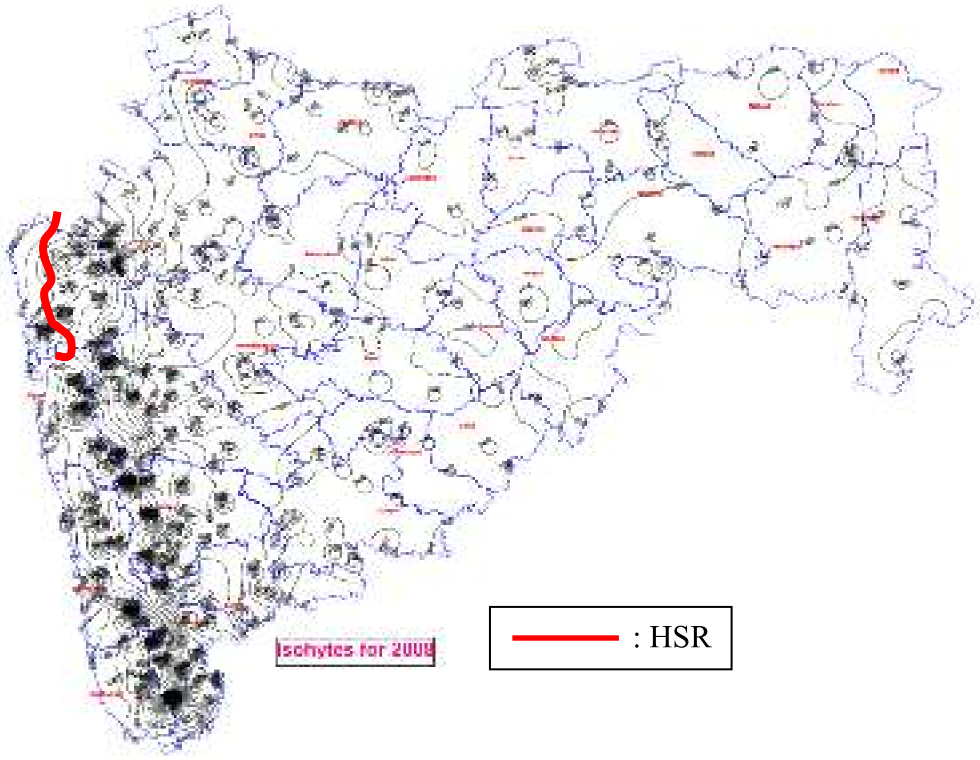
Source: www.imdpune.gov.in/

Exhibit 4.8.5: Isohyte Map of Maharashtra-2007



Source: www.imdpune.gov.in/

Exhibit 4.8.6: Isohyte Map of Maharashtra-2008



Source: www.imdpune.gov.in/

Atmospheric Pressure

The diurnal variation of atmospheric pressure reveals that the barometric pressure is highest during early morning and gradually decreases as the earth's surface starts warming up through absorption of solar radiation to reach a minimum at or immediately after sunset. This diurnal variation has been observed to be true, irrespective of the season. As regards monthly variation, it has been observed that barometric pressure is lowest in the month of June and July and highest in December and January. On perusal of the Tables 4.8.1 to 4.8.6, the lowest atmospheric pressure was observed as 995.2 hPa (8.30 HRS IST)-992.1 hPa (17.30 HRS IST) at Ahmedabad in the month of July and the highest was recorded as 1013.3 hPa (8.30 HRS IST)-1009.9 hPa (17.30 HRS IST) at Bharuch in the month of January.

Wind Speed and Direction

In the coastal region the wind speed is good throughout the year. The monthly mean wind speed varies from 6.7 km/hr to 17.9 km/hr. In view of the good wind speed, dispersal of gaseous releases will be good. In the mainland of Gujarat the mean monthly wind speed varies from 3.0 km/hr to 14.7 km/hr. Throughout the study area, the annual mean wind speed varies from 5.5 km/hr (IMD, Vadodara) to 10.5 km/hr (IMD, Dahanu).

In the mainland of Gujarat, the Winds blow from W and SW for most part of the year. During the winter months, the wind is from northeast corridor. The records of the meteorological observatories of the study area of Gujarat reveal that the wind is from southwest corridor in most part of the year. However, in the months of October to December, it is from northeast. The annual wind rose diagrams of all IMD stations of the study area are shown in Exhibit 4.8.7 to Exhibit 4.8.12.

Conclusions

The following conclusions can be drawn from the long term climatological data:

- The area is sub-tropical and humid;
- The area receives rainfall mainly during the southwest monsoon months;
- The wind is gentle with low to moderate strengths;
- The area falling in the Gujarat region prone to draught.

Table 4.8.1: Climatological Data of IMD, Dahanu (1983-2005)

Month	Minimum Temp (°C)	Maximum Temp (°C)	Mean Monthly Relative Humidity (%)	Monthly Atmospheric Pressure (hPa)		Monthly Mean Wind Speed (km/hr)	Monthly Rainfall (in mm)
				8.30 IST	17.30 IST		
January	19.5	32.8	44.9	1013.1	1010.1	7.5	0.6
February	19.2	30.5	44.1	1012.0	1008.9	8.4	1.5
March	23.5	32.8	46.0	1010.6	1007.3	9.3	0.1
April	24.2	36.8	54.2	1008.7	1005.2	10.4	0.6
May	24.8	36.7	66.9	1006.6	1003.6	11.9	13.2
June	24.4	32.0	83.1	1003.5	1001.3	15.0	574.1
July	23.8	26.2	87.0	1002.7	1001.1	17.9	868.3
August	23.3	25.9	87.0	1004.2	1002.4	15.7	553.0
September	22.7	26.5	84.0	1007.0	1004.5	10.0	306.4
October	23.0	29.5	67.5	1009.5	1006.5	6.8	62.9
November	22.8	30.4	48.4	1011.8	1008.7	6.7	14.9
December	21.4	29.4	44.8	1013.0	1010.0	6.8	5.6

Month	Minimum Temp (°C)	Maximum Temp (°C)	Mean Monthly Relative Humidity (%)	Monthly Atmospheric Pressure (hPa)		Monthly Mean Wind Speed (km/hr)	Monthly Rainfall (in mm)
				8.30 IST	17.30 IST		
Total/ Average	**22.7**	**30.8**	**63.3**	**1008.6**	**1005.8**	**10.5**	**2422.1**

Source: Climatological Data Book of IMD

Table 4.8.2: Climatological Data of IMD, Mumbai (1983-2005)

Month	Minimum Temp (°C)	Maximum Temp (°C)	Mean Monthly Relative Humidity (%)	Monthly Rainfall (in mm)	Monthly Mean Wind Speed (km/hr)	Monthly Atmospheric Pressure (hPa)	
						8.30 IST	17.30 IST
January	15.8	33.7	67	0.5	8.0	1013.2	1010.3
February	16.8	34.5	67	1.0	8.6	1012.1	1009.2
March	20.0	34.9	68	0.3	9.3	1010.8	1007.7
April	22.9	34.7	70	1.9	9.5	1009.0	1005.6
May	24.8	34.7	69	11.0	9.3	1007.0	1004.0
June	23.4	34.4	78	583.6	11.9	1003.8	1001.7
July	23.4	31.9	85	750.4	14.2	1003.1	1001.5
August	23.3	31.3	82	460.9	13.3	1004.6	1002.9
September	23.0	32.2	77	258.6	9.2	1007.3	1004.8
October	22.3	35.6	70	64.9	6.9	1009.7	1006.7
November	20.6	35.6	69	10.4	6.7	1011.9	1009.0
December	17.9	34.6	68	3.1	7.3	1013.1	1010.2
Total/ Average	**15.4**	**36.9**	**72.5**	**2146.6**	**9.5**	**1008.8**	**1006.1**

Source: Climatological Data Book of IMD

Table 4.8.3: Climatological Data of IMD, Bharuch (1983-2005)

Month	Minimum Temp (°C)	Maximum Temp (°C)	Mean Monthly Relative Humidity (%)	Monthly Rainfall (in mm)	Monthly Mean Wind Speed (km/hr)	Monthly Atmospheric Pressure (hPa)	
						8.30 IST	17.30 IST
January	7.9	34.9	52	1.2	5.9	1013.3	1009.9
February	9.8	38.4	45	1.0	6.2	1011.8	1008.1
March	14.1	41.7	44	0.8	7.0	1010.0	1005.9
April	19.5	43.6	56	1.0	8.8	1007.6	1003.4
May	23.4	44.4	70	12.5	12.4	1005.0	1001.0
June	23.0	39.8	81	121.0	14.7	1001.3	998.1
July	23.5	35.9	84	307.6	13.2	1000.0	997.7
August	23.4	34.4	76	243.1	11.5	1001.6	999.0
Septembe r	22.7	36.5	60	197.6	8.6	1005.1	1002.1
October	17.3	38.4	58	35.2	5.7	1008.7	1005.1
November	13.1	37.4	55	3.7	4.7	1011.8	1008.5
December	9.7	35.0	54	0.1	5.2	1013.4	1010.1
Total/ Average	**7.4**	**44.8**	**61.25**	**954.6**	**8.7**	**1007.5**	**1004.1**

Source: Climatological Data Book of IMD

Table 4.8.4: Climatological Data of IMD, Ahmedabad (1983-2005)

Month	Minimum Temp (°C)	Maximum Temp (°C)	Mean Monthly Relative Humidity (%)	Monthly Rainfall (in mm)	Monthly Mean Wind Speed (km/hr)	Monthly Atmospheric Pressure (hPa)	
						8.30 IST	17.30 IST
January	7.3	32.1	43	2.6	5.8	1009.7	1006.7
February	8.5	35.7	36	1.1	5.9	1008.2	1004.8
March	13.1	40.2	32	1.0	6.3	1006.0	1002.2
April	19.1	43.2	35	0.9	7.0	1003.3	999.0
May	22.7	44.7	43	6.0	9.2	1004.4	995.4
June	23.4	42.4	60	108.7	10.1	996.6	992.2
July	23.7	37.6	76	265.3	8.7	995.2	992.1
August	23.2	35.2	79	219.8	7.2	997.0	994.0
September	22.0	37.3	71	171.9	6.0	1001.0	997.6
October	16.6	38.2	51	10.8	4.3	1005.2	1001.9
November	12.6	36.0	43	8.9	4.6	1008.5	1005.3
December	8.6	32.7	45	2.6	5.3	1010.0	1006.8
Total/ Average	**6.4**	**44.9**	**51.17**	**803.4**	**6.7**	**1003.4**	**999.8**

Source: Climatological Data Book of IMD

Table 4.8.5: Climatological Data of IMD, Vadodara (1983-2005)

Month	Minimum Temp (°C)	Maximum Temp (°C)	Mean Monthly Relative Humidity (%)	Monthly Rainfall (in mm)	Monthly Mean Wind Speed (km/hr)	Monthly Atmospheric Pressure (hPa)	
						8.30 IST	17.30 IST
January	7.5	34.3	50	1.2	4.0	1011.8	1008.5
February	8.9	37.9	43	0.6	4.1	1010.3	1006.7
March	13.1	41.5	37	2.2	4.2	1008.5	1004.3
April	18.4	43.9	37	0.9	4.8	1005.9	1001.4
May	23.2	44.5	46	4.4	8.7	1003.1	998.3
June	23.5	41.5	64	146.8	10.3	999.4	995.4
July	23.5	36.9	80	297.6	8.4	998.1	995.3
August	23.4	34.6	82	284.7	7.1	999.8	997.0
September	22.4	37.0	75	141.7	5.1	1003.6	1000.2
October	16.7	38.5	58	22.0	3.0	1007.5	1004.0
November	12.9	37.2	53	16.2	3.0	1010.5	1007.2
December	9.6	34.5	55	4.4	3.6	1011.9	1008.7
Total/ Average	**6.9**	**44.8**	**56.67**	**922.7**	**5.5**	**1005.9**	**1002.3**

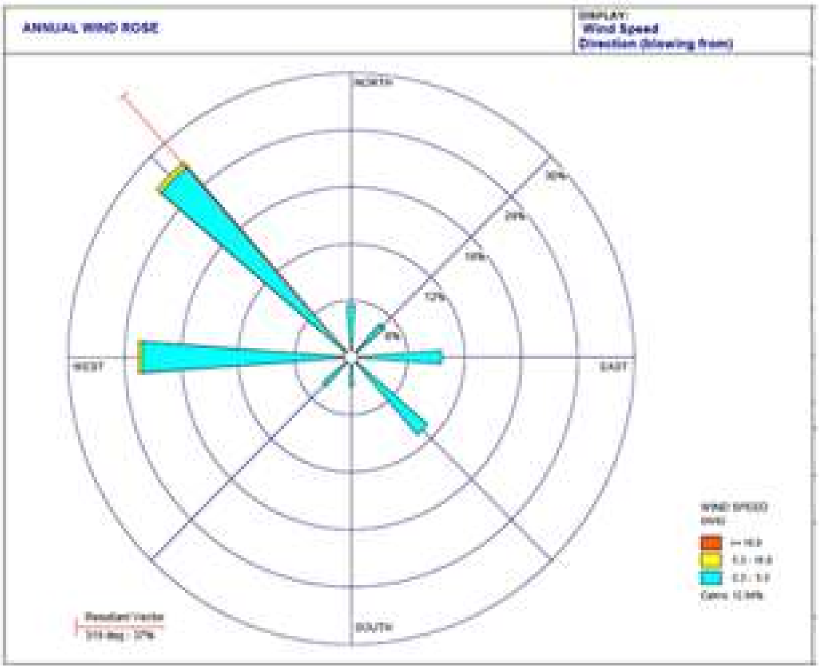
Source: Climatological Data Book of IMD

Table 4.8.6: Climatological Data of IMD, Surat (1983-2005)

Month	Minimum Temp (°C)	Maximum Temp (°C)	Mean Monthly Relative Humidity (%)	Monthly Rainfall (in mm)	Monthly Mean Wind Speed (km/hr)	Monthly Atmospheric Pressure (hPa)	
						8.30 IST	17.30 IST
January	10.3	35.5	52	0.0	6.9	1014.2	1010.9
February	11.5	38.1	48	0.4	7.1	1021.9	1009.3
March	15.7	41.0	48	1.5	7.5	1011.2	1007.2
April	20.3	42.4	52	0.3	8.3	1008.8	1004.7
May	23.5	41.9	57	7.3	1.9	1006.2	1002.6
June	23.4	37.4	75	249.3	13.5	1002.4	999.8
July	23.3	34.4	84	417.7	12.6	1001.3	999.1
August	23.2	33.2	84	299.4	11.0	1003.0	1000.8
September	22.5	36.4	73	190.7	7.9	1006.5	1003.5
October	19.4	38.7	61	27.2	6.2	1010.1	1006.6
November	15.5	37.7	52	13.0	6.6	1012.9	1009.5
December	12.1	35.9	54	2.6	7.2	1014.2	1010.9
Annual Average	**9.7**	**43.3**	**61.67**	**1209.4**	**8.9**	**1006.5**	**1005.4**

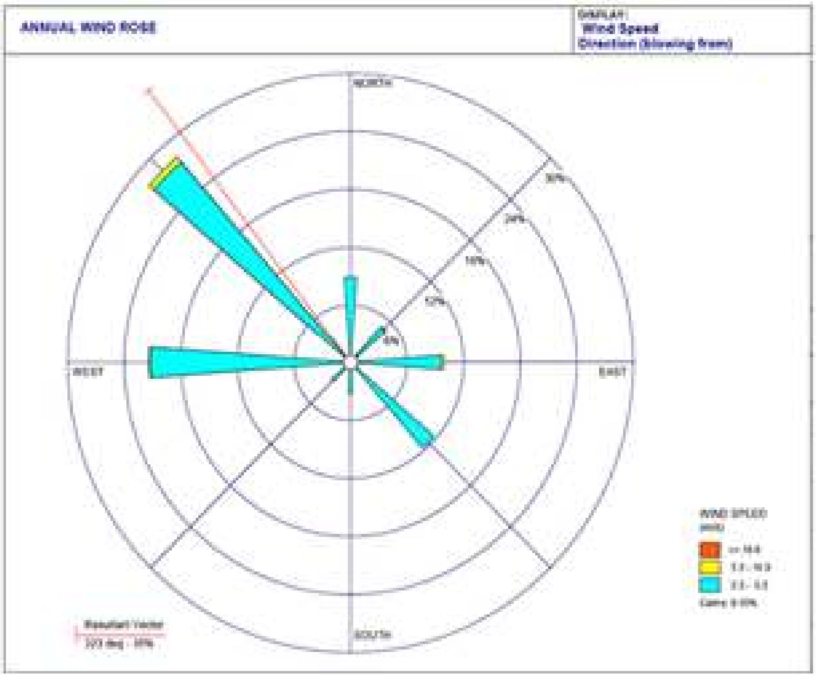
Source: Climatological Data Book of IMD

Exhibit 4.8.7: Annual Wind Rose Diagram of Dahanu (Based on Long Term Data of IMD)



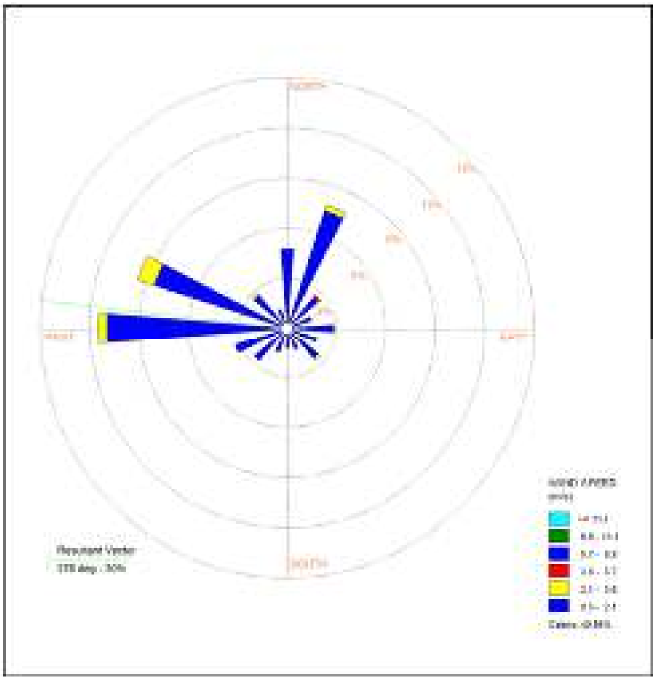
Source: Prepared by Study Team

Exhibit 4.8.8:Annual Wind Rose Diagram of Mumbai (based on Long Term Normals)



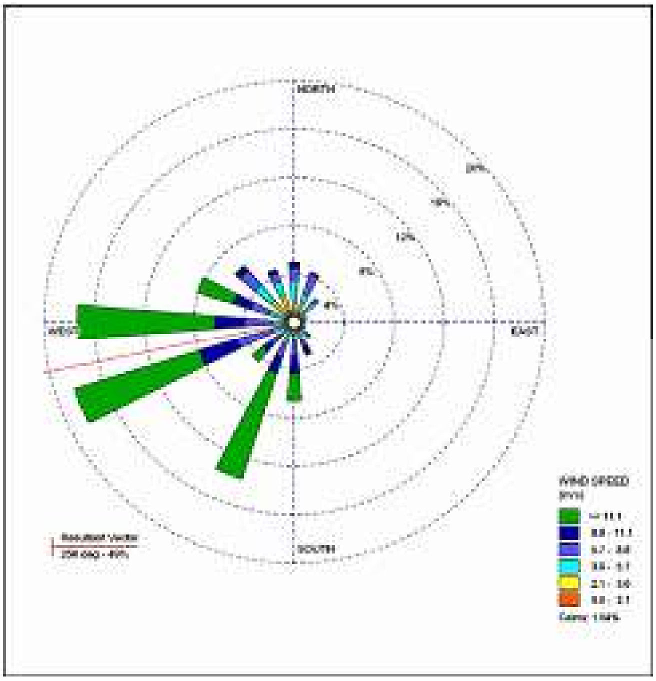
Source: Prepared by Study Team

Exhibit 4.8.9: Annual Wind Rose Diagram of Ahmedabad



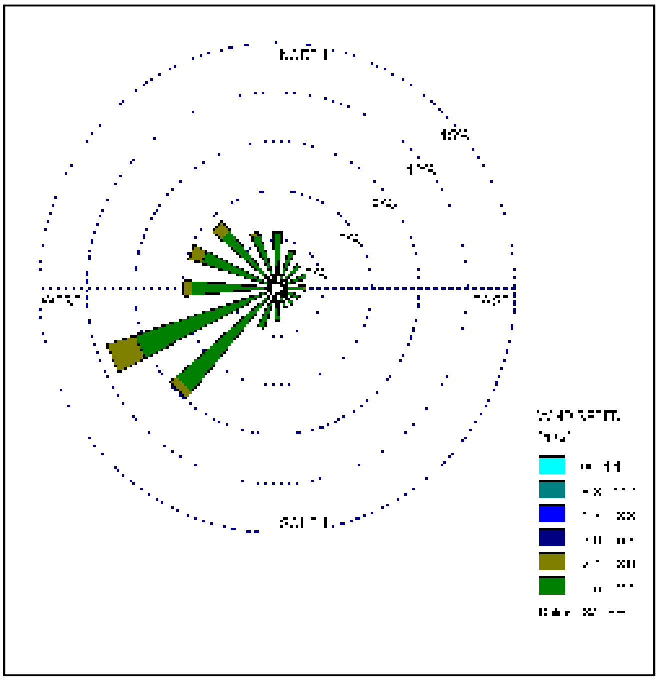
Source: Prepared by Study Team

Exhibit 4.8.10: Annual Wind Rose Diagram of Vadodara



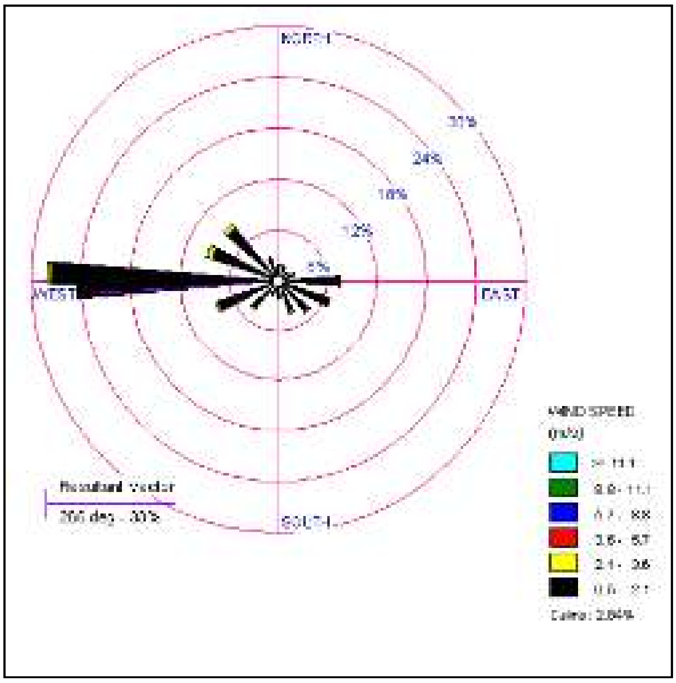
Source: Prepared by Study Team

Exhibit 4.8.11: Annual Wind Rose Diagram of Bharuch



Source: Prepared by Study Team

Figure 4.8.12: Annual Wind Rose Diagram of Surat



Source: Prepared by Study Team

(2) MICRO-METEOROLOGY

The micro-meteorological conditions at the project site regulate the transport and diffusion of air pollutants released into the atmosphere. The principal meteorological variables are horizontal convective transport (average wind speed and direction), vertical convective transport (atmospheric stability, mixing height) and topography of the area. The data on surface meteorological parameters (wind speed and direction, ambient temperature, relative humidity, atmospheric pressure, solar radiation, rainfall *etc.*) in the study area were collected using portable weather monitoring station. An Automatic Weather Station (WM 250) of M/s Envirotech Instrument Pvt. Ltd. was used at two stations - one at Mumbai (Anjur Village, Silphata, Close to proposed alignment) and another on the roof of Swami Narayan Building at Randesan Theatre Road in on 01-May-2017 and continued till 31-May-2017. The sensors of this equipment were kept at about 10 m above ground level with free exposure to atmosphere. In this report the on-site meteorological data generated from 01-May-2017 to 31-May-2017 has been incorporated and subjected to statistical analysis.

For other cities like- Bharuch, Navsari and Vadodara, the AWS data from nearest India Meteorological Department (IMD) observatory was procured and has been presented in the report after statistical analysis.

In this report the on-site meteorological data recorded during the field study (01-May-2017 to 31-May-2017) has been presented in Table 4.8.7. The wind rose diagram for the month of May 2017 for these stations have been prepared and shown in Exhibit 4.8.13 to Exhibit 4.8.17.

Table 4.8.7: On-Site Meteorological Data (May 2017)

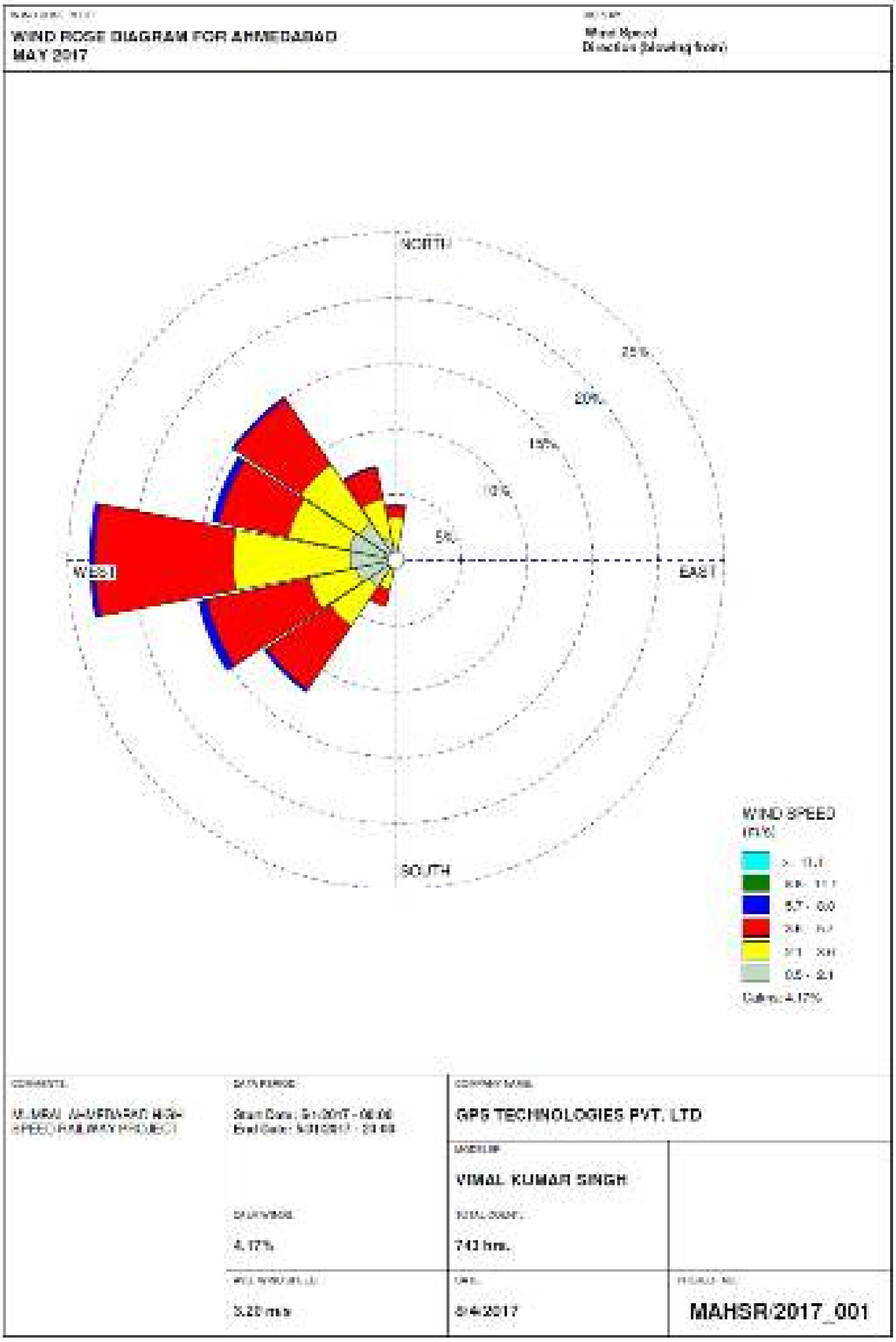
Station	Temp. (^{0}C)		Relative Humidity (%)		Rainfall (mm)	Mean Wind Speed	Atmospheric Pressure (hPa)	
	Min.	Max.	Min	Max			Min	Max
Ahmedabad	29.7	42.8	8	74	0.0	3.2 m/s	991.6	997.6
Navsari	27.8	38.5	10	77	0.0	2.2 m/s	996.9	998.1
Bharuch	27.4	39.5	9	76	0.0	2.0 m/s	995.2	997.3
Vadodara	27.7	42.5	13	75	0.0	0.8 m/s	1001.1	1006.2
Mumbai	25.6	36.5	65	79	0.0	3.3 m/s	1007.4	1009.2

Source: Study Team and IMD Observatory

Discussion

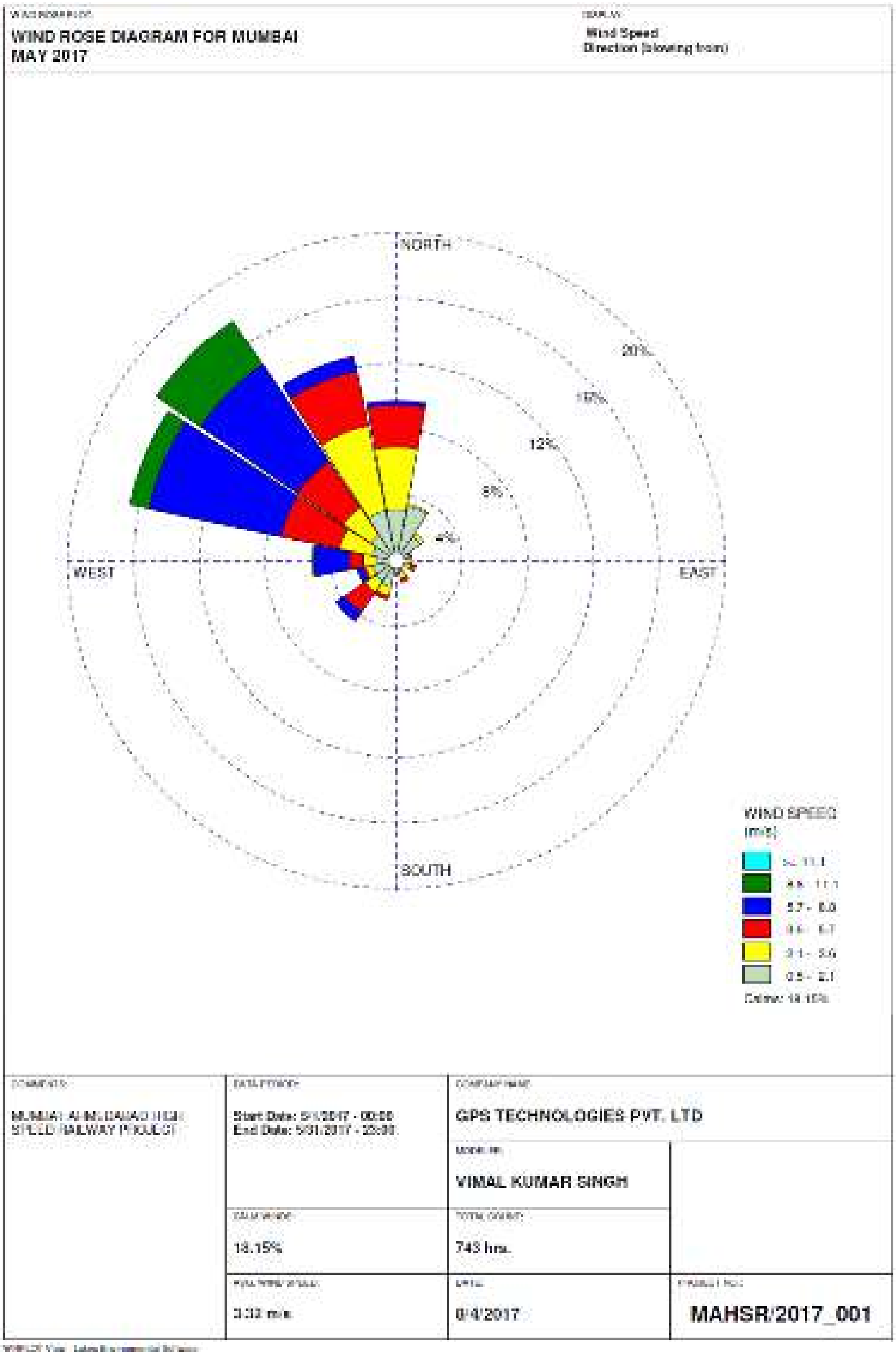
On perusal of Table 4.8.7 it can be inferred that the temperature during the month of May 2017 varied from 25.6^{0}C (Mumbai) to 42.8^{0}C (Ahmedabad). The relative humidity was on higher side in Mumbai-79 per cent followed by Navsari-77 per cent and lowest at Vadodara-75 per cent. Mumbai being coastal city, the wind speed was observed to be on higher side (3.3 m/s) followed by Ahmedabad with wind speed of 3.2 m/s. It is evident from the wind rose diagram that the prevalent wind direction is from west most of the time followed by southwest and south. No rain was observed during the month of May 2017 in the study area.

Exhibit 4.8.13 Wind Rose Diagram of Ahmedabad-May 2017



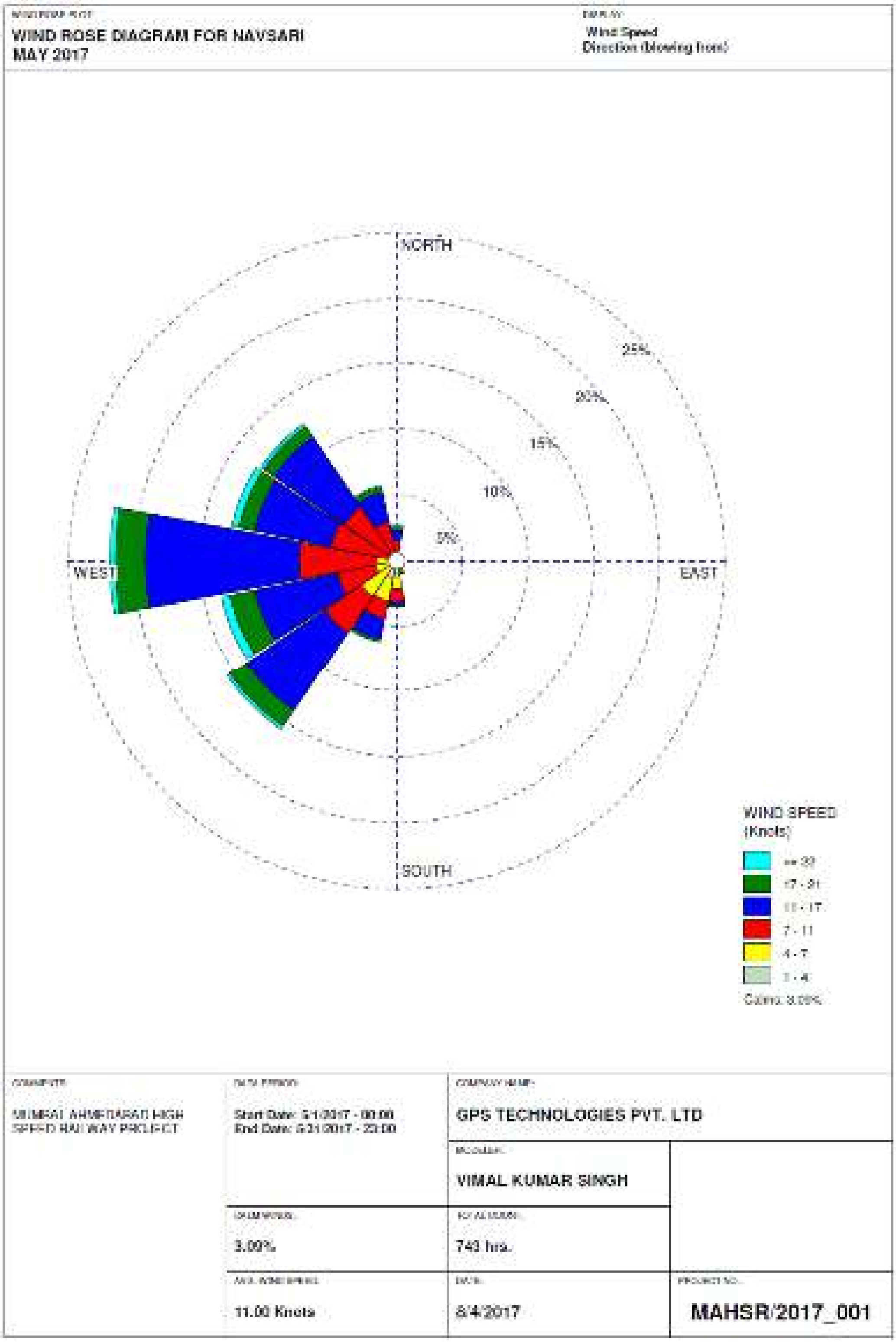
Source: Study Team

Exhibit 4.8.14: Wind Rose Diagram of Mumbai-May 2017



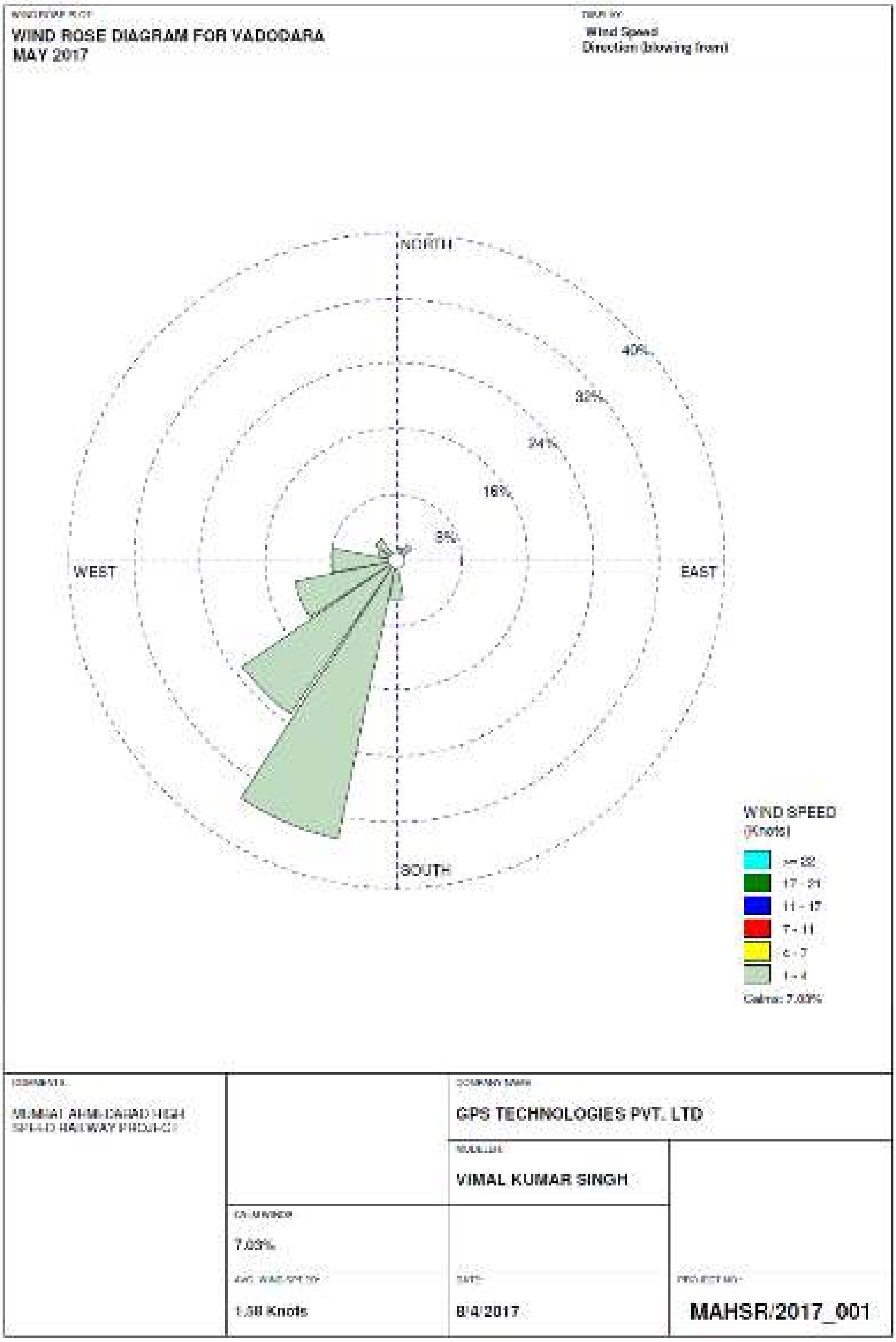
Source: Study Team

Exhibit 4.8.15: Wind Rose Diagram of Navsari-May 2017



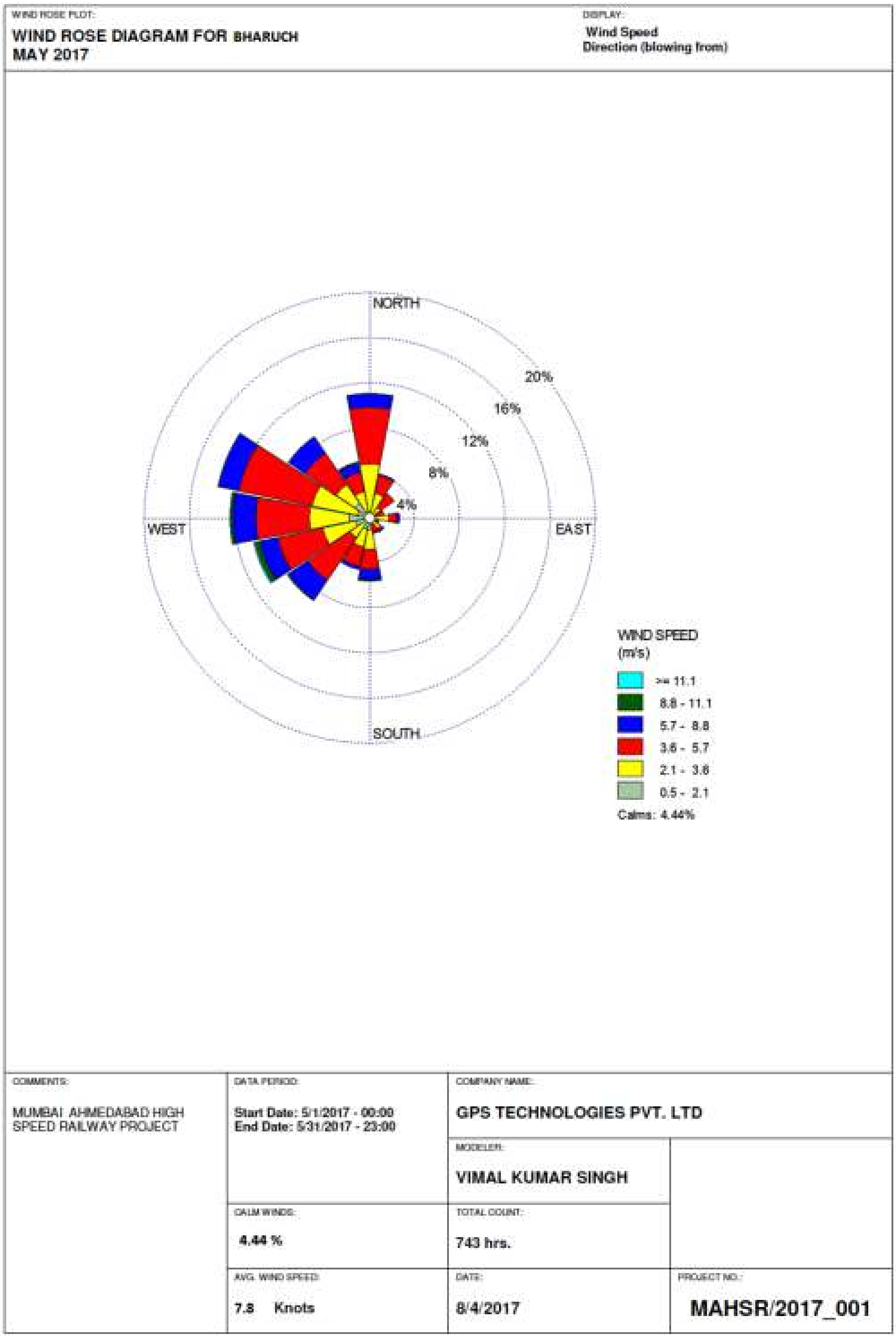
Source: Study Team based on AWS data of Navsari-IMD

Exhibit 4.8.16: Wind Rose Diagram of Vadodara-May 2017



Source: Study Team based on AWS data of Vadodara-IMD

Exhibit 4.8.17: Wind Rose Diagram of Bharuch-May 2017



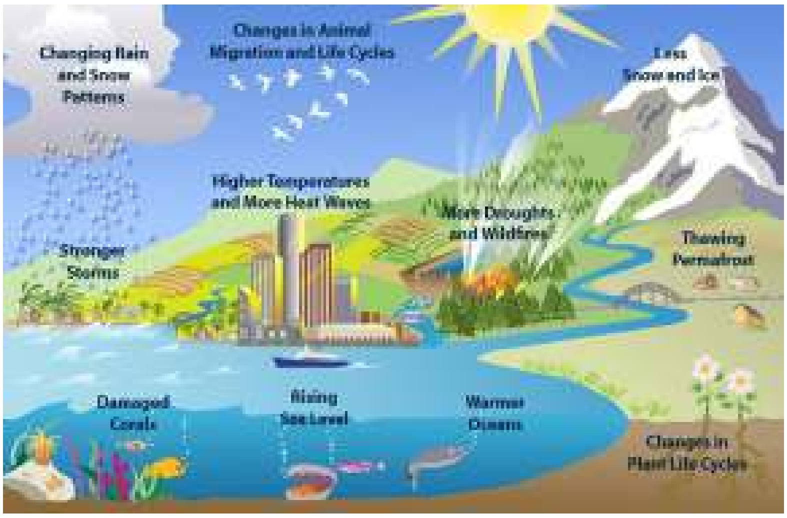
Source: Study Team based on AWS data of Bharuch-IMD

Annexure 4.9

4.9 Climate Change-Introduction

Climate change refers to a broad range of global phenomena created predominantly by burning fossil fuels, which add heat-trapping gases to Earth's atmosphere. These phenomena include the increased temperature trends described by global warming, but also encompass changes such as sea level rise; ice mass loss in Greenland, Antarctica, the Arctic and mountain glaciers worldwide; shifts in flower/plant blooming; and extreme weather events.

Exhibit 4.9.1: Effects of Climate Change



Source: http://www.basscoast.vic.gov.au

4.9.1 Indian Subcontinent

The Climate change effects on the Indian subcontinent vary from the submergence of low-lying islands and coastal lands to the melting of glaciers in the Indian Himalayas, threatening the volumetric flow rate of many of the most important rivers of India and South Asia. In India, such effects are projected to impact millions of lives. As a result of ongoing climate change, the climate of India has become increasingly volatile over the past several decades; this trend is expected to continue. Elevated carbon dioxide emissions from industries, factories, vehicles etc. have contributed to the greenhouse effect, causing warmer weather that lasted long after the atmospheric shroud of dust and aerosols had cleared. Further climatic changes 20 million years ago, long after India had crashed into the Laurasian landmass, were severe enough to cause the extinction of many endemic Indian forms. The formation of the Himalayas resulted in blockage of frigid Central Asian air, preventing it from reaching India; this made its climate significantly warmer and more tropical in character than it would otherwise have been. According to data from 2009 India is the world's third biggest emitter of CO_2 after China and the United States - pushing Russia into fourth place. Climate has also changed as outcome of the tectonic activity since then over a period of time River Systems have emerged and dissipated. One of such example from the project area of MAHSR is the drying up of the Saraswati River and conversion of the Rann of Kutch from a Delta to Salt Planes and Desert.

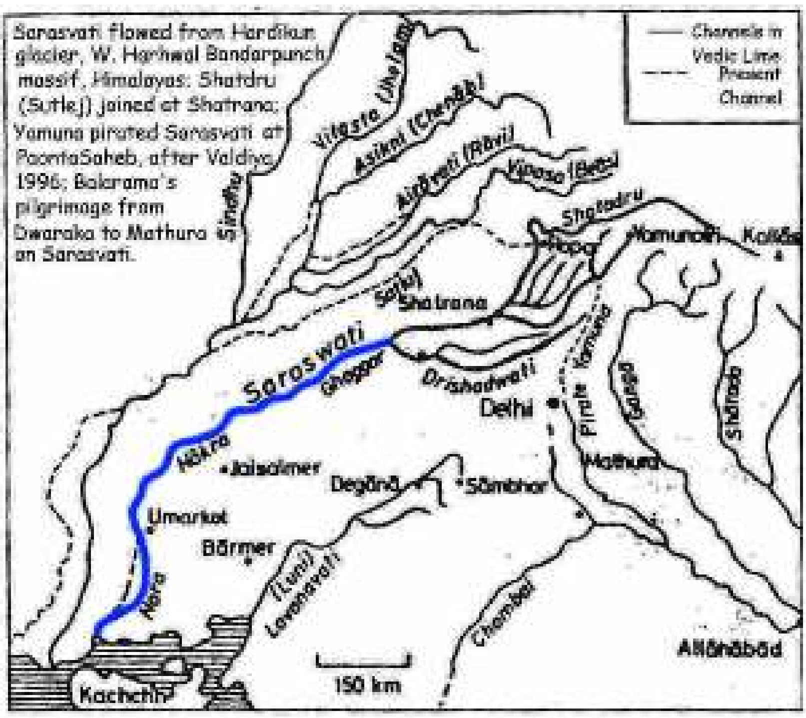
4.9.2 Historic Climate Change Occurrences

Tectonic shifts are not new: for example, earlier in the current Holocene epoch (4,800–6,300 years ago), parts of what is now the Thar Desert were wet enough to support perennial lakes; researchers have proposed that this was due to much higher winter precipitation, which coincided with stronger monsoons. Similarly, Kashmir, which once had a warm subtropical climate, shifted to a substantially colder temperate climate 2.6–3.7 million years ago (mya), it was then repeatedly subjected to extended cold spells starting 1 mya.

4.9.3 Geographical Change

Nearly ten thousand years ago when mighty rivers started flowing down the Himalayan slopes, western Rajasthan was green and fertile. Great civilizations prospered in the cool amiable climate on riverbanks of northwestern India. The abundant waters of the rivers and copious rains provided ample sustenance for their farming and other activities. Some six thousand years later, Saraswati, one of the rivers of great splendour in this region, for reasons long enigmatic, dwindled and dried up. (Refer Exhibit 4.9.2)

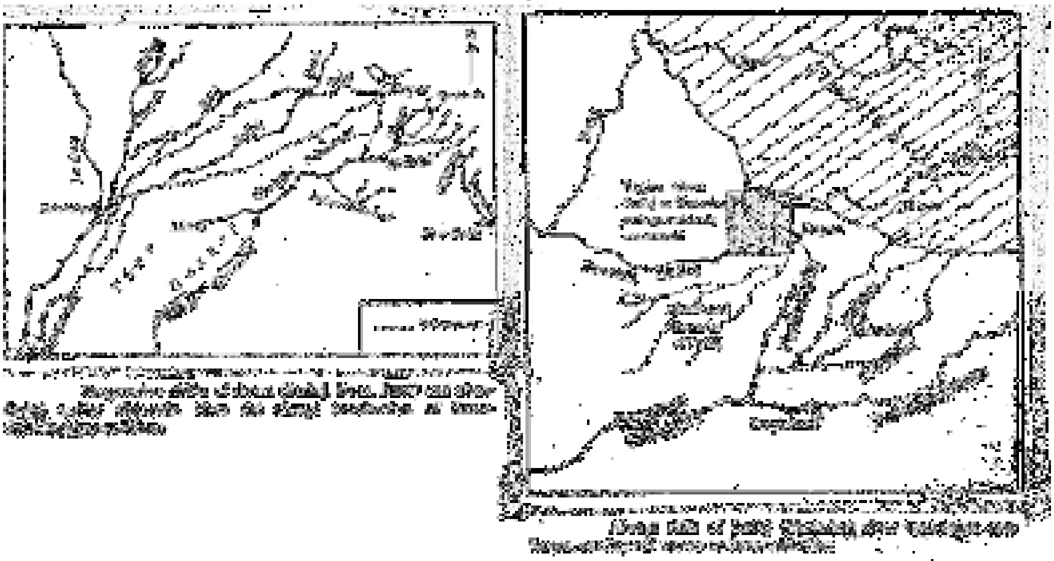
Exhibit 4.9.2: Saraswati River Course



http://www.iisc.ernet.in/currsci/oct25/articles20.htm

Several other rivers shifted their courses; some of their tributaries were 'pirated' by neighbouring rivers or severed from their main courses. The greenery of Rajasthan was lost, replaced by an arid desert where hot winds piled up dunes of sand. The flourishing civilizations vanished one by one. By geological standards, these are small-scale events; for earth, in its long 4.5 billion years history, had witnessed many such changes, some of them even accompanied by wiping out of several living species. But those that occurred in northwest India took place within the span of early human history affecting the livelihood of flourishing civilizations and driving them out to other regions.

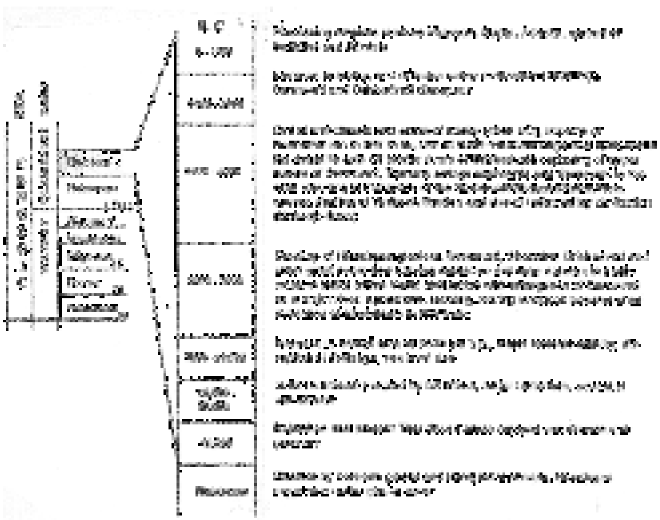
Exhibit 4.9.3: Progressive shift of Rivers



http://www.iisc.ernet.in/currsci/oct25/articles20.htm

Considerable tectonic activity connected with Himalayan orogeny continued during the Holocene and later times although uplifts to heights of 3000–4000 m were at their peak during 0.8–0.9 my span. The high elevation of the mountains perturbed the wind circulation patterns and induced climatic changes. Moderate terrain of earlier times became rugged and hilly affecting the channels of rivers[14]. That was the scenario of the Himalayan region when Saraswati emerged as a major river about 9000 y ago[20] and flowed in all splendour during the Vedic times till its decline to an impermanent monsoon dependent state some 4000 y later. Bulk of earlier studies on Saraswati pertain more to the civilizations that flourished along its banks and many of the reasons attributed for the decline of this river were speculative. The impacts of middle to late Quaternary geologic events on the river systems in this region, however, had received only cursory attention. Awareness to the potentialities of geologic, meteorological, climatic and other cyclic events, basically triggered by plate tectonism, earth's orbital and tilt variations and similar global phenomena came up much later. (Refer Exhibit 4.9.3 and 4.9.4)

Exhibit 4.9.4: Sequence of geological and climatic event during Holocene



Source :- http://www.iisc.ernet.in/currsci/oct25/articles20.htm

The waning period of Vedic civilization around 3700 BC was also the period that disrupted both Saraswati and Drishadvati. Several evidences indicate that rivers of this area changed their courses often in the last 5000 years and one detailed study about Saraswati has identified at least four progressive westward shifts in Rajasthan, due to encroaching sands

4.9.4 Climate Change-Indian Scenario

India is both a major greenhouse gas emitter and one of the most vulnerable countries in the world to projected climate change. The country is already experiencing changes in climate and the impacts of climate change, including water stress, heat waves and drought, severe storms and flooding, and associated negative consequences on health and livelihoods. With a 1.2 billion growing population and dependence on agriculture, India probably will be severely impacted by continuing climate change. Global climate projections, given inherent uncertainties, indicate several changes in India's future climate. India is already experiencing a warming climate. Unusual and unprecedented spells of hot weather are expected to occur far more frequently and cover much larger areas. Under 4°C warming, the west coast and southern India are projected to shift to new, high-temperature climatic regimes with significant impacts on agriculture. A decline in monsoon rainfall since the 1950s has already been observed. The frequency of heavy rainfall events has also increased. 2°C rise in the world's average temperatures will make India's summer monsoon highly unpredictable. At 4°C warming, an extremely wet monsoon that currently has a chance of occurring only once in 100 years is projected to occur every 10 years by the end of the century. An abrupt change in the monsoon could precipitate a major crisis, triggering more frequent droughts as well as greater flooding in large parts of India.

India's northwest coast to the south eastern coastal region could see higher than average rainfall. Dry years are expected to be drier and wet years wetter. Evidence indicates that parts of South Asia have become drier since the 1970s with an increase in the number of droughts. Droughts have major consequences. In 1987 and 2002-2003, droughts affected more than half of India's crop area and led to a huge fall in crop production. Droughts are expected to be more frequent in some areas, especially in north-western India, Jharkhand, Orissa and Chhattisgarh.

Crop yields are expected to fall significantly because of extreme heat by the 2040s. More than 60% of India's agriculture is rain-fed, making the country highly dependent on groundwater. Even without climate change, 15% of India's groundwater resources are overexploited. Although it is difficult to predict future ground water levels, falling water tables can be expected to reduce further on account of increasing demand for water from a growing population, more affluent life styles, as well as from the services sector and industry.
Source: World Bank

4.9.5 Rise in Sea Level

The corresponding sea level rise at the end of the 21st Century relative to the end of the 20th Century ranges from 0.18 to 0.59 m (excluding any rapid dynamical changes in ice flows in the future). Ongoing sea level rises have already submerged several low-lying islands in the Sundarbans, displacing thousands of people. Temperature rises on the Tibetan Plateau, which are causing Himalayan glaciers to retreat. It has been predicted that the historical city of Thatta and Badin, in Sindh, Pakistan would have been swallowed by the sea by 2025, as the sea is already encroaching 80 acres of land here, every day. Warming oceans and a changing climate are resulting in extreme weather patterns which have bought about an increase of infectious diseases – both new and re-emerging.

Mumbai has the world's largest population exposed to coastal flooding, with large parts of the city built on reclaimed land, below the high-tide mark. Rapid and unplanned urbanization further increases the risks of sea water intrusion. With India close to the equator, the sub-continent would see much higher rises in sea levels than higher latitudes. Sea-level rise and storm surges would lead to saltwater intrusion in the coastal areas, impacting agriculture, degrading groundwater quality, contaminating drinking water, and possibly causing a rise in diarrhea cases and cholera outbreaks, as the cholera bacterium survives longer in saline water. Kolkata and Mumbai, both densely populated cities, are particularly vulnerable to the impacts of sea-level rise, tropical cyclones, and riverine flooding.

4.9.6 Project States

Climate Change in India will have a disproportionate impact on the more than 400 million that make up India's poor. This is because so many depend on natural resources for their food, shelter and income. More than 56% of people in India work in agriculture, while many others earn their living in coastal areas.

a. Maharashtra

Maharashtra, one of India's largest states and home to the commercial hub of Mumbai, is facing up to the serious threat posed by climate change. Although Maharashtra is a relatively industrialized state, the majority of its population continues to work in agriculture. This high level of dependency on the land, combined with a vulnerable coastline of more than 840 km, leaves the state particularly susceptible to changing weather patterns. As well as fluctuations in temperature and precipitation, there is the potential for climate change to affect the frequency and intensity of extreme events such as droughts, floods, cyclones, storm surges and heat waves. Of course, Maharashtra is not alone. Many other areas of India, and other parts of the world, face a similar challenge. But what's particularly interesting about Maharashtra is what is being done now to tackle that challenge and how others may be able to learn from the project. It's likely that the strongest impact of climate change will be felt by the world's least developed countries. Without detailed climate change information at a local level, regional authorities and governments will not be able to plan adequately for the future — yet few developing countries currently have the capacity to perform the necessary climate research on their own.

b. Gujarat

Managing Climate Change is a major challenge to humanity. To tackle it, Gujarat has established a separate Department for Climate Change. This Initiative by Gujarat Government is a trendsetter not only for India but for the whole of Asia as it is the "First in Asia" with a Department for Climate Change. It is the only 4th State/Province in the World to have a Department for Climate Change. Set up in February 2009, the Department is headed by Shri Narendra Modi to handle issues of Climate Change. The Initiative is to give a human face to environmental issues; empower people to become active agents of sustainable development; promote an understanding that communities are pivotal to changing attitudes towards environmental issues; and advocate partnership, which will ensure all citizens and people in Gujarat to enjoy a safer and more prosperous future. The vulnerability to climate change is greater in developing countries like India- which are mostly located in lower, warmer latitudes. Climatic data of different stations of Gujarat have been analysed to ascertain the climatic change/variability in the state and its likely impact on crop production using crop models. The long period rainfall analysis showed slight increase in annual rainfall by 2.86 mm per year. The rainfall intensity in terms of daily maximum rainfall also showed increasing trend. The rate of maximum temperature increase was between 0.2 to 0.5°C per decade, maximum being in summer season. Similarly, the minimum temperature was found to increase but with slightly lower rate of 0.2 to 0.3°C per decade in different seasons. The calibrated DSSAT-3.5 models were used to simulate the wheat and maize yield under hypothetical weather condition that may be arising due to climate change. The climate scenario simulated for temperatures (± 1 to ± 3°C), radiation (± 1 to ± 3 MJm-2 day-1) and CO2 (440, 550 and 660 ppm against present concentration of 330 ppm) were well within the range of projected climate scenario by IPCC.

Results revealed that increase in temperature significantly reduced the wheat yield (-8 to -31 %) while decrease in temperature increased the yield (10 to 26%). The effect of maximum temperature on maize yield had similar effect but the magnitude is marginal (- 4 to 6%) over whole range of temperature (±3°C) change. The minimum temperature had similar effect on wheat yield with less magnitude of variation (-14 to +19 %), however on maize yield increasing trend was observed with increase in minimum temperature. The effect was higher in wheat crop (-50 to 40%) than maize (-18 to 8%). Increase in CO2 had beneficial effect on both the crops. Large Scale Infrastructure changes have transformed the economy and environment to a Green Gujarat. Gujarat is the only state in India with a Gas Grid, using India's natural gas to replace coal use and reduce pollution. Gujarat has committed to reach gas to hundreds of thousands of households and industries to lower carbon emissions. Already industries, transport vehicles and households are using gas, giving much less pollution in our cities.

It has been estimated that Gujarat's Gas Grid has reduced seventeen million tonnes of carbon emissions. While groundwater levels are falling in other States, in Gujarat the levels are increasing. Data from the Central Ground Water Board (CGWB) shows Gujarat has increased groundwater levels over the last eight years. Over four hundred thousand water-harvesting structures have been constructed: checkdams, bori-bandh and khet talavadi (farm ponds).Climate Change requires change on a mass scale. The Government has increased micro irrigation by offering a subsidy and loan as well as a fast-track application system. Jyotigram Scheme has regulated groundwater use by controlling power supply for agriculture areas. We have successfully controlled the wasteful use of agriculture electricity in Gujarat. International studies have shown that water management reforms have led to a huge increase in output of crops and milk Gujarat, while taking care of the environment. Bus Rapid Transport System is now operational in Ahmedabad, a city of over 4.5 million people. The impact of BRTS has been estimated at a reduction of thirty-seven thousand tonnes of carbon emissions. We are planning to build BRTS in other large cities next for even greater benefits. Gujarat is already committed to using Green Energy for the future. We have created the most attractive policies for Solar, Wind and Biomass Energy production. Gujarat is an ideal place for solar power generation because of large open space for solar panels and high-intensity solar radiation. Gujarat Government has already approved thirty-four solar power projects that will produce seven hundred and sixteen mega watts of electricity, and a reduction of one point two five million tonnes of carbon emissions. Recently the Clinton Climate Initiative announced setting up the world's largest solar power plant in Gujarat, giving an additional capacity of 3000 mega watts. Gujarat Government plans to make Gujarat an international solar hub for manufacturing solar power equipment, research and development and for generating solar energy.

Gujarat has the longest coastline in India of over 1600 km where wind speeds are good for harnessing wind energy. Private wind power plants have been set up along the coast and Gujarat's total wind power capacity is now over one thousand six hundred mega watts. Gujarat plans to add more than four thousand mega watts of wind power capacity by 205. The United Nations Clean Development Mechanism (CDM) is encouraging carbon emission reductions. Gujarat has over one hundred CDM projects registered with the highest amount of carbon dioxide reduction in India, of twenty-two million tonnes of carbon dioxide. Gujarat is transforming polluting cities to green cities. In 2003 Ahmedabad was named as the most polluted city in India. In 2009 Ahmedabad topped the list of United Nations 'Green Cities'. We must transform how cities prepare for climate change. Surat City in Gujarat has been selected by the Rockefeller Foundation - for the Asian Cities Climate Change Resilience Network (ACCCRN) project to prepare an action plan to withstand and recover from impacts of climate change. This will be an international model for other cities to make climate change action plans. The initiative taken by the Government of India to implement MAHSRC will certainly reduce the CO_2 emissions at greater level and will be helpful in combating the challenge of Climate Change at large scale.

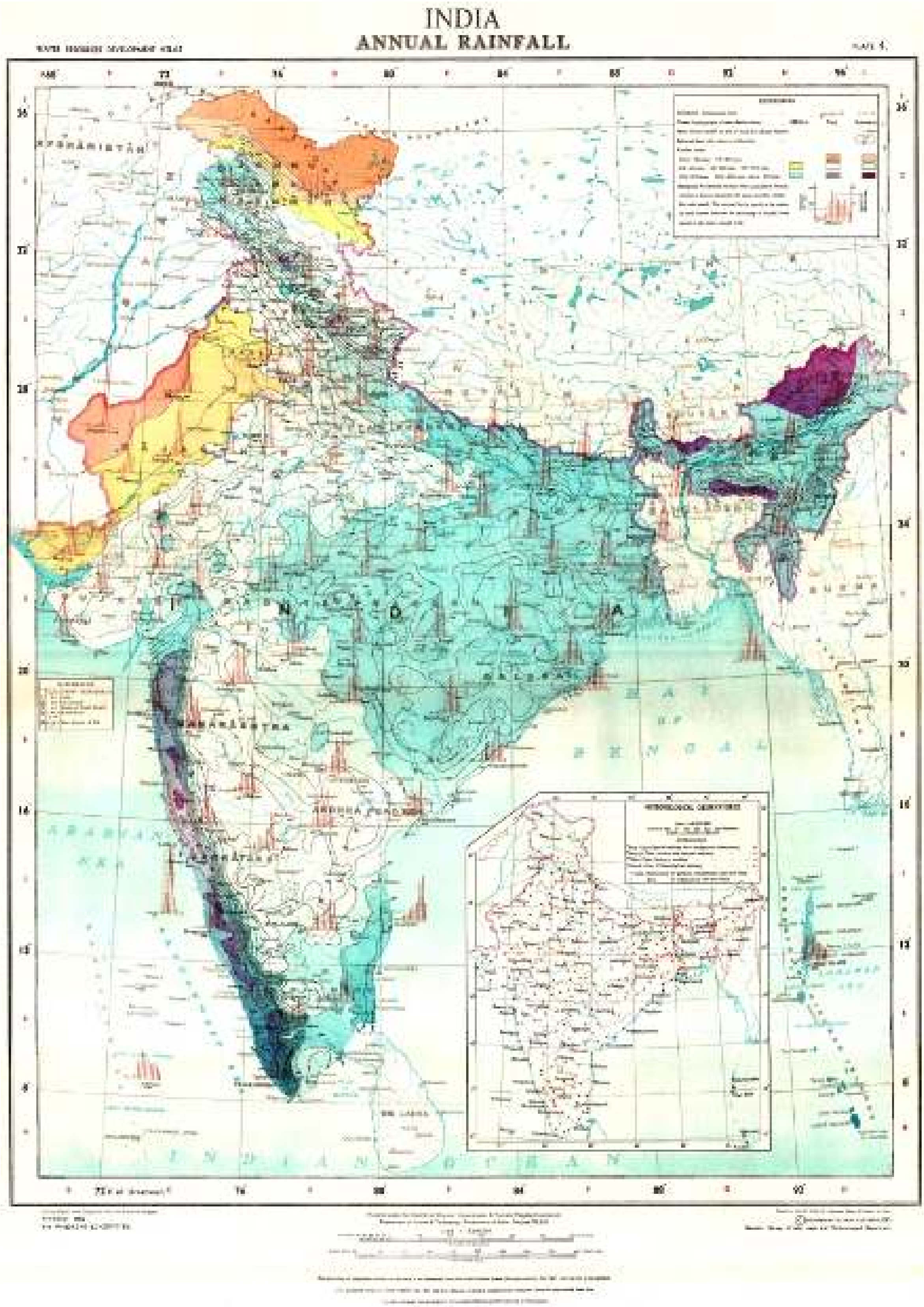
4.9.7 Rainfall

Rainfall is an important element of the Indian economy. Although the monsoons affect most part of India, the amount of rainfall varies from heavy to scanty on different parts. There is great regional and temporal variation in the distribution of rainfall. Over 80% of the annual rainfall is received in the four rainy months of June to September. The average annual rainfall is about 55 cm, but it has great spatial variations.

Areas of Heavy Rainfall (Over 200cm): The highest rainfall occurs in west costs, on the western Ghats as well as the Sub-Himalayan areas in North East and Meghalaya Hills. Assam, West Bengal, West Coast and Southern slopes of eastern Himalayas. Areas of Moderately Heavy Rainfall (100-200 cm): This rainfall occurs in Southern Parts of Gujarat, East Tamil Nadu, North-eastern Peninsular, Western Ghats, eastern Maharashtra, Madhya Pradesh, Orrisa, the middle Ganga valley. Areas of Less Rainfall (50-100 cm): Upper Ganga valley, eastern Rajasthan, Punjab, Southern Plateau of Karnataka, Andhra Pradesh and Tamil Nadu. Areas of Scanty Rainfall (Less than 50 cm): Northern part of Kashmir, Western Rajasthan, Punjab and Deccan Plateau. The two significant features of India's rainfall is that in the north India, rainfall decreases westwards and ii. in Peninsular India, except Tamil Nadu, it decreases eastward.

In addition to increasing temperatures, climate change is expected to alter the magnitude and shape of global precipitation patterns. For Maharashtra, all four projections in this study suggest an increase in monsoon rainfall, particularly along the state's coastlines and the Western Ghats, with only slight decreases in rainfall seen further inland by projections B and C (ref. Figure 4.9.5). Strong increases in rainfall, such as those seen along the Maharashtra coast, could result in extreme flooding events, which could drastically reduce the productivity of the state's agricultural industry, and promote the presence of waterborne diseases such as cholera.

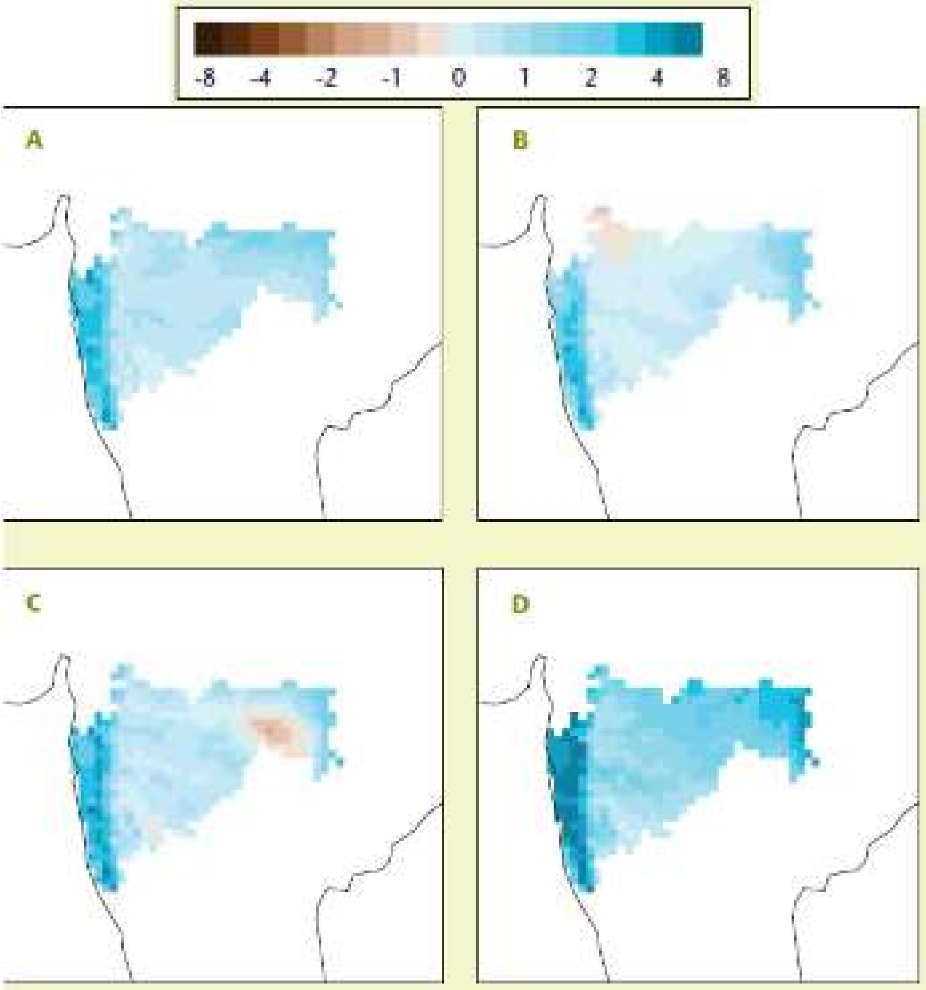
Exhibit 4.9.6: Annual Rainfall map



Source: National Atlas and Thematic Mapping Organization

Exhibit 4.9.7 Future Rainfall Projections

Changes in rainfall (mm/day) during 2070-2099 with respect to 1971-2000



Source: Climate Change Threat to Maharashtra-TERI

4.9.8 Key Changes and Impacts

The main climate changes and potential impacts expected in Maharashtra are as follows:

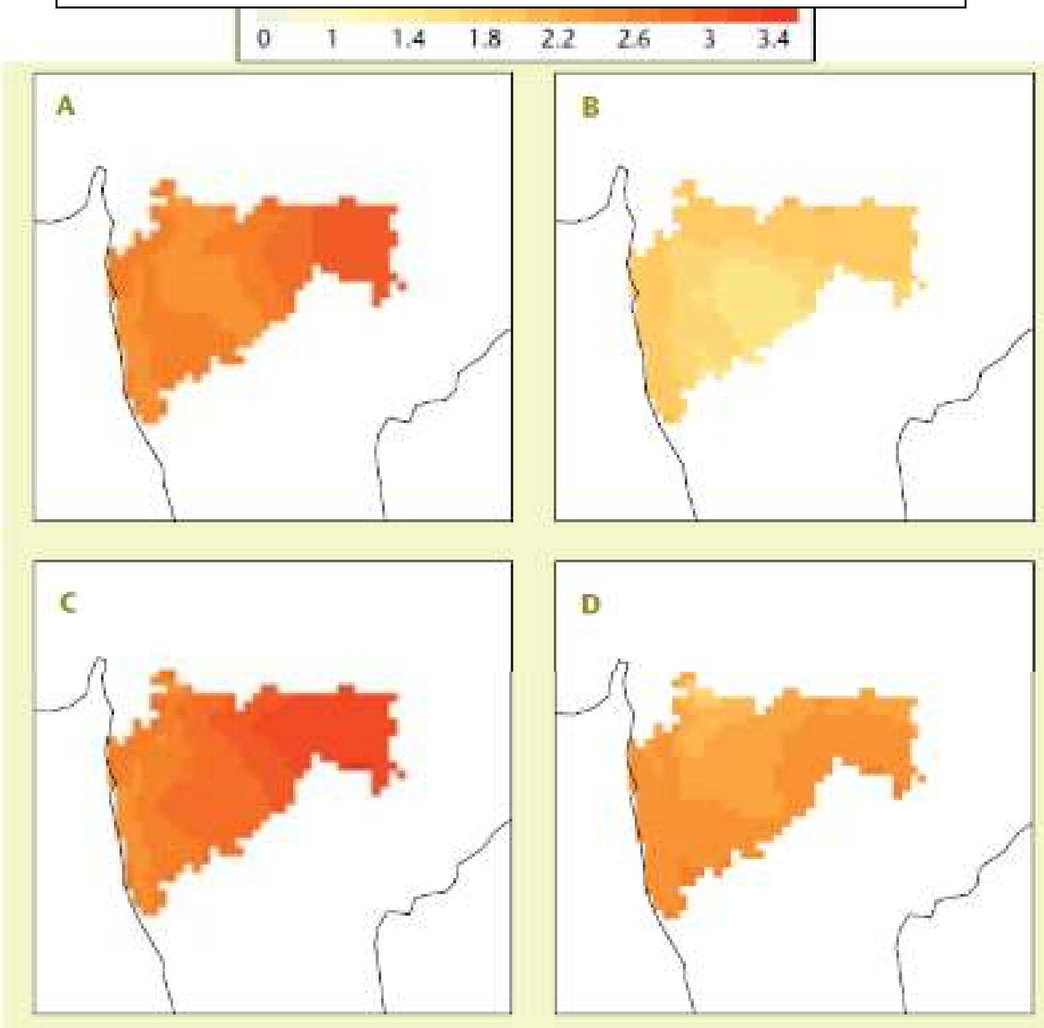
- Increased temperatures and altered seasonal precipitation patterns (both in amount and timing) could affect the hydrological systems and agricultural productivity.
- Increased risk of severe weather events may have a devastating impact on agriculture, water resources, forestry and the well-being of the population.
- Coastal communities face a serious threat from rising sea levels. A one-metre rise in sea level would put more than 1.3 million people at risk.
- If no action is taken, the associated costs of climate change-related damages in Mumbai alone could be upwards of Rs. 2 trillion.

4.9.9 Temperature

With rising concentrations of carbon dioxide, it is understood that globally averaged temperatures are expected to increase. However, regional climate change could exhibit different behaviour to this global average, and hence regional climate modelling techniques are used in order to identify the effect of climate change on a local scale. For the region of Maharashtra, the climate studies performed in this project consistently project an increase in temperature over the entire region for the monsoon season, with a range between 1.5 °C and 3 °C for the four models used (herein denoted projection A, B, C and D, see Figure 4.2.4). The threat of increasing temperatures for the region of Maharashtra could lead to severe drought, water scarcity, and reduced crop yield, all of which could have a devastating impact on people.

Exhibit 4.9.8: Future Temperature Projections

Changes in temperature (°C) during 2070-2099with respect to 1971-2000



Source: Climate Change Threat to Maharashtra-TERI

4.9.10 Proposal for Ten Carbon Neutral Municipal Towns

Initially ten towns are suggested to be developed as Carbon Neutral towns by using Wind Energy and Solar Energy. The potential of Wind and Solar Energy is high in Gujarat as Gujarat is the coastal state with high wind velocities and it is the State with such latitudes which experiences one of the best exploitable solar radiations. Baseline data of electricity consumption by these Municipalities are found from Municipal Energy Efficiency Programme (MEEP). Further development of town and extension of water supply and sewerage network will increase the electricity consumption, by keeping this scenario in consideration the size of renewable energy system is proposed at higher side.

4.9.11 UN has Commissioned the Study (UNFCC)

The Intergovernmental Panel on Climate Change (IPCC) was set up by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to provide an objective source of scientific information. The year 2013 provided more clarity about human-generated climate change than ever before. The UN Intergovernmental Panel on Climate Change (IPCC) released its Fifth Assessment Report which looked at the science of climate change. It is categorical in its conclusion: climate change is real and human activities are the main cause.

Fifth Assessment Report

The report provides a comprehensive assessment of sea level rise, and its causes, over the past few decades. It also estimates cumulative CO_2 emissions since pre-industrial times and provides a CO_2 budget for future emissions to limit warming to less than 2 °C. About half of this maximum amount was already emitted by 2011. Thanks to the IPCC, this is what we know:

From 1880 to 2005, the average global temperature increased by 0.85 °C.

Oceans have warmed, the amounts of snow and ice have diminished, and the sea level has risen. From 1901 to 2010, the global average sea level rose by 19 cm as oceans expanded due to warming and ice melted. The sea ice extent in the Arctic has shrunk in every successive decade since 1979, with 1.07×10^6 km² of ice loss per decade.

Given current concentrations and ongoing emissions of greenhouse gases, it is likely that the end of this century will see a 1–2° C increase in global mean temperature above the 1990 level (about 1.5–2.5° C above the pre-industrial level). The world's oceans will be warmer and ice melt will continue. Average sea level rise is predicted to be 24–30 cm by 2065 and 40–63 cm by 2100 relative to the reference period of 1986–2005. Most aspects of climate change will persist for many centuries, even if emissions are stopped.

There is alarming evidence that important tipping points, leading to irreversible changes in major ecosystems and the planetary climate system, may already have been reached or passed. Ecosystems as diverse as the Amazon rainforest and the Arctic tundra, may be approaching thresholds of dramatic change through warming and drying. Mountain glaciers are in alarming retreat and the downstream effects of reduced water supply in the driest months will have repercussions that transcend generations.

Annexure 4.10

4.10 AMBIENT AIR QUALITY

The atmosphere is a reservoir of several elements essential to life and it serves many purposes and functions. It contains life saving gases like oxygen for human beings and animals, and carbon dioxide for plants to perform the process of photosynthesis. The air present in the atmosphere contains oxygen (20.95 %), nitrogen (78.08%), carbon dioxide (0.038%), argon (0.93%) and remaining gases (0.002459 %) in a fixed proportion. However, anthropogenic activities are rapidly altering the proportion of gases in the atmosphere and causing unprecedented climate change, having serious repercussions for Life on Earth.

The term Pollution generally refers to unfavorable alternation of our surroundings, wholly or largely as a by-product of man's action through direct and indirect effects of changes in energy pattern, chemical and physical construction and abundance of organisms. The EP Act defines Environmental Pollutant as *any solid, liquid or gaseous substance present in such concentration as may be or tend to be injurious to environment*. Ironically, Nature is the biggest polluter itself but has built in mechanisms to offset them, however, the human contribution to pollution has been increasing constantly and have impaired the ability of the Earth to heal and repair itself.

Air pollutants degrade the atmosphere by reducing visibility, damaging property, combining to form smog, reducing the productivity or vigor of crops or natural vegetation, and reducing human or animal health. Air quality describes the presence and concentration of pollutants in air to which the life is exposed. Air quality in the India is governed by the National Ambient Air Quality Standards (NAAQS) administered by Air (Prevention and Control of Pollution) Act, 1981.

Pollutants that have established national standards are referred to as “criteria pollutants.” For these pollutants, Central Pollution Control Board (CPCB) has established NAAQS to protect public health and welfare. The sources of these pollutants, their effects on human health and the nation's welfare, and their final deposition in the atmosphere vary considerably. A brief description of each pollutant which has been considered for the proposed MAHSR project, is provided in the following sections.

1. Particulate Matter (PM)

A) <u>Definition/Criteria</u>

Particulate Matter is composed of solid particles or liquid droplets that are small enough to remain suspended in the air. In general, particulate pollution can include dust, soot, and smoke; these can be irritating but usually are not poisonous. However, PM pollution can include substances that are highly toxic. Of particular concern are those particles that are smaller than, or equal to, 10 micrometers (µm) (PM_{10}) or 2.5 µm ($PM_{2.5}$). $PM_{2.5}$ refers to particulates that are 2.5 µm or less in diameter, approximately 1/28th the diameter of a human hair.

B) <u>Source</u>

a) Major sources of PM_{10} include motor vehicles; wood- burning stoves and fireplaces; dust from construction, landfills, and agriculture; wildfires and brush/waste burning; industrial sources; windblown dust from open land; and atmospheric chemical and photochemical reactions.

b) Source of $PM_{2.5}$: A small portion of PM is the product of fuel combustion processes. However, the combustion of fossil fuels accounts for a significant portion of $PM_{2.5}$ pollution. $PM_{2.5}$ results from fuel combustion (from motor vehicles, power generation, and industrial facilities), residential fireplaces, and wood stoves. In addition, $PM_{2.5}$ can be formed in the atmosphere from gases such as SO_2, NOx, and VOCs.

C) <u>Adverse Effects</u>

These suspended particulates produce haze and reduce visibility. The main health effect of airborne PM is on the respiratory system. Like PM_{10}, $PM_{2.5}$ can penetrate the human respiratory system's natural defenses and damage the respiratory tract when inhaled. Whereas particles 2.5 to 10 µm in diameter tend to collect in the upper portion of the respiratory system, particles 2.5 µm or less can penetrate deeper into the lungs and damage lung tissue.

The effects of PM_{10} and $PM_{2.5}$ emissions for the project are examined on a localized (*i.e.*, microscale) basis.

<u>Carbon Monoxide (CO)</u>

CO is a colorless gas and has 250 times more affinity for human hemoglobin than Oxygen. CO is emitted almost exclusively from the incomplete combustion of fossil fuels. Motor vehicle exhaust is the primary source of CO. In cities, 85% to 95% of all CO emissions may come from motor vehicle exhaust. Prolonged exposure to high levels of CO can cause headaches, drowsiness, loss of equilibrium, and heart disease. CO levels are generally highest in the colder months of the year when inversion conditions (*i.e.*, warmer air traps colder air near the ground) are more frequent. CO concentrations can vary greatly over relatively short distances. Relatively high concentrations of CO are typically found near congested intersections, along heavily used roadways carrying slow-moving traffic, and in areas where atmospheric dispersion is inhibited by urban street canyon conditions.

<u>Oxides of Nitrogen (NOx)</u>

Nitrogen Dioxide (NO_2) is a brownish gas that irritates the lungs. It can cause breathing difficulties at high concentrations. NO_2 is one of a group of highly reactive gases known as "oxides of nitrogen," or "nitrogen oxides (NOx)." As with Ozone (O_3), NO_2 can be formed through a reaction between nitric oxide (NO) and atmospheric oxygen. NOx are major contributors to O_3 formation. NO_2 also contributes to the formation of PM_{10}. At atmospheric concentrations, NO_2 is only potentially irritating. At high concentrations, the result is a brownish-red cast to the atmosphere and reduced visibility. There is some indication of a relationship between NO_2 and chronic (long-term) pulmonary fibrosis. An increase in bronchitis in children 2 to 3 years old has also been observed at concentrations below 0.3 parts per million (ppm).

<u>Sulfur Dioxide (SO_2)</u>

SO_2 is a product of high-sulfur fuel combustion. The main sources of SO_2 are coal and oil used in power stations, industry, and domestic heating. Industrial chemical manufacturing is another source of SO_2. SO_2 is an irritant gas that attacks the throat and lungs. It can cause acute respiratory symptoms and diminished ventilator function in children. SO_2 can also cause plant leaves to turn yellow and corrode iron and steel. Although heavy-duty diesel vehicles emit SO_2, transportation sources are not considered by EPA (or other regulatory agencies) to be significant sources of this pollutant. Therefore, an analysis of the impacts of SO_2 emissions from railway projects is not warranted as it does not use any fossil fuel.

Ambient Air Quality Study

Objective of the Study

The prime objective of the baseline study with respect to ambient air quality is to establish the existing air quality and its conformity to ambient air quality standards. The major sources of anthropogenic air pollution in aregion are vehicular traffic, industrial emissions, domestic fuel burning, construction and demolition activities etc.

The ambient air quality monitoring was carried out in May 2017 (pre-monsoon season) during baseline survey to assess the ambient air quality status in the study area (250 m both side of the centre line of the proposed alignment). This isa follow up of ambient air quality monitoring carried out in October- 2014 (post-monsoon season) during the F/S Stage of EIA study.At all the monitoring stations $PM_{2.5}$, PM_{10} as well as SO_2, NOx and CO were monitored on 24-hour basis. The data collected was subjected to statistical analysis to arrive at maximum, minimum and average value. The results were compared with National Ambient Air Quality Standards (NAAQS) and are presented in Table 4.10.3.

(1) CRITERIA FOR SELECTION OF MONITORING LOCATIONS

The ambient air quality monitoring locations were established on the basis of the following considerations:

- Meteorological conditions;
- Topography of the area;
- Sensitive receptors in the vicinity of the proposed MAHSR alignment;
- Nearest habitation from the MAHSR alignment; and
- Representativeness of likely affected area.

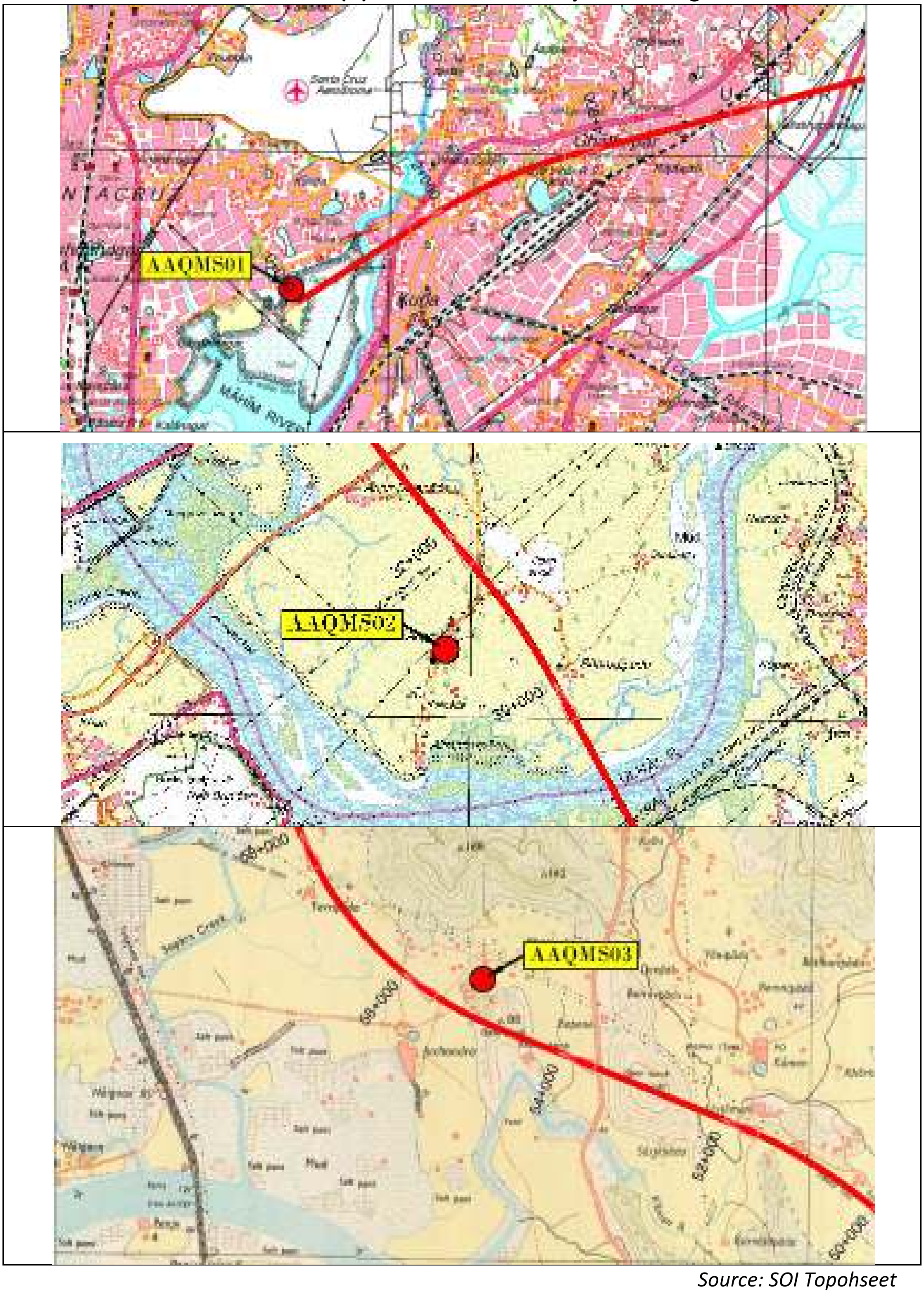
Twelve (12) ambient air quality monitoring locations were selected in line with the EIA Study of F/s stage to have holistic comparison and taking into consideration the predominant downwind direction, population zone and sensitive receptors and upwind direction. Logistic considerations as easy accessibility, security, availability of reliable power supply *etc*. were also examined while selecting the locations.

Table 4.10.1: Ambient Air Quality Monitoring Locations

Location Code	Location	Geo-coordinates		Distance & Direction w.r.t. proposed MAHSR	Justification
		Latitude (N)	Longitude (E)		
AAQMS1	Bandra Kurla Complex	19^{0}04'13.6"	72^{0}52'05.9"	0.24 Km/E	Nearest Habitation in the downwind direction
AAQMS2	Thane-Village Anjur, Bhiwandi	19^{0}12'49.9"	73^{0}02'16.6"	0.81 Km/ W	East of Ulhas River
AAQMS3	Virar Stn-Bapne	19^{0}21'40.9"	72^{0}52'53.1"	0.16 Km/N	Near Forest
AAQMS4	Vapi Stn- Nearest Habitation	20^{0}20'46.2"	72^{0}56'24"	1.2 Km/W	Near Pond Dominant Upwind direction
AAQMS5	Valsad Stn-Ujjwal Nagar Society	20^{0}37'10.3"	72^{0}58'18.7"	0.85 Km/W	Close proximity to the Estuary
AAQMS6	Surat Jn-Near NH-6, Oviyan	21^{0}11'26.7"	72^{0}56'19.7"	0.11 Km/E	North of flowing river
AAQMS7	Bharuch Stn-Dehgam	21^{0}41'44.5"	72^{0}56'22.9"	0.44 Km/W	Close to River and Nearest Habitation in the Upwind direction
AAQMS8	Vadodara Stn-Nand Nagar Chhani Lake	22^{0}21'49.2"	73^{0}10'18.7"	0.47 Km/E	North of Chhani Lake in the Dominant downwind direction
AAQMS9	Vasad –Sardar Vallabhbhai Institute of Technology	22^{0}28'14.2"	73^{0}04'34.1"	0.74 Km/E	West of River Tapi & close to sensitive receptor
AAQMS10	Nadiad Rly Stn-Bhumel Bus Stand Near Lake	22^{0}27'33.2"	73^{0}05'39.7"	0.22 Km/SW	Close to Lake and habitation
AAQMS11	Ahmedabad –BBC Market, Behind BSNL Office	23^{0}01'31.4"	72^{0}35'56.01"	0.33 Km/W	Sensitive location
AAQMS12	Sabarmati-Marudhar Society	23^{0}04'59.2"	72^{0}35'15.3"	0.26 Km/EEN	Nearest Habitation in the dominant downwind direction

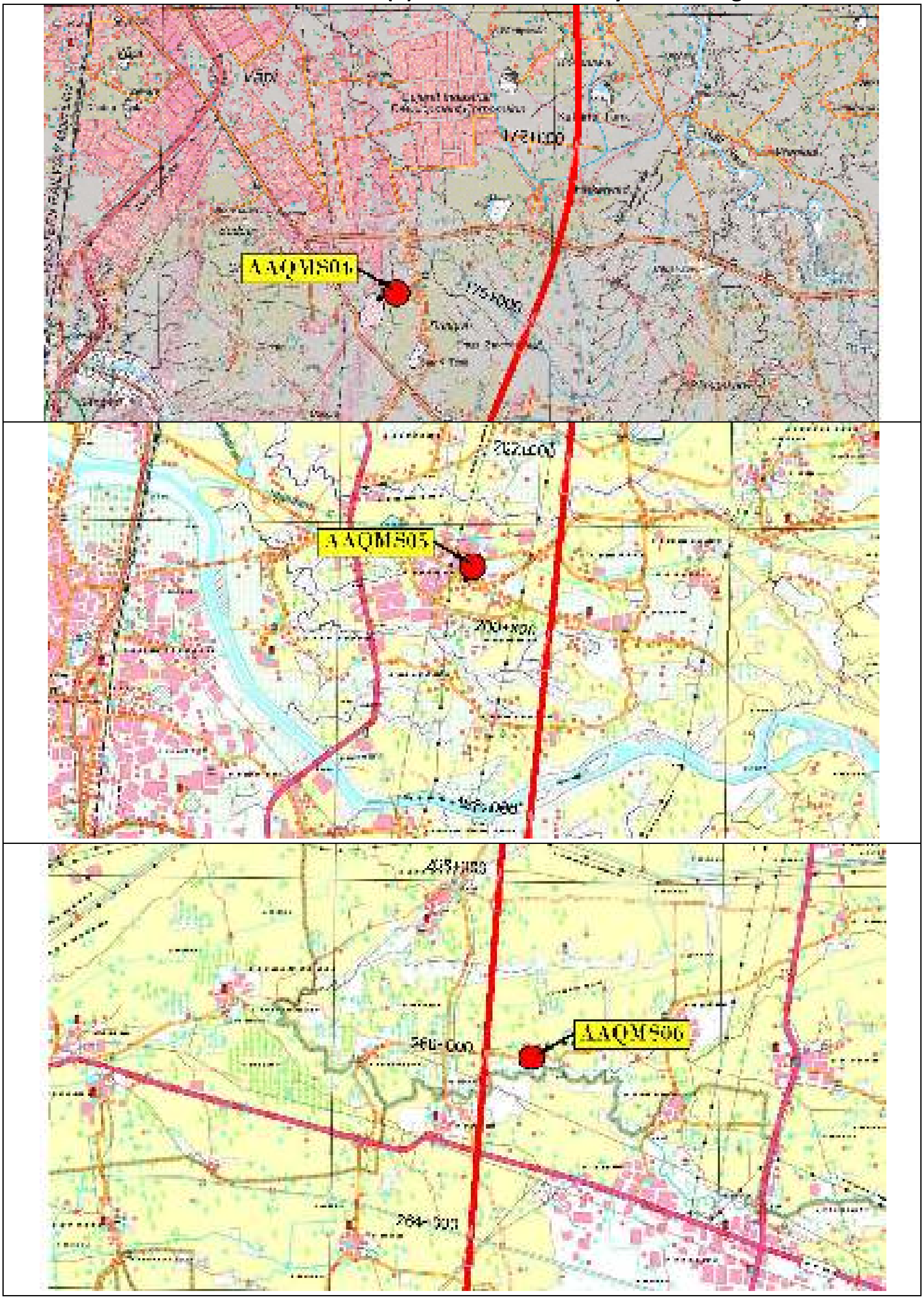
Source: Study Team

Exhibit 4.10.1(A): Ambient Air Quality Monitoring Locations



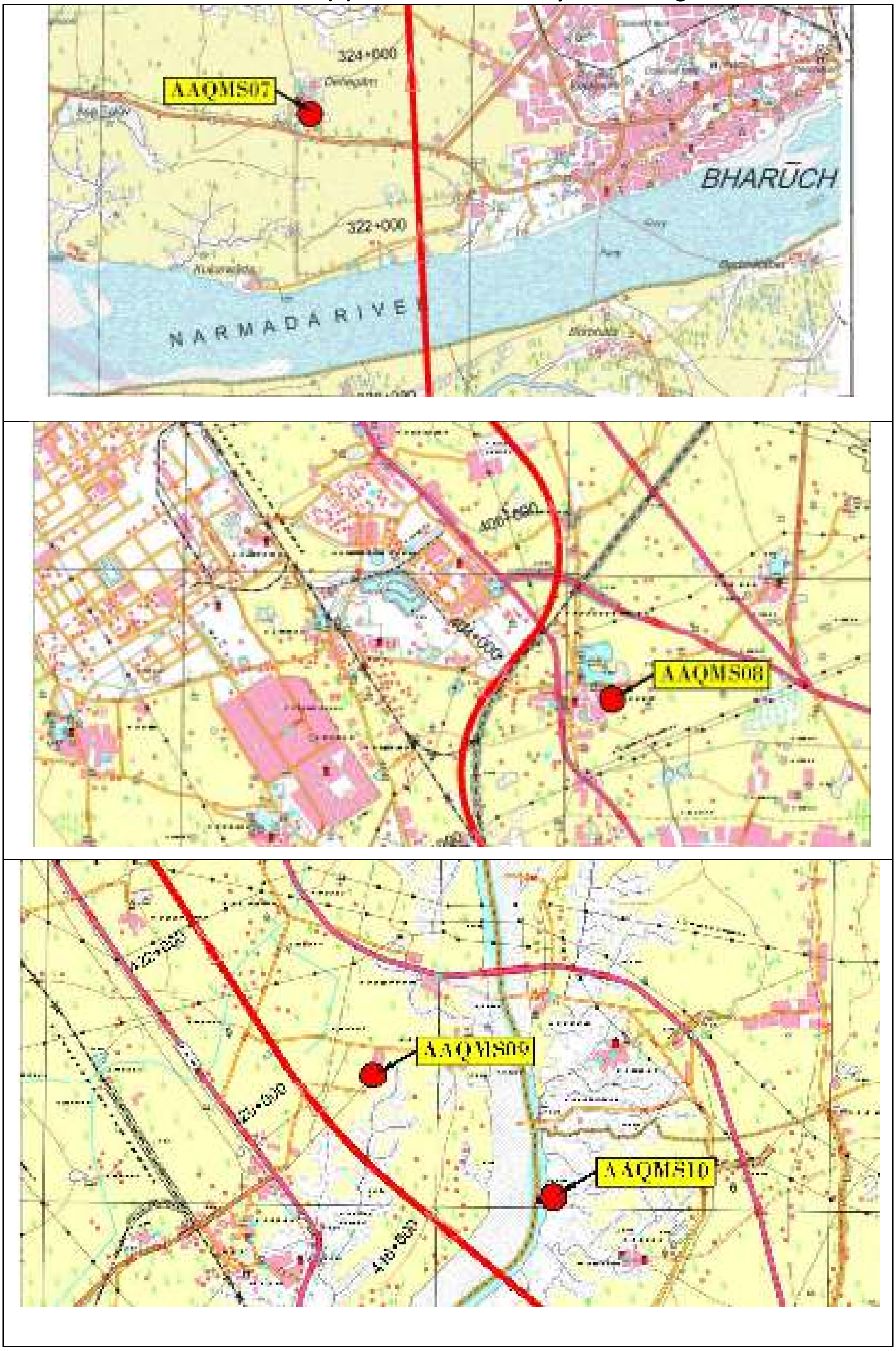
Source: SOI Topohseet

Exhibit 4.10.1(B): Ambient Air Quality Monitoring Locations



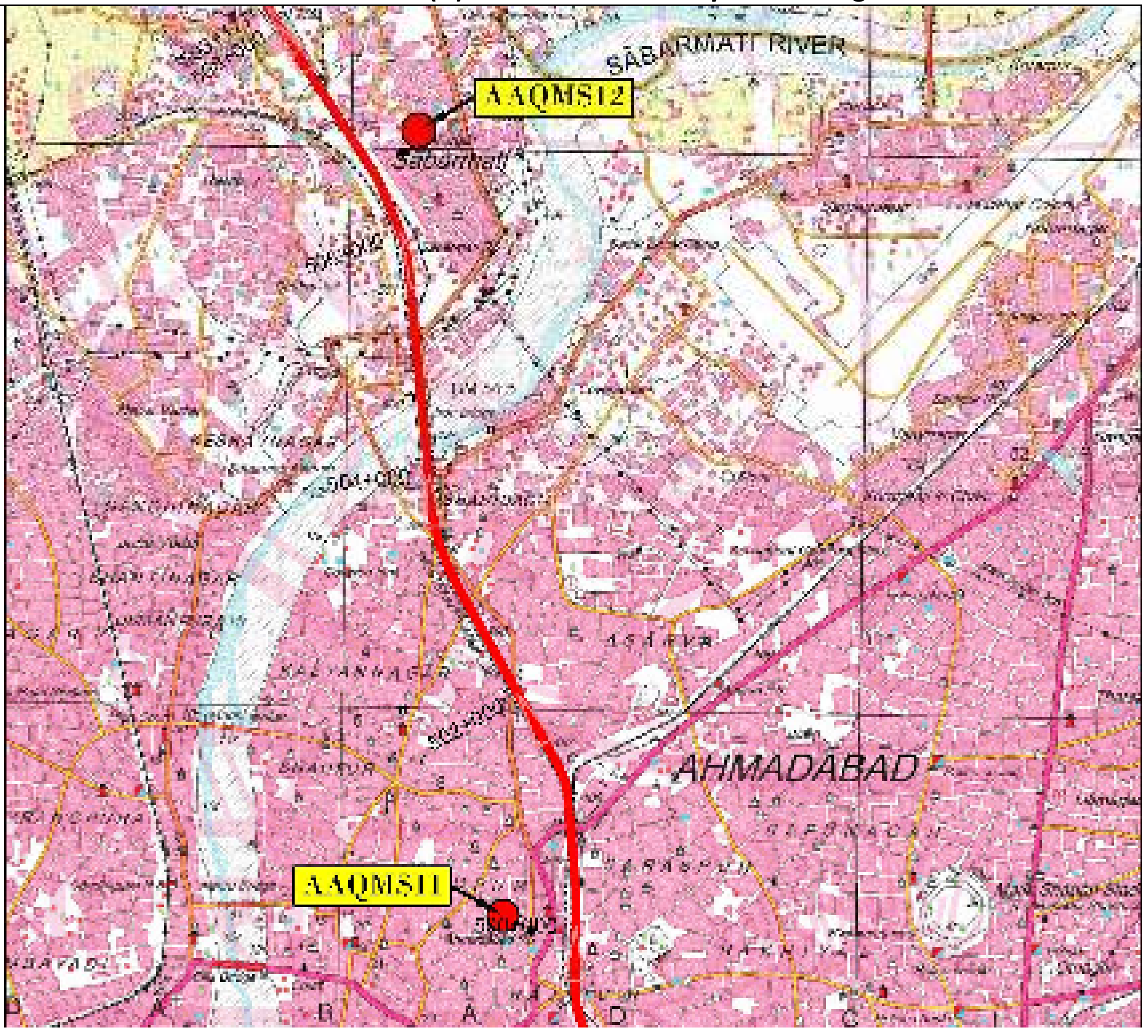
Source: SOI Topohseet

Exhibit 4.10.1(C): Ambient Air Quality Monitoring Locations



Source: SOI Topohseet

Exhibit 4.10.1(D): Ambient Air Quality Monitoring Locations



Source: SOI Topohseet

(2) Methodology

The protocol adopted for ambient air quality monitoring and analysis is detailed below keeping in correlation with the proviso and guidelines prescribed by the Central Pollution Control Board (CPCB) for each parameter. Upon finalization of Ambient Air Quality Monitoring Locations, adequate no. of APM 540 equipment were mobilized and deployed at the selected monitoring locations. The monitoring carried out in accordance with the CPCB Guidelines. The samples collected were analyzed in the laboratory for the following parameters $PM_{2.5}$, PM_{10}, SO_2, NO_2 and CO. The technical protocol for the analysis is given in Table 4.10.2.

Table 4.10.2: Technical Protocol for Ambient Air Quality Monitoring and Analysis

S.	Parameters	Unit	Protocol	Detection Limit
1	Particulate Matter, PM_{10}	µg/m³	IS:5182 (P-23) : 2006 Gravimetric TOEM Beta Attenuation	5-1000
2	Fine ParticulateMatter, $PM_{2.5}$	µg/m³	SOP1/SKAS/Ambient Air/Gravimetric Method, Gravimetric, TOEM Beta Attenuation	5-1000
3	Sulphur Dioxide (as SO_2)	µg/m³	IS:5182 (P-2): 2006 Improved West and Gaek, Ultraviolet fluorescence	0.01-100
4	Carbon Monoxide (as CO)	µg/m³	IS:5182 (P-10): 1999,RA-2003	0.06-100
5	Oxide of Nitrogen (as NO_2)	µg/m³	IS:5182 (P-6): 2006 Improved West and Gaek, Ultraviolet fluorescence	6-2000

Source: CPCB-Ambient Air Quality Monitoring Guidelines

SO_2

Sulphur dioxide from air is absorbed in a solution of potassium tetrachloromercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely colored pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer

NO_2

Ambient nitrogen dioxide (NO_2) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO_2) produced during sampling is determined colorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)- ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm.

PM_{10}

Air is drawn through a size-selective inlet and through a 20.3 x 25.4 cm (8 x 10 in) filter at a flow rate, which is typically 1132 L/min. Particles aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM_{10} in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

$PM_{2.5}$

An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a mass flow/volumetric flow controller coupled to a microprocessor into specially designed inertial particle-size separator (*i.e.* cyclones or impactors) where the suspended particulate matter in the $PM_{2.5}$ size ranges is separated for collection on a 47 mm polytetrafluoroethylene (PTFE) filter over a specified sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the ambient air is computed as the total mass of collected particles in the $PM_{2.5}$ size ranges divided by the actual volume of air sampled and is expressed in $\mu g/m^3$. The microprocessor reads averages and stores five-minute averages of ambient temperature, ambient pressure, filter temperature and volumetric flow rate. In addition, the microprocessor calculates the average temperatures and pressure, total volumetric flow for the entire sample run time and the coefficient of variation of the flow rate.

CO (Carbon Monoxide)

Sampling begins with conditioning a sampling train and then gas analyzer. Pressure system is preferred to condition the sampling train by installing pump before the analyzer. Reducing valve needs to be fitted between the analyzer and pump to eliminate the pulsing effect of pump on the analyzer. Flow meter is installed just before the analyzer. A fibre filter is used to capture the particulate matter prior to the optical cell to prevent its interference, as it often accumulates on the optical cell reducing its efficiency. To eliminate the interference of water vapour, refrigeration or desiccant with magnesium per chlorate is used. Continuous analysis is carried out at the flow rate of about 100 ml/min to 1000 ml/min (depending upon the pollution level near the sampling location) for the desired sampling period.

(3) Frequency and Parameters for Monitoring

The Ambient Air Quality monitoring was carried out with a frequency of 24 hourly (8 Hour for CO.) samples twice a week at each location during the pre-monsoon season (May 2017).
The baseline data of ambient air has been generated for the following parameters:

- Particulate Matter ($PM_{2.5}$ and PM_{10});
- Sulphur Dioxide (SO_2);
- Oxides of Nitrogen (NOx); and
- Carbon Monoxide (CO).

(4) Instrument Used for Sampling

Particulate Matter Sampling Equipment APM-451 and APM 550 manufactured by Envirotech Instrument Pvt. Ltd. were installed on the roof top of the building at a height of 4.0 m from the ground level, for monitoring Particulate Matter ($PM_{2.5}$& PM_{10}) and gaseous pollutants like SO_2 and NOx. For monitoring of CO, Non-dispersive Infra Red Absorption Gas Analyzer (NDIR) was used.

(5) Results and Discussion

The date wise result of respective AAQ monitoring location for pollutants PM_{10}, $PM_{2.5}$, SO_2, NO_X and CO during the study period (pre-monsoon season) are presented in Table 4.10.3.The National Ambient Air Quality Standards (NAAQS) have been presented in Table 4.10.4. The graphical representation of the finding of the monitoring is shown in Exhibit 4.10.2

Table 4.10.3: Ambient Air Quality Status in the Project Area-Zone of Influence
(Value in $\mu g/m^3$ for all the pollutants except CO)

Location Code & Date of Monitoring	Place	PM_{10}		$PM_{2.5}$		SO_2		NOx		CO (mg/m^3)	
	Date of Monitoring	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Prescribed NAAQ Standards		**100**		**60**		**80**		**80**		**02 (4 Hrly)**	
AAQMS1 A-6/05/2017 B-9/05/2017	Bandra Kurla Complex-adjacent to the proposed station site	87.2	81.2	46.8	40.8	6.2	5.2	27.5	22.5	2.6	2.4
AAQMS2 A-3/05/2017 B-6/05/2017	Village-Anjur, Tehsil-Bhiwandi Thane	84.2	89.7	44.8	52.8	5.2	8.7	25.5	29.5	2.1	1.8
AAQMS3 A-5/05/2017 B-8/05/2017	Near Virar in Bapane Village	89.2	87.2	51.8	48.8	6.6	5.6	29.5	27.5	2	1.9
AAQMS4 A-14/05/2017 B-17/05/2017	Vapi in Valsad District, on the roof top of Jagannath Temple	97.2	90.2	57.8	51.8	6.6	5.6	19.5	22.5	1.7	1.9
AAQMS5 A-13/05/2017 B-16/05/2017	Valsad on the roof top of a residential house	116.5	126.1	70.6	74.9	8.4	9.6	27.5	30.2	1.6	1.4
AAQMS6 A-13/05/2017 B-16/05/2017	Vill -Oviyen, Tehsil-Kamraj, Distt-Surat	94.1	89.6	56.9	57.9	8.6	6.5	35.5	32.6	2.7	2.5
AAQMS7 A-12/05/2017 B-15/05/2017	Village-Dehgam, Bharuch	95.4	85.6	52.5	56.8	8.6	7.2	31.5	28.6	2.3	2.1
AAQMS8 A-12/05/2017 B-16/05/2017	Village-Chhani, Distt-Vadodara	89.5	80.5	49.5	45.9	8.9	8.1	35.5	32.5	2.4	2.5
AAQMS9 A-11/05/2017 B-15/05/2017	Village-Rajupura, Distt-Anand	95.5	90.5	55.5	50.5	9.9	8.9	36.5	34.2	2.5	2.3
AAQMS10 A-11/05/2017 B-16/05/2017	Vill-Bhumel, Tehsil-Nadiad, Distt-Kheda	85.5	76.2	51.5	48.5	7.9	8.5	34.5	28.4	1.8	1.9
AAQMS11 A-8/05/2017 B-12/05/2017	BBC Market, Behind BSNL Office, Ahmedabad	127.2	115.2	**69.5**	**64.5**	16.2	12.2	47.5	42.5	2	1.9
AAQMS12 A-6/05/2017 B-9/05/2017	Sabarmati-Marudhar Society	112.50	126.50	64.90	68.90	15.60	18.60	42.60	48.60	1.6	1.5
Minimum		76.2		40.8		5.2		19.5		1.4	
Maximum		127.2		74.9		18.6		48.6		2.7	
(Maximum Value of location has been taken into account) Average		101.7		57.85		11.9		34.05		2.03	

Source: Study Team

(6) Particulate Matter $PM_{2.5}$

The statistical analysis of ambient air quality results revealed that the minimum and maximum $PM_{2.5}$ concentration was observed as 40.8 μg/m^3 at Bandra Kurla Complex, Mumbai and 74.9 μg/m^3 at Valsad respectively. The higher concentration at Valsad was due to fugitive dust emission from the nearby road and it was above the NAAQS threshold limit. The average concentration of $PM_{2.5}$ was 57.85 μg/m^3 among the all monitoring locations during the monitoring period.

PM_{10}

The minimum concentration of PM_{10} was observed at village Bhumel in the Nadiad Tehsil as 76.2 μg/m^3 whereas the maximum as 127.2 μg/m^3 at Ahmedabad (BBC market). The concentration at Ahmedabad exceeds the NAAQS threshold limit due to heavy congestion and fugitive dust emission coming out of the nearby road. The average concentration of PM_{10} was arrived at 101.7 μg/m^3 among all monitoring locations during the monitoring period.

(7) Sulfur Dioxide (SO_2)

The highest concentration of SO_2 was reported as 18.6 μg/m^3 at Marudhar Society located in Sabarmati nearby the proposed HSR station due to heavy traffic on the nearby road and the lowest concentration was recorded as 5.2 μg/m^3 at Anjur village, outskirt of Bhiwandi at during monitoring period. The average concentration of SO_2 was arrived at 11.9 μg/m^3 among all monitoring locations during the monitoring period.

(8) Oxide of Nitrogen (NOx)

The highest concentration of NOx was reported as 48.6 μg/m^3 at Marudhar Society located in Sabarmati nearby the proposed HSR station due to exposure of plying of heavy traffic on the nearby road and lowest as 19.5 μg/m^3 at Vapi. The average concentration of NOx was arrived at 34.05 μg/m^3 among all monitoring locations during the monitoring period.

(9) Carbon Monoxide (CO)

The highest concentration of CO was reported as 2.6 mg/m^3 at Oviyen village due to vehicular traffic running on the adjacent road and lowest as 1.4 mg/m^3 at Valsad during the monitoring period. The concentration of CO exceeded the NAAQS threshold limit at few locations which is due to the proximity of road and plying of vehicles without pollution certificate. The average concentration CO among all the monitoring locations of the study area arrived at 2.03 mg/m^3.

(10) Comparison of the Two Seasons Results

On perusal of the results of the monitoring of two seasons *i.e.* post-monsoon season (undertaken in October 2014 during Feasibility Stage EIA Study) and pre-monsoon season (May 2017-EIA study being undertaken at detailed design stage), following conclusions can be drawn-

- The concentration of pollutants particulate matter and gaseous except CO are on higher side in the pre-monsoon season (May 2017) which is due to the wash out of the pollutants on account of rain which lasted till the end of the September in 2014.
- The concentration of CO was on higher side in post-monsoon season (October 2014) due to vehicular emission and decrease in the mixing height due to low temperature.

(11) Conclusions

The data demonstrates that the concentration of the measured pollutants was higher than prescribed NAAQS standards at few locations in the study area and the situation in the rural area is quite satisfactory and the air quality was well within the NAAQS standards.

PM_{10}& $PM_{2.5}$: Ahmedabad, Valsad and Sabarmati have the highest PM_{10}& $PM_{2.5}$ ofall locationsand higher than NAAQS standards. The PM_{10}& $PM_{2.5}$thoughare less than NAAQS standards at other locations but quite close to it.

SO_2& NOx: were measured to be lower than NAAQS standards at all the locations.

CO: was measured to be higher than NAAQS standards at multiple locations including BKC, Surat, Bharuch, Vadodara & Anand. It is pertinent to mention that these locations are Industrial belts/Urban areas.

Exhibit 4.10.2 (a): Graphical Presentation of the Monitoring Results

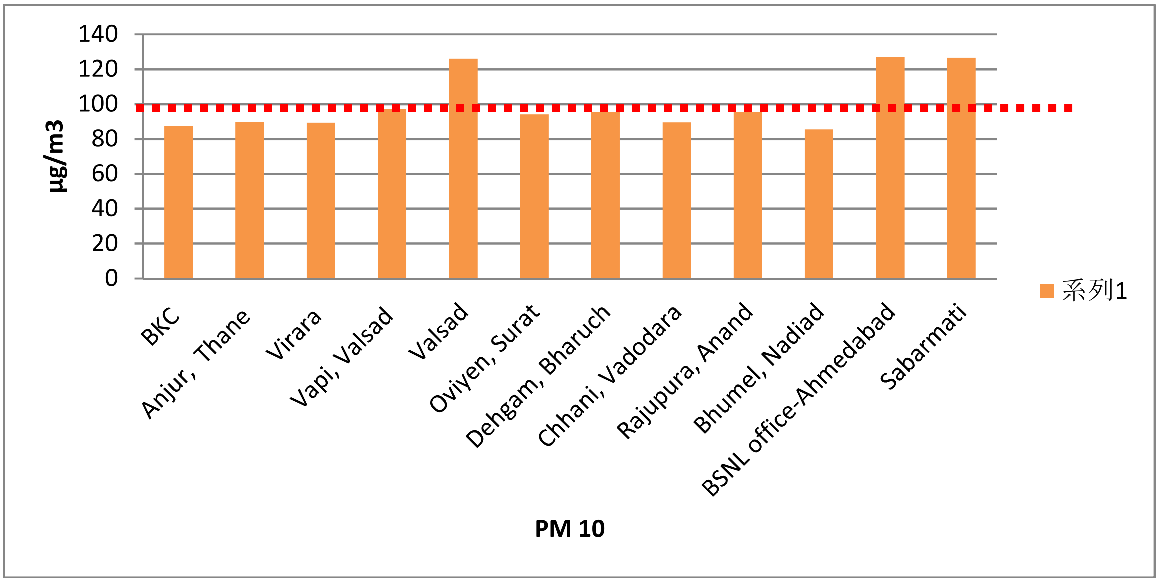
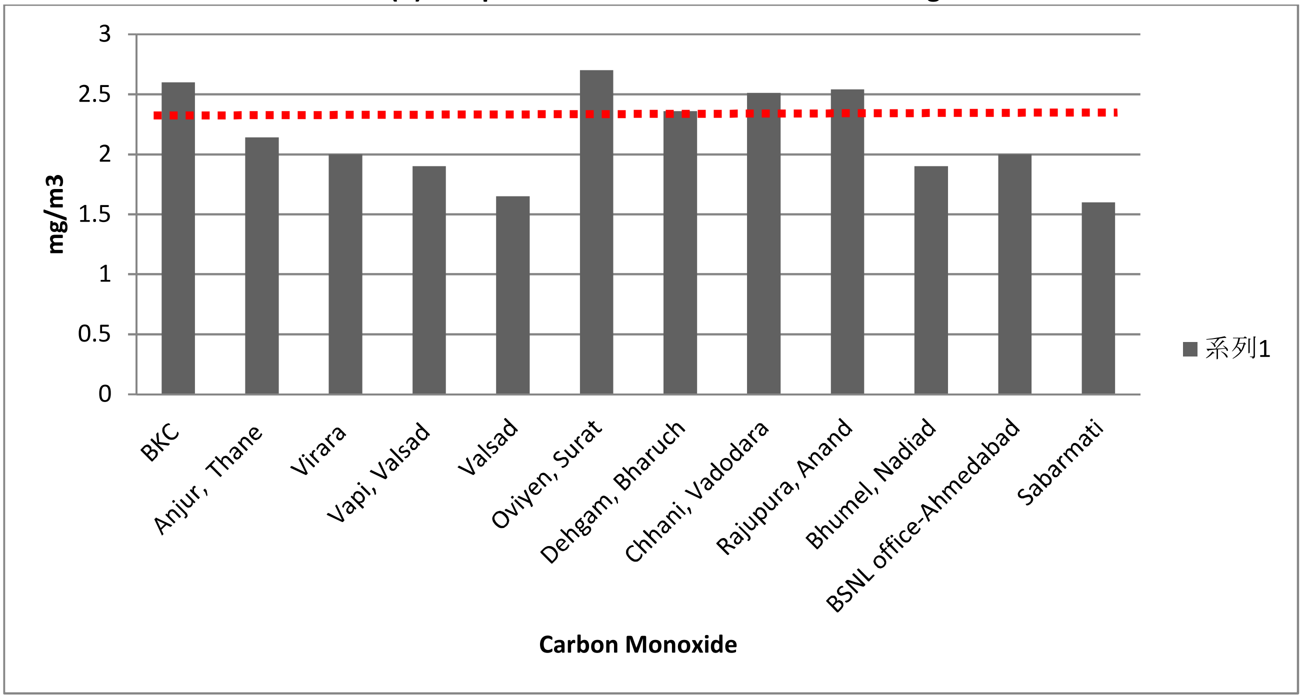


Exhibit 4.10.2 (b): Graphical Presentation of the Monitoring Results



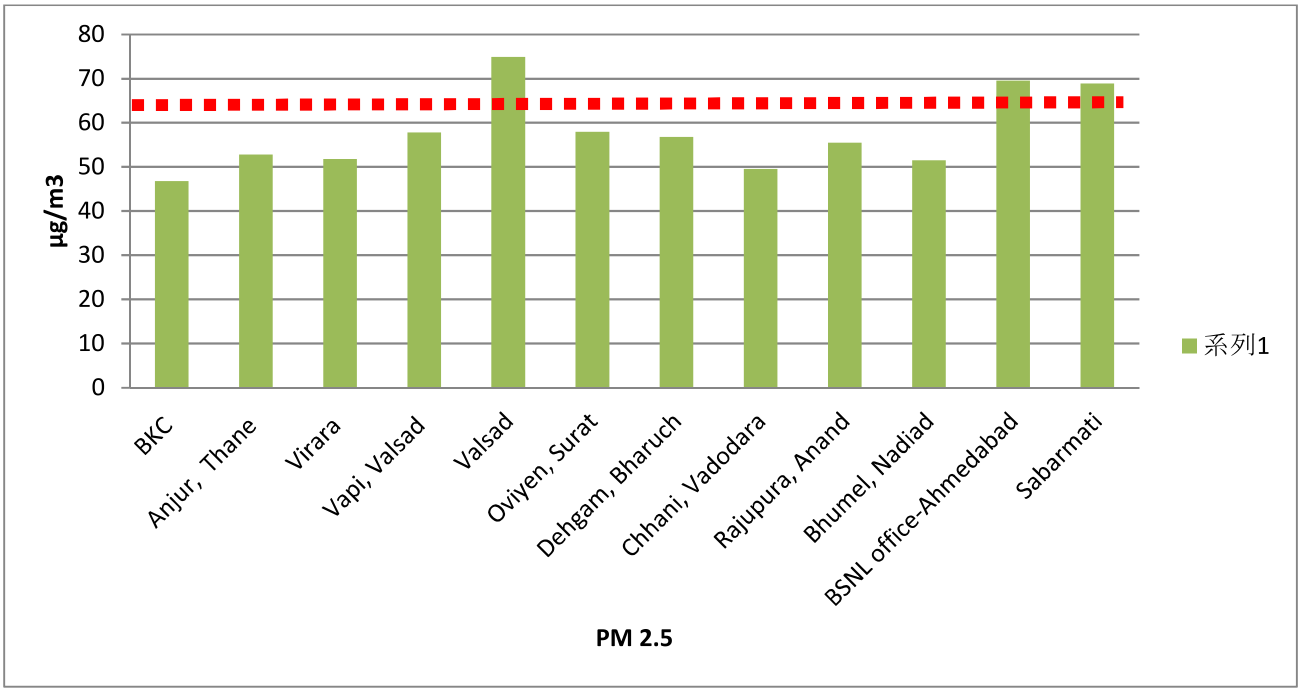


Exhibit 4.10.2 (c): Graphical Presentation of the Monitoring Results

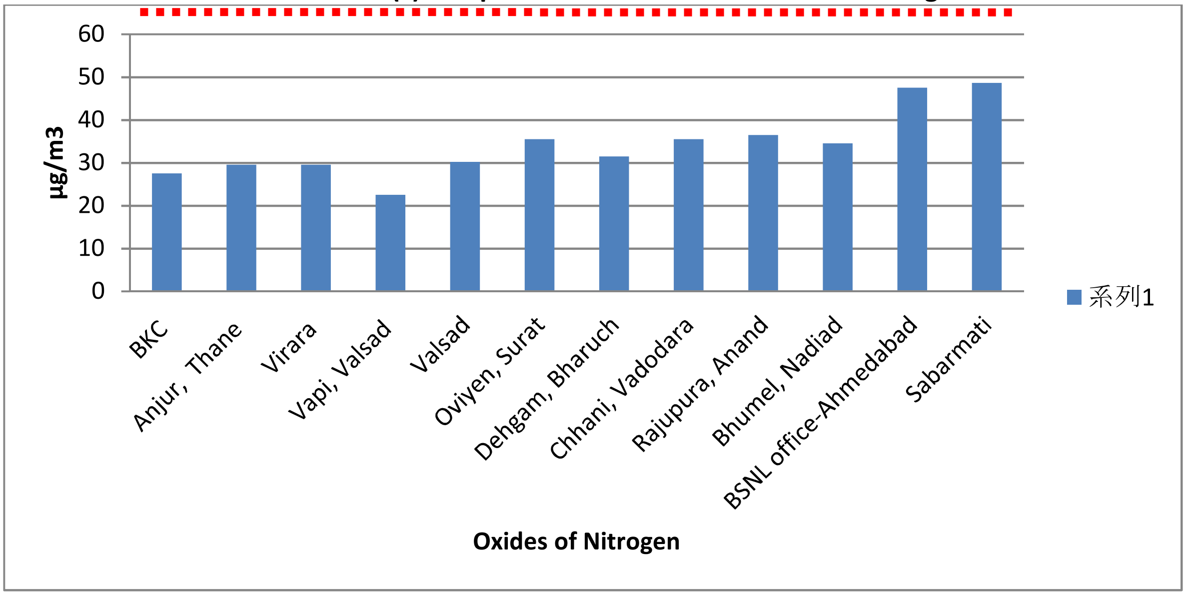


Table 4.10.4: National Ambient Air Quality Standards
(CBCB Gazette Notification No. 29016/20/90/PCI-L dated 18-November-2009)

S. No.	Pollutants	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (Notified by Central Government)	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1	Sulphur Dioxide (SO_2), µg/m^3	Annual*	50	20	-Improved West and Gaek, -Ultraviolet fluorescence
		24 hours **	80	80	
2	Nitrogen Oxide (NO_2), µg/m^3	Annual*	40	30	-Modified Jacob & Hochheiser (No Arsenite) -Chemiluminescence
		24 hours **	80	80	
3	Particulate Matter (size less than 10µm) or PM_{10}µg/m^3	Annual*	60	60	-Gravimetric -TOEM -Beta attenuation
		24 hours **	100	100	
4	Particulate Matter (size less than 2.5µm) or $PM_{2.5}$µg/m^3	Annual*	40	40	-Gravimetric -TOEM -Beta attenuation
		24 hours **	60	60	
		1 hour**	04	04	
5	Carbon Monoxide (CO) mg/m^3	8 hours**	02	02	-UV photometric -Chemilminescence -Chemical Method
		1 hour**	04	04	

* *Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.*

*** 24 hourly or 8 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring*

Source: The principal rules were published in the Gazette of India, Extraordinary vide number S.O 844 (E) dated the 19th November, 1986; and subsequently amended vide numbers S.O. 433 (E), dated the 18th April, 1987; G.S.R. 176 (E), dated the 2nd April 1996; and were recently amended vide numbers G. S.R. 97(E), dated the 18th February, 2009; G. S.R. 149(E), dated the 4th March 2009; G.S.R. 512(E), dated the 9th July 2009; G.S.R. 543(E) dated the 22nd July, 2009; G.S.R. 595 (E), dated the 21st August, 2009; and G.S.R. 794 (E), dated the 4th November, 2009.

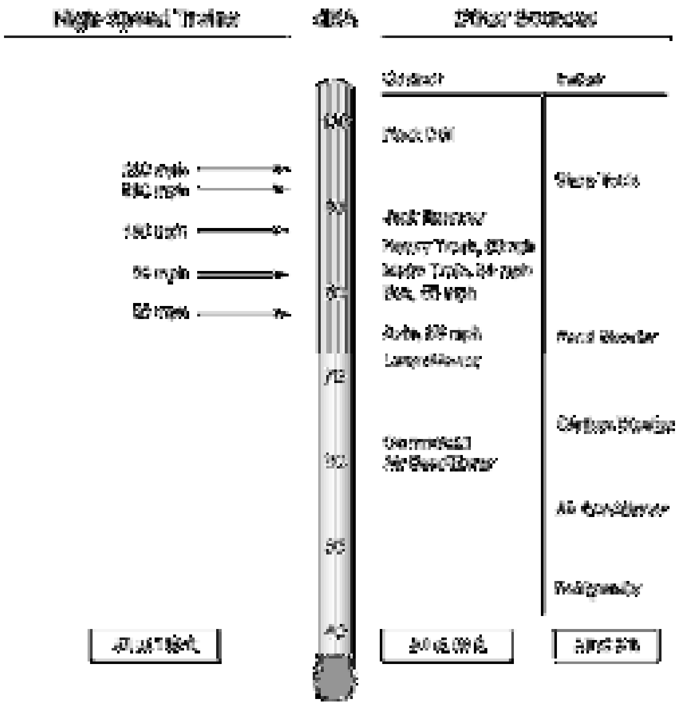
Annexure 4.11

4.11 AMBIENT NOISE

Ambient noise refers to the sound energy content of the natural system including any sound produced due to anthropogenic activities. In the present case, it is the proposed MAHSR project. Noise from an HSR system is expressed in terms of a “source-path-receiver” framework. The “source” generates noise levels that depend on the type of source (e.g., a high-speed rail) and its operating characteristics (e.g., speed). The “receiver” is the noise-sensitive land use (*e.g*., residence, hospital, or school) exposed to noise from the source. In between the source and the receiver is the “path,” where the noise is reduced by distance, intervening buildings, and topography. Environmental noise impacts are assessed at the receiver. Noise criteria are established for the various types of receivers because not all receivers have the same noise sensitivity.

The expected typical maximum A-weighted Sound Pressure Levels from a high-speed train is shown in Exhibit 4.11.1

Exhibit 4.11.1: Typical Maximum A-Weighted Sound Pressure Levels



Baseline Survey

Ambient noise measurement was carried out to establish the baseline ambient noise conditions along the proposed MAHSR alignment in the pre-monsoon month (May 2017). The aim was to identify areas with high noise levels as well as areas that are expected to experience higher noise levels on account of construction and operation of the proposed MAHSR project, and to design adequate mitigation measures, as applicable.

The alignment of proposed HSRC passes through densely populated areas such as Ahmedabad, Vadodara, Surat, Vapi, Vasai, Thane and Mumbai and numerous other moderate and low density human settlements along its route of 508.17 km. Out of the total length, the MAHSR alignment will pass through eight tunnels with total length of 26.203 km, mostly in Maharashtra State (the longest tunnel length being 20.375 km) in all remaining areas, the MAHSR shall be on elevated structure (viaduct). During construction and operation phases, the project is expected to add additional noise to the existing noise levels along its route, thereby increasing the ambient noise. Whereas, the noise from proposed project during construction phase shall be temporary and localized, the generation of noise during operation phase shall be of intermittent nature based on passing of trains throughout the day.

In order to assess the likely impacts on ambient noise due construction and operation of proposed project, ambient noise measurement has been carried out along the route of MAHSR at selected locations as explained in the following sections.

Selection of Measurement Locations

The study area with respect to ambient noise of the proposed project includes sensitive receptors that are located within the proximity of 250 m from the proposed MAHSR alignment centerline on both sides. This study area has been determined based on a screening distance corresponding to known conditions in the corridor. The noise study area defined by the screening distance is sufficiently large to include all receptors that may potentially be exposed to noise impact. Consistent with CPCB guidelines, the screening distance of 250 m was determined based on project-specific conditions and all noise-sensitive receptors within this distance were further evaluated for potential impact. The study area extends farther than typical screening distances primarily because existing noise conditions in some areas are relatively low, there would be a greater number of MAHSR operations, and train speeds would be higher.

For the present study, 31 locations were selected along the entire proposed MAHSR alignment comprising residential, commercial, industrial and sensitive zones. Out of the 31 locations, 24 locations were in Gujarat and 7 locations were in Maharashtra. The list of noise measurement locations, land use, geographical location *etc.* are described in Table 4.11.1 and shown in Exhibit 4.11.2.

Table 4.11.1: Noise Level Measurement Locations

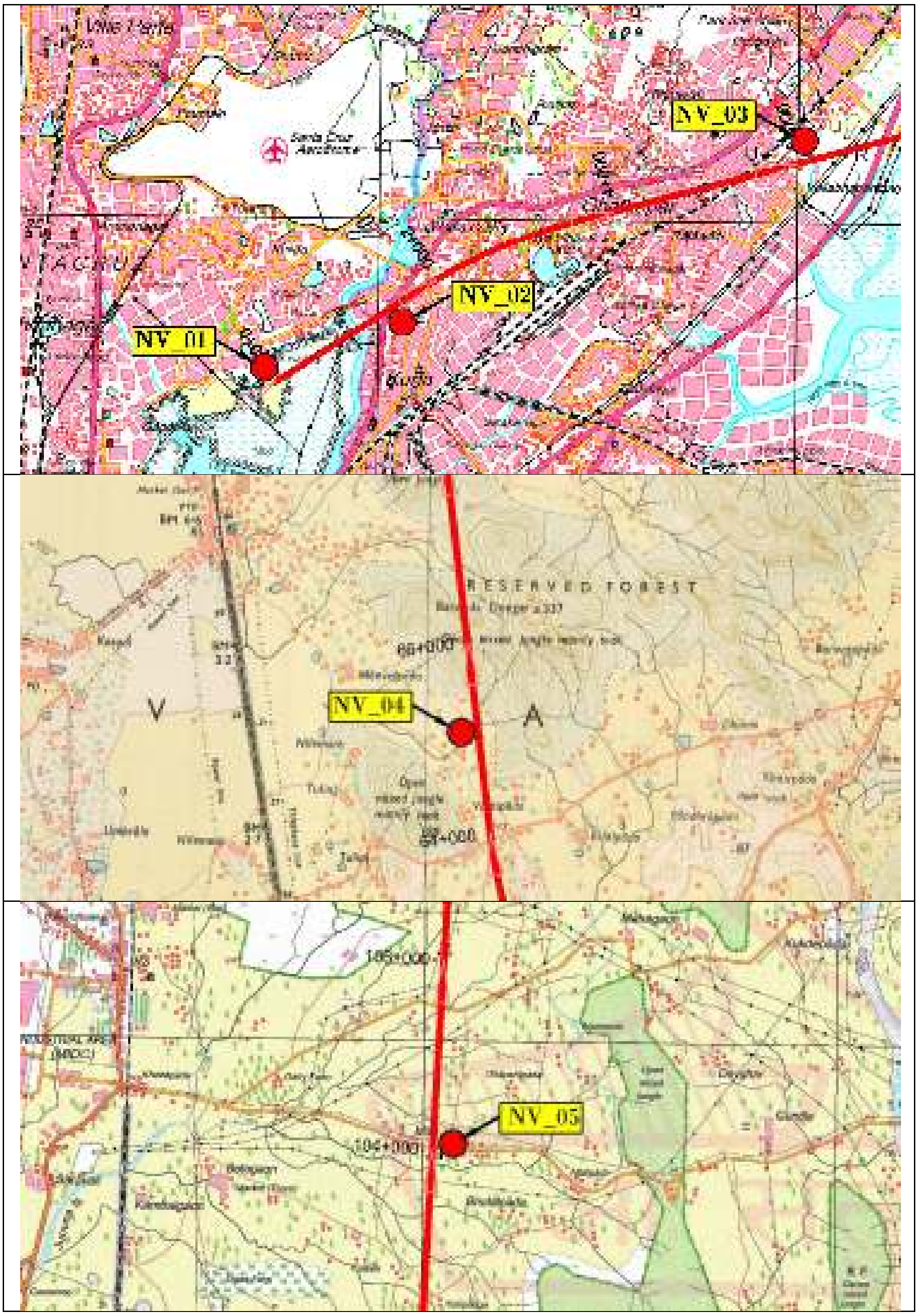
Location Code	Location Name	Latitude	Longitude	Distance to Project Site (m)	Land Use
NV1	Near the proposed BKC Station - Existing civil structure, Mumbai	19° 4'2.26"N	72°51'58.15"E	101	Commercial
NV2	Jaama Masjid-Kapadia Nagar, Mumbai	19° 4'23.61"N	72°52'26.21"E	40	Sensitive
NV3	Civil Structure near Tunnel W Shaft ½ and close by Mangrove (Godrej Industries), Vikhroli, Thane	19° 5'39.29"N	72°55'25.99"E	62	Sensitive
NV4	Manevale Pada - habitation close to Virar Station, Palghar, MH	19°26'8.83"N	72°50'14.35"E	79	Residential
NV5	Panchayat Office & School Maan Village, Palghar, MH	19°46'51.50"N	72°47'34.28"E	66	Sensitive
NV6	Zari Structure in a tribal village, Palghar, MH	20° 8'29.00"N	72°52'27.83"E	22	Residential
NV7	Residential Building nearby	20°13'40.48"N	72°54'23.14"E	110	Residential

Location Code	Location Name	Latitude	Longitude	Distance to Project Site (m)	Land Use
	the proposed alignment, Achad, Valsad, GJ				
NV8	Industrial shed near Nagwas in Dhanoli area, Valsad, GJ	20°15'39.51"N	72°55'25.22"E	104	Industrial
NV9	Mosque near Vapi Stn, Valsad, GJ	20°20'3.38"N	72°56'48.27"E	67	Sensitive
NV10	Crossing of Vapi Koparli Road, Valsad, GJ	20°22'44.05"N	72°57'34.04"E	92	Commercial
NV11	Paria Gaon, Valsad, GJ	20°26'43.15"N	72°57'53.34"E	30	Residential
NV12	Casa Residential Complex, Vadodara, GJ	22°14'58.50"N	73°10'31.91"E	62	Residential
NV13	AXN Resort Valsad, GJ	20°32'49.92"N	72°58'17.41"E	66	Commercial
NV14	Sabarmati Bridge, Ahmedabad, GJ	23° 4'0.10"N	72°35'17.90"E	83	Residential
NV15	Residential building in Jujwa village, Valsad, GJ	20°35'11.97"N	72°58'42.36"E	41	Residential
NV16	Habitation near Valsad Stn	20°37'25.99"N	72°58'52.17"E	70	Residential
NV17	Cancer Hospital in Panchlai, Valsad, GJ	20°42'43.06"N	73° 0'10.49"E	48	Sensitive
NV18	Civil Structure Undach Vaniya Faliya, Navsari, GJ	20°44'18.19"N	73° 0'9.87"E	20	Residential
NV19	Commercial Shed near Bilmora Stn, Navsari, GJ	20°45'53.88"N	73° 0'31.70"E	80	Commercial
NV20	Residential and Habitation area near Vadsangadh village, Navsari	20°48'57.76"N	73° 0'59.05"E	26	Residential
NV21	Residential and Habitation area near Chnaga Village, Navsari, GJ	20°49'40.18"N	73° 0'51.66"E	22	Residential
NV22	Civil Structure Heavy Industrial Area, Navsari, GJ	20°56'59.52"N	72°58'46.94"E	91	Commercial
NV23	Near Mosque in Mahmood Nagar Village, Navsari, GJ	21° 2'17.52"N	72°56'33.71"E	77	Sensitive
NV24	Near Railway Line, Godasa, Ahmedabad, GJ	22°58'46.08"N	72°37'10.54"E	34	Commercial
NV25	Genius Educational Campus Building, Surat, GJ	21° 8'11.64"N	72°55'41.14"E	50	Sensitive
NV26	Near Euro School under construction building, Anand, GJ	22°39'43.47"N	72°51'29.81"E	44	Commercial
NV27	Hindu temple near slum area in Kholvad, Surat, GJ	21°16'40.71"N	72°56'23.53"E	40	Sensitive
NV28	High School building falling in ROW of MAHSR, Surat, GJ	21°17'21.94"N	72°56'4.72"E	31	Sensitive
NV29	School building near proposed Bharuch station, Baruch, GJ	21°41'48.30"N	72°57'20.06"E	114	Sensitive

Location Code	Location Name	Latitude	Longitude	Distance to Project Site (m)	Land Use
NV30	Kothy Vantersa Masjid in Kothy Vantersa Village - Muslim dominated society, Baruch, GJ	21°55'5.62"N	72°59'27.90"E	25	Sensitive
NV31	South Vasai Bridge, Mira Bhayandar, Thane, MH	19°19'5.60"N	72°51'12.20"E	5280	Residential

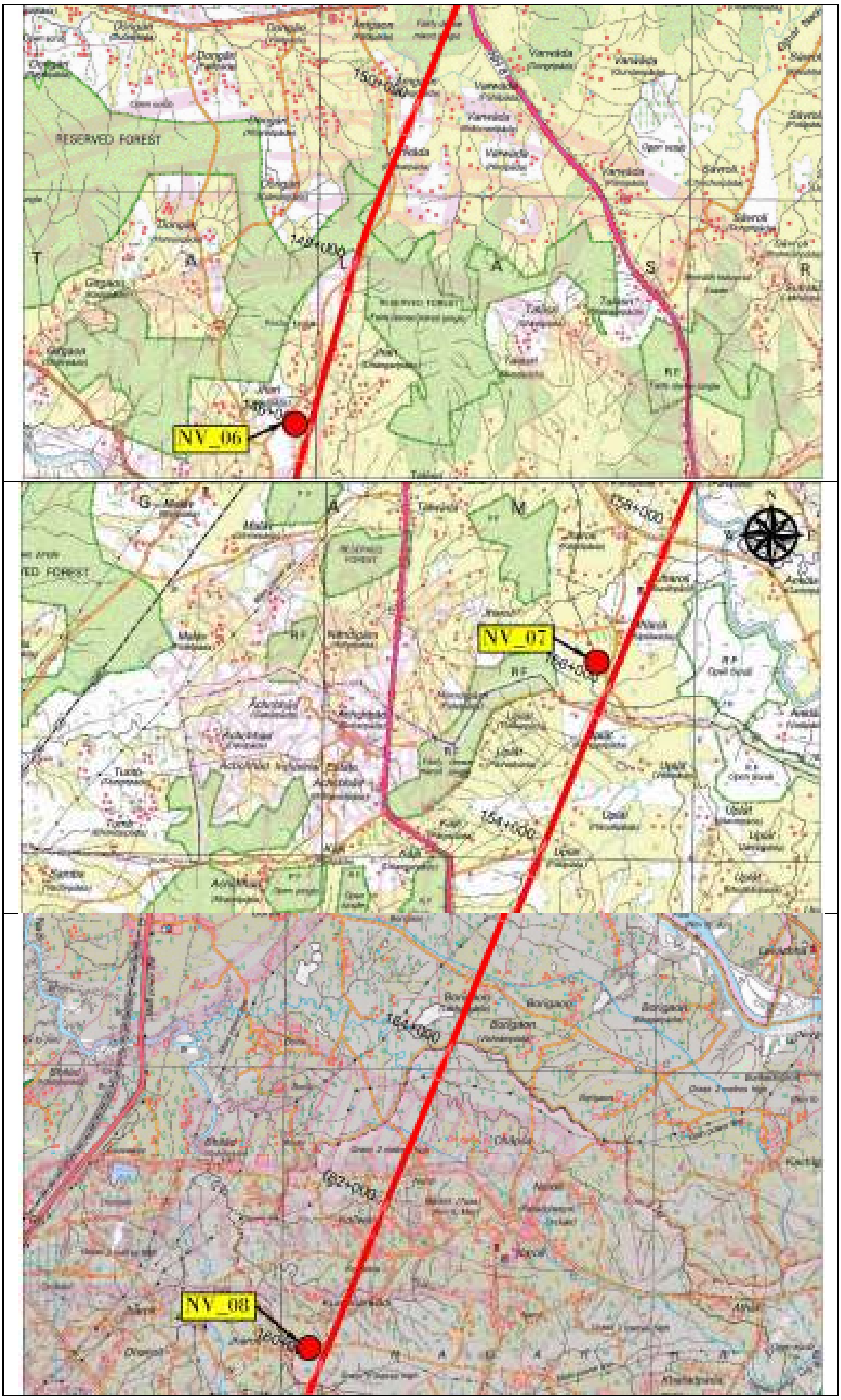
Source: Study Team

4.11.1(A): Ambient Noise Measurement Locations



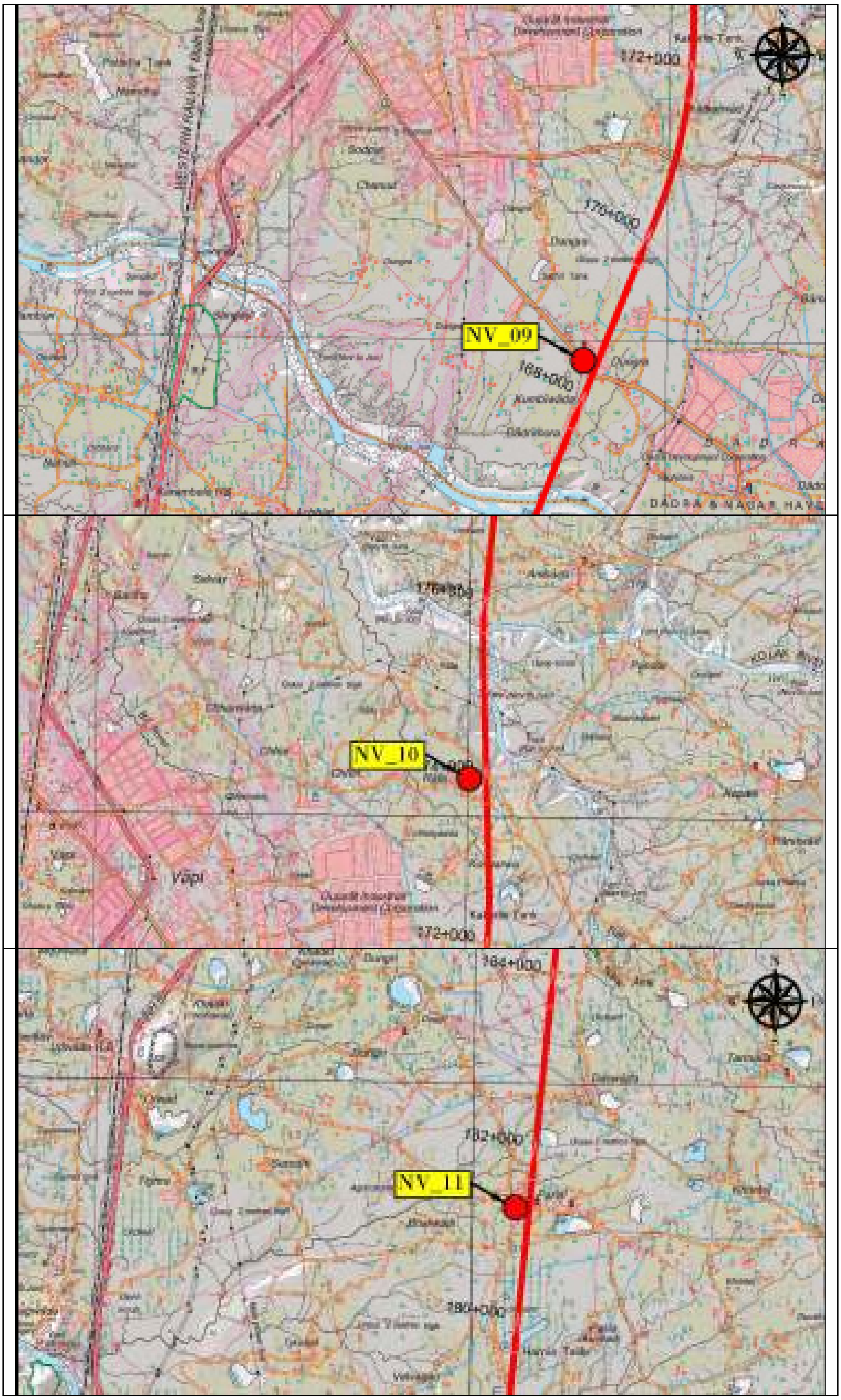
Source: SOI Toposheet

4.11.1(B): Ambient Noise Measurement Locations



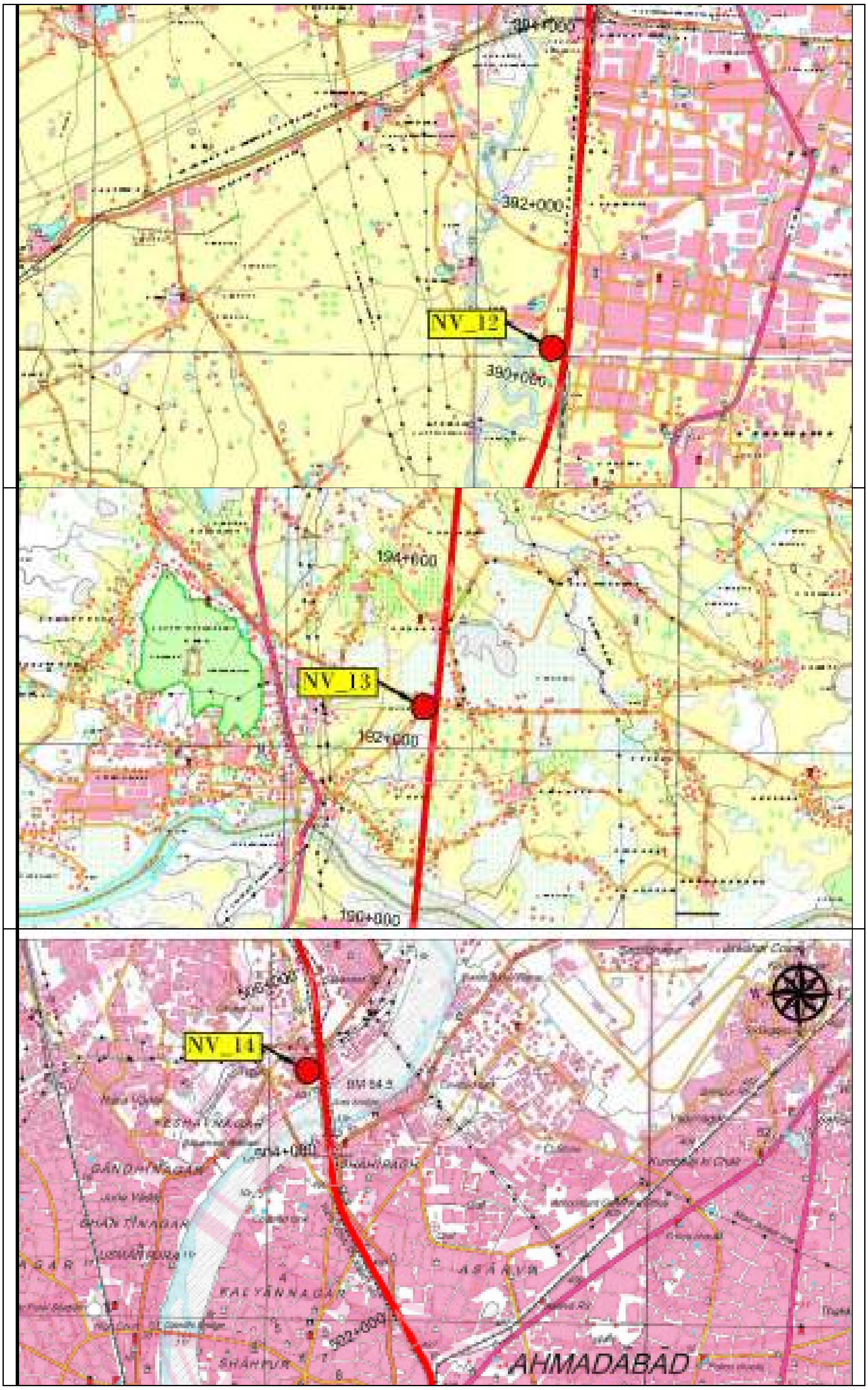
Source: SOI Toposheet

4.11.1(C): Ambient Noise Measurement Locations



Source: SOI Toposheet

4.11.1(D): Ambient Noise Measurement Locations

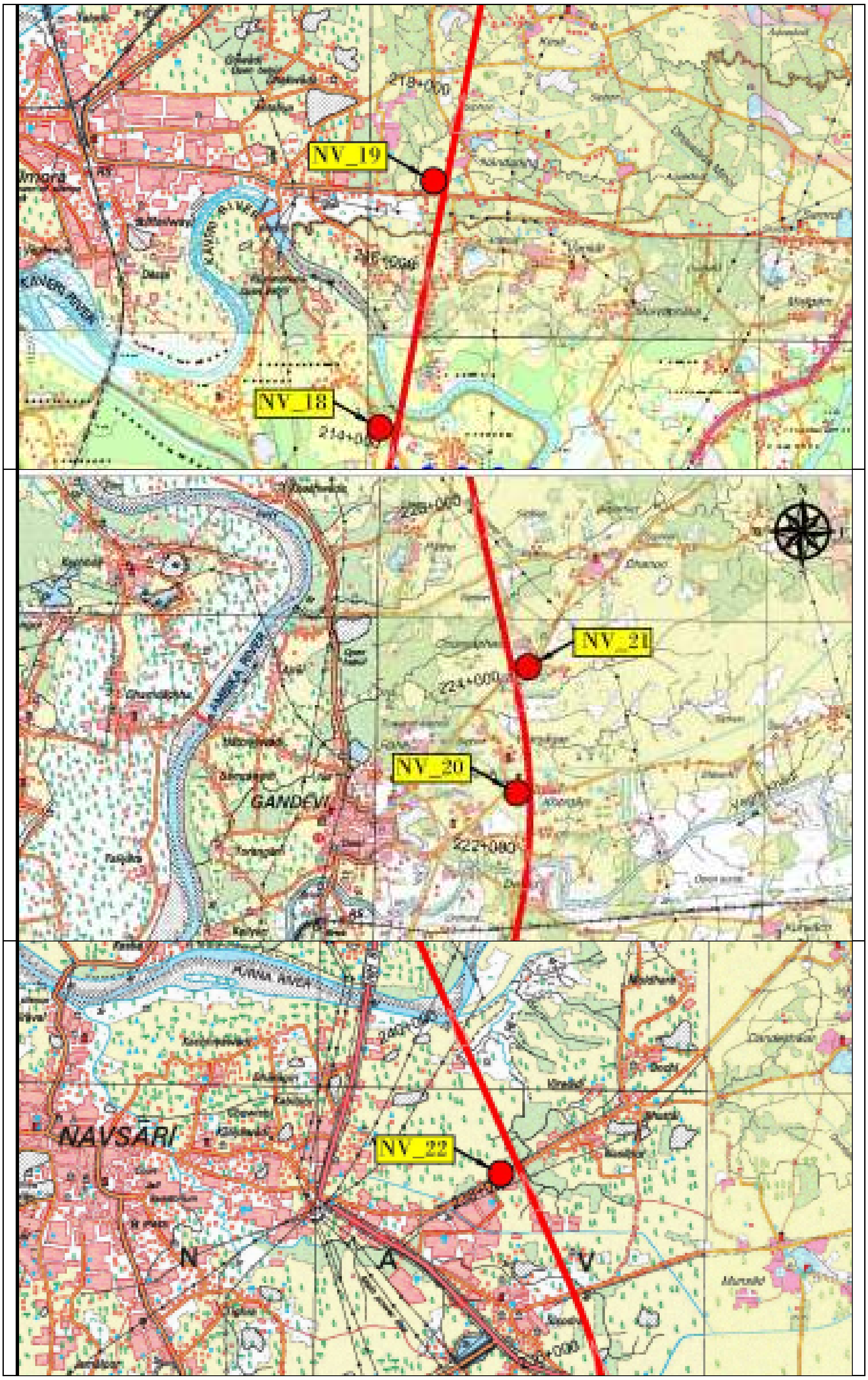


Source: SOI Toposheet

4.11.1(E): Ambient Noise Measurement Locations

Source: SOI Toposheet

4.11.1(F): Ambient Noise Measurement Locations

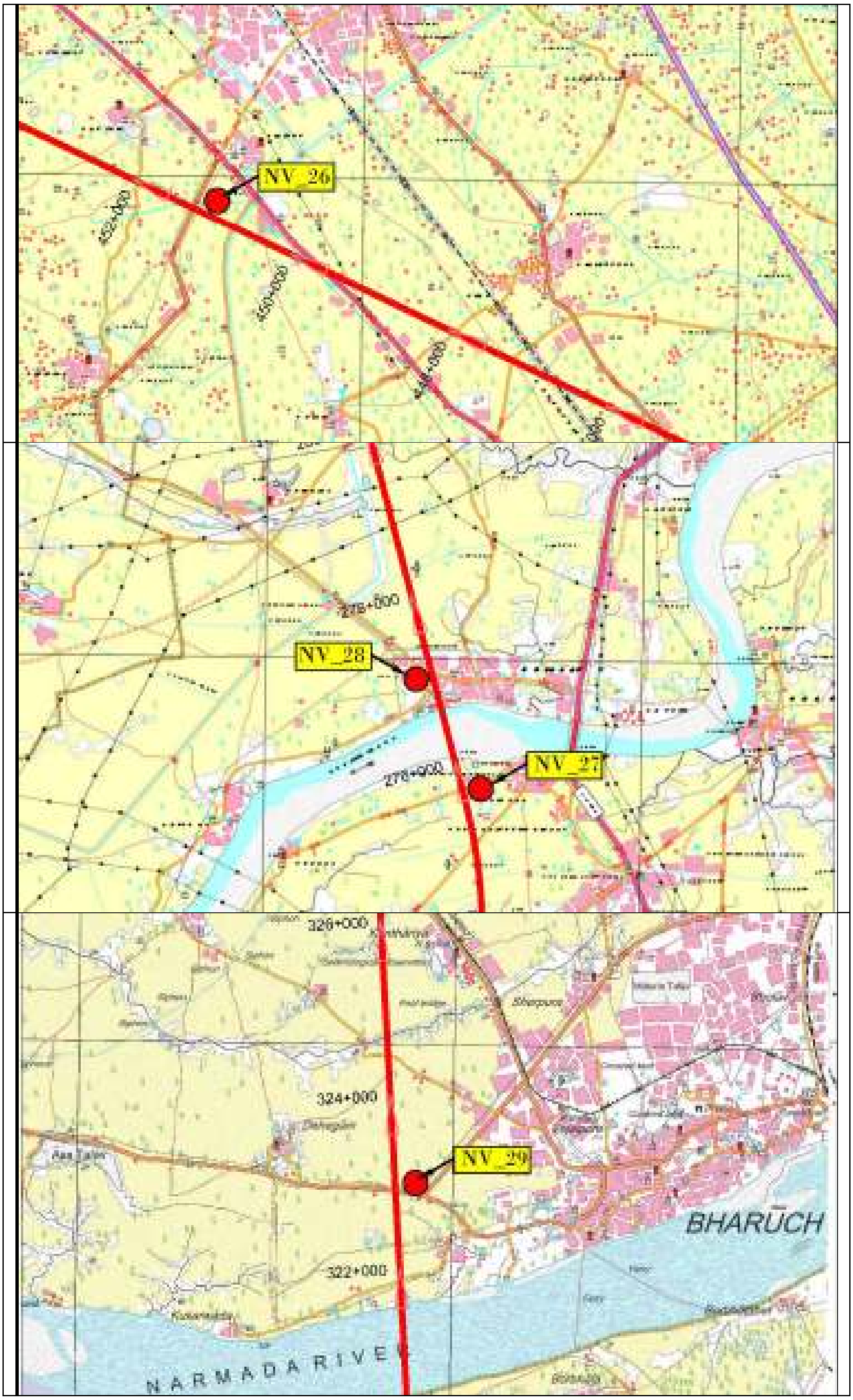


Source: SOI Toposheet

4.11.1(G): Ambient Noise Measurement Locations

Source: SOI Toposheet

4.11.1(H): Ambient Noise Measurement Locations



Source: SOI Toposheet

4.11.1(I): Ambient Noise Measurement Locations

Source: SOI Toposheet

Methodology Adopted for Ambient Noise Measurement

To establish baseline of existing environmental noise levels for project noise impact assessment, project analysts took a series of noise measurements according to CPCB guidelines at selected locations along the proposed MAHSR alignment in the month of May 2017. The noise measurements were taken at locations selected to be representative of the noise environment throughout the study area, and especially at those locations most likely to be affected by high speed train noise. The measurement was taken for 24 hours duration at each location using integrated Sound Level Meter with inbuilt data logger. At each location, the instrument was positioned to characterize the exposure of the site to the dominant noise sources in the area and a height of 1.5 m above the ground.

The 24 hours data was recorded for each location for sound level indicators such as L_{max}, L_{10}, L_{50}, L_{90}, L_{eq}, L_{Day} and L_{Night}. Measurements were carried out at 'A' weighting and in slow response mode. The L_{Day} and L_{Night} levels were compared with the Ambient Air Quality Standards with respect to Noise stipulated by MoEF&CC vide Gazette Notification dated 14.2.2000 and The Noise Pollution (Regulation and Control) (Amendment) Rules 2010 as given in Table 4.11.2.

Table 4.11.2: Ambient Air Quality Standards with Respect to Noise*

Area Code	Category of Area	Limits in dB(A), L_{eq}	
		** Day time	#Night time
A	Industrial Area	**75**	**70**
B	Commercial Area	**65**	**55**
C	Residential Area	**55**	**45**
D	Silence Zone @	**50**	**40**

* *Environment (Protection) Third Amendment Rules, 2000.*

Gazette Notification, MoEF&CC dated 14.2.2000 and The Noise Pollution (Regulation and Control) (Amendment) Rules 2010.

*** Day Time: 6.00 AM to 10.00 PM*
 # Night Time: 10.00 PM to 6.00 A.M

@ Silence zone is defined as an area up to 100-meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the competent authority; Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.

Note: Mixed categories of areas should be declared as ''one of the four above mentioned categories by the Competent Authority and the corresponding standard shall apply.

Interpretation of Results

The interpretation of results is based on a customized colored scale. The scale is based on difference in the prescribed noise standards as per Land Use category and the recorded noise levels. A positive difference (Prescribed Noise Standard - Recorded Noise Level) greater than and equal to 0 and less than 5 dB(A) is marked ‘Safe’ and greater than and equal to 5 dB(A) is marked as ‘Very Safe’. On the other hand,a negative difference less than 0 and greater than -5 dB(A) is marked as ‘Unsafe’ and less than and equal to -5 is marked as ‘Very Unsafe’.The interpretation using the above scale is performed for both L_{Day} and L_{Night} noise levels. The colored scale for noise level interpretations is presented in Table 4.11.3.

Table 4.11.3: Colored Scale for Noise Level Interpretations

Noise Difference	<–5dBA	< 0 and >–5dBA	>= 0 and <5dBA	> +5dBA
Status	**Very Unsafe**	**Unsafe**	**Safe**	**Very Safe**
Color Code				
Interpretations	These locations already have very high noise levels. Any new activity at these locations will make the situation much worse and shall require adoption of significant mitigation measures, strict regulations, prohibitions and implementation of noise checking best practices during construction and operation stages to prevent negative impacts on human beings as well as fauna.	These locations having minimally high noise levels are on the brink and shall require minimal use mitigation measures along with regulations and noise checking best practices to maintain current levels or to further improve them during implementation of proposed project.	These locations shall remain in the safe conditions with implementation of noise checking best practices during construction and operation phase of proposed project.	**These locations shall remain safe even after commencement of a new activity. However, noise checking best practices shall be used as a preventive measure.**

The summary of measured parameters like L_{eq}, L_{Day}, L_{Night}, L_{10}, L_{50}, L_{90}, $L_{Max}$for all the locations during the baseline study period (May 2017), are presented in Table 4.7. 4. Perusal of the measured values shows that the overall L_{eq} value varied between 43.4 dB(A) to 80.1 dB(A) among all locations. L_{Day} and L_{Night} value varied between 44.1 dB(A) to 81.2 dB(A) and 32.2 dB(A) to 65.3 dB(A) respectively. The highest L_{eq} value 80.1 dB(A) was recorded at Bandra Kurla Complex (BKC) due to proximity of plying vehicles and running of various equipment while the lowest L_{eq} 43.4 dB(A) was recorded at Kholvad in Surat, a slum area. The highest L_{Day} 81.2 dB(A) was recorded again at Bandra Kurla Complex (BKC) and lowest value of L_{Day} 44.1 dB(A) at Kholvad. The existing ambient noise was higher than prescribed standards at multiple locations in MH & GJ especially in Urban areas during both day and night.

Table 4.11.4: Ambient Noise Measurement Results
[All values in dB(A)]

Location Code	Land Use	L_{10}	L_{50}	L_{90}	L_{MAX}	L_{eq}	L_{Day} (6:00 am to 10:00 pm)	L_{Night} (10:00 pm to 06:00 am)
NV1	Commercial	85.3	78.5	75.5	89.2	80.1	81.2	65.3
NV2	Sensitive	80.0	71.9	66.8	84.5	74.8	75.4	56.7
NV3	Sensitive	75.7	62.7	59.4	78.2	67.2	68.7	50.7
NV4	Residential	50.9	44.8	40.2	54.1	46.7	48.7	37.6
NV5	Sensitive	52.1	44.6	37.8	54.6	48.0	50.1	38.3
NV6	Residential	45.9	45.8	45.5	48.1	45.8	46.9	35.2
NV7	Residential	49.0	45.9	45.7	51.7	46.1	47.2	32.6
NV8	Industrial	75.7	62.7	59.4	78.4	67.2	68.9	55.4
NV9	Sensitive	73.3	69.9	58.6	75.4	73.5	74.2	52.4
NV10	Commercial	61.2	52.1	51.9	65.4	53.5	54.5	38.6
NV11	Residential	62.2	56.9	52.3	66.8	58.5	59.2	42.5
NV12	Residential	63.2	45.9	45.6	67.7	51.1	52.5	39.3
NV13	Commercial	66.3	62.6	52.5	70.4	65.7	66.8	44.2
NV14	Residential	80.5	76.4	75.5	84.1	76.8	77.2	62.4
NV15	Residential	65.7	59.2	50.5	68.6	63.0	64.1	40.0
NV16	Residential	68.8	61.1	56.1	72.4	63.8	65.2	53.1
NV17	Sensitive	67.6	66.5	64.7	70.2	66.6	62.8	56.5
NV18	Residential	71.1	66.6	63.4	73.6	67.5	66.2	58.6
NV19	Commercial	78.6	64.4	63.6	81.3	68.1	68.4	63.2
NV20	Residential	51.3	45.2	40.1	54.9	47.3	48.2	37.3
NV21	Residential	50.8	43.2	38.4	53.7	45.8	47.6	36.5
NV22	Commercial	48.1	42.8	40.2	54.6	43.8	45.5	36.9
NV23	Sensitive	49.2	44.6	38.2	51.6	46.6	48.2	37.3
NV24	Commercial	63.2	45.9	45.6	66.8	51.1	52.6	40.4
NV25	Sensitive	55.2	48.5	42.6	57.8	51.1	53.2	40.8
NV26	Commercial	70.2	55.5	46.2	74.1	65.1	66.2	45.2
NV27	Sensitive	45.5	42.8	39.7	47.8	43.4	44.1	35.2
NV28	Sensitive	48.7	44.5	41.3	51.4	45.4	46.2	32.4
NV29	Sensitive	64.1	45.3	41.8	67.9	53.6	54.8	41.2
NV30	Sensitive	49.5	46.6	42.2	54.5	47.5	48.4	32.2
NV31	Residential	50.2	44.5	37.4	56.5	48.2	46.4	37.2

Source: Study Team

Annexure 4.12

4.12 VIBRATION

Ambient vibration or environmental vibration seldom have such magnitude to be perceptible or cause audible ground borne noise unless there are specific vibration sources close by. Such sources may be present outside the buildings such as such as railway line, road traffic etc. or within the building itself such as air conditioning and ventilation systems, generator sets etc. Therefore, assessment of existing vibration levels is most essential at certain receptors which are susceptible to an increase in vibration levels or which are already located in close range from existing vibration sources such railway line, road traffic etc.

All structures falling close to the proposed HSRC are vulnerable to vibrational impact of the project during construction as well as operation phases of the project, especially those having vibration sensitive manufacturing, research or laboratory activities. Careful assessment of pre-existing vibration provides valuable information on real sensitivity of the activity to external vibration and provided reference points. Similar, old, historic or archeological sites are particularly vulnerable to vibration and hence, there real sensitivity shall be assessed. Vibration assessment is also important at locations where there is an existing source of vibration and another new source of vibration is proposed.

In order to assess the likely vibrational impacts due to construction and operation of proposed project, ambient vibration monitoring has been carried out along the route of HSRC at selected locations as explained in the following sections.

Methodology Adopted for Ambient Vibration Measurement

Ambient vibrations levels have been recorded at 42 locations along the proposed alignment of HSRC. These locations included residential, commercial, industrial and sensitive zones. The vibration monitoring was carried out during July 2017. The monitoring was carried out for 30 minutes duration at each location using vibrometer with inbuilt data logger. The measurements were mostly taken outdoors. Vibration measurements were recorded in terms of vibration velocity (mm/sec).

Selection of Measurement Locations

The locations for vibration monitoring have been selected to include areas having no conspicuous vibration source, along major road corridor (cause of traffic vibration) and along existing railway lines (cause of railway related vibrations). No vibration sensitive manufacturing, research or laboratory activities exist along the proposed HSRC route. The details of the vibration measurement locations are described in Table 4.12.1.

Table 4.12.1: Ambient Vibration Measurement Locations

Location Code	Location Name	Reason for Selection	Existing Source (Yes/No)	Distance to Project Site (m)	Latitude (N)	Longitude (E)
NV1	BKC, Mumbai	Proposed BKS Stn. / Commercial	No	80	19°04'05.2"	72°52'01.8"
NV2	Jaama Masjid-Kapadia Nagar	Sensitive / Old Building / Road Traffic	Yes	60	19°04'25.2"	72°52'25.6"
NV3	Residential/	5-6 story building /	Yes	93	19°04’58.2”	72°53’47.2”

Location Code	Location Name	Reason for Selection	Existing Source (Yes/No)	Distance to Project Site (m)	Latitude (N)	Longitude (E)
	Commercial Complex	Road Traffic				
NV4	Manevale Pada-habitation	Proposed Virar Stn. / Mining / RMC Plant	Yes	36	19°05'19.2"	72°55'0.6"
NV5	Palghar	Location skipped due to local resistance				
NV6	Zari – Vapi	Location skipped due to non-motorable road				
NV7	Zaroli- Vapi	Location skipped due to non-motorable road				
NV8	Silvassa, Dadar Nagar Haveli	Road Side Retails Shops	No	22	20°15'43.6"	72°55'17.8"
NV9	Silvassa, Dadar Nagar Haveli	Road Side Retails Shops / Road Traffic	Yes	14	20°19'47.5"	72°57'0.3"
NV10	Vapi Ambach Rd	Road Side Retails Shops	No	5	20°22'44.4"	72°57'37.2"
NV11	Paria Gaon	Residential	No	76	20°26'45.1"	72°57'55.3"
NV12	Casa Residential Complex, Vadodara Gujarat	Residential / Near Railway Track	Yes	60	22°15'01.8"	73°10'33.1"
NV13	Prathmik Arogya Kendra, Valsad Gujarat	Hospital	No	55	20°32'46.0"	72°58'25.7"
NV14	Sabarmati Bridge, Ahmedabad, Gujarat	Rail bridge with Rajdhani and Other Trains Passing (Event Vibration)	Yes	-	23.0619	72.58948
NV15	Jujwa village, Gujarat	Residential	No	75	20°35'07.2"	72°58'43.8"
NV16	Hazrat Pirn Dargah, Valsad, Gujarat	Religious / Sensitive	No	21	20°37'27.2"	72°58'54.1"
NV17	Cancer Hospital in Panchlai, Gujarat	Sensitive	No	643	20°42'41.4"	73°00'12.6"
NV18	Civil Structure Undach Vaniya Faliya	Industrial	No	27	20°44'19.3"	73°00'11.2"
NV19	Factory, Billimora, Gujarat	Industrial	No	52	20°45'51.4"	73°00'30.2"
NV20	Factory, Chnaga, Gujarat	Industrial	No	8	20°48'57.5"	73°00'59.2"
NV21	Habitation area, Chnaga	Residential	No	66	20°49'39.3"	73°00'50.3"

Location Code	Location Name	Reason for Selection	Existing Source (Yes/No)	Distance to Project Site (m)	Latitude (N)	Longitude (E)
	Village					
NV22	GIDC, Navsari, Gujarat	Industrial	No	34	20°56’57.4”	72°58’48.6”
NV23	Dhabel, Gujarat	Boundary wall near Mosque / Sensitive	No	98	21°02’11.8”	72°56’13.5”
NV24	Shop, Godasar, Ahmedabad	Residential and Commercial / Railway line at 18m	Yes	147	21° 6'8.33"	72°55'33.81"
NV25	Genius Educational Campus Building	School, Sensitive	No	6	21°08’12.6”	72°55’45.0”
NV26	EURO School. Nadiad, Gujarat	School, Sensitive	No	13	22°39’45.9”	72°51’29.0”
NV27	Hindu temple near slum area in Kholvad	Location skipped due to	No Data available			
NV28	School, Surat, Gujarat	School, Sensitive	No	52	21°17’20.2”	72°56’06.0”
NV29	Retail shops, Bharuch, Gujarat	Proposed Baruch Station / Road Traffic	Yes	118	21°41’34.5”	72°57’11.2”
NV30	Local Masjid, Kothy, Gujarat	Sensitive	No	-	21°55’04.8”	72°59’27.0”
NV31 (Without Train)	South Vasai Bridge, Mumbai	Railway Bridge	No	-	19°19'05.9"	72°51'10.8"
NV31 (With Train)	South Vasai Bridge, Mumbai	Railway Bridge	Yes	-	19°19'05.9"	72°51'10.8"
NV32	South Vasai Bridge, Mumbai	Railway Bridge (With Rajdhani Express Passing)	Yes	-	19°19'05.9"	72°51'10.8"
NV100	Atlanta Enclave - Multistory, Mhape, Mumbai	Exit of Thane Tunnel / Residential	No	43	19°07’06.7”	73°01’22.0”
NV101	Country Inn hotel, Vashi, Mumbai	Commercial / Road Traffic	Yes	10	19°6'50.80"	73°0'46.45"
NV102	Residential Colonies, Vashi, Mumbai	Commercial / Road Traffic (Station Highway) / TBM Operation Proposed	Yes	20	19°06'42.6"	73°00'15.2"
NV103	Marathi Vidhyalaya,	School / TBM Operation Proposed	No	40	19°05’19.2”	72°55’00.6”

Location Code	Location Name	Reason for Selection	Existing Source (Yes/No)	Distance to Project Site (m)	Latitude (N)	Longitude (E)
	Mumbai					
NV104	Don Bosco Institute of Technology	School / TBM Operation Proposed	No	16	19°04'53"	72°53'19.3”
NV105	Kohinoor City, Mumbai	Residential / TBM Operation Proposed	No	70	19°04'44.9"	72°53'07.5"
NV106	Mahape Industrial Area, Mumbai	Industrial / TBM Operation Proposed	No	20	19°04’52.8”	72°53’19.3”
NV107	India Bulls Megamall: Vishwamitra Area, Vadodara	Commercial / Railway Line at 100m / Vishwamitra Railway Station	Yes	28	22°18’21.6”	73°10’48.0”
NV108	Shivam Tenament Vadodara	Residential / Railway line 50-100m	Yes	30	22°20’45.9”	73°09’33.7”
NV109	House, Maninagar Railway Station	Residential / Maninagar Railway Station	Yes	15	22°59’49.8”	72°36’45.8”
NV111	Indian Railway Division Senior Section Engineer (Bridge)-Vadodara	Existing railway Track at 25m	Yes	15	22°18’18.5”	73°10’50.2”

Source: Study Team

A summary of vibration measurement results recorded at the monitoring stations are presented in Table 4.12.2.

Table 4.12.2: Interpretation of Results

Location Code	Location Name	Reason for Selection	Existing Source (Yes/No)	Maximum PPV (mm/s)	Minimum PPV (mm/s)	Average PPV (mm/s)
NV1	BKC, Mumbai	Proposed BKS Stn. / Commercial	No	0.077	0.0005	0.025
NV2	Jaama Masjid-Kapadia Nagar	Sensitive / Old Building / Road Traffic	Yes	0.101	0.0005	0.032
NV3	Residential/ Commercial Complex	5-6 story building / Road Traffic	Yes	0.0115	0.0005	0.00025
NV4	Manevale Pada - habitation	Proposed Virar Stn. / Mining / RMC Plant	Yes	0.18	0.0005	0.0005

Location Code	Location Name	Reason for Selection	Existing Source (Yes/No)	Maximum PPV (mm/s)	Minimum PPV (mm/s)	Average PPV (mm/s)
NV5	Palghar	Location skipped due to local resistance				
NV6	Zari – Vapi	Location skipped due to non-motorable road				
NV7	Zaroli- Vapi	Location skipped due to non-motorable road				
NV8	Silvassa, Dadar Nagar Haveli	Road Side Retails Shops	No			
NV9	Silvassa, Dadar Nagar Haveli	Road Side Retails Shops / Road Traffic	Yes	0.006	0.005	0.00
NV10	Vapi Ambach Rd	Road Side Retails Shops	No	0.005	0.00	0.00
NV11	Paria Gaon	Residential	No	0.029	0.0005	0.00075
NV12	Casa Residential Complex, Vadodara Gujarat	Residential / Near Railway Track	Yes	0.023	0.0005	-
NV13	Prathmik Arogya Kendra, Valsad Gujarat	Hospital	No	0.0025	0.0005	-
NV14	Sabarmati Bridge, Ahmedabad, Gujarat	Rail bridge with Rajdhani and Other Trains Passing (Event Vibration)	Yes	0.175	0.0005	0.003
NV15	Jujwa village, Gujarat	Residential	No	0.016	0.0005	0.001
NV16	Hazrat Pirn Dargah, Valsad, Gujarat	Religious / Sensitive	No	0.0325	0.0005	0.0025
NV17	Cancer Hospital in Panchlai, Gujarat	Sensitive	No	0.0835	0.0005	0.0015
NV18	Civil Structure Undach Vaniya Faliya	Industrial	No	0.083	0.001	0.023
NV19	Factory, Billimora, Gujarat	Industrial	No	0.1265	0.0005	0.0055
NV20	Factory, Chnaga, Gujarat	Industrial	No	0.059	0.0005	0.005
NV21	Habitation	Residential	No	0.0555	0.0005	0.007

Location Code	Location Name	Reason for Selection	Existing Source (Yes/No)	Maximum PPV (mm/s)	Minimum PPV (mm/s)	Average PPV (mm/s)
	area, Chnaga Village					
NV22	GIDC, Navsari, Gujarat	Industrial	No	0.0765	0.0005	0.023
NV23	Dhabel, Gujarat	Boundary wall near Mosque / Sensitive	No	0.0325	0.0005	0.005
NV24	Shop, Godasar, Ahmedabad	Residential and Commercial / Railway line at 18m	Yes	0.2305	0.0005	0.0077
NV25	Genius Educational Campus Building	School, Sensitive	No	0.0465	0.0005	0.0095
NV26	EURO School. Nadiad, Gujarat	School, Sensitive	No	0.011	0.0005	-
NV27	Hindu temple near slum area in Kholvad					
NV28	School, Surat, Gujarat	School, Sensitive	No			
NV29	Retail shops, Bharuch, Gujarat	Proposed Baruch Station / Road Traffic	Yes	0.0095	0.0005	-
NV30	Local Masjid, Kothy, Gujarat	Sensitive	No			
NV31 (Without Train)	South Vasai Bridge, Mumbai	Railway Bridge	No	0.027	0.0005	0.004
NV31 (With Train)	South Vasai Bridge, Mumbai	Railway Bridge	Yes	0.045	0.002	0.0085
NV32	South Vasai Bridge, Mumbai	Railway Bridge (With Rajdhani Bridge Passing)	Yes	0.049	0.0005	0.014
NV100	Atlanta Enclave - Multistory, Mhape, Mumbai	Exit of Thane Tunnel / Residential	No	0.011	0	-
NV101	Country Inn hotel, Vashi, Mumbai	Commercial / Road Traffic	Yes	0.0025	0.0005	-
NV102	Residential Colonies, Vashi, Mumbai	Commercial / Road Traffic (Station Highway) / TBM Operation Proposed	Yes	0.09	0.002	0.026
NV103	Marathi	School / TBM	No	0.085	0.0005	-

Location Code	Location Name	Reason for Selection	Existing Source (Yes/No)	Maximum PPV (mm/s)	Minimum PPV (mm/s)	Average PPV (mm/s)
	Vidhyalaya, Mumbai	Operation Proposed				
NV104	Don Bosco Institute of Technology	School / TBM Operation Proposed	No	0.006	.0.0005	-
NV105	Kohinoor City, Mumbai	Residential / TBM Operation Proposed	No	0.077	0.0005	0.009
NV106	Mahape Industrial Area, Mumbai	Industrial / TBM Operation Proposed	No	0.030	0.0005	0.00065
NV107	India Bulls Megamall: Vishwamitra Area, Vadodara	Commercial / Railway Line at 100m / Vishwamitra Railway Station	Yes	0.0195	0.0005	0.0005
NV108	Shivam Tenament Vadodara	Residential / Railway line 50-100m	Yes	0.0105	0	-
NV109	House, Maninagar Railway Station	Residential / Maninagar Railway Station	Yes	0.0125	0.0005	-
NV111	Indian Railway Division Senior Section Engineer (Bridge)-Vadodara	Existing railway Track at 25m	Yes	0.116	0.0005	0.0005

Source: Study Team

Annexure 4.13

4.13 WATER QUALITY

Surface Water

A watershed is a valuable resource for any country. More, so far a country like India, which is essentially agrarian and a vast majority of its population derives its sustenance from agriculture. Adequate knowledge of water bodies is necessary for rational formulation of water management policies. Moreover, unplanned population growth along river basins have led to large scale river pollution, which prevents beneficial use of river waters. There are two major river basins in the entire stretch of the proposed alignment of MAHSR-Narmada and Tapi Basins and both in Gujarat. Most of the nallahs and rivers which cross the alignment are the tributaries of Narmada and Tapi basins except few of them. Geologically, the river bed and the adjoining regions are part of the Paleogene sedimentary rocks of Maharashtra consisting of hard and undulating laterite and basalt formations with scattered laterite and Alluvial plains cover of varying thickness in the Maharashtra region of the proposed alignment. The part of the proposed alignment which falls in Gujarat is covered by the alluvial plain. Existing Information and result of field survey of each river has been described in the subsequent paragraphs.

Numbers of water resources were identified along the proposed alignment of MAHSR. These water resources can be broadly classified in flowing water resources (rivers, estuaries, creeks, nallahs) and stagnant water resources (pond, lakes).

Rivers

The project area falls largely in the region of alluvial plains and traverse across several river basins. The rivers intersecting the proposed alignment are Narmada, Tapi, Ambica, Purna, Par, Damanganga, Mindhol, Ghadvi, Mahi, Vanki, Kolak, Vaitarna, Ulhas, Mithi, Sabarmati. The chainage wise details of the rivers, estuaries, canal, nallahs intersecting the proposed alignment of MAHSR has been discussed in Chapter 1 of the S-EIA report.

The Narmada Basin

Naramada is the seventh largest, probably the holiest of the rivers of India. Archaeological investigations have revealed human habitations along its bank even earlier than 5000 B.C. Narmada is an interstate river and flows through the three states of Madhya Pradesh, Maharashtra and Gujarat. The basin covers 23 districts (20 of Madhya Pradesh, 2 of Gujarat and one of Maharashtra). Though, it is one of the main rivers of central India, the river basin has only a few urbanized and industrialized pockets. The total length of Narmada is 1312 km, of which 1077 km in Madhya Pradesh, 30 km along the common border of Madhya Pradesh and Maharashtra, 39 km along Maharashtra and Gujarat, and 166 km along Gujarat. The total basin area is approximately 98,800 km^2, out of which 85860 km^2 lies in Madhya Pradesh, 1540km^2 in Maharashtra, and 11400km^2 in Gujarat.

The Tapi Basin

The Tapi is a major west flowing river in the western part of India. It originates from a tank in the Satpura mountains in Betul district of Madhya Pradesh at an elevation of 752 m above Mean Sea Level. The river flows through rocky terrain in Nimar in Madhya Pradesh and thereafter through the fertile plains of Khandesh in Maharashtra and again the Western Ghats in the State of Gujarat, meeting the Gulf of Khambhat. Total length of the river Tapi is 724 km of which the first

282 km lies in Madhya Pradesh, of which 54 km forms the common boundary with Maharashtra. The stretches in Maharashtra and Gujarat are 228 and 214 km respectively. The river is joined by its most important tributary Purna which also rises in the Betul district of Madhya Pradesh. The northern part of the basin after the confluence of Purna is narrow and steep.

The Ulhas River

The Ulhas River originates in a valley north of the Rajmachi hills formed by mountain streams draining the northern slope of those hills which are part of the Sahyadri range of the Western Ghats in the Raigad district of Maharashtra. From the point of origin the river flows north turning left where it is joined by River Salpe, its right-bank tributary. It then begins its north-eastward journey and passes the Anglo-Eastern Maritime Academy which is situated on its right bank at Khandpe village. The river bypasses the Palasdhari village where it receives the discharge from the Palasdhari Dam starting a northward course beyond this point coming to lie parallel to the rail tracks only to be distracted by the town of Karjat. Meandering through Karjat, it reaches further north synapsing with River Peg between Bhivpuri road and Neral. Continuing its run along Neral, it is joined by River Poshir, another right-bank tributary at Nikhop village. It flows north skirting Badlapur where it receives the run-off from Chikoli Dam. Near Raw water pump house of MIDC Jambhul the river meets Barvi Dam discharge water also called as Barvi River. The confluence is a tourist and fishing hub for villagers around. The river flows through Ulhasnagar to which it gives its name. It then passes under the rail bridge connecting Ambivali and Shahad and shortly after confluences with its biggest tributary formed by merging of River Bhatsa and River Kalu which together account for 55.7% of the total catchment area of River Ulhas. Beyond Kalyan the river, nearly flowing at sea level, merges with the creek waters and its flow comes to be dictated by the tidal forces. From here on, it forms an estuary and also supports a mangrove forest near Diva-Dombivali. In rainy season and during low tide the river continues to flow till Thane where splits into two branches which flow west and south, respectively, around Salsette Island, on which lies the metropolis of Mumbai. The main branch turns northwestward to Ghodbunder, where it opens into the estuary of Vasai Creek. Thane Creek flows south to enter into Bombay Harbour. The estuary of the Ulhas is the site of the historical ports of Kalyan, Kopri (Chersonesus/Coprostaneum) and Shurparaka (now Sopara).

The Daman Ganga River

The Daman Ganga is a river in western India. It originates from the western slope of the Western Ghats range, and it flows west into the Arabian Sea. The Daman Ganga is a river in western India. The river's headwaters are on the western slope of the Western Ghats range, and it flows west into the Arabian Sea. The river flows through Maharashtra and Gujarat states, as well as the Union territories of Daman and Diu and Dadra and Nagar Haveli. The industrial towns of Vapi, Dadra and Silvasa lie on the north bank of the river, and the town of Daman occupies both banks of the river's estuary.

The river supplies drinking water to Vapi. Daman Ganga is also the most polluted of Indian rivers according to participants of the Machhimar Adhikar Rahstriya Abhiyan or the national campaign to save the coast and fish workers' rights in India (June 2008) from Kutchch to Kanyakumari, Vapi which is on the banks of this river has a lot of chemical and pharmaceutical companies release unprocessed and hazardous chemicals into the river which creates a lot of problems for the residents near the river and it looks like only dirty water and chemicals flowing instead of the River Water.

The Sabarmati River

The Sabarmati river is one of the biggest rivers of Gujarat. It originates in Dhebar lake in Aravalli Range of the Udaipur District of Rajasthan and meets the Gulf of Cambay of Arabian Sea after travelling 371km in a south-westerly direction. The Sabarmati basin has a maximum length of 300km. and maximum width of 105km. The total catchment area of the basin is 21674 km^2 out of which, 4124 km^2 lies in Rajasthan State and the remaining 18550km2 in Gujarat State. The National Water Quality Programme led by Central Pollution Control Board (CPCB) categorises Sabarmati River as one of the most polluted rivers in India. Sabarmati River Basin is situated in the mid-southern part of Rajasthan. To its east lie the Banas and Mahi Basins, to its north the Luni Basin and to its west the West Banas Basin. The main tributaries of the Sabarmati river are Wakal river and the Sei Nadi, which also rise in the Aravali hill range west of Udaipur city and flow south-westwards in courses generally parallel to the Sabarmati river, up to their confluence with the river (in Gujarat). Ahmedabad and Gandhinagar, the commercial and political capitals of Gujarat, were established on the banks of Sabarmati river. During India's independence struggle, Mahatma Gandhi established Sabarmati Ashramas his home on the banks of this river. The Govt. of Gujarat has developed the river front of Sabarmati as a place of tourist interest.

The River Mahi

The river Mahi, the third largest river of Gujarat after Narmada and Tapi, rise from about 556m above sea-level in the Malwa region around Sardarpur in Madhya Pradesh. It flows for about 180km in Gujarat before entering into the Gulf of Khambhat. The lower course of the river for about 70 km is characterized by heavily gullied cliffy sand-banks and ravines. Further south, of the river Dhadhar rising from the Shivrajpur hills also flows into the Gulf of Khambhat. This river is met by a major tributary Visvamitri, 25 km Southwest of Vadodara.

The River Meshow and Vatrak

The plains of Central Gujarat lying between Sabarmati and Mahi are drained by a number of tributaries of Sabarmati, viz., Khari, Shedhi, Mejan, Andheri, Meshwo and Vatrak. Of these, Meshwo and Vatrak are the major ones. Meshwo originates in Dungarpur district of Rajasthan and meets the Vatrak river. The Vatrak also rises from the Dungarpur hills and meets Sabarmati at Vautha. The river Shedhi which forms the chief drainage of the alluvial plains between Sabarmati and Mahi originates from the eastern hills of Panchmahals district and meets Vatrak at Kheda.

The Dhadar Basin

The Dhadhar River is one of the west flowing rivers in Gujarat state. It originates from the Pavagadh Hills of Gujarat state and flows through Vadodara and Bharuch districts. The river Dhadar after flowing 87km receives Vishwamitri tributary from right bank at Pingalwada village 500 m. up stream of Gauge and Discharge site. After flowing another 55 km it falls in to the Gulf of Khambhat. The total length of the river from its source to outfall in the Gulf of Khambhat is about 142km. The important tributaries of the Dhadar River are Vishwamitri, Jambuo river, Dev and Surya River. The catchment area of the Dhadar basin is 3423 sq.km and catchment area up to the site is 2400 sq.km.

The Purna Basin

Purna river is an important west flowing river with its catchment in Gujarat and Maharashtra. The river Purna rises in the Saputara hills of the Western Ghats near the village Chinchi in Maharashtra. The length of the river from its source to outflow in the Arebean Sea is about 180 km. The important tributaries of the river are Dhodar nalla, Bardanala, Nagihpar nala, Girna river, Zankari river and Dumas khadi.The catchment area of the Purna basin is 2431 sq. km.

The River Vaitarana

The Vaitarana, the largest of Konkan rivers, rises in the Tryambak hills in the Nasik district, opposite the source of the river Godavari, and enters Thane at Vihigaon near Kasara, after passing through a deep gorge while descending the plateau top to the Konkan lowland. The river Vaitarana is 154-kilometer-long and has a drainage area that practically covers the northern sections of the district. It has a number of tributaries, the most important of which are the Pinjal, the Surya and the Tansa.

The River Mindhol

Mindhola River is a river in western India in Gujarat whose origin is near Doswada, Songadh. Its basin has a maximum length of 105 km. The total catchment area of the basin is 1518 sq.km.

Physico-chemical parameters have been determined to establish the baseline status of the existing sources of surface water. Samples were collected during pre-monsoon season (03-May-2017 to 15-May-2017). Sampling locations for surface water quality are enlisted in Table 4.13.1 and shown in Exhibit 4.13.1. The illustration of sampling is shown in photograph placed as Exhibit 4.13.2.

(1) Methodology of Sampling and Analysis

Water (surface and ground water) samples measuring 2-litre were collected once during the baseline survey in the month of May 2017 and analyzed for physico-chemical and biological parameters. The parameters such as pH, temperature were measured at site and DO were fixed with the help of DO probe at the time of collection of sample (with the help of water testing kit developed by CPCB) while for other parameters, samples were preserved and analyzed in laboratory as per the prescribed guidelines of Central Pollution Control Board (CPCB). The general precautions in the Bureau of Indian Standards *i.e.,* IS-3025/1622 and/or Standard Methods for the Examination of Water & Wastewater- latest edition [Published jointly by American Public Health Association (APHA), and Americal Society for Testing and Materials (ASTM)] were followed during the sampling. Samples were collected, preserved and analyzed for physico-chemical, microbial parameters as per Standard Methods for the Examination of Drinking and Waste Water (CPCB, APHA, AWWA and WPCF). The results so obtained were compared with the prescribed standards.

Sampling Locations with Justifications

Physico-chemical parameters have been determined to establish the baseline status of the existing sources of surface water. Samples were collected during pre-monsoon season (03-May-2017 to 15-May-2017). The details of the selected sampling locations is given in Table 4.13.1 and shown in Exhibit 4.13.1.

The water quality sampling locations were selected on the basis of the following considerations-

- X-ing MAHSR alignment
- Proximity of the alignment
- Discharge point
- Intake point

- Estuary
- Proximity to the proposed construction yard
- Proximity to the proposed maintenance depot

Presentation of Results

The result of analysis of the collected samples, have been presented in Table 4.13.2 (i) to Table 4.13.2 (v).

Prescribed Standards/Limit

The prescribed standards of Central Pollution Control Board for Indian Standards for Drinking Water and Indian Standards for Industrial and Sewage Effluents Discharge are presented in Table 4.13.4 and Table 4.13.5 respectively. The other Indian Standards IS: 2296 -1992(Class C) is already incorporated in the result.

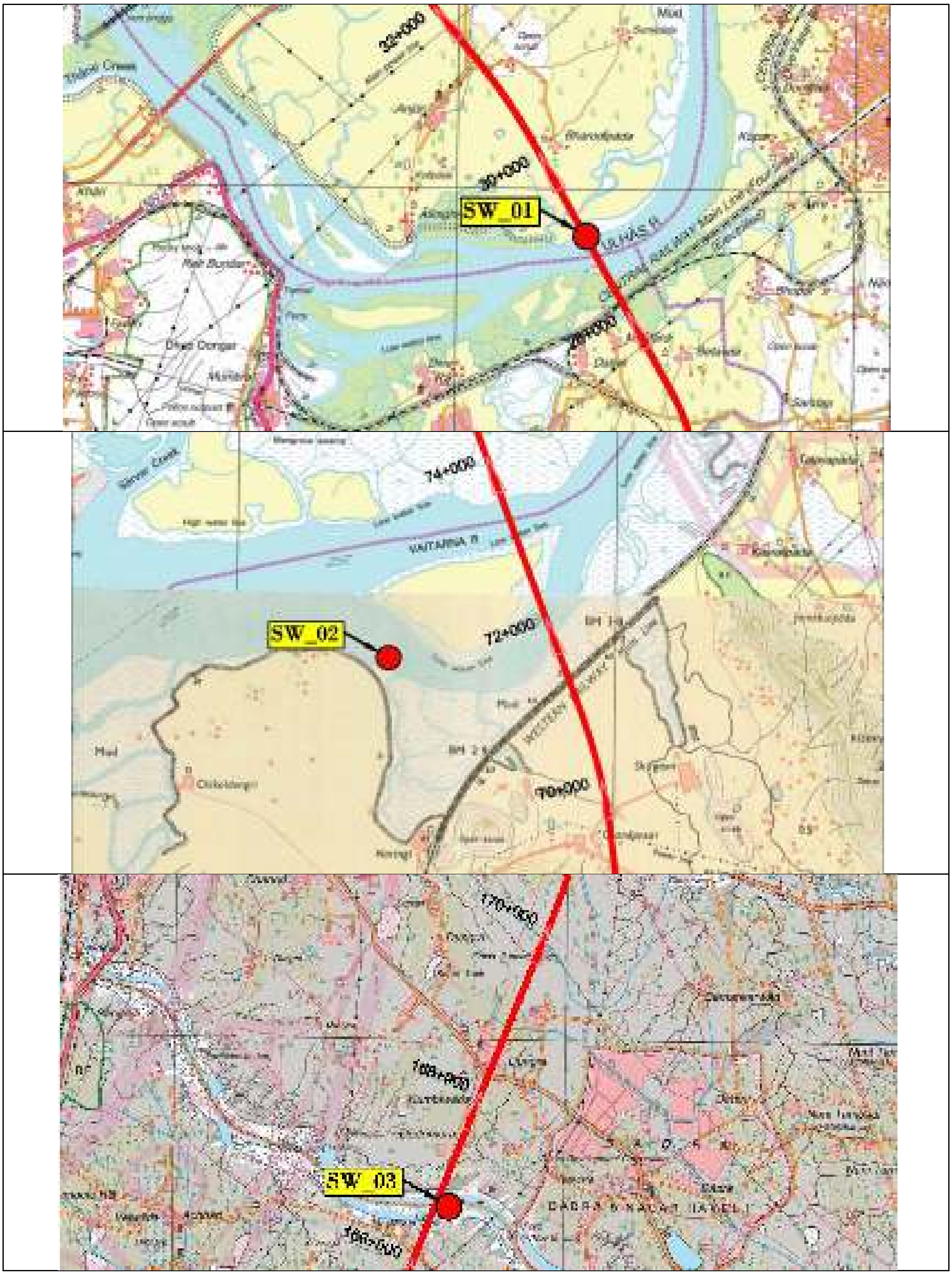
Table 4.13.1: Water (Surface and Ground Water) Quality Sampling Locations

Location Code	Location	Section	Geo Coordinates		Date of Sampling	Environmental Setting
			Latitude	Longitude		
Surface Water Sampling Locations						
SW1	Ulhas River	Mumbai - Thane - Virar	19°12'11.20"N	73° 3'15.62"E	06-05-2017	River is mainly polluted due to untreated discharge from the industries outlet present in the upstream course. Before 2005, availability of fish in the river was good, but now the availability is only in rainy season that too very low due to increase in pollution level due to discharge of various effluents.
SW2	Vaitarna River	Virar - Dahanu	19°29'39.24"N	72°49'27.41"E	06-05-2017	Fishes available in river. Lot of river bed sand mining presently going in the area. Sample was taken during low tide.
SW3	Damanganga River	Dahanu-Vapi, Near Achchhari	20°18'57.18"N	72°56'33.43"E	07-05-2017	Village is mainly covered with the Mango trees, rest sugarcane and rice is also grown the village. Fishes are available in water mainly Rehu fish and algae is also present in wate. Madhuban Dam is the source of the river water.
SW4	Kolak River	Vapi - Valsad	20°23'38.29"N	72°57'33.67"E	07-05-2017	Mainly Mango trees are available in the village and sugarcane is also grown with small area occupied by Wheat crop. Sample was taken from river edge.3 feet below the surface of river.
SW5	Par River	Vapi - Valsad	20°31'31.85"N	72°58'17.54"E	07-05-2017	Industries are present at downstream of the river. Fishes are available in river water, water is supplied from Madhuban Dam, farming present in village mainly of wheat and sugarcane.
SW6	Kaveri River	Valsad - Surat	20°35'45.10"N	72°58'33.28"E	08-05-2017	Industries present at upstream of the river, fishes are available in water and river mining is in process in the river. Mainly mango farming is present in the village. Locals use river water for drinking.
SW7	Ambica River	Valsad - Surat	20°44'34.08"N	73° 0'11.26"E	08-05-2017	Water flow in the river is very low; farming of local veggies such as lady finger, brinjal, chilly are grown in the village. Mango farm is present in the abundant. Algae present in water.

Location Code	Location	Section	Geo Coordinates		Date of Sampling	Environmental Setting
			Latitude	Longitude		
SW8	Purna River	Valsad - Surat	20°52'4.75"N	73° 0'14.58"E	08-05-2017	Agriculture is the main occupation in the village. Samples were taken from the river edge and on upstream and Downstream of the river.
SW9	Mindhol River	Valsad - Surat	20°57'55.80"N	72°58'9.46"E	09-05-2017	Sugarcane and rice are grown in the village. River bed sand mining was being done. Fishing activity is prevailing.
SW10	Tapi River	Surat - Bharuch	21°16'55.57"N	72°56'4.10"E	09-05-2017	Fresh water fishes available in water with algae. Agriculture is the main occupation in the village surrounding the river.
SW11	Narmada River	Surat - Bharuch	21°40'38.63"N	72°56'51.90"E	10-05-2017	Fresh water fishes available in water. Agriculture is the main occupation in the village. Cash crops like sugarcane, Cotton are grown at large scale.
SW12	Mahi River	Vadodara-Vasad	22°27'2.52"N	73° 5'21.85"E	10-05-2017	The land around the Mahi river is flat and fertile of alluvium tract. The populations depend on farming.
			22°27'33.74"N	73° 5'37.98"E	10-05-2017	
SW13	Sabarmati River	Ahmedabad	23° 3'41.76"N	72°35'18.99"E	10-05-2017	Sabarmati is one of the most important rivers of India and Gujarat. The weather condition was fair and clear sky at the time of sampling. This is the lifeline of Ahmedabad.
Ground Water Sampling Locations						
GW1	Residential Apartment near Alignment	Umiya, Nadiad, GJ	22°39'44.80"N	72°51'28.79"E	09-05-2017	Ground water sample taken from Naidiad Opp. Patidas Society of godown. Depth to ground water table is at 150ft. Location is surrounded by residential houses.
GW2	Between NH 8 & SH60	Sadanandpura, Vasad, GJ	22°35'20.78"N	72°58'21.13"E	10-05-2017	Ground water sample taken from a hand pump of temple in the village. Depth to ground water table is 150 ft.
GW3	School & Society	Kothy Vantersa, Vadodara	21°55'3.24"N	72°59'27.24"E	10-05-2017	Ground water sample taken from hand pump of Avathi Vathar village, Depth to ground water table is 150 ft.
GW4	Mixed	Kamrej, Surat	21°11'5.50"N	72°55'52.17"E	09-05-2017	Ground water sample taken from hand pump of Pantoli village. Depth to ground water table is 160 ft.
GW5	Hospital	Faterwadi, Palghar, MH	19°24'18.47"N	72°50'59.56"E	06-05-2017	Ground water sample taken from HP petrol pump, Depth to ground water table is 60 ft.

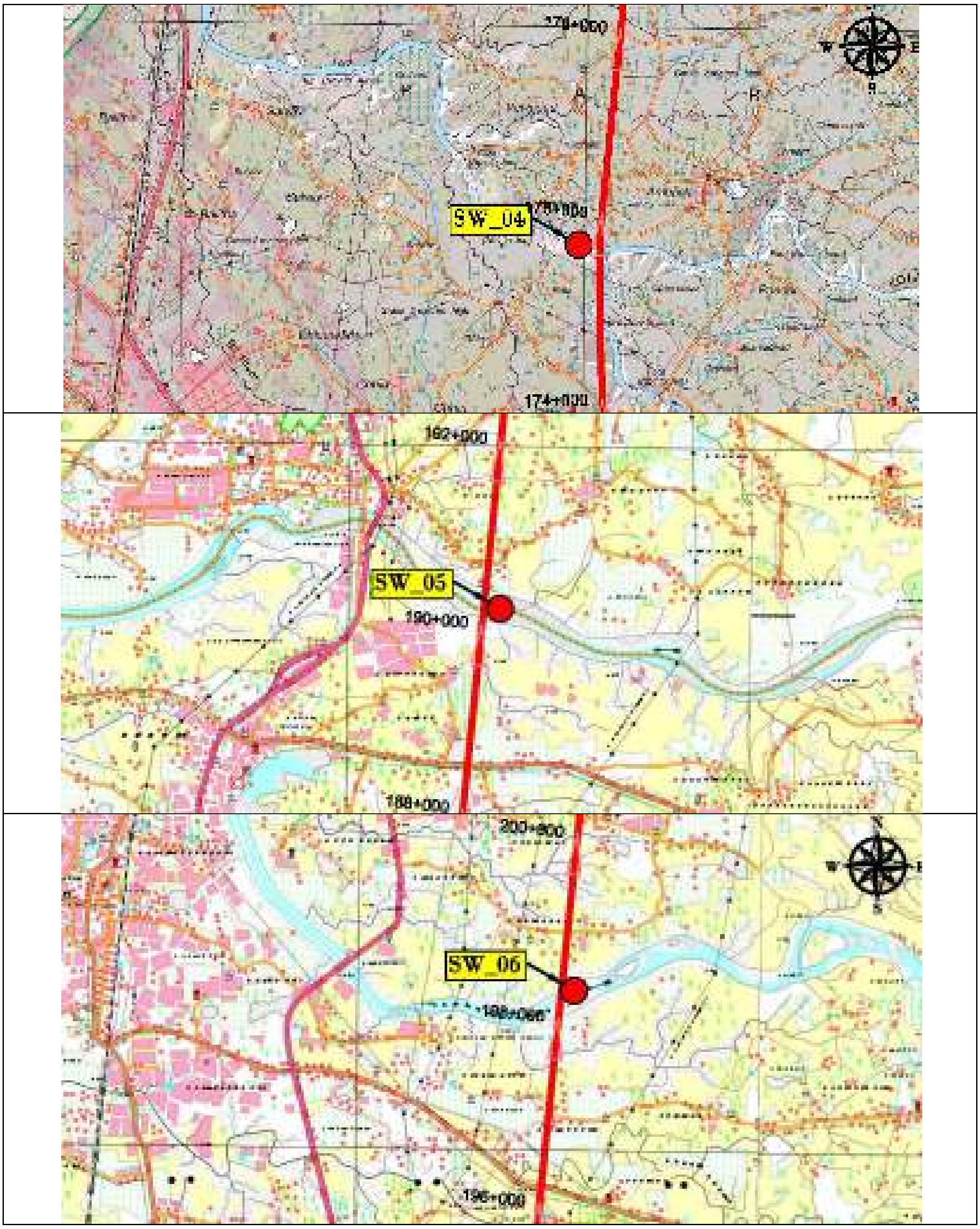
Source: Study Team

Exhibit 4.13.1(A): Water (Surface & Ground Water) Quality Sampling Locations



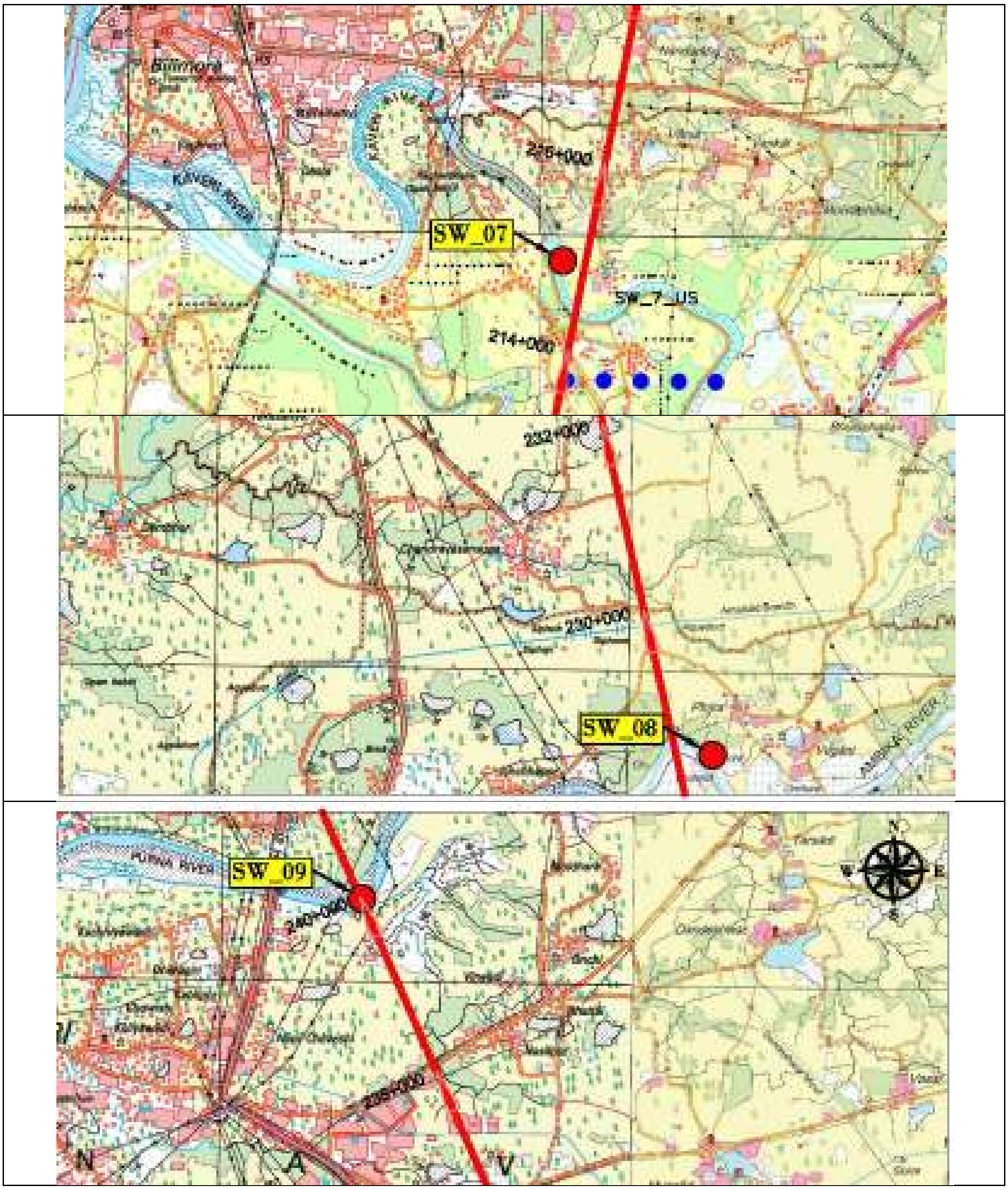
Source: SOI Toposheet

Exhibit 4.13.1(B): Water (Surface & Ground Water) Quality Sampling Locations



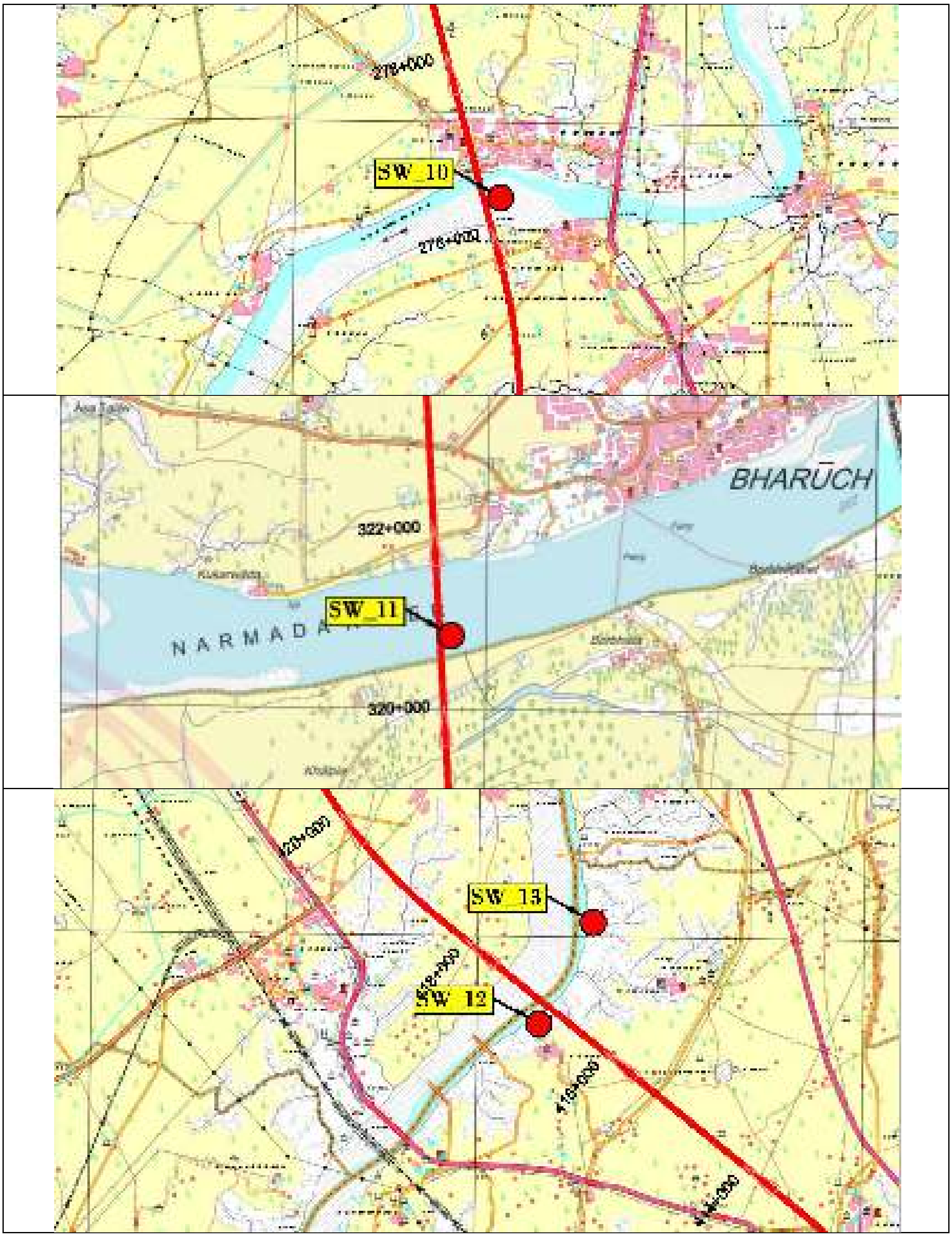
Source: SOI Toposheet

Exhibit 4.13.1(C): Water (Surface & Ground Water) Quality Sampling Locations



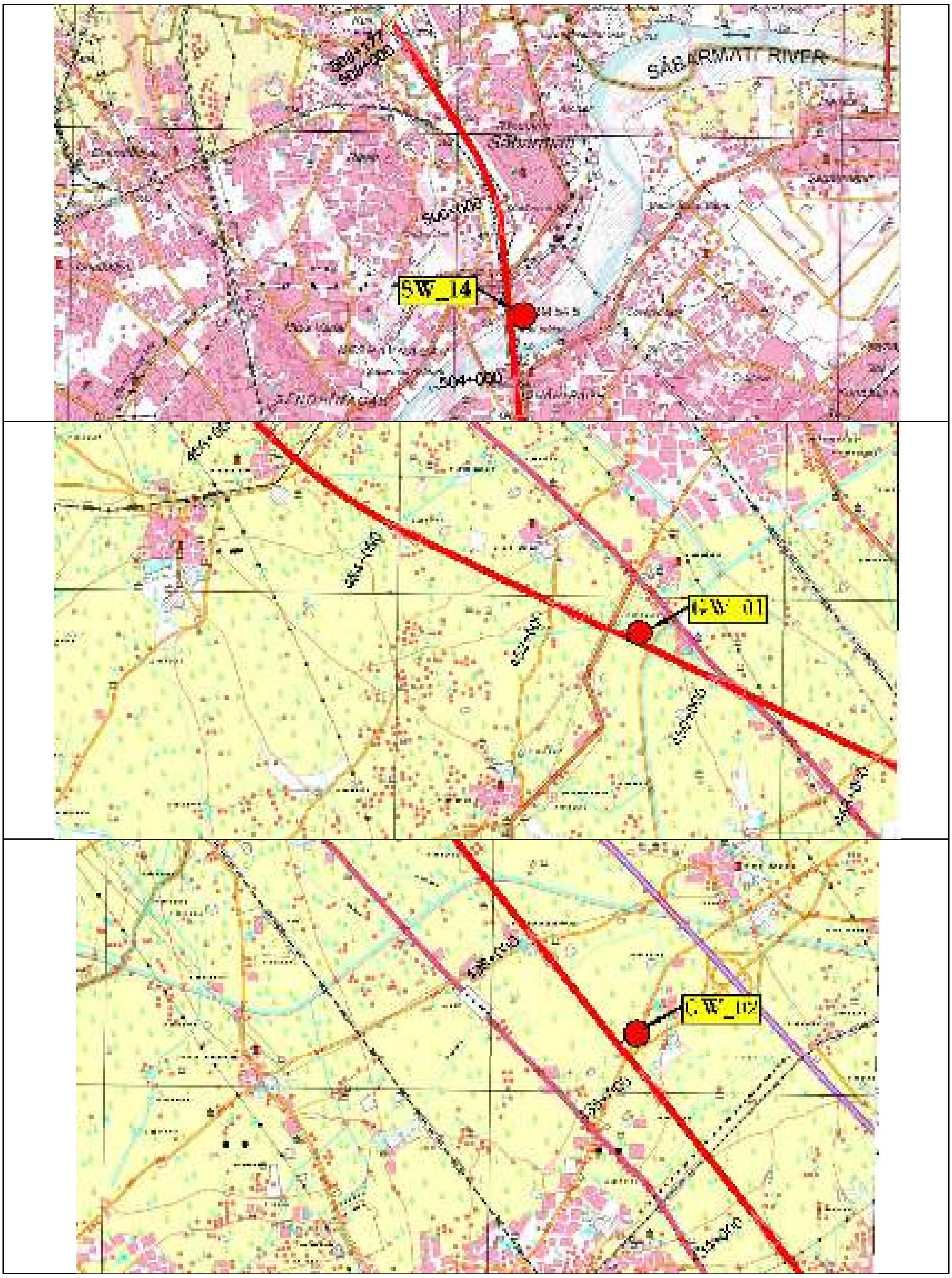
Source: SOI Toposheet

Exhibit 4.13.1(D): Water (Surface & Ground Water) Quality Sampling Locations



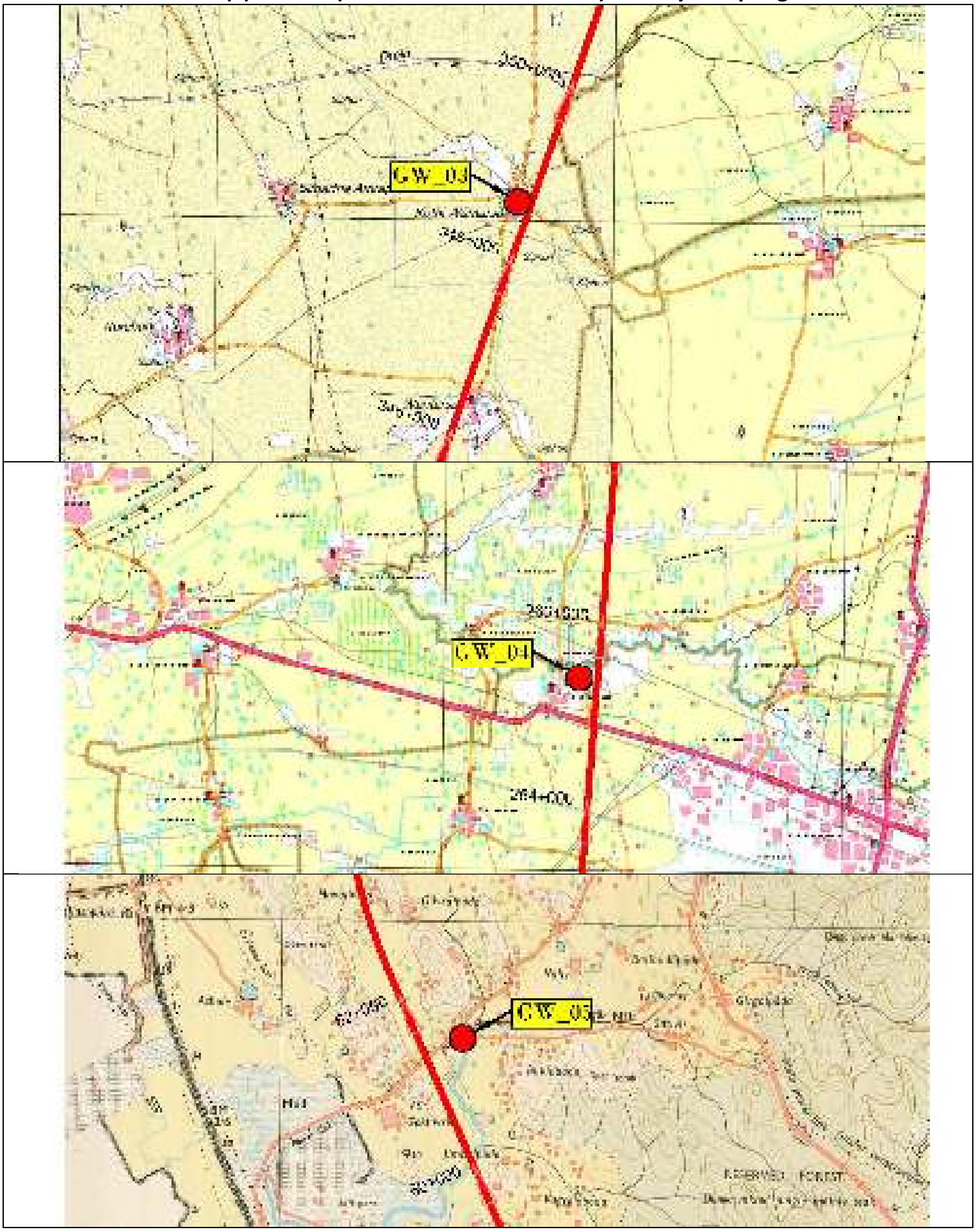
Source: SOI Toposheet

Exhibit 4.13.1(E): Water (Surface & Ground Water) Quality Sampling Locations



Source: SOI Toposheet

Exhibit 4.13.1(F): Water (Surface & Ground Water) Quality Sampling Locations



Source: SOI Toposheet

(2) PHYSICO-CHEMICAL CHARACTERISTICS

Physico-chemical parameters along with biological indicators of pollution have been estimated for ascertaining the baseline status of water environment and presented in Table 4.13.2 (i) to Table 4.13.2 (v).

(3) Surface Water-River (Other than Estuarine Water) -SW3, SW4, SW5, SW6, SW7, SW8, SW9, SW10, SW12, SW13& SW14

Physical Parameters

In pre-monsoon season, for surface water the values of physical parameters *viz.* pH, temperature, turbidity, TSS and TDS were found in the range as follows (Table 4.13.2 (i) to Table 4.13.2 (v)).

- pH = 6.84-8.32
- Temperature = 29 -37^{0}C
- TSS = 7-42 mg/l
- TDS = 158-3430 mg/l

Inorganic Parameters

The Inorganic parameters *viz.* total alkalinity, total hardness, chlorides, sulphate, sodium and potassium were found in the range as follows [Table 4.13.2 (i) to Table 4.13.2 (v)].

- Total alkalinity = 92-280 mg/l
- Total hardness = 80-1042 mg/l
- Chlorides = 36-2560 mg/l
- Sulphate = 5.9-228 mg/l
- Potassium = 5.5-28.6 mg/l

Nutrient Parameters

The nutrient and demand parameters viz. nitrate, total phosphate, dissolved oxygen, chemical oxygen demand and biochemical oxygen demand were in the range as follows [Table 4.13.2 (i) to Table 4.13.2 (v)].

- Nitrate = 0.12-23.5 mg/l
- Dissolved Oxygen = 4.8-6.4 mg/l
- Chemical Oxygen Demand = 36-124 mg/l
- Biochemical Oxygen Demand = 9-22 mg/l

Trace Elements

Concentrations of trace metals in water are often close to the background level due to their efficient removal from the water column through hydrolysis. The bioavailability and toxicity of trace metals such as Cd, Cu, and Zn are related to the activity of the free metal ion rather than the total metal concentration. The concentration of all the trace elements were below the permissible limit of IS: 2296 in the river water.

(4) Estuarine Water –SW1, SW2 and SW11

On perusal of theTable 4.13.2 to Table 4.13.9 following results can be inferred-

Temperature

It affects many chemical and biological parameters (Gupta, 2004). As the temperature increases molecular motion of water increases and due to evaporation, solubility of gases get reduced. In present study temperature ranges from 28 to 35^{0}C at all the sampling locations.

pH

pH indicates the presence of acidic or alkaline nature of water. It ranges from 7.34 to 7.85 for all the locations of estuarine water.

Turbidity

It measures the scattered light at right angle of the path of incident light. Turbidity shows presence of settled particles, garbage and other pollutants. It measures in nephelometric turbidity unit (NTU). In the present study, as evident from the Table 4.13.2 to Table 4.13.9, the observed value of turbidity ranges from 11 to 35 NTU for all the sampling locations of estuarine water.

Total Dissolved Solids (TDS)

The standard range of TDS is 100 to 600 mg/l. The values were found more than desirable range. The increase in amount of TDS in samples is due to presence of algal cell in the effluents. In present study TDS ranged from 177 to 23038 mg/l. The highest value of TDS was reported in Vaitarni river which is due to the pollution load and discharge of untreated sewerage, industrial effluents and other garbage.

Total Suspended Solids (TSS)

In the present study, TSS ranged from 24-59 mg/l for all the sampling locations among the estuarine water. The physical characteristics i.e. pH, temperature, turbidity, total suspended solids (TSS), and total dissolved solids (TDS) were observed to be in the range as follows [Table 4.13.2 (i) to Table 4.13.2 (v)].

Parameter	Observed Values
pH	7.34-7.85
Temperature	28^{0}C -35^{0}C
Turbidity	11.0-35.0 NTU
Total Suspended Solids (TSS)	24-59 mg/l
Total Dissolved Solids (TDS)	177-23038 mg/l

Inorganic Parameters

In pre-monsoon season, for estuarine water, inorganic parameters i.e. total alkalinity; chloride, sulphate and salinity were observed to be in the range as follows [Table 4.13.2 (i) to Table 4.13.2 (v)].

Parameter	Observed Values
Total Alkanity	150-187 mg/l
Chloride	250-2450 mg/l
Sulphate	42- 210 mg/l
Salinity	4-32%

Nutrient Parameters

The nutrient and demand parameters *viz.* nitrate, dissolved oxygen, Chemical Oxygen demand and Biochemical Oxygen Demand (B.O.D.) were in the range as follows [Table 4.13.2 (i) to Table 4.13.2 (v)].

Parameter	Observed Values
Nitrate	0.24-32.6 mg/l
Dissolved Oxygen (DO)	1.1 – 5.3 mg/l
Biochemical Oxygen Demand (BOD)	20-172 mg/l
Chemical Oxygen Demand (COD)	72-544 mg/l

Bacteriological Characteristics

The coliform group of bacteria is significant as a principal indicator of degree of pollution of water and is also indicative of the sanitary quality. The coliform density is now a criterion to assess the suitability of water for domestic and recreational uses. The coliform group belongs to the family of *Enterobacteriaceae* and includes all aerobic and facultative anaerobic, gram-negative, non-spore forming, rod-shaped bacteria that ferment lactose with gas and acid formation within 48 hrs at 35°C. For estimation of bacterial contents in water samples, the standard test for the coliform group was carried out by the membrane filter (MF) technique. The MF technique involves direct plating for detection and estimation of total coliform and faecal coliform densities.

River Water

The total coliform density in surface water was observed to be in the range of 170-5004 CFU/100 ml. The water quality satisfies the Class C of surface water (Drinking water source with conventional treatment followed by disinfection) (IS 2296: 1982). The levels of total coliform and faecal coliform are at normal level with slight organic pollution.

Estuarine Water

The total coliform density in the estuarine water was observed to be in the range of 6600-240000 CFU/100 ml. The highest value of total coliform was recorded in the Ulhas river, an estuary. This indicates some amount of organic contamination in sea water.

Trace Elements

Concentrations of trace metals in water are often close to the background level due to their efficient removal from the water column through hydrolysis. The bioavailability and toxicity of trace metals such as Cd, Cu, and Zn are related to the activity of the free metal ion rather than the total metal concentration. For Cd it is the Cd C12 complex that predominates in seawater. Therefore, salinity is the overriding factor which can alter free Cd ion activity {Cd2+}, and hence, bioavailability and toxicity in marine systems. The cadmium concentration in the estuarine water was found below detectable limit at all locations. The concentration of mercury and chromium were also below detectable limit at all locations.

Conclusions

The surface water quality of the fresh river water was good with no organic pollution and very less nutrients especially nitrates. The Drinking Water Quality Standards is presented in Table 4.1.4. The physico-chemical characteristics of the estuarine water at all the three stations are within normal range of sea water except few parameters.

GROUND WATER

WATER is one of the essential natural resources for sustaining life on blue planet "**Earth**". The demand of fresh / usable water has increased manifold globally due to rapid growth in population, which in turn caused change in agricultural pattern and increase in industrial activities. To meet the demand of fresh water of various sectors, there is an enormous stress on ground water resources as the surface water pollution is increasing day by day. This has resulted in the water level decline in many parts of the country.

Depth to Ground Water Table

The ground water table in the project area ranges from 0.50 mbgl (Thane) to 58.30 mbgl (Gandhinagar). It shows that soutrhern part of the project corridor is relatively less water stressed than as one move northward. This coincides with the rainfall amount also that reduces as one moves north ward in the project area. However, yield is higher in the unconsolidated formation i.e. 25 to 40 l/sec in Surat, Bharuch and Vadodara. The hilly region in Palgarh gets a yield of 1 l/sec. The stage of ground water development is high in Gujarat i.e. 76% while that in Palgarh is around 48%. Hence, though the yield is higher in the Gujarat portion of project area, due to exploitation the water table has gone down. So water extraction for construction purpose has to be done with utmost care that the confined aquifersdoes not get over exploited and also rainwater harvesting structures to be implanted accordingly (more in the Gujarat portion). The provision of rainwater harvesting structure at the rate of 2 per km shall be given and the design shall be specific to the presence of aquifer, water table, soil characteristics. The depth to ground water table at various locations along the proposed alignment is presented in Table 4.13.2 (A).

Table 4.13.2 (A): Depth to Ground Water Table in the Project Area

Sl. No.	Location	Depth to Ground Water Table (in m)
1	Dadar Nagar Haveli	2.5 -7.30
2	Mumbai	3.0 -13.75
3	Thane	0.50-5.0
4	Dahanu	4.40-4.60
5	Palghar	5.0-10.0
6	Vadodara	1.20-29.51
7	Navsari	2.18-27.13
8	Vapi	3.40-10.15
9	Bharuch	0.96-18.14
10	Nadiad	1.25-34.80
11	Surat	1.0-21.67
12	Ahmedabad	0.85-24.77
13	Anand	1.65-24.26
14	Gandhinagar	11.99-58.30
15	Valsad	2.53-13.53

Source: Central Ground Water Year Book, Gujarat (2015-2016) and Maharashtra (2015)

Sampling Locations with Justifications

Physico-chemical parameters have been determined to establish the baseline status of the existing ground water in the project area along the proposed MAHSR alignment. Samples were collected during pre-monsoon season (May 2017) at five locations. The ground water sampling locations are presented in Table 4.13.1.

The ground water quality sampling locations were selected on the basis of the following considerations-

- Proximity of MAHSR alignment
- Proximity of Habitation *w.r.t.* MAHSR alignment
- Geological strata of the area

Results and Discussion

The result of the analysis of the collected ground water samples were analysed in the NABL/NABET Accredited laboratory and the result of analysis is presented in Table 4.13.3.

On perusal of the results presented in the Table 4.13.3 (i) and Table 4.13.3(ii), it may be inferred the Total Dissolved Solids and Chlorides are a little higher than the permissible limits in GW5 sample from Vasai in Thane District of Maharashtra. All other parameters were found within the permissible limit of the Indian Standard for the Drinking Water Quality- IS: 10500-2012. Some of the vital parameters are above permissible / desirable limits as mentioned above.

Table 4.13.2 (i): Results of Surface Water Quality of the Intersecting Rivers/Estuarine

S. No	Parameters	Unit	SW 1 Estuary 6/5/17			SW 2 Estuary 6/5/17	SW 3 River Water 7/5/17			Tolerance Limit IS:2296
			D/s	Centre	U/s	Centre	D/s	Centre	U/s	
1	pH	-	7.65	7.44	7.41	7.85	6.87	6.95	6.98	6.9-9.0
2	Temperature	ºC	32	34	35	28	31	31	32	4
3	D.O	mg/l	1.1	1.3	1.2	4.7	6.1	6.2	6.4	-
4	TSS	mg/l	59	54	51	38	10	7	8	-
5	TDS	mg/l	14487	15031	15511	23038	164	172	158	1500
6	Conductivity	µmhos/cm	21300	22100	22800	33400	259	262	244	-
7	Turbidity	NTU	32	35	34	22	2	1	1	5
8	Alkalinity as CaCO3	mg/l	220	220	240	160	100	96	92	200
9	Total Hardness (as CaCO3)	mg/l	3280	3160	3380	1234	108	100	120	300
10	Calcium(as Ca2+)	mg/l	516	556	556	504	25.6	25.6	19.2	75
11	Magnesium (as Mg2+)	mg/l	483.6	430.1	483.57	2692.44	10.7	8.7	17.5	-
12	Nitrate(as NO3)	mg/l	32.6	31.5	30.9	6.98	0.26	0.24	0.25	50
13	Chlorides (as	mg/l	8749	8721	8777	19000	36	38	40	600
14	Sulphate (as SO4)	mg/l	29.5	30.6	32.8	45.9	10.8	12.8	12.5	400
15	Fluoride (as F)	mg/l	0.97	0.92	0.85	0.45	0.46	0.41	0.39	1.5
16	Oil & Grease	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
17	Phenolic Compound (as C6H5OH)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005
18	BOD	mg/l	172	156	168	32	12	11	10	30
19	COD	mg/l	544	500	522	124	44	42	36	-
20	Arsenic	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.2
21	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	No

S. No	Parameters	Unit	SW 1 Estuary 6/5/17			SW 2 Estuary 6/5/17	SW 3 River Water 7/5/17			Tolerance Limit IS:2296
			D/s	Centre	U/s	Centre	D/s	Centre	U/s	
22	Lead	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
23	Cadmium (as Cd)	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.01
24	Chromium (as Cr+6)	mg/l	0.073	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
25	Copper (as Cu)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.5
26	Zinc (as Zn)	mg/l	0.032	0.106	0.03	0.053	0.039	0.035	0.034	1.5
27	Selenium (as Si)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05
28	Iron (as Fe)	mg/l	1.356	0.087	0.23	1.075	0.233	0.224	0.213	1
29	Sodium	mg/l	10820.2	10860.2	10453.3	16820.2	16.8	14.8	16.9	-
30	Potassium	mg/l	4230.5	4252.6	4125.3	9230.5	6.6	5.5	6.2	-
31	Total Coli form	MPN/100ml	240000	220000	200000	18400	5400	5200	5000	5000

Source: Study Team

Table 4.13.2 (ii): Results of Surface Water Quality of the Intersecting Rivers/Estuarine

S. No	Parameters	Unit	SW 4 River water 7/5/2017		SW 5 River water 7/5/2017			SW 6 River water 7/5/2017			Tolerance Limit IS:2296
			D/s	U/s	D/s	Centre	U/s	D/s	Centre	U/s	
1	pH	-	6.96	6.88	7.48	7.43	7.45	6.98	6.92	6.84	6.9-9.0
2	Temperature	°C	33	32	32	32	32	33	33	33	4
3	D.O	mg/l	5.1	5.4	5.6	5.8	5.9	6.1	6.2	6.3	-
4	TSS	mg/l	12	10	10	8	8	14	12	12	-
5	TDS	mg/l	224	207	198	232	194	3260	3310	3430	1500
6	Conductivity	µmhos/cm	360	332	305	368	295	4900	5012	5500	-
7	Turbidity	NTU	5	3	4	3	3	8	6	7	5
8	Alkalinity as $CaCO_3$	mg/l	120	114	120	120	108	160	280	128	200
9	Total Hardness (as $CaCO_3$)	mg/l	80	120	120	120	120	952	1040	1042	300
10	Calcium(as Ca^{2+})	mg/l	19	33.6	25.6	25.6	20.6	112	96	96	75
11	Magnesium (as Mg^{2+})	mg/l	7.8	8.6	13.6	13.6	16.64	164	194	194	-
12	Nitrate(as NO_3)	mg/l	0.12	0.14	0.26	0.23	0.21	1.79	1.95	1.65	50
13	Chlorides (as Cl)	mg/l	62	54	54	78	52	2560	2480	2552	600
14	Sulphate (as SO_4)	mg/l	8.9	6.5	15.6	16.8	19.5	228	224	210.6	400
15	Fluoride (as F)	mg/l	0.52	0.44	0.29	0.3	0.25	1.42	1.36	1.29	1.5
16	Oil & Grease	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
17	Phenolic Compound (as C_6H_5OH)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005
18	BOD	mg/l	22	18	18	16	14	11	9	9	30
19	COD	mg/l	72	64	60	56	50	44	36	36	-
20	Arsenic	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.2
21	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	No Relaxation
22	Lead	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
23	Cadmium (as Cd)	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.01
24	Chromium (as Cr+6)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	0.076	0.072	0.069	0.05
25	Copper (as Cu)	mg/l	<0.02	<0.02	0.065	0.062	0.053	<0.02	<0.02	<0.02	1.5
26	Zinc (as Zn)	mg/l	0.035	0.036	0.045	0.041	0.038	0.066	0.063	0.065	1.5
27	Selenium (as Si)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05
28	Iron (as Fe)	mg/l	0.152	0.149	0.525	0.519	0.518	0.119	0.111	0.115	1
29	Sodium	mg/l	23.5	25.6	42.2	44.2	16.3	21.4	26.8	24.9	-
30	Potassium	mg/l	6.9	7.9	18.5	18.6	19.3	8.6	8.5	7.2	-
31	Total Coli form	MPN/100ml	6600	6400	4400	4200	4000	3400	3200	3000	5000

Source: Study Team

Table 4.13.2 (iii): Results of Surface Water Quality of the Intersecting Rivers/Estuarine

S. No.	Parameters	Unit	SW 7 River Water 8/5/2017		SW 8 River Water 8/5/2017		SW 9 River Water 9/5/2017			Tolerance Limit IS:2296
			D/s	Centre	D/s	U/s	D/s	Centre	U/s	
1	pH	-	7.95	7.66	8.233	8.201	7.05	6.95	6.98	6.9-9.0
2	Temperature	ºC	36	36	36	36	31	34	31	4
3	D.O	mg/l	5	5.2	4.8	5	4.9	5.1	5.2	-
4	TSS	mg/l	12	11	38	32	42	32	27	-
5	TDS	mg/l	298	312	221	216	234	228	243	1500
6	Conductivity	µmhos/cm	475	492	342	336	365	368	378	-
7	Turbidity	NTU	3	2	12	12	19	16	16	5
8	Alkalinity as $CaCO_3$	mg/l	160	168	132	140	144	140	144	200
9	Total Hardness (as $CaCO_3$)	mg/l	140	140	312	320	132	136	140	300
10	Calcium(as Ca^{2+})	mg/l	20.8	25.6	30	32	19.2	22.4	20.8	75
11	Magnesium (as Mg^{2+})	mg/l	21.38	18.46			20.4	19.44	21.38	-
12	Nitrate(as NO_3)	mg/l	0.59	0.65	0.21	0.16	1.54	1.65	1.42	50
13	Chlorides (as Cl)	mg/l	44	48	40	44	54	56	60	600
14	Sulphate (as SO_4)	mg/l	55.6	57.6	8.9	9.2	5.9	6.7	5.9	400
15	Fluoride (as F)	mg/l	1.46	1.36	1.48	1.32	0.64	0.62	0.61	1.5
16	Oil & Grease	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
17	Phenolic Compound (as C_6H_5OH)	mg/l	<0.001	<0.001	<0.005	<0.005	<0.001	<0.001	<0.001	0.005
18	BOD	mg/l	21	19	29	27	16	18	14	30
19	COD	mg/l	72	64	124	116	44	42	40	-
20	Arsenic	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.2
21	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	No Relaxation
22	Lead	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
23	Cadmium (as Cd)	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.01
24	Chromium (as Cr+6)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
25	Copper (as Cu)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.5
26	Zinc (as Zn)	mg/l	0.142	0.141	0.029	0.026	0.0.041	0.039	0.038	1.5
27	Selenium (as	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05
28	Iron (as Fe)	mg/l	0.165	0.162	0.295	0.278	1.396	1.393	1.392	1
29	Sodium	mg/l	52.2	54.2	32.2	36.3	23.5	24.6	25.6	-
30	Potassium	mg/l	28.5	28.6	8.5	9.3	6.9	7.6	7.9	-
31	Total Coli form	MPN/100 ml	8600	8400	9300	8600	6000	5600	5200	5000

Source: Study Team

Table 4.13.2 (iv): Results of Surface Water Quality of the Intersecting Rivers/Estuarine

S. No.	Parameters	Unit	SW 10 River Water 9/5/2017			SW 11 Sea Water 10/5/2017			Tolerance Limit IS:2296
			D/s	Centre	U/s	D/s	Centre	U/s	
1	pH	-	8.22	8.16	8.09	7.56	7.42	7.34	6.9-9.0
2	Temperature	°C	32	30	31	33	31	31	4
3	D.O	mg/l	5.2	5.3	5.4	4.9	5.1	5.3	-
4	TSS	mg/l	12	10	10	26	24	26	-
5	TDS	mg/l	202	194	218	177	184	188	1500
6	Conductivity	µmhos/cm	306	301	348	275	286	285	-
7	Turbidity	NTU	3	2	2	12	11	11	5
8	Alkalinity as $CaCO_3$	mg/l	160	144	148	106	100	104	200
9	Total Hardness (as $CaCO_3$)	mg/l	124	140	140	120	100	108	300
10	Calcium(as Ca^{2+})	mg/l	25.6	25.6	24	27	26	24	75
11	Magnesium (as Mg^{2+})	mg/l	14.5	18.5	19.44	12.75	8.51	11.66	-
12	Nitrate(as NO_3)	mg/l	0.29	0.32	0.25	0.26	0.25	0.24	50
13	Chlorides (as Cl)	mg/l	42	44	48	42	38	38	600
14	Sulphate (as SO_4)	mg/l	9.9	10.2	8.5	5.9	5.8	5.4	400
15	Fluoride (as F)	mg/l	1.89	1.85	1.82	0.39	0.35	0.33	1.5
16	Oil & Grease	mg/l	<0.003	<0.003	<0.003	<0.03	<0.03	<0.03	0.03
17	Phenolic Compound (as C_6H_5OH)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005
18	BOD	mg/l	24	22	20	22	21	20	30
19	COD	mg/l	76	72	68	76	72	72	-
20	Arsenic	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.2
21	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	No Relaxation
22	Lead	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
23	Cadmium (as Cd)	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.01
24	Chromium (as Cr+6)	mg/l	<0.02	<0.02	<0.02	0.076	0.072	0.078	0.05
25	Copper (as Cu)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.5
26	Zinc (as Zn)	mg/l	0.038	0.039	0.037	0.034	0.032	0.03	1.5
27	Selenium (as Si)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05
28	Iron (as Fe)	mg/l	0.117	0.116	0.114	1.358	1.356	1.351	1
29	Sodium	mg/l	52.2	54.2	56.3	32.5	34.6	35.6	-
30	Potassium	mg/l	18.5	18 .6	19.3	15.2	9.6	9.9	-
31	Total Coli form	MPN/100ml	4400	4200	4000	8000	7200	6600	5000

Source: Study Team

Table 4.13.2 (v): Results of Surface Water Quality of the Intersecting Rivers/Estuarine

S. No.	Parameters	Unit	SW 12 River Water 10/5/2017			SW 13 River Water 11/5/2017			Tolerance Limit IS:2296
			D/s	Centre	U/s	D/s	Centre	U/s	
1	pH	-	8.32	8.28	8.25	7.28	7.26	7.2	6.9-9.0
2	Temperature	°C	32	31	32	29	30	30	4
3	D.O	mg/l	4.9	5.1	5.2	4.8	5.1	5.2	-
4	TSS	mg/l	8	7	7	26	22	20	-
5	TDS	mg/l	248	242	266	309	302	368	1500
6	Conductivity	µmhos/cm	388	379	412	482	476	578	-
7	Turbidity	NTU	3	2	2	10	9	8	5
8	Alkalinity as $CaCO_3$	mg/l	180	176	172	160	150	200	200
9	Total Hardness (as $CaCO_3$)	mg/l	160	154	150	160	140	220	300
10	Calcium(as Ca^{2+})	mg/l	33.6	32	35.2	48	40	24	75
11	Magnesium (as Mg^{2+})	mg/l	18.46	18	15.06	27.2	24.3	47.62	-
12	Nitrate(as NO_3)	mg/l	0.56	0.52	0.48	23.5	22.6	21.9	50
13	Chlorides (as Cl)	mg/l	46	44	48	90	85	130	600
14	Sulphate (as SO_4)	mg/l	24.5	22.5	19.6	25.6	32.5	29.5	400
15	Fluoride (as F)	mg/l	0.68	0.62	0.59	0.98	0.92	0.89	1.5
16	Oil & Grease	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
17	Phenolic Compound (as C_6H_5OH)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005
18	BOD	mg/l	23	22	18	22	20	19	30
19	COD	mg/l	76	70	66	74	68	64	-
20	Arsenic	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.2
21	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	No Relaxation
22	Lead	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
23	Cadmium (as Cd)	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.01
24	Chromium (as Cr+6)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
25	Copper (as Cu)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.5
26	Zinc (as Zn)	mg/l	0.033	0.032	0.031	0.036	0.035	0.032	1.5
27	Selenium (as Si)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05
28	Iron (as Fe)	mg/l	0.137	0.136	0.125	0.11	0.1	0.09	1
29	Sodium	mg/l	88.53	64.5	65.2	32.2	34.2	36.3	-
30	Potassium	mg/l	22.5	18.6	17.6	8.5	8.6	9.3	-
31	Total Coli form	MPN/100ml	6600	6000	6400	6200	6000	5900	5000

Source: Study Team

Table 4.13.3 (i): Results of Ground Water Quality in the Project Area

S. No	Parameters	Unit	IS-10500:2012 Desirable Limit	IS-10500:2012 Permissible Limit	GW1	GW2	GW3	Test Method
1	Color	Hazen	5	15	<5	<5	<5	IS: 3025(Pt-4) 1983, Reaff. 2002
2	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	IS: 3025(Pt-5) 1983, Reaff. 2002
3	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	IS: 3025(Pt-8)-1984, Reaff. 2002
4	Turbidity	NTU	1	5	<1	<1	<1	IS 3025(Part-10): 1984, RA 2006
5	pH	-	6.5-8.5	No Relaxation	7.97	7.27	8.21	IS: 3025(Pt-11)1983, Reaff. 2002
6	Total Hardness (as $CaCO_3$)	mg/l	200	600	82	260	104	IS 3025(Part-21): 2009
7	Iron (as Fe)	mg/l	0.3	No Relaxation	0.192	0.212	0.165	3500-Fe- B, APHA 22nd Ed. 2012
8	Chlorides (as Cl)	mg/l	250	1000	52	95	42.5	IS 3025(Part-32): 1988
9	Fluoride (as F)	mg/l	1	1.5	0.48	0.15	0.58	APHA 21st Ed., 4500F(D)
10	TDS	mg/l	500	2000	317	532	332	IS 3025(Part-16): 1984, RA 2006
11	Calcium (as Ca^{2+})	mg/l	75	200	14.4	39	16	IS 3025(Part-40): 1991, RA 2003
12	Magnesium (as Mg^{2+})	mg/l	30	100	11.18	39.48	15.5	3500- Mg B, APHA 22nd Ed. 2012
13	Sulphate (as SO_4)	mg/l	200	400	12.9	67.5	30.5	IS 3025(Part-24):1986, RA 2003
14	Nitrate (as NO_3)	mg/l	45	No Relaxation	6.2	21.6	2.56	IS: 3025(Pt-34)1988, Reaff. 2003
15	Residual Free Chlorine	mg/l	0.2	1	<0.1	<0.1	<0.1	4500-Cl-B, APHA 22nd Ed. 2012
16	Chromium (as Cr+6)	mg/l	0.05	No Relaxation	<0.01	<0.01	<0.01	IS 3025(Part-52): 2003
17	Alkalinity as CaCO3	mg/l	200	600	192	240	200	IS 3025(Part-23): 1986 , RA 2003

S. No	Parameters	Unit	IS-10500:2012		GW1	GW2	GW3	Test Method
			Desirable Limit	Permissible Limit				
18	Aluminum (as Al)	mg/l	0.03	0.2	<0.03	<0.03	<0.03	IS 3025(Part-55): 2003
19	Arsenic	mg/l	0.05	No Relaxation	<0.005	<0.005	<0.005	3110- B, APHA 22nd Ed. 2012
20	Mercury	mg/l	0.001	No Relaxation	<0.001	<0.001	<0.001	

Source: Study Team

Table 4.13.3 (ii): Results of Ground Water Quality in the Project Area

S. No.	Parameters	Unit	IS-10500:2012		GW4	GW5	Test Method
			Desirable Limit	Permissible Limit			
1	Color	Hazen	5	15	<5	<5	IS: 3025(Pt-4) 1983, Reaff. 2002
2	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	IS: 3025(Pt-5) 1983, Reaff. 2002
3	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	IS: 3025(Pt-8)-1984, Reaff. 2002
4	Turbidity	NTU	1	5	<1	<1	IS 3025(Part-10): 1984, RA 2006
5	pH	-	6.5-8.5	No Relaxation	7.24	7.94	IS: 3025(Pt-11)1983, Reaff. 2002
6	Total Hardness (as $CaCO_3$)	mg/l	200	600	408	108	IS 3025(Part-21): 2009
7	Iron (as Fe)	mg/l	0.3	No Relaxation	0.12	0.131	3500-Fe- B, APHA 22nd Ed. 2012
8	Chlorides (as Cl)	mg/l	250	1000	1556	82	IS 3025(Part-32): 1988
9	Fluoride (as F)	mg/l	1	1.5	0.36	0.42	APHA 21st Ed., 4500F(D)
10	TDS	mg/l	500	2000	7.24	7.94	IS 3025(Part-16): 1984, RA 2006
11	Calcium (as Ca^{2+})	mg/l	75	200	408	108	IS 3025(Part-40): 1991, RA 2003
12	Magnesium (as Mg^{2+})	mg/l	30	100	0.12	0.131	3500- Mg B, APHA 22nd Ed. 2012
13	Sulphate (as SO_4)	mg/l	200	400	1556	82	IS 3025(Part-24):1986, RA 2003
14	Nitrate (as NO_3)	mg/l	45	No Relaxation	0.36	0.42	IS: 3025(Pt-34)1988, Reaff. 2003
15	Residual Free Chlorine	mg/l	0.2	1	<0.1	<0.1	4500-Cl-B, APHA 22nd Ed. 2012
16	Chromium (as Cr+6)	mg/l	0.05	No Relaxation	<0.01	<0.002	IS 3025(Part-52): 2003
17	Alkalinity as CaCO3	mg/l	200	600	220	224	IS 3025(Part-23): 1986 , RA 2003
18	Aluminum (as Al)	mg/l	0.03	0.2	<0.03	<0.02	IS 3025(Part-55): 2003
19	Arsenic	mg/l	0.05	No Relaxation	<0.005	<0.005	3110- B, APHA 22nd Ed. 2012
20	Mercury	mg/l	0.001	No Relaxation	<0.001	<0.001	

Source: Study Team

Table 4.13.4: Indian Standards/Specifications for Drinking Water IS: 10500-1991(2012)

S. No.	Substances or Characterstic Max.	Requirement (Desirable limit)	Undesirable effects outside the desirable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS:3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Essential Characteristics						
1	Colour, Hazen unit	5	Above, consumer acceptance decreases	25	4 of 3025, 1983	Extended upto 25 only if toxic substances are not suspected in absence of alternate source
2	Odour	-	Unobjectionable	-	5 of 3025, 1983	(a) Test cold and when heated (b) Test at several dilutions
3	Taste	-	Agreeable	-	-	Test to be conducted only after safety has been established
4	Turbidity, NTU	5	Above, consumer acceptance decreases	10	8	-
5	pH Value	6.5-8.5	Beyond this range the water will affect the mucous membrane and/or water supply system	No relaxation	8	-
6	Total hardness, as $CaCo_3$, mg/L	300	Encrustation on water supply structure and advere effects on dometic use	600	-	-
7	Iron (as Fe), mg/L	0.3	Beyond this limit, taste/appearance are affected, has adverse effect on domestic uses and water supply structures & promotes iron bacteria	1.0	32 of 3025, 1964	-
8	Chlorides (as Cl), mg/L	250	Beyond this limit, taste, corrosion and palatability are affected	1000	32 of 3025, 1988	-
9	Residual free chlorine, mg/L	0.2	-	-	26 of 3025, 1986	To be applicable only when water is chlorinated Tested at consumer end, when protection against viral infection is required, it should be min. 0.5 mg/L
Desirable Characteristics						
10	Dissolved solids, mg/L	500	Beyond this palatability decrease and may cause gastrointestinal irritation	2000	16 of 3025, 1984	-
11	Calcium (as Ca), mg/L	75	-	200	40 of 3025, 1984	-
12	Copper (as Cu), mg/L	0.05	Astringent, taste discoloration of pipes, fitting and utensils will be caused beyond this	1.5	36 of 3025, 1964	-
13	Manganese (as Mn), mg/L	0.1	Astringent taste,	0.3	35 of 3025, 1964	-
14	Sulphates (as SO_4), mg/L	200	Beyond this causes gastro intestinal irritation when magnesium or sodium are present	400	24 of 3025, 1986	May be extended upto 400 provided (as Mg) does not exceed 30 mg/L
15	Nitrates (as NO_3), mg/L	45	Beyond this methaemoglobine-mia	100	-	-

			takes place			
16	Fluoride (as F), mg/L	1.0	Fluoride may be kept as low as possible. High fluoride may cause fluorosis	1.5	23 of 3025, 1964	-
17	Phenolic substances, mg/L (as C_6H_5OH)	0.001	Beyond this, it may cause objectionable taste and odour	0.002	54 of 3025, 1964	-
18	Mercury (as Hg), mg/L	0.001	Beyond this, the water becomes toxic	No relaxation	See note mercury ion analyzer	To be tested when pollution is suspected
19	Cadmium (as Cd), mg/L	0.01	Beyond this, the water becomes toxic	No relaxation	See note mercury ion analyzer	To be tested when pollution is suspected
20	Selenium (as Se), mg/L	0.01	Beyond this, the water becomes toxic	No relaxation	28 of 3025, 1964	To be tested when pollution is suspected
21	Arsenic (as As), mg/L	0.05	Beyond this, the water becomes toxic	No relaxation	37 of 3025, 1988	To be tested when pollution is suspected
22	Cyanide (CN), mg/L	0.05	Beyond this, the water becomes toxic	No relaxation	27 of 3025, 1986	To be tested when pollution is suspected
23	Lead (Pb), mg/L	0.05	Beyond this, the water becomes toxic	No relaxation	Refer note 86	To be tested when pollution plumbosolvency is suspected
24	Zinc (as Zn), mg/L	5	Beyond this limit it can cause astringent taste and an opalescence in water	15	30 of 3025, 1964	To be tested when pollution is suspected
25	Anionic detergents, mg/L as MBAS)	0.2	Beyond this limit, it can cause a light froth in water	1.0	Methylene blue extraction method	To be tested when pollution is suspected
26	Chromium (as Cr^{+6}), mg/L	0.01	May be carcinogenic above this limit	0.05	28 of 3025, 1964	To be tested when pollution is suspected
27	Polynuclear aromatic hydrocarbons (as PAH), mg/L	-	May be carcinogenic	-	-	-
28	Mineral oil, mg/L	0.01	Beyond this limit undesirable taste and odour	0.03	Gas chromato-graphic method	To be tested when pollution is suspected
29	Pesticides, mg/L	Absent	Toxic	0.001	58 of 3025, 1964	-
30	Radioactive materials	-	-			
	(a) Alpha emitters Bq/L	-	-	0.1	-	-
	(b) Beta emitters pci/L	-	-	1.0	-	-
31	Alkalinity (as $CaCO_3$), mg/L	200	Beyond this limit, taste becomes unpleasant	600	13 of 3025, 1964	-
	Aluminium (as Al), mg/L	0.03	Cumulative effect is reported to casuse dementia	0.2	31 of 3025, 1964	
	Boron (as B), mg/L	1	-	5	29 of 3025, 1964	

Source: CPCB

Table 4.13.5: Indian Standards for Industrial and Sewage Effluents Discharge IS: 2490-1982

S. No.	Parameters	Industrial Effluent			
		Into Inland Surface Water	**On land for Irrigation**	**Into Marine Coastal Area**	**Into Public Sewers**
1	Colour/Odour	-	-	-	-
2	Suspended Solids, mg/l	100	200	100 (For process waste)	600
3	Particulate Size Suspended Solids	Shall pass 850 microns IS sieve	-	Floatable Solids Max 3mm Settleable Solids Max 850 microns	-
4	Dissolved Solids (inorganic) mg/l, Max.	2100	2100	-	2100
5	pH Value	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
6	Temperature ^{0}C	Shall not exceed 40 in any section of the stream within 15 mts downstream from the effluent outlet	-	45 at the point of discharge	-
7	Oil & Grease, mg/l, Max.	10	10	20	20
8	Total residual Chlorine, mg/l, Max.	1	-	1	-
9	Ammonical Nitrogen (as N) mg/l, Max.	50	-	50	50
10	Total Kjeldahl Nitrogen (as N) mg/l, Max.	100	-	100	-
11	Free Ammonia (as NH_3) mg/l, Max.	5	-	5	-
12	Biochemical Oxygen Demand (5 Days at $20^{0}C$), Max.	30	100	100	350
13	Chemical Oxygen Demand, mg/l, Max.	250	-	250	-
14	Arsenic (as As), mg/l, Max.	0.2	0.2	0.2	0.2
15	Mercury (as Hg), mg/l, Max.	0.01	-	0.01	0.01
16	Lead (as Pb), mg/l, Max.	0.1	-	1.0	1.0
17	Cadimium (as Cd), mg/l, Max.	2	-	2	1
18	Hexavalent Chromium (*as Cr6+), mg/l, Max.	0.1	-	1	2
19	Total Chromium (as Cr) mg/l, Max.	2	-	2	2
20	Copper (as Cu), mg/l, Max.	3	-	3	3
21	Zinc (as Zn), mg/l, Max.	5	-	15	15
22	Selenium (as Se), mg/l, Max.	0.05	-	0.05	0.05
23	Nickel (as Ni), mg/l, Max.	3	-	5	3
24	Boron (as B), mg/l, Max.	2	2	-	2
25	Percent Sodium, Max.	-	60	60	-
26	Residual Sodium Carbonate, mg/l, Max.	-	50	-	-
27	Cyanide (as CN), mg/l, Max.	0.2	0.2	0.2	0.2
28	Chloride (as Cl), mg/l, Max.	1000	600	-	1000
29	Fluoride (as F), mg/l, Max.	2	-	15	15
30	Dissolved Phosphate (as P), mg/l, Max.	5	-	-	-
31	Sulphate (as SO_4), mg/l, Max.	1000	1000	-	1000
32	Sulphide (as S), mg/l, Max.	2	-	5	-
33	Phenolic Compounds (as C_6H_5OH), mg/l, Max.	1	-	5	6
34	Radioactive materials				
	(a) Alpha emitters µc/ml, Max.	10^{-7}	10^{-8}	10^{-7}	10^{-7}
	(b) Beta emitters µc/ml, Max.	10^{-6}	10^{-7}	10^{-6}	10^{-6}
35	Manganese (as Mn), mg/l	2	2	-	2

36	Iron (as Fe), mg/l	3	3	-	3
37	Vandium (as V), mg/l	0.2	-	0.2	0.2
38	Nitrate Nitrogen, mg/l	18	20	-	0.2

Source: CPCB

Annexure 4.14

4. 14 BOTTOM SEDIMENT

(1) Introduction

Sediments form a natural buffer and filter system and often play an important role in the storage and release of nutrients in the aquatic ecosystems. Pollution of the environment is reflected by levels of contamination of estuary, rivers, lakes and other reservoirs. There are sites of accumulation of impurities coming from human activity, due to dissolution, precipitation and adsorption (Abdel-Satar, 2010). Sediments can also be defined as the material deposited at the bottom of rivers, which are silt and deposits (Davies. O. A. *et al*, 2009). During the last two centuries, heavy metals released by human activities have superimposed new pattern of metal distribution on those which are naturally occurring. Heavy metals are widely used in automobiles, mining industries, pesticides, house-holds appliances, dental amalgams, paints, photographic papers, photo chemicals *etc*. (Lohani *etal*. 2008). A number of processes influence the sedimentary content and quality of estuary/river water. Sediments in water originate from surface erosion and contain mineral, bedrock erosion and organic components during the process of soil formation (Mohd Khairul Amri Kamarudin *et al.*2009). Sediment has important role in the nutrient cycle of aquatic environment. Sediment analysis is increasingly important in evaluating qualities of the total ecosystem of a water body, in addition to the water sample analysis practiced for years. (O. K. Adeyemo *et al*. 2008).

In rivers the predominant source of bottom sediments is land runoff. Impoundments and estuaries are often characterized by heavy siltation from tributary streams. In fertile lakes and swamps, the sediment may be largely composed of decaying vegetation, *i.e*., humus.

a) Study Area

There are two major river basins in the study area - Narmada and Tapi Basins (earlier known as Tapti) and both lie in Gujarat. Most of the nallah's and rivers that intersect the alignment are the tributaries of Narmada and Tapi basins except a few. Geologically, the river bed and the adjoining regions are part of the Paleogene sedimentary rocks of Maharashtra, consisting of hard, undulating laterite and basalt formations with scattered laterite and Alluvial plain cover of varying thickness along the MAHSRC alignment falling in Maharashtra. The stretch of the proposed alignment falling in Gujarat is covered by the alluvial plain.

The water bodies along the proposed alignment were identified. These can be broadly classified in flowing water resources (rivers, estuaries, creeks, nallah's *etc*.) and stagnant water resources (pond, lakes *etc*.).

It is necessary to know the existing geochemical characteristics of the bottom sediment of the surface water bodies as during the construction phase, foundation of the piers/well shall be constructed in the crossing rivers/estuaries which may cause some disturbance.

b) Sediment Sampling and Analysis

In the light of above, the bottom sediment samples were collected in zip-lock polythene bags from 13 selected sites (ten samples from each sampling site) during the month of May 2017 (pre-monsoon season). The collected sediment samples were first air dried at room temperature, then crushed using a porcelain mortar and pestle and then sieved for further analysis (Saha S.B. *et al*. 2001; Dalai *et al.* 2004). The organic carbon content was determined by following Walkley and Black’s method, Chloride by titrimetric method using silver nitrate and pH by electrometric method (in 1:5 soil suspension) (Trivedi and Goel,1986). The concentration of potassium was determined by flame photometer. Other nutrient based parameters *i.e.* available phosphate, sulphate and total nitrogen were estimated using standard methods of APHA (1987), and Trivedi and Raj (1996).

The sediment samples were analyzed for physico-chemical and nutrient parameters and heavy metals *viz*; Lead (Pb), Nickel (Ni), Copper (Cu) and Zinc (Zn) using the Inductive Coupled Plasma Spectrometer (ICP-MS). The selected sampling locations are described in Table 4.14.1 and shown in Exhibit 4.14.1 (Refer Section 4.13.-Water Quality).

c) Results and Discussion

Physico-Chemical and Nutrients

The variation in physico-chemical and nutrient parameters of sediments at all the sampling sites are summarized in Table 4.14.1 and discussed in the subsequent paragraphs.

Table 4.14.1: Mean Value of Physico-chemical Parameters at each Sampling Station

Locations	Parameters							
	pH	OC (%)	OM (%)	K (mg/g)	Cl (mg/g)	SO_4 (mg/g)	TN (mg/g)	PO_4 (mg/g)
SW1-Ulhas	7.52	2.172	1.025	20.10	0.160	0.240	0.520	0.234
SW2-Vaitarna	7.75	0.370	0.625	30.67	0.142	0.024	0.784	0.030
SW3-Damanganga	6.85	0.621	0.936	31.20	0.194	0.020	0.774	0.246
SW4-Kolak	6.95	0.556	0.925	30.10	0.182	0.018	0.756	0.241
SW5-Par	7.62	0.276	0.675	35.64	0.162	0.006	0.652	0.220
SW6-Ghadvi	6.91	0.651	0.924	28.69	0.176	0.015	0.711	0.241
SW7-Ambica	7.73	0.245	0.543	31.55	0.132	0.010	0.548	0.209
SW8-Purna	8.34	0.372	0.652	41.05	0.143	0.007	0.160	0.154
SW9-Mindhol	7.01	0.530	0.856	28.61	0.165	0.012	0.659	0.212
SW10-Tapi	8.155	0.380	0.756	42.53	0.154	0.009	0.170	0.190
SW11-Mahi	7.45	0.280	0.680	34.53	0.168	0.008	0.725	0.224
SW12-Narmada	8.32	1.126	0.645	40.25	0.145	0.008	0.165	0.189
SW13-Sabarmati	7.05	0.541	0.933	29.23	0.172	0.011	0.717	0.231
OC: Organic Carbon, OM: Organic Matter, K: Potassium, Cl: Chloride, SO_4: Sulphate, TN: Total Nitrogen, PO_4: Available Phosphate								

Source: Study Team

On perusal of the Table 4.14.1 following conclusion can be drawn. The Organic Carbon content in river sediments is a key component in a number of chemical, physical and biological processes and contributes significantly to acidity through formation of organic acids. The mean values of organic carbon content in the sediments varied between 0.245% at SW7 to 2.172% at SW1. The highest concentration of organic carbon was reported in the Ulhas estuary. Natural processes and human activities have resulted in elevated content of organic carbon in soil, sediment and streams. These include diverse input from inappropriate animal waste applications and disposals, forest clear cuttings, agricultural practices and changes in land uses.

The organic matter in lotic system includes fresh and detritus phytoplankton and contribution from heterotrophic processes like sloppy feeding and defecation by zooplanktons and bacterial biomass. The highest value of % organic matter was recorded as

1.025% at SW 1, whereas the lowest value of 0.543% was recorded at SW7 in the study area. A higher value of organic matter at SW 1 might be due to deposition and decomposition of macrophytes whereas the concentration observed in Sabarmati could be attributed to organic matter from the industrial and municipal wastewater *i.e.* anthropogenic inputs in aquatic system. Further pH did not show any significant variation among the variouslocations, but the values varied spatially and ranged between 6.91 at SW6 to 8.34 at SW8.

The fertility and biodiversity in an aquatic system is greatly influenced by nitrogen concentration of the sediment. It is one of the critical limiting factors to algal growth and eutrophication in many water bodies. In the present study the concentration of total nitrogen varied from 0.160 mg/g (SW8) to 0.784 mg/g (SW2). The high nitrogen value might be due to the dissipation from agricultural runoff and also due to low adhesion of nitrates to inorganic contents of sediments. The concentration of total nitrogen was the highest during May 2017 at SW2-Vaitarna estuary *i.e.* 0.784 mg/g which could be attributed to oxidation of organic matter which has settled on the top layer of sediment.

Phosphorous is a second key nutrient found in the soil. Phosphorous content of water in aquatic systems is greatly influenced by bottom sediments. Sediments often play an important role in the uptake, storage and release of dissolved inorganic phosphorous in aquatic systems. The available phosphate content varied between 0.030 mg/g to 0.246 mg/g. Addition of fertilizers from agricultural runoff, sewage contaminated storm water outfalls and other anthropogenic activities such as use of detergents, bathing; cattle wading *etc*. contribute to high levels of phosphate in river sediments.

Potassium is yet another major nutrient required for plant growth apart from nitrogen and phosphorous. The potassium content was minimum at SW1 *i.e.* 20.10 mg/g and maximum at SW10 *i.e.* 42.53 mg/g.

Chloride is one of the essential micronutrients. It is added to the sediments from animal manures, fertilizers, plant residue and other organic matter. Measurement of Chloride in sediment provides information on salinity problems. In the present study the concentration of chloride was the highest at SW3-Damanganga. The higher values could be attributed to the high rate of evaporation of water during summer season which resulted in the deposition of salts in the bottom sediments.

Elemental Pollution

The variation in heavy metal concentration of sediments at all the sampling sites are summarized in Table 4.14.2 and discussed in the subsequent paragraphs.

The concentration of Copper ranged between 4.6-178.2 mg/kg. The highest concentration of Cu was recorded at SW10-Tapi River. The values were lower than the prescribed guidelines of Interim Sediment Quality Guidelines *(ISQGS)* for the protection of aquatic life (*permissible limit 35.7mg/kg)* at SW3, SW4, SW5, SW6, SW7, SW8, SW9 and SW13. Whereas the concentration of Cu at SW1, SW2, SW10, SW11 and SW12 exceeded the ISQG's permissible limit and varied between 85.4-178.2 mg/kg.

Nickel is suspected to be essential trace elements for plants as well as for animals and used principally in its metallic form combined with other metals and nonmetals as alloys. Nickel ranged between 0.01-245.1 mg/kg. Metals such as chromium, copper, and nickel have interacted with organic matter in aqueous phase and settled to the bottom, resulting in a high concentration of these metals in the sediment.

Zinc was the second most abundant in sediments and its concentration ranged from 9.8-240.1 mg/kg. The highest value of Zn concentration was recorded at Narmada estuary near Bharuch and the lowest at Par. As SW12 is surrounded by many agricultural farms, the higher concentration of Zinc in sediment may be attributed to the presence of unused remains of Zinc Sulphate in fertilizers.

The concentration of lead was found in the range of 2.5 -156.2 mg/kg. The maximum concentration observed was 156.2 mg/kg at SW10 Tapi River while the lowest concentration observed was 2.5 mg/kg at SW4 Kolak River. The values obtained were below ISQGs value at eight sites *(35.0 mg/kg)*. The lower values of lead might be attributed to less solubility of Pb containing minerals in natural water. Whereas the concentration of Pb at SW1, SW2, SW10, SW11 and SW12 exceeded the ISQGs values and varied between 51.2-156.2 mg/kg.

Table 4.14.2: Mean Value of Heavy metal concentration in Sediments

Location	**Parameter**			
	Pb (mg/kg)	**Ni (mg/kg)**	**Zn (mg/kg)**	**Cu (mg/kg)**
ISQGs Standard value	<35 mg/kg	<52 mg/kg	123mg/kg	<35.7mg/Kg
SW1-Ulhas	55.9	0.02	66.52	99.4
SW2-Vaitarna	51.2	0.01	54.50	85.4
SW3-Damanganga	22.1	0.02	30.0	8.0
SW4-Kolak	2.5	0.04	19.0	8.0
SW5-Par	4.3	0.12	9.8	4.6
SW6-Ghadvi	8.6	0.14	22.5	15.2
SW7-Ambica	5.6	0.04	18.0	7.0
SW8-Purna	3.2	0.01	12.0	5.6
SW9-Mindhol	2.6	0.04	48.0	16.0
SW10-Tapi	156.2	0.06	157.0	178.2
SW11-Mahi	60.6	21.8	52.9	126.9
SW12-Narmada	70.1	245.1	240.1	120.0
SW13-Sabarmati	9.80	10.64	51.07	20.09

Source: Study Team

Annexure 4.15

4.15 ECOSYSTEM

4.15.1 Habitat along the Propoded MAHSR Alignment

Natural environment conditions vary along the MAHSR alignment due to different ecological and ago-climatic variation. The forest areas in Thane District are mostly dry and degraded land and supports very little habitat pattern. Most of these forest areas are under the influence of encroachment and increased human activities. The proposed alignment also passes through the Sanjay Gandhi National Park, Borivali, Tungareshwar Wildlife Sanctuary and Thane Creek Flamingo Sanctuary in Thane District.

(1) Study Area

India has rich diversity of flora and fauna like the diverse culture, religion, climate and soil. The Indian flora and fauna are an eye candy for the nature lovers. Nearly 23.68 per cent of the gross physical area of India is covered under forest. The forest types vary from region to region and each one has some unique features, be flora or fauna, both terrestrial and aquatic, and estuarine ecosystems. The Indian flora and fauna include around 15,000 species of flowering plants, 400 species of mammal, 1250 species of bird, 10,000 species of insect, 2546 species of fish, 197 species of amphibian and 408 reptile species.

(2) Aim of the Study

The ecological study of the area has been conducted in order to understand the status of the existing flora and fauna to generate baseline information and evaluate the probable impacts of MAHSR on the biological environment.

(3) Scope of the Study

It is covered under the following heads/components:

(a) Flora

- To assess the status of major floral components (tree, shrub, herb including grass, mangroves and climber) within the ZOI of the proposed MAHSR alignment;
- Identification, listing and quantification of floral species of conservation significance (RET species) in accordance with WCMC and BSI, and preparation of floral biodiversity index (BDI) for different habits of flora across the habitats/ecosystems of the study area;
- Collection and compilation of secondary information on the status of flora in Reserved (RF) and Protected Forests (PF) located in the study area.

Fauna

- To assess the status of major faunal groups (Butterfly, Amphibian, Reptile, Bird and Mammal) in the ZOI of MAHSR;
- Identification, listing and quantification of fauna of conservation significance (RET species) in accordance with IUCN, CITES, CAMP and Wildlife Protection Act, 1972 of MoEFCC (GOI) in the study area, and preparation of faunal biodiversity index (BDI) across the habits/ecosystems of the study area;
- Collection and compilation of secondary information on the status of fauna in Reserved and Protected Forests located in the study area.

(b) Ecologically-Sensitive Areas (ESAs)

- Identification of ESAs of State/local compliance, such as, Wetland, Community conserved reserve, area of aesthetic values (*e.g.,* sacred groves, temple and archeologically-sensitive area), breeding/nesting colonies of birds existing in the vicinity in the study area;
- Identification of ESAs of National Compliance [*e.g.,* Protected area, National Park, Sanctuary, Biosphere Reserve and Important Bird Area (IBA)] and major Wildlife migratory routes existing in the study area;
- Identification of ESAs of International compliance (*e.g.* Ramsar Site, World heritage site of IUCN) existing in the study area.

(c) <u>Habitat and Mapping</u>

- Preparation of general base map of different habitats/ecosystems of the study area
- Identification and mapping of any bird and wildlife migratory routes/corridors that exist within the study area
- Preparation of map showing spatial distribution of ESAs of Local, State, National and International importance in the study area

(4) Impact Assessment

- Assessment of possible impact of the construction of the proposed MAHSR project and operation of the High-Speed Train;
- Assessment of possible impact on the ecosystem of the study area due to construction and operation of the various facilities like Station and Maintenance Depot *etc*.

(5) Mitigation and Management Plan (MMP)

- Suggest conservation and management plan (CMP) to improve the habitat quality of the stucy area to enhance the overall biodiversity (flora and fauna);
- Suggest Species-specific Biodiversity (Wildlife) Conservation and Management Plan [SSB (W) CMP] for Threatened, Critically-endangered and Endangered faunal species (Schedule-I), if any, reported within the study area of the Local, State, National and International compliance;
- Suggest Biodiversity (Wildlife) Conservation and Management Plan [B (W) CMP] specific to any critical habitat/ecosystem(s) identified to enhance their ecosystem services;
- Provide technical input for the approval of [B (W) CMP] by the concerned State Forest Department Authority.

(6) Approach and Field-Level Methodology of the Study

<u>Macro-Level Approach</u>

(a) <u>Reconnaissance Survey</u>

- Rapid survey of the study site to identify and understand the existing habitats and bio-physical and socio-economic attributes of the study area;
- Interaction with the project proponent to obtain information about the Project and associated activities;
- Determine appropriate sampling locations and sample numbers to study diverse biodiversity components falling under the scope of the study.

(b) <u>Collection of Secondary Data</u>

- Collection and collation of the Project-related secondary information from the Project proponent in the form of base maps, technical reports and EIA Report
- Collection and collation of information related to flora and fauna (occupying different habitats) from the State and Divisional Office of the Forest Department and other stakeholders, and published literature, electronic media, *etc*.

(c) **Delineation of the Study Area**

- Core Zone: Right of Way (ROW) of the proposed MAHSR alignment;
- Buffer Zone: Vicinity area 250 m either side of the core zone (proposed alignment).

Micro-Level Approach

(a) **Collection of Field Data**

- Inventorization of the biodiversity (flora and fauna) in the study area in terrestrial and aquatic ecosystems habitat-wise through actual field surveys
- Interaction with local people, experts and rural development agencies and collection of secondary information from the State Forest Department and published literature to present overall status of biodiversity
- Existing information on the flora and fauna were collected on year-round data, including the monsoon season.

(b) **Flora**

- Collection of primary data through ground surveys for angiospermic plant diversity (tree, shrub, herb, grass and climber) both qualitatively and quantitatively using standard ecological methods and field surveys in different habitats in land and water ecosystems

(c) **Fauna**

(i) Mammals/Primates

- Qualitative and quantitative information about mammalian diversity in the study area using line transect/road count in different habitats;
- Relative abundance of mammalian fauna through 20 m radius plots in each sampling location for indirect evidences, such as, pellets, dung, droppings, scats and other tracks and signs.

(ii) Avifauna

- Assessment of bird diversity in terrestrial and aquatic ecosystems using point count/ perambulation technique and flock count method, respectively,
- Survey of the study area to identify the presence of breeding/nesting sites and roosting sites of the avifauna.

(iii) Herpetofauna

Assessment of the status of reptiles in the study site using Intensive Time Constrained Searth Method in different habitats

(iv) Amphibians

Ground-level search around hedges in the aquatic habitats to study occurrence of amphibians

(v) Butterfly

Qualitatively and quantitative study of butterfly diversity in the study area in diverse habitats following Perambulation technique

(d) <u>RET Species</u>

Identification of RET (Rare, Endangered and Threatened) species of wild plants and animals from the information on biodiversity gathered through field surveys and secondary sources utilizing authorized references, such as, WCMC, BSI, ZSI, WPA, *etc.*

<u>Status of Floral Diversity</u>

- Taxonomical Status, Species Diversity, Importance Value Index, Life-Form Status and Abundance Status (density for common and wild tree species)

<u>Status of Faunal Biodiversity</u>

- Taxonomical status, species diversity (for avifauna), abundance status (for herpatofauna and mammals), and migratory status and foraging guild (for bird species)

<u>Occurrence of RET Species</u>

- Status of RET flora and fauna; Conservation significance of Local, State, National and Global level; Areas of conservation significance, *e.g.*, breeding/nesting sites; flocking/roosting sites of terrestrial and aquatic birds; any critical habitat/ecosystem at local level; and wildlife corridor and linkages

(7) Expected Output of the Study

<u>Status of Floral and Faunal Diversity</u>

- Taxonomical Status, Species Diversity, Importance Value Index, Life-Form Status and Abundance Status (density for common and wild tree species)

(8) Field Surveys

<u>Reconnaissance-Level Surveys</u>

The potential for project impacts on biological resources depends largely on the presence of suitable habitat in and adjacent to areas that would be affected by the project. Reconnaissance-level field surveys involved preliminary data gathering for the purpose of recognizing and identifying resources that warrant additional or more focused surveys (*e.g.,* for special-status plants, as described below). Project ecologist along with scientist conducted these reconnaissance-level field surveys to determine the presence or absence of biological resources, and to document the location of any biological resources through habitat characterization and mapping. All habitat characterization and mapping were done from publically accessible roads along or near the proposed MAHSR alignment. The results of these surveys provided background for the focused special-status plant surveys.Habitattypes identified during the reconnaissance-level field assessments were compared against the known habitat requirements for each special-status plant species with potential to occur in the regional area. The potential for a particular special-status species to occur within the special-status plant species study area was then assessed and ranked as either no potential, future potential, unlikely potential, low potential, moderate potential, or high potential.

(9) Terrestrial Ecosystem

Methodology used for the study of various organisms has been provided under different section of group of species. Species order has been followed of classical evolutionary system, such as, flora, invertebrates and vertebrates. Entire vicinity area of MAHSR alignment was surveyed extensively for socio-economic analysis of human settlements (villages) and biodiversity assessment. Terrestrial and aquatic species are described under respective sections of habits and habitat of the particular species. Biodiversity assessment of MAHSR project area was conducted quantitatively by a team of experts by visiting the area in pre-monsoon season (May 2017) to describe first hand information about flora and fauna along the MAHSR alignment as well as its vicinity area. Using information on geographical locations, the maps were prepared. The present study highlights floristic diversity and the faunal wealth, including ethno-botanical and silvicultural issues, in the study area. Accordingly, for the ecological study, the total area has been sub-divided into habitats as follows:

- Natural vegetation
- Vegetation of the proposed alignment
- Forest area (Protected/Reserved)
- Road side plantation
- Near human habitation
- Agriculture
- Mangrove Ecosystems
- Creek Ecosystems
- Ecosystems of National Parks and Wildlife Sanctuaries

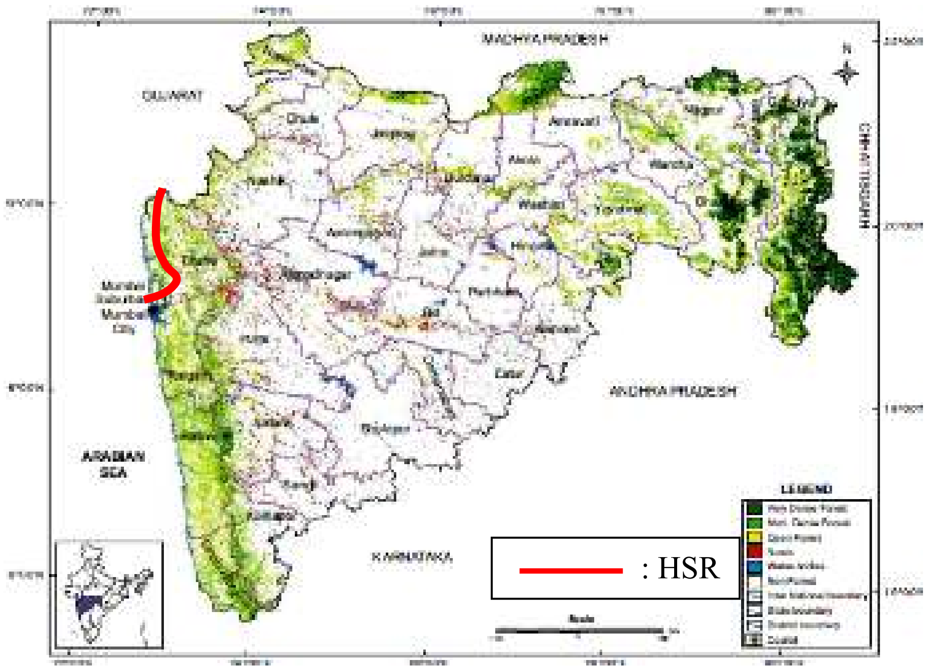
(10) Bio-Geographic Setting and Forest Type-Maharashtra Region

Biogeography is the study of the distribution of living organisms, and the natural processes that affect these distributions. It forms a basis to classify the biosphere into distinct physical and biological entities that contain distinct biotic communities. As every living species is an integral component of some ecosystem or ecosystems, it follows that its conservation is dependent on the survival of those ecosystems or biotic communities. Within the context of the World Conservation Strategy (IUCN, 1980), a system of selecting protected areas on the basis of well-founded biogeographic principles is an important tool for evaluating conservation efforts and for determining priorities for future action.The biogeographic classification developed by the WII (Wildlife Institute of India), Dehradun has recognized 10 broad bio-geographical zones of India. Within these zones, there are 25 biotic provinces. According to the biogeographic classification, the Maharashtra Region of ZOI belongs to 5 A - Malabar Plains. The present coverage of Malabar plains by protected areas in India is only 0.4 per cent against the proposed area of 1.1 % by Wildlife Institute of India, Dehradun in 1988. Looking into the forests of SGNP and TWLS, there is a need to augment the area of SGNP and TWLS by adding the contiguous forest areas which are with the FDCM and the Thane Territorial Division. According to revised forest types (Champion and Seth, 1968) the study area of Maharashtra region, falls in:

- 3 B/C1 Southern moist teak bearing forests;
- 3 B/C2 Southern moist mixed deciduous forests;
- B/TS1 Mangrove scrubs;
- 8 A/C2 Western sub-tropical hill forests.

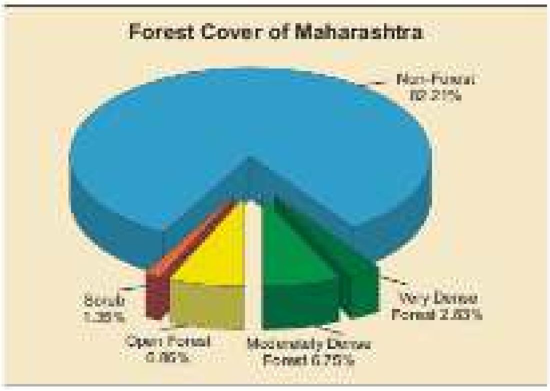
The mangrove vegetation is evergreen with entire leathery leaves. Soft tidal mud submerged by salt water is common. The forest cover map of Maharshtra is shown in Exhibit 4.15.1.

Exhibit 4.15.1: Forest Cover Map of Maharashtra



Source: Forest Survey of India 2013

Figure 4.15.2: Forest Cover of Maharashtra



Source: Forest Survey of India 2013

(11) Bio-Geographic Setting and Forest Type-Gujarat Region

Gujarat holds a unique bio-climatic gradation ranging from dry desert conditions to humid subevergreens, as well as dry hilly scrub lands to dry thorny plains and forests. The state has a wide variety of wild life comprising of about 40 species of mammals and 425 species of birds. The biodiversity in terms of flora and fauna, has been an important component to provide distinctive characters to its various ecosystems. On the basis of geological environment, the ecosystems of Gujarat are grouped into eight major ecoregions as explained in the Table 4.15.1.

Table 4.15.1: Ecoregions of Gujarat

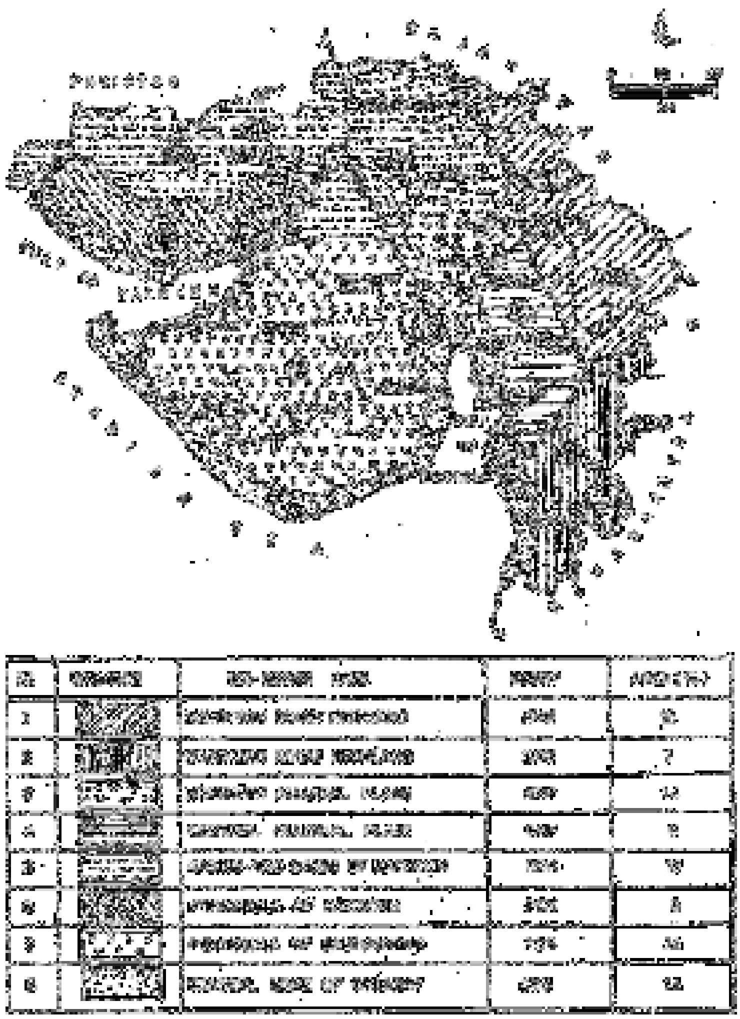
Ecoregion	Eco-Region Name	Abbreviation	Area (%)
1	Northern Rocky Highland	NRH	12
2	Southern Rocky Highland	SRH	7

Ecoregion	Eco-Region Name	Abbreviation	Area (%)
3	Northern Alluvial Plain	NAP	14
4	Central Alluvial Plain	CAP	8
5	Ranns and Banni of Kachchh	RBK	13
6	Penninsula of Kachchh	POK	8
7	Peninsula of Saurashtra	POS	24
8	Coastal Zones of Gujarat	CZG	14

Source: Ecoregions of Gujarat by Gujarat Ecology Commission, Vadodara

As per the categorization of the ecoregions as discussed above, the major stretch of the proposed MAHSR alignment comes under Central Alluvial Plain, Southern Rocky Highland and a little in the Coastal Zones of Gujarat as shown in Exhibit 4.15.3.

Exhibit 4.15.3: Ecoregions of Gujarat

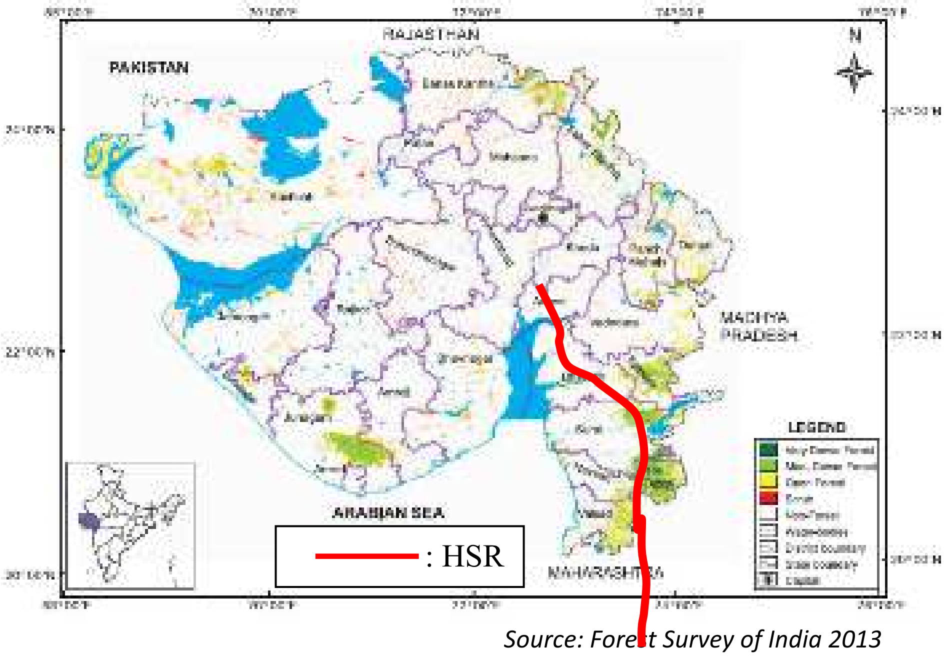


Source: Ecoregions of Gujarat by Gujarat Ecology Commission, Vadodara

Gujarat holds a unique bio-climatic position in the country. It posses several bioclimatic gradations, from dry thorny ecosystems to humid subevergreens and dry hilly scrublands to swamp forests.

The vegetal growth, ranging from typical desert forests plants to moist deciduous forests, is the result of variations in climate, rock type, topography and water regime. Major concentration of forest is observed all along the eastern border as well as the hilly part of Saurashtra, but the plains are mainly devoid of full stocked forest cover. The major types of forests covering about 10 percent area of the state are grouped as (i) tropical moist deciduous, (ii) tropical dry deciduous, (iii) tropical scrub, (iv) dry grassland and (v) littoral and swampy. The forest areas of S Gujarat, Panchmahals, Aravali foothills of NE Gujarat, the Little Rann of Kachchh and the Gir Forest of Saurashtra are the major domains of wild life in the state. The forest cover map of Gujarat is shown in Exhibit 4.15.4.

Exhibit 4.15.4: Forest Cover Map of Gujarat



Source: Forest Survey of India 2013

Exhibit 4.15.5: Forest Cover Area (%) of Gujarat

Source: Forest Survey of India 2013

(11) Sanjay Gandhi National Park (SGNP)

The proposed MAHSR alignment passes through the ecosensitive zone of SGNP and buffer zone of TWLS. In view of the requirement of NBWL clearance, a separate Management and Conservation Plan shall be prepared. Therefore, in this section only brief description of SGNP, TWLS and Thane Creek Flamingo Sanctuary are discussed in the subsequent paras.

This Division falls between longitude 72^0 51’ 49” E to 72^0 58’ 32” E and latitude 19^0 08’ 20” to 19^0 20’ 44” N. SGNP Division is situated partly in Thane District (59.24 Sq.Km.) and in Mumbai Suburban District (44.44 Sq.Km.) of Maharashtra State. Originally, areas of this Division were within Thane Forest Circle. Now this Division is under the administrative control of Additional Principal Chief Conservator of Forest (Wildlife) West Mumbai. The SGNP Division is controlled and managed by Chief Conservator of Forests & Director, SGNP.The total area of this Division is 103.68 sq. km, out of which the notified area of SGNP, hereinafter referred to as SGNP, constitutes 86.96 sq. km. SGNP was declared as a National Park vides Maharashtra Government Resolution No. WLP/1094/ OR 177/F-1 dated 16.01.96. Vasai creek passes through this Division from west to east and divides it into north block (Nagla block) with an area of 16.93 sq. km. and south block with an area of 86.75 sq. km. The entrance/main gate of this park is on Mumbai-Ahmedabad National Highway. There is another approach from Thane but at present this gate (Bhandup gate) is not open for public since it passes through the high security BMC area and the core zone of SGNP. ESZ boundary has been delineated and notified vide Gazette Notification S.O. 3645(E) dated 5th December 2016. The authenticated map of SGNP with MAHSR alignment is shown in Exhibit 4.15.5.

Importance

SGNP Division, a green tract amidst the thickly populated metropolis of Mumbai and Thane, is bestowed with immense biological, ecological, archaeological, environmental, recreational and educational values. These values scale from local to International significance. This area represents unique and fragile ecosystem and it belongs to one of the least represented biogeographic zone*i.e.* Malabar Coast of Western Ghats. No other National Park exists within this bio-geographic zone except SGNP, hence, SGNP is unique. Though the major portion of the park *i.e.* south of Vasai Creek is fragmented, it still harbours high density of leopards. As a true representative of the Northern Malabar coast, this area has vast faunal and floral diversity. The park is home to a number of endangered species of flora and fauna. The forest area of the Park houses large number of plant species, 254 species of migratory, land and water birds, about 50,000 species of insects, 40 species of mammals. In addition, the Park also provides shelter to 38 species of reptiles, 9 species of amphibians and about 150 species of butterflies and a large variety of fishes. It protects the catchments of two lakes *i.e* Tulshi and Vihar; which supply water to Mumbai and Thane.

Environmental Value

As mentioned above, the park is surrounded on all sides by one of the most densely urbanized areas of the world, comprising of the cities of Mumbai and Thane. The Vasai-Virar belt is also rapidly expanding in the North West portion of the SGNP and is contributing to the pressures on SGNP, particularly on the Nagla Block. Despite all these immense pressures, the SGNP still survives, due to the various Orders of the Hon’ble Bombay High Court and the Hon’ble Supreme Court of India and with the whole-hearted support of the nature loving people.The fact that two lakes which supply water to Mumbai and Thane Vihar Lake and Tulsi Lake are located within SGNP. The catchment areas of both these lakes also lie within SGNP, ensuring that the quality of water supplied by both these lakes is unsurpassed anywhere in the country. Besides its role in protecting the water supply of Mumbai and Thane, a fact that is not widely appreciated is that these lakes have never been dried up. Another great benefit that has still not been fully appreciated is the vital role played by the forests of SGNP in reducing the atmospheric pollution caused by the anthropogenic activities in Mumbai and Thane. The vegetation in SGNP literally absorbs the pollutants and significantly improves the air quality of the surrounding areas.There is yet one more factor that is under appreciated and that is the role of the forests of SGNP in temperature control. Visitors to the SGNP can immediately notice the drop-in temperature when they walk into the SGNP. At most times of the year, the temperature within SGNP is lower by 3-5 degrees Celsius as compared to the temperature outside the SGNP. The forests of SGNP literally act as a natural air conditioner for the cities of Mumbai and Thane, and significantly help in reduction of the electricity consumed by those residents residing along the periphery of the SGNP Division. Finally, in this era of climate change, we cannot but be conscious of the huge amounts of carbon that have been sequestered by these City Forests of SGNP.Four important rivers of Mumbai namely the Mithi River, the Poisar River, the Oshiwara River and the Dahisar River originate from the SGNP.

Biological Value

The vegetation of this area ranges from littoral forests to western sub-tropical hill forests. The park is home to a number of endangered species of flora and fauna. Large numbers of vertebrate and invertebrate species belonging to various classes and orders are indicators of immense biological diversity of this area. Observations and checklists show that there are about 550 faunal species that are found in this area. Besides, this area is a natural home for many endangered faunal species. Recently tail less whip scorpion was seen in the Tulsi tunnel during a jungle trek organized by the Director on 06-10-2011 during Wildlife week celebration in October 2011. While orange breasted green pigean was also seen recently by some bird watchers. Some dominant species are Kadamba, teak, karanj, species of *acacia, ziziphus*, flame of the forest, red silk cotton. Karvi or Karvy, a flowering plant that flowers once in seven years, is also there in the Park.

EcologicalValue

This area acts as a carbon sink for Mumbai and Thane cities and veritably it is known as a “green lungs” of Mumbai and Thane. It protects the catchments of Tulsi and Vihar Lakes that supply potable water to the metropolis of Mumbai and Thane.

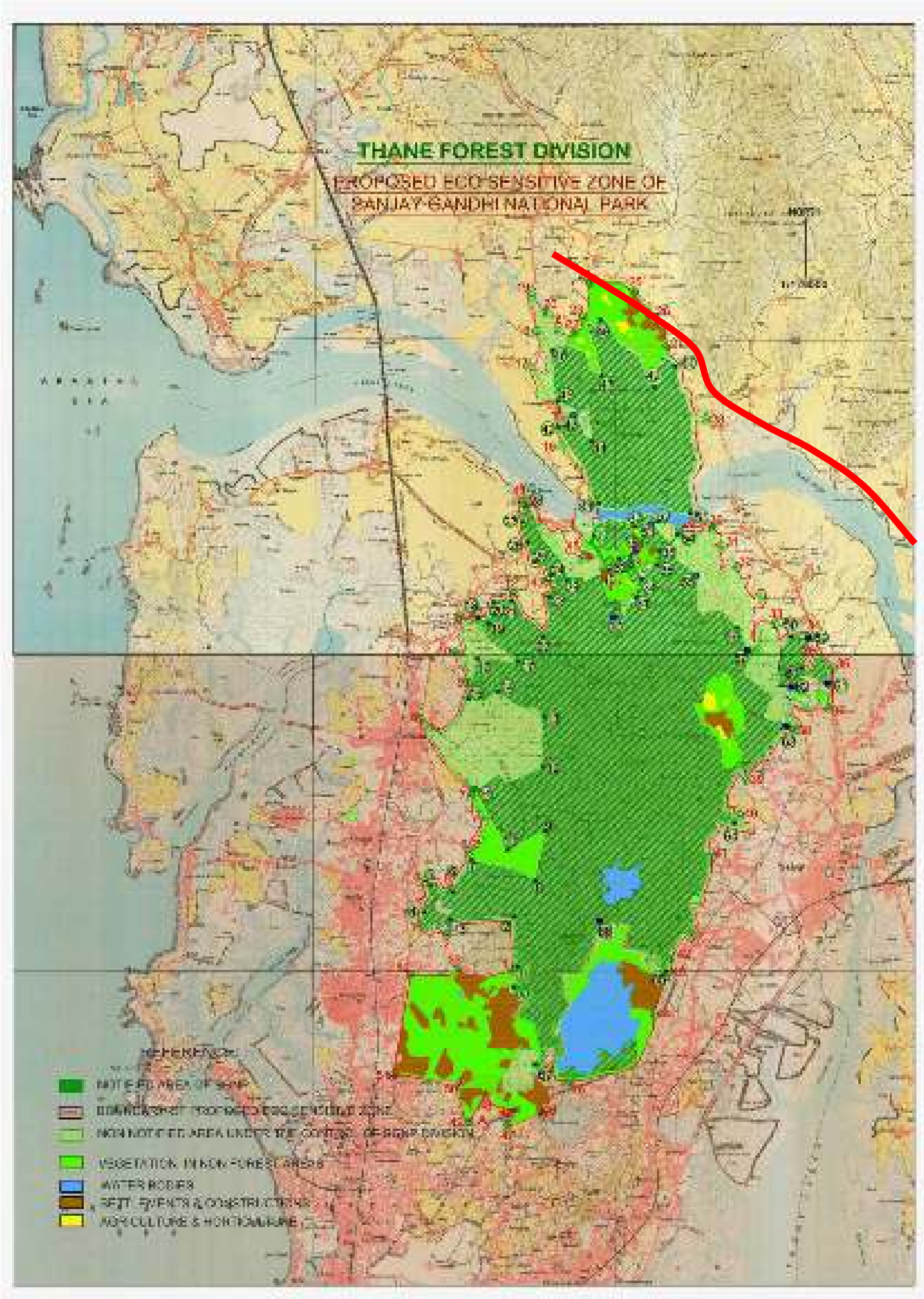
Archaeological Value

The Kanheri Caves, located within the park, form a major point of interest. The caves are said to date from the 1st century BC to the 9th century AD and had been occupied by a well-organized Buddhist establishment of monks on an ancient trade route connecting a number of Indian sea-ports.There are total of 109 caves with most of the caves being chiseled in the volcanic basalt rock. The small chambers are known as *“Vihars”* whereas the larger and deeper chambers are known as *“Chaityas”*.

Recreational and Educational Value

The unique location of this area makes it a paradise amidst thickly populated surroundings. Approximately a million visitors visit this area every year. They encounter rich natural and cultural diversity and are exposed to the need and importance of biodiversity and its conservation.The Nature Interpretation Centre of the SGNP provides invaluable opportunities to create awareness among visitors regarding the importance of nature and biodiversity and also educate them about the importance of forests for their own survival.

Exhibit 4.15.5: SGNP and MAHSR Alignment



Source: Office of the APCCF (mangrove Cell), Thane

SGNP Division belongs to 5 A - Malabar Plains. The present coverage of Malabar plains by protected areas in India is only 0.4 per cent against the proposed area of 1.1 % by Wildlife Institute of India, Dehradun in 1988. Looking into the forests of SGNP and Tungareshwar there is, therefore, a need to augment the area of SGNP and Tungareshwar Wildlife

Sanctuary by adding the contiguous forest areas which are with the FDCM and the Thane Territorial Division.

Species of Conservation Importance

(A) Trees / Plants

a) *Saraca indica* (Sita Ashok)

It is rare and endemic species of the national park. A75 hectare patch of *Saraca Ashoka*, popularly known as 'Ashok Van' is seen near Kanheri Caves. Flowers are seen from March to May. Monkeys, langurs and other herbivores eat the pods.

b) *Garcinia indica* (Kokam)

It is an evergreen species seen mostly at the highest point area in the vicinity of Yeur & above Kanheri caves. Monkeys, langurs and some birds eat fruits. Fruits are of medicinal value and are used as an antidote for stomach upset.

c) White Orchids

Two species of white orchids are found at the highest peak. Orchids are seen in the month of September. They have been identified as species of Platanthera and Habernaria.

(B) Mammals

1. Leopard (or Leopard)
2. Rusty Spotted Cat
3. Sambar

(C) Avifauna

1. Brown fish owl
2. Mottled wood owl

(D) Butterfly / moth

1. Blue mormon (the largest butterfly)
2. Atlas moth (the largest moth)

(12) Forest Type

According to the revised classification of forest types of India by Champion & Seth, the forests of SGNP Division represent the following forest types:

- 3 B/C1 Southern moist teak bearing forests;
- 3 B/C2 Southern moist mixed deciduous forests;
- B/TS1 Mangrove scrubs;
- 8 A/C2 Western sub-tropical hill forests.

3 B/C1 Moist teak bearing forests

The moist teak bearing forests constitutes 3-5 % of the total area of National Park. These forests exist where the soil condition is relatively better. Density is generally above 0.4 and it goes upto 0.7. The forests are mostly concentrated in Yeur and Ghodbander rounds. Earlier Nagla block had vast areas under teak forest but teak has been almost wiped out from this area due to illicit cutting.

Important tree species of this forest type include *Tectona grandis* (Teak), *Garuga pinnata* (Kakad), *Lannea grandis* (Shemat), *Schleichera oleosa* (Koshimb), *Mimusops hexandra*

(Rinjan), *Mangifera indica* (Amba), *Adina cordifolia* (Hed), *Pterocarpus marsupium* (Bija), *Bombax malabaricum* (Sawar), and *Syzygium cumini* (Jambul).

Important shrubs include *Carissa carandus* (Karvand), *Helicteres isora* (Murudsheng), *Adhatoda vasica* (Adulsa), and *Thespesia lampas* (Ranbhendi). The climbers are *Abrus precatorius* (Gunj), *Climatis triloba* (Ranjai), *Zizyphus rugosa* (Toria). Bamboo species found in the forests are *Dendrocalamus strictus* (Manvel), *Bambusa arundinacea* (Katas). Important grass species are *Cynodon dactylon* (Harali), *Dicanthium annulatum* (Ranbangdi), *Coix gigantea* (Ranjondhala), *Eragrostis spp*. (Darbha), and *Panicum glabrum* (Varai).Table 4.15.2. shows the checklist of flora found in this area.

3 B/C2 Southern Moist Mixed Deciduous Forest

The Southern moist mixed deciduous forests are profusely found in the area. Teak is occasionally found in low proportions. The density varies from 0.4 to 0.7. Clumps of manvel bamboo (*Dendrocalamus strictus*) and Katas Bamboo (*Bambusa arundinacea*) are found in the area. This forest type covers major part of the Division. The soil is deep, loamy and generally rich in humus content. The semi evergreen species found in this forest type are Mango, Lokhandi, Shendri, Koshimb and Ashok, though Ashok is mostly localised along the stream courses in Kanheri, Chene and Krishnagiri Upvan forests.

4B/TS1 Mangrove Scrubs

The coastal line of Maharashtra is about 720 km. (National Institute of Oceanography - GOA, 1998) and numerous river mouths, creeks, small bays, headlands, cliffs *etc.* indent it. Bassein creek is one of the 37 stations which were surveyed by National Institute of Oceanography for the floral and faunal diversity. Bassein creek is the longest creek with 41 km. length. However only 23% area *i.e.* approximately 2000 hectares has mangrove coverage (NIO 1998). This creek passes through SGNP. *Avicenna marina* is dominating the vegetation. *Bruguiera gymnorhiza* and *Lumnitzera racemosa* have almost vanished from the estuaries of Bassein Creek, while species like *Sonneratia alba*, *Rhizophora apiculata*, *Acrosticham sureum* are absent from this region. The marine Algae found in Bassein creeks are *Entromorpha clathrata* and *Claloglossal epureurii*. At present SGNP has about 40 ha. of mangrove forests.

8 A/C2 Western Sub-tropical Hill Forests

These are the few remnant patches of natural forests of higher elevations that occur on low lying hills (Bio-diversity of the Western Ghats, 1997). The western sub tropical hill forests are found in very small patches at high altitude. Density is around 0.6. It is semi-evergreen type of forest with many evergreen species present in the crop. The Bamboo is typically absent. The floristic includes, climbers, orchids and ferns. *Mangifera indica* (Mango), *Pongamia pinnata* (Karanj), *Gardcinia indica* (Kokam), *Syzygium cuminii* (Jambul), *Calophyllum inophyllum* (Undi), *Sideroxylon tomentosum* (Kate-Kumbal), *Ixora* (Lokhandi), *Murraya paniculata* (Pandari). *Garcinia* is located on the way to highest point above Kanheri Forests.

(13) Plantation

Some plantations have been taken up in the past in Yeur and Nagla forests. In the period from 1981-82 to 1991-92, over 500-hectare area has been brought under fruit and fodder species plantations. These plantations are successful. *Glyricidia* had been extensively planted on the western side of the area in the past. Since 2008, after removing the encroachment of huts, 17 ha. area has been planted with density of 2500 pits/ha. Species like teak, khair, and other indigengous plants have been planted. The exotics species like Subabul and Australian Babul have been planted in the past. *Glyricidia* and the other exotics species give a tinge of artificiality to the area and needs to be removed only after the area is replanted with better indigenous species.

Table 4.15.2: Floristic Composition of SGNP Area

Category	Botanical Name	Local Name	IUCN Status
Trees	*Adansonia digitata*	Gorakh Chinch	LC
	Azadirachta indica	Kaduneem	LC
	Adina cordifolia	Haldu	LC
	Alstonia scholaris	Satwin, Saptaparni	LC
	Annona squamosa	Sitaphal	
	Anona reticulata	Ramphal	LC
	Anacardium occidentale	Kaju	
	Acacia arabica	Babul	LC
	Acacia catechu	Khair	
	Aegle marmelos	Bel	LC
	Anogeissus latifolia	Dhawda	
	Albizzia procera	Kinhai	LC
	Albizzia lebbek	Siris, Sankesar	LC
	Albizzia odoratissima	Chinchona	LC
	Albizzia chinensis	Pharadi	LC
	Acacia suma	Shenkhair	LC
	Atlantia racemosa	Ranilimbu	LC
	Acacia Ferruginea	Pandhara Khair	LC
	Bombax malabaricum	Sawar, Kate Sawar	
	Borassus flabellifer	Tad	
	Bauhinia racemosa	Apta	LC
	Bauhinia variegata	Kanchan	LC
	Bridelia retusa	Asana	
	Bauhinia vahlii	Mahul	
	Bauhanania lanzam	Charoli	
	Bauhinia malabarica	Ambotha	
	Barringtonia acutangula	Nivar (Samudra-phal)	
	Butea monosperma	Palas	LC
	Cocos nucifera	Naral	LC
	Cassia fistula	Arnaltas, Bahawa	LC
	Cordia myxa	Bhokar	
	Cyperus Spp.	Motha	LC
	Cordia macleodii	Daiwas (Dahivel)	LLC
	Careya arborea	Kumbh	
	Casuarina equisetifolia	Suru	
	Calophyllum inophyllum	Undi	
	Dalbergia latifolia	Shisam	LC
	Delonix regia	Gulmohar	LC
	Diospyros melanoxylon	Tendu	LC
	Dalbergia paniculata	Dhobin	LC

Category	Botanical Name	Local Name	IUCN Status
	Dalbergia Sisoo	Shisoo	LC
	Dillenia pentagyna	Karambel	LC
	Dolichandrone falcata	Medsingi	
	Erythrina indica	Pangara	LC
	Ehretia laevis	Daterang	
	Euphorbia parviflora	Newali, Thor	
	Excoecaria agallocha	Phungali	
	Emblica officinalis	Awala	
	Elaeodendron glaucum	Jamrasi	
	Ficus tsiela	Pipar	
	Ficus arnottiana	Payar	
	Ficus bengalensis	Wad	
	Ficus mysorensis	Bhurwad	
	Ficus religiosa	Pimpal	
	Ficus elastica	Indian Caoutchuc Tree	
	Ficus hispida	Kala Umbar	
	Ficus glornerata	Umbar	
	Ficus asperrima	Kharwat	
	Ficus retusa	Nandruk	
	Ficus retusa	Nandruk	
	Ficus heterophylla	Datir	
	Flacourtia montana	Attak, Champer	
	Feronia elephantum	Kawath	
	Garcinia indica	Kokarn	LC
	Garuga pinnata	Kakad	
Trees	*Grewia colimnaria*	Kala Dhaman	
	Grewia tiliaefolia	Dhaman	
	Gardenia latifolia	Ghogari	
	Gmelina arborea	Shivan	
	Glycosmis pentaphylla	Kirmira	
	Holoptelea integrifolia	Vavla, Papra	
	Hymenodictyon excelsum	Potur	
	Holarrhena antidysenterica	Kuda	
	Heterophragma quadriculata	Warus, Panlag	
	Ixora arborea	Kuda	
	lxora parviflora	Lokhandi	
	Ixora nigricans	Lokhandi	
	Jatropha curcus	Mogli, Erandi	
	Kydia calycina	Aranga	
	Lannea grandis	Shemat	
	Lagerstroemia parviflora	Bondara	
	Lagerstroemia lanceolata	Lendi	
	Mangifera indica	Amba	LC
	Madhuca indica	Mohwa	

Category	Botanical Name	Local Name	IUCN Status
	Manilkara hexandra	Ahmadabadi hewa	
	Mimnusops elengi	Bakul	
	Morinda tinctoria	Shevga	
	Macaranga peltata	Chandoda	
	Mitragyna parviflora	Kalamb	
	Memecylon edule	Anjani	
	Murraya koenigii	Kadulimb	
	Melia dubia	Bakan	
	Murraya exotica	Pandhari	
	Mimusops hexandra	Bakul	
	Mallotus phillipensis	Kamela, Kunku	
	Nyctanthes arbortristis	Parijatak	
	Ochrocarpus longifolius	Surangi	
	Oroxylum indicum	Tetav	
	Olea dioica	Par-Jambhul	
	Ougenia oojeinensis dalbergioides	Tiwas	
	Ptrocarpus marsupium	Bibla	
	Phoenix sylvestris	Shindi	
Trees	*Pterospermum suberifolium*	Konak Champa	
	Parkinsonia acutangula aculeata	Vedi -Babul	
	Pongamia pinnata	Karanj	LC
	Randia dumetorum	Gela	
	Ricinus communis	Erandi	
	Sterculia colorata	Khavas	
	Sterculia urens ureus	Kadhai	
	Saccopetalum tomentosum	Humb	
	Syzygium cumini	Jambhul	
	Stereospermum personatum	Padal	
	Sapindus trifoliatus	Ritha	
	Semecarpus anacardiurn	Biba	
	Sesbania grandiflora	Agasta	
	Salvadora persica	Khakan	
	Streblus asper	Kharota	
	Schleichera oleosa	Kusum	
	Spondias magnifera	Ambada	
	Sideroxylon tomentosum	Katekumbhal	
	Sterculia guttata	Kukeri	
	Tamarindus indica	Chinch	LC
	Terminalia bellerica	Behada	
	Terminalia tomentosa	Ain, Sadada	
	Terminalia arjuna	Arjun	
	Terminalia chebula	Hirda	
	Tectona grandix grandis	Sagwan	
	Trewia polycarpa	Petari	
	Trema orientalis	Ran-Ambada, Kargol	LC

Category	Botanical Name	Local Name	IUCN Status
	Thespesia populnea	Ranbhendi	LC
	Vengueria spinosa	Alu	
	Wrightia tinctoria	Dudhi	LC
	Xylia xylocarpa	Jambu	
	Zizyphus jujuba	Bor	
	Zizyphus xylopyra	Ghatbor	
Shrubs	*Acacia pinnata*	Shembati	
	Adhatoda vasica	Adulsa	
	Asparagus racemosus	Shatawari	
	Acacia concinna	Shikekai	
	Amorphophallas campanulatus		
	Bambusa arundinacea	Bamboo (Katas)	
	Barleria prionitis	Koranti	
	Capparis spinosa	Waghata	
	Capparis zeylanica	Waghati	
	Calycopteris floribunda	Ukshi	
	Carissa carandas	Karwand	
	Calotropis gigantea	Rui	
	Clerodendron inerne	Koyanel	
	Crotolaria retusa	Ghogali	
	Euphorbia neriifolia	Nivdung	
	Erythropsis calorata	Khavas	
	Helicteres isora	Murudsheng	
	Ixora parviflora	Bakors	
	Jasminum pubescens	Ranmogra, Ranjai	
	Jatropha curcas	Chandrajyot	
	Kirganolis reticulata	Pavan	
	Leea edgeworthii	Dina	
	Lawsonia inermis	Mendi	
	Lepidagathis cristata	Kumbhi	
	Lantana camera	Ghaneri	
	Lantana alba	Gultora	
	Microcos paniculata	Shetali	
	Mayenia arecta	Alu	
	Moghania strobelifera	Kanfuti	
	Nerium indicum	Ran Kanher	
	Opuntia dillenii	Nivdung	LC
	Ocimum canum	Ran-Tulas	
	Pogostemon purpuria	Pangal i	
	Strobilanthes callosus	Karvi	
	Solanum indicum	Bhui, Ringani	
	Vitex negundo	Nirgudi	
	Woodfordia floribunda	Dhayati	

Category	Botanical Name	Local Name	IUCN Status
	Zizyphus cenoplia	Makor	
Herbs	*Agave americana*	Ghaypat	
	Argemone mexicana	Pivla Dhotra	
	Abutilon indicum	Mudra	
	Aeschynomene indica	Silar-	
	Alysiarpus rugosus	Baker	
	Ammania baccifera	Bhar jambhul	
	Ammania multiflora	--	
	Anisomeles indica	--	
	Achyranthes aspera	Aghada	
	Alternanthera sessilis	kanchari	
	Amaranthus spinosus	Kate-Math	
	Biophytum sensitivum	--	
	Begonia crenota crenata	--	
	Bidens biternata	--	
	Blumea laciniata	Burada	
	Blepharis asperrima	--	
	Corchorus capsularis	--	
	Corchorus aestuans	--	
	Corchorus olitorius	Jute	
	Cardiospermum helicacabum	Kapsihodi	
	Cassia tora	Takla	
	Crotalaria juncea	Taag	
	Centalla asiatica	--	
	Caesulia axillaris	Maka	
	Centratherum anthelminticum	--	
	Centarium centaurioides	--	
	Coldenia procumbens	--	
	Commelina benghalensis	Kena	
	Commelina obliqua	Kena	
	Curcuma aromatica	Jungli Halad	
	Desmodium triflorum	Ran Methi	
	Dinebra retroflexa	Kardi	
	Datura kutal	Dhotra	
	Digera muricata	Tanduliira	
	Dioscorea bulbifera	--	
	Dioscorea pentaphyla	Babra	
	Eclipta alba	Maka	
	Elephantopus scaber	--	
	Evolvulus alsinoides	Shankavali	
	Eupho irbia hirta	Dudhi	
	Grangea maderaspatana	--	
	Hemidesmus indicus	Anant-Mul	

Category	Botanical Name	Local Name	IUCN Status
	Helianthus Spp	Suryaphul	
	Hoppea dichotoma	--	
	Holiotropium indicum	Bhurundi	
	Haplanthus tentaculatus	--	
	Hemigraphis latebrosa	--	
	Hygrophila serpyllum	--	
	Indigofera astragalina	--	
	Impatiens balsamina	Terdi	
	Jussiaea suffruticosa	Ban Lavang	
	Justicia simplex	Sokamble Zara	
	Leea macrophylla	Dindi	
	Limnophila indica	--	Endangered
	Lindernia ciliata	--	Endangered
	Leucas aspera	--	
	Malachra rotundifolia	Ran Bhendi	
	Melochia corchorifolia	Methuri	
	Mollugo pentaphylla	--	
	Musa superba	Jungli-K	
	Oxalis latifolia	Khatta Zara	
	Oldenlandia corymbosa	Bit Papda	Endangered
	Portulaca oleracea	Ghola	
	Phaseolus radiatus	Mug, Moong	
	Phaseolus trilobus	--	
	Plumbago zeylanica	Shitrak	
	Physalis minima	Ran Popti	
	Peristrophe bicalyculata	--	
	Phyla nodiflora	--	
	Polygonum glabrurn	Dongra	
	Phyllanthus niruri	Ran-Aol i	
	Pavetta indica	Papadi	
	Sida acuta	Jungli Methi	
	Sida retusa	Atibala	
	Smithia hirsuta	--	
	Smithia	--	
	Sphaeranthus indicus	Gorkmundi	
	Solanum xanthocarpum	Bhuivangani	
	Sesamum indicum	Til	
	Stachytarpheta indica	Tuisi Zara	
	Strychnos nuxvomica	Kuchla	
	Scilla indica	--	
	Triumfetta annua	--	
	Triumfetta pilosa	--	
	Tephrosia purpurea	Sai-p Mukhc	
	Tridax procumbens	Degadipala	

Category	Botanical Name	Local Name	IUCN Status
	Trichodesma indicum	Ghotakalpa	
	Urena lobata	Jal -Jaltang	
	Vernonia cineria	Sahadevi	
	Waltheria indica	--	
	Woodfordia floribunda	Dhaiti	
	Xanthium strumarium	Gokharu	
Grasses	*Apluda mutica*	Pochati, Fuli-Zara	
	Arundinella ciliata	--	
	Arundinella intricata	--	
	Arundinella minila	--	
	Andropogon triticus	Bhale Kusa	
	Andropogon monticola	Dongari Gavat	
	Andropogon pertusus	Ghanya Marvel	
	Andropogon pumilus	Gondval	
	Andropogon halepensis	Boru	
	Andropogon contortus	Kusali	
	Andropogon annulatus	Marvel	
	Andropogon schoenanthus	Rosha	
	Anthistiria ciliate	Bhongrut	
	Aristida paniculata	Bhuri	
	Brachiaria eruciformis	Sheprut	
	Coix aquatic	Ran Jondhala	
	Cynodon dactylon	Hariali, Durwa	
	Eleusine coracana	Nachni, Nagli	
	Eragrostis Spp	Darbha, Kusha	
	Imperata cylindrica	--	
	Ischaemum indicum	Ber	
	Ophismenus Ophismanus	Hirvi Bangadi	
	Paspalidium flavidum	*Panicum*	LC
	Panicurn glabrum	Varai	
	Paspalum disticum	--	
	Spodiopogon rhizophorus	Math-Zara	
	Sporobolus indicus	--	
	Themeda triann dra	Gondel	
Bamboos	*Bambusa arundinacea*	Katas	
	Dendrocalarnus strictus	Manvel	
Climbers	*Ampelocissus latifolia*	Kandvel, Rudrakshi	
	Abrus precatorius	Gunj	
	Argyreia nervosa	Samudra-Ashok	
	Argyreia sericea	Sambarvali	
	Butea superb	Palasvel	
	Capparis horrid	Tarati	
	Clematis triloba	Ranjai	

Category	Botanical Name	Local Name	IUCN Status
	Cocculus villosus	Parval	
	Cissus repanda	Arbatvel	
	Cissus auriculata	Kalivel	
	Cylista scariosa	Ran Ghewada	LC
	Coccinia indica	Tondli	
	Caesalpinia sepiaria	Chillari	
	Celastrus paniculata	Malkangni, Pingvel	
	Capparis sepiaria	--	
	Combretum ovalifolium	Madhel	
	Derris trifolia	Kajarvel	
	Entada scandens	--	
	Gloriosa superba	Bachmag	LC
	Hemidesmus indicus	Anantvel	
	Ipomea digitata	Bhuikohala	
	Jasminum malbaricum	Jai	
	Luffa acutangula	Shirali	
	Mucuna pruriens	Khajkoyli	
	Momordica dioica	Kartoli	
	Marsdenia volubilis	--	
	Parsonsia spiralis	Nagalkuda	
	Smilax zeylanica	Ghotvel	
	Tinospora cordifolia	Gulvel	
	Teramnus labialis	Ranudid	
	Trichosanthes palmata	Padval	
	Zizyphus rugosa	Torai	
Epiphytes	*Cuscuta reflexa*	Amarvel	
	Dendrophthoe falcata	Bandgul	
	Viscum nepalensis	Banda	
	Vanda tessellata	Aitkel	LC
Aquatic plants	*Asteracantha longifolia*	Kolshinda, Talimkhan	LC
	Cariops tagal	Chauri	
	Ipomoea aquatica	--	
	Limnanthemum indicum	Kumud	LC
	Murdannia nudiflora	--	
	Pistia Pistacia stratiotes	Gondal	
	Utricularia orbiculata	--	
Halophytes	*Aegiceras corniculata*	Kunjala	
	Acanthus ilicifolius	Marandi (Seaholly)	LC
	Avicennia officinalis	Tivar	LC
	Avicennia marina	Tivar	LC
	Pandanus tectorius	Kewada	
	Sonneratia apetala	Tivar	Endangered
Orchids	*Platanthera spp.*		

Category	Botanical Name	Local Name	IUCN Status
	Habenaria spp.		

Source: SGNP Working Plan

(14) Wild Animals

The forests in this area were bestowed with rich faunal density in the past. However, this rich heritage of wildlife had dwindled due to the problems caused by the huge encroachments. However, removal of some of the encroachments and implementation of conservation practices over a period of 40 years, this area now becoming rich in wildlife (Table 4.15.3). The tiger which had become extinct from this area in the early forties, made a surprising but unconfirmed reappearance in 2004 as per the existing records the origin and destination of the tiger that lived in the Nagla block for around 6 weeks in 2004 still remains a mystery and no photographic confirmation was made.

Table 4.15.3: Faunal Density and Diversity

	Mammal	Reptile	Amphibian	Bird
Order	7	3	1	18
Family	17	14	4	46
Species	43	38	9	250

Source: SGNP Working Plan

Innumerable species of grasshoppers, spiders, bugs, mosquitoes, beetles, termites, mantises, bees, hornets, wasps, cockroaches, cicadas, aphids, moths and butterflies, dragonflies and damselflies are found in SGNP. Leaf insects and stick insects are seen in the area. This area boasts to harbour almost 150 butterfly species. September to January is the best time for their observation. The Atlas moth was seen in September 1999, which is regarded as a valuable discovery.The vertebrate fauna of the area includes 43 species of Mammals, 250 species of birds, including the migratory land and water birds, 38 species of reptiles and 9 species of amphibians.

Mammals

Wildlife habitats in SGNP Division supports are number of species of herbivores, carnivores and omnivores. Nearly 43 species of mammals belonging to 8 natural orders and 17 families are seen in the national park. Out of these 8 species are “Endangered” and have been included in the Schedule - I and Part-II of Schedule-II of the Wildlife (Protection) Act, 1972. The details are given in Table 4.15.4.

Table 4.15.4: Endangered Faunal Species

Common Name	Scientific Name
Leopard or Leopard	*Leoparda pardus*
Rusty-Spotted Cat	*Felis rubiginosa*
Jungle Cat	*Felis chaus*
Common Name	**Scientific Name**
Small Indian Civet	*Viverricula indica*
Common Palm Civet	*Pardoxurus hermaphroditus*
Jackal	*Canis aureus*
Four-horned Antelope	*Tetracerus quadricornis*
Mouse Deer	*Tragulus meminna*

Source: SGNP Working Plan

Leopard is the only big cat found in this area. In total, eight Leopard lairs have been seen in this area. Jungle cat, small Indian civet, common palm civet or Toddy cat, rusty-spotted cat, jackal, stripped hyena are quite rare. The jackals are seen in the scrub forest around Vihar and also near the MAFCO factory, in the Krishnagiri Upvan. The hyenas are seen particularly around the Yeur village and were earlier found near the MAFCO factory, which has now been demolished.

Leopard

Leopards of this area have some unique features. The spatial distribution of Leopard in this area has been studied in light of census data of Leopard conducted in this Division in the past. The scat analysis shows that leopards mainly feed on domestic dogs, chital, *etc.* The scat analysis showed that 77% scats contained only one prey species, 21% scats contained two species and 2% contained three species. After demolition of the MAFCO factory the artificial feeding ground has been disappeared and that had resulted in the better distribution of leopards within SGNP. Recently a study was undertaken by the park administration to assess the distribution of leopards and to focus on measures to be taken to mitigate the man-animal (mainly leopard) conflict; the study is called as "Mumbaikars for SGNP".

Large Herbivores

Large herbivores of this area represent four families of Artiodactyla as shown in the Table 4.15.5.

Table 4.15.5: Large Herbivores Species

Large Herbivores Order: Artiodactyla (even-toed ungulates)		
Family	**Group Name**	**Common Name**
Suidae	Pig	Wild boar
Tragulidae	Chevrotains	Mouse deer
Cervidae	Deer	Spotted deer
		Sambar
		Barking deer
Bovidae	Cattle	chousinga

Source: SGNP Working Plan

The spotted deer are seen mostly around the Tulsi and Vihar lake area and also around Tumnipada area. Sambars are mostly seen in the Shilondha forests, around Tulsi and Vihar lakes, Yeur and Chene forests. The population of the Mouse Deer is concentrated mainly around Tulsi and Vihar lakes and Kanheri caves. Wild boars/pigs are mostly seen around Tulsi and Vihar lakes and Shilondha forests.

Small Herbivores

The black-naped hare is common in all valleys. The crested porcupine is commonly seen around Kanheri Caves area. A detailed study of small herbivores shall be taken in near future.

Primates

Three species of monkeys *viz.* the Bonnet macaque, the Rhesus macaque and the common or Hanuman langur are seen in the area. The Bonnet monkey is common in many parts. It is also reported that there is also a hybrid species of macaques due to the inter-breeding of the Bonnet and Rhesus macaques.

Bats

Seven species of bats have been recorded in the area. Brosset (1962) had studied extensively all the seven species of bats from this area and had published his findings in his book – "The Bats of Central and Western India" (published by the B.N.H.S.). The records include all three species of fruit-eating bats (*Megachiroptera*).

Avifauna

The avifauna of this area is an attractive wildlife feature of this park. About two hundred and fifty bird species, both resident and migrant, belonging to eighteen different orders and forty-seven families have been recorded here. The period between December and February is ideal for bird watching. This area is a home of five endangered birds, namely the Peafowl(*Pavo cristatus*)**,** Osprey or fish-eating eagle(*Pandion haliaetus*)**,** white-bellied sea eagle **(***Haliaetus leucoquaster*), Hawks (*Accitridae*)and large Falcons(*Falco peregrinus, Falcobiarmicus and Falco chicuera*)**.**The cormorant is a common bird of the area. Migratory ducks such as common teal, garganey and the redheaded poachard are seen in small numbers in Vihar and Tulsi Lakes. Two species of Jacanas namely the Pheasant tailed jacana and the Bronzed winged jacana have also been recorded in the area.Mangrove swamps attract a variety of plovers, sandpipers, gulls and terns. The nocturnal birds include the Barn Owl, the Great Horned Owl, the barred Jungle Owlet and the Spotted Owlet.The Rose-ringed parakeet and the Blossom headed parakeet are common and breed within the park. The white-breasted kingfisher and the common kingfisher are common. Several types of woodpeckers including the rare heart-spotted woodpeckers occur in the park.

Reptiles

The reptiles found in the park are covered under three orders and fourteen families. In the park there are thirty-eight species of reptiles of which seven are "Endangered" and are included in Schedule I and Part II of Schedule II of Wildlife (Protection) Act.1972. Details are given in Table 4.15.6.

Table 4.15.6: Endangered Reptiles

Sr.No.	Common Name	Scientific Name
1	Indian Marsh Crocodile (Mugger)	*Crocodilus palustris*
2	Indian Rock Python	*Python molurus*
3	Dhaman or Rat snake	*Ptyas mucosus*
4	Indian Cobra	*Naja naja*
5	Russel's Viper	*Vipera russelli*
6	Checkered keelback	*Natrix piscatar*
7	Common monitor	*Varanus monitor*

Source: SGNP Working Plan

The eleven species of lizards found in this area which includes the chameleon and the monitor lizard. There are twenty-three species of serpents in the park, of which seven species are "Endangered" and are included in the Schedule-I and Part-II of Schedule-II of Wildlife (Protection) Act, 1972.

Amphibia

The Kanheri Caves with its perennial pools of water have a variety of frogs and toads. Besides the common ones such as the tree frogs, the bullfrog and common toad, the uncommon toad (*Ramanella montana*) has been recorded in the area. Fungoid frogs are seen in Tulsi tunnel.In the cisterns in the rocks around Kanheri caves, a few interesting species of frogs have been recorded including the six-toed frog and the skipper frog. Common during the rains are the extraordinary tadpoles of *Rana loith* capable of swimming upstream. In all, nine species of amphibia belonging to four different families are seen in the area.

Ichthyofauna

The Bassein Creek and the other watercourses in and around the area abound in fishes. During the monsoons when deep-sea fishing is suspended many sea fishes migrate to the shore. 25 species of the marine fishes and 18 species of the freshwater fishes are seen within the park.

The faunal species found in the SGNP Division are enlisted in Table 4.15.7.

Table 4.15.7: Faunal Species Reported in the SGNP

Order	Family	Scientific Name	Common English Name
Insectivora	Pterodidae	*Suncus murinus*	House Shrew or Grey Musk Shrew
Chiroptera		*Rousettus leschenaulti*	Fulvous Fruit Bat
		Pteropus giganteus	Indian Flying Fox
		Cynopterus sphix	Shortnosed Fruit Bat
	Emballonuridae	*Taphozous melanopogon*	Black-beared Tomb Bat
		Taphozous soccolaimus	Pounch Bearing Bat
	Megadermatidae	*Megaderma spasma*	Malay False Vampire
		Megaderma iyra	Indian False Vampire
		Rhinolophus rouxi	Roux's Horseshoe Bat
		Hiposideros sperosis	Schenider's Leaf-nosed Bat
		Hipposideros bicolox	Bicoloured Leaf-nosed Bat
		Hipposiderous galeritus	Cantor's Leaf-nosed Bat
	Vespertilionidae	*Pipistrellus coromandra*	Indian Pipistrelle
		Pipistrellus minus	Indian Pigmy Pipistrelle
		Pipistrellus dormeri	Dormer's Bat
		Hesperoptenus tickelli	Indian Tickell's Bat
		Scotophilus heathi	Coomon Yellow Bat
		Kerivoula picta	Painted Bat
Primates	Cercopithecidae	*Macaca radiata*	Bonnet Macaque
		Macaca mulata	Rhesus Macaque
		Presbytis entellus	Common Langur
Carnivora	Canidae	*Canis aureus*	Jackal
	Viverridae	*Viverricula indica*	Small India Civet
		Paradoxurus hermaphroditus	Toddy Cat or Small India Civet
		Herpestes edwardsi	Indian Grey Mongoose
	Hyaenidae	*Hyaena hyaena*	Striped Hyaena
	Felidae	*Felis chaus*	Jungle cat
		Panthera pardus	Leopard
		Felis rubiginosa	Rusty Spotted Cat
Artiodactyla	Suidae	*Sus scrofa*	Wild Boar
	Tragulidae	*Tragulus meminna*	Mouse Deer or Indian Spotted Chevrotain

Order	Family	Scientific Name	Common English Name
	Cervidae	*Axix axis*	Spotted Deer
		Cervus unicolor	Sambar
		Muntiacus muntjac	Barking Deer or Muntjac
	Boridae	*Tetracerus quadricornis*	Fourhorned Antelope or Chausinga
Lagomorphia	Leoporidae	*Lepus nigricollis*	Indian Black Naped Hare
Rodentia	Sciuridae	*Funambulus palmarum*	Three Stripped Palm Squirrel
		Funambulus pennanti	Five striped Palm Squirrel
		Hystrix indica	Indian Crested Porcupine
	Muridae	*Rattus blanfordi*	Whitetailed Wood Rat or Blanford's Rat
		Rattus rattus	House Rat
		Mus musculus	House Mouse
		Bandicota bengalensis	Indian Mouse, Rat or Lesser Bandicoot

Source: SGNP Management Plan

Table 4.15.8: Avifauna Reported in the SGNP

Order	Family	Scientific Name	Common English Name	Move-ment	Abun-dance
Podicipediformes	Podicipitidae - Grebes	*Podiceps ruficollis capensis*	Little Grebe or Dabchick	R	O
Peiecaniforms	Phalacrocoracidae	*Phalaerocorax niger*	Little of Pigmy cormorant	R	C.F.
		Anhinga rufa Melanogaster	Dartar	R	O
Cicomipormes	Ardeidae	*Ardeola - gray*	Pond Heron or paddy bird	R	C
		Bubulcus ibis, Coromandus	Cattle Egret	R	C.F.
		Egretta alub modesta	Large Egret	R	U
		Elgrettca intermedia	Median or Smaller Egret	R	O
		Egretta gazzetta gazzetta	Little Egret	R	C
		Nicticorax nicticorex	Night Heron	R	U
		Ixobrychus cinnamomeus	Chestnut Bitters	R	U
	Ciconidae	*Anastomus ositanas*	Openbill stork	R	UF
		Ciconia episcopus	White Necked Stork	R	OF
Anserjformes	Anatidae	*Dendrocygna javanica*	Lesser Whistling Teal	R	C.F.
		Anas acuta	Pintail	M	C.F.
		Anas creca creca	Common Teal	M	OF
		Anas poecilorhyncha	Spotbill Duck	R	OF
		Anas quercquedula	Gazganey or Blue Winged Teal	M	C.F.

Order	Family	Scientific Name	Common English Name	Move-ment	Abun-dance
		Aythaya ferina	Comman or Redneded Pochard	M	OF
		Aythya nyroca	White Eyed Pochard	M	C.F.
		Aythya fuligula	Tuffed Duck	M	C.F.
		Nettapus coromandelianus	Cotton Teal	R	C.F.
Falconifor-ces	Accipitridae	*Elanus caeruleus vociferus*	Black winged kite	RLM	O
		Pernis ptilorhyncus ruficollis	Crested Honey Buzzard	R	O
		Milvus migrans govinda	Pariah Kite	R	C
		Haliastur indus	Brahminy Kite	R	O
		Accipiter badius dussumieri	Indian Shikra	R	C
		Accipiter trivirgatus	Crested Goshawk	R	U
		Accipter nisus melaschistos	Sparrow Hawk	M	U
		Butastur teesa	White Eyed Buzzard	R	U
		Aquila rapax vindhina	Ta Wny Eagle	LM	O
		Ictinactus Malayensis	Black Eagle	R	U
		Haliaeetus leucogaster	White Bellied Sea Eagle	R	O
		Gyps indicus	Indian Longbilled Vulture	R	OF
		Gyps bengalensis	Indian Whitebacked Vulture	R	C.F.
		Neophron perenopterus	Indian Scavenger Vulture	R	OF
		Circus macrourus	Pale Harrier	M	O
		Circus pygarus	Montagus Harrier	M	O
		Spilornis cheela melanotis	Crested Serpent Eagle	R	O
		Pandion hatiaetus	Osprey	M	U
		Falco tinnunculus	European Kestrel	M	O
	Falconidae	*francolinus pictus*	Painted patridge	R	C
Galliformes	Phastanidae	*Coturnix coturnix*	Common Grey Quail	M	C.F.
		Coturnix coromandelica	Blackbreasted or Rain Quail	M	C.F.
		Perdicula asiatica	Jungle Bush Quail	R	C.F.
		Galloperdix spadicea	Red Spurfoud	R	C.F.
		Gallus gallus	Red Jungle Fowl	R	U
		Gallus sonneratti	Grey Jungle Fowl	R	O
		Pavo cristatus	Common Peafowl	R	C.F.

Order	Family	Scientific Name	Common English Name	Move-ment	Abun-dance
		Turnix sylvatica dussumier	Liggle Bustard Quail	R	U
		Turnix suscitator taigoor	Common Bustard Quail	R	C
		Rallus stviatus albiventer	Blue Brested Banded Rail	R	U
	Rallidae	*porxana pusilla*	Baillon's Grake	M	U
		Porzane porzane	Spottd Crake	M	O
		Amaurarnis phoenicurus	White Brested Waterhen	R	C
		Amaurornis fuscus zelonicus	Ruddy Crake	M	O
		Gallicrex chinerea cinerea	Water Gock or Kora	R	O
		Gallinula chloropus indica	Moorhen	R	O
		Porphyrio porphyrio poliocephalus	Purple Moorhen	R	O
		Fulica atra	Coot	R	OF
		Hydropha sianus chirurgus	Pheasant Tailed Jacana	R	C
Charadriiformes	Jacanidae	*Metopidicus*	Bronzewinged Jacana	R	C
		Haematopus ostralegus	Dyster catcher	R	C
		Venellus indicus	Red watted lapwing	R	C
		Vanellus malbaricus	Yellow wattled lapwing	R	O
Charadriiformes	Jacanidae	*Numeniua phaeopus*	Whimbrel	R	O
		Numenius orquata	Curlew	R	O
		Tringa totanus eurhinus	Common Redshank	M	C.F.
		Tringa stagnatills	Marsh sandpiper	M	U
		Tringa nebuiaria	Green shank	M	O
		Tringa ochropus	Green sand piper	M	C
		Tringa hupoleucos	Common sand piper	M	C
		Gappela stenura	Pintail Snipe	M	C.F.
		Gapella gallinago	Fantail shipe	M	C.F.
		Gapella mihima	Jack shipe	M	C.F.
		Caldris minutus	Little stint	M	C.F.
		Caldris temminickii	Temminck's Stint	M	C.F.
		Phiomachus pugnax	Ruft and Reeve	M	C.F.
		Rostratula benghalensis	Painted shipe	R	OF
	Rostratulidae	*Himantopus himantopus*	Blackwinged stilt	MR	C.F.

Order	Family	Scientific Name	Common English Name	Move-ment	Abun-dance
	Recurvirostridae	*Burhinus ocdicnemus*	Stone curlew	M	O
	Burhinidae	*Cursorius coromandelicus*	Indian courser	M	O
	Glareolidae	*Larus brunnicephalus*	Brounheaded Gull	M	C.F.
	Lardiae	*Larus brunnicephalus*	Brounheaded Gulla	M	C.F.
		Childonias bybrida indica	Whiskered Tern	LM	OF
		Gelochelidon nilotica	Gullbilled Tern	LM	OF
		Sterna aurantia	Indian River Tern	LM	OF
		Sterna acuticauda	Blackbellied Tern	LM	OF
		Sterna albifvons	Little Tern	M	OF
		Petrocles exustus	Indian sandgrouse	M	O
Columbiforms	Ptercolidae	*Treron pompadora affinis*	Grey fronted Gveon	LM	OF
	Columbidae	*Treron pheonicoptera chlorigaster*	Pigeon Yellow legged green pigeon	LM	OF
		Columba livia intermedia	Blue Rock Pigeon	R	C.F.
		Streptopelia decaocto	Indian Ring Dove	R	O
Columbiforms	Columbidae	*Streptopelia tranque baraca*	Red Turtile Dove	R	O
		Stveptopelia chinensis surantemsis	Spotted Dove	R	C
		Streptopila Senegalensis Cambayensis	Little Brown Dove	R	C
		Chalcophas indica indica	Emeraldd Dnv«o	C	O
		Psittacula eupatria eupatria	Large Alexandrine Parakeet	LM	U
Psittaciformes	Psittacidae	*Psittacula krameri manillensis*	Roseringed Parakeet	R	C.F.
		Psittacula Cyanocephala	Blossomheaded Parakeet	R	OF
		Loriculuc vernalis	Indian Lorikeet	R	U
		Clamator Coromandus	Redwinged Crested	B.M.	C
Cuculiformes	Cuculidae	*Clamator jacobinus serratus*	Pied Crested Cuckoo	B.M.	C
		Cuculus varius varius	Common Hawk, Cuckoo or Brain Fever Bird	M	O
		Cuculus Micropterus micropterus	Indian Cuckoo	M	O
		Cuculus canorus	Cuckoo	M	O
		Cacomantis sonneratti sonneratti	Indian Baybanded Cuckoo	B.M.	O

Order	Family	Scientific Name	Common English Name	Move-ment	Abun-dance
		Cacomantis Merulinus passezinus	Indian Plaintive Cuckoo	B.M.	O
		Surniculus lugubris dicruroides	Drongo Cuckoo	B.N.	O
		Eudynamys scolopacea	Koel	R	C
		Taccocua leschenaultii	Sipkeer Cuckoo	R	C
		Centropus sinensis parroti	Gow Pheasant or Coucal	R	C
		Tyto alba stertens	Barn Owl	R	O
Strigiforms	Strigidae	*Otus scops*	Scops Owl	R	O
		Bubo bub	Great Horned Owl or Eagle Owl	R	O
		Bubo zeyionensis	Brown Fish Owl	R	U
		Glaucidium radiatum	Barred Jungle Owlet	R	C
		Athene brama brama	Spotted Owlet	R	C
		Asio flammeus	Shorteared Owl	M	O
		Caprimulgus indicus	Indian Jungle Nightjar	R	O
Carrimulgiporns	Carrimulgidae	*Caprimulgus asiaticus*	Common Indian Nightjar	R	O
		Apus affinis	House awiff	R	C.F.
Apodiformes	Apodidae	*Cypsiurus parvus batasiensis*	Palm swift	R	C.F.
		Harpactes fasciatus legerli	Central Indian Trogon or Malabar Trogon	R	U
Trogoniformes	Trogonidae	*Ceryle rudis*	Lesser Pied Kingfisher	R	C
Coractiformes	Alcedinidae	*Alcedo atthis taprobana*	Small Blue or Common Kingfisher	R	C
		Ceyx erithacus	Three Toed Kingfisher	R	C
		Halcyon smyrnesis fusca	White Breasted Kingfisher	R	C
		Halcyon Pileata	Black Capped Kingfisher	L.M.	C
		Merops Philippinus	Blue Tailed Bee-eater	P.M.	OF
	Meropidae	*Merops Orientails Orientails*	Green Bee-eater	MR	C.F.
		Coracias benghalensis indica	Indian Roller or Blue Jay	LM	C
	Coracudae	*Upupa-Epops*	Hoopoe	M	C
	Upupidae	*Tockus griseus*	Malabar Indian Grey Hornbill	R	O
	Bucrotidae	*Megalaima Zeylanica inornata*	Large Green Barbet	R	C
Pictformes	Capitonidae	*Megalaima huemacephala indica*	Crimsonbreasted Barbet or Copper smith	R	C
	Picidae	*Jynx torquilla*	Wryeck	M	O

Order	Family	Scientific Name	Common English Name	Move-ment	Abun-dance
		torquilla			
		Micropternus brachyurus jerdonil	Rufous Wood Pecked	R	C
		Dinopun benghalense tehminae	Lesser Gold Backed Wood Pecker	R	C
		Dinopium Javanense	Indian Goldenbacker Three Toed Wood Pecker	R	C
		Dryocopus Javensis	Indian Great Black Wood Pecker	R	O
		Picoides mahraltensis	Yellow Fronted Pied or Maratha Wood Pecker	R	O
		Picoides hunus hardwickil	Brownarouned Pygmy Wood Pecker	R	O
		Hemicirecus canente	Heart Spotted Wood Pecker	R	U
		Chrysocolaptes lucidus	Larget Golden Backed Wood Pecker	M	U
		Chrysccolaptes fistivus	Black Backed Wood Pecker	R	U
		Pitta brachyura	Indian Pitta	PM	RO
Passerofpres	Pittidae	*Mirafra erythroptera*	Redewinged Bush lark	R	O
		Eremopterix grisea	Ashycrowned finch-larK	R	C
		Ammomanes phoenicurus	Rufoustailed finch lark	R	C
		Galerida malabarica	Malbar Gested lark	R	C
		Aluuda gulgula	Small or Eastern Skylark	R	O
		Hirundo concolar	Dusky Carg martin	M	C
	Harundinidae	*Hirundo rustica*	Swallow	M	C.F.
		Hirundo srnithii filifera	Wiretailed swallow	R	OF
		Hirundo dawrica nipalensis	Straited swallow	M	C.F.
		Hirundo dawrica erythropygia	Redrumped swallow	R	O
		Lanius schach erythronotus	Rufous backed shrika	M	C
	Lanidae	*Oriolus oriolus*	Golden Oriode	LMR	C
	Oriolidae	*Oriolus xanthornus*	Blackheaded onde	R	C
		Dicrurus adsimilies macrocercus	Black Drongo or king Crow	R	C
	Dicruridae	*Dicrurus leucophaeus longicaudatus*	Grey or Ashy Drongo	M	C
		Dicrurus aeneus aeneus	Bronzed Drongo	LM	U
		Dicrurus hottentottus	Haircrested Drongo	RS	U

Order	Family	Scientific Name	Common English Name	Move-ment	Abun-dance
		Dicrurus paradiseus	Large Racket tailed Drongo	R	O
		Artamus fascus	Ashy Swallow shrike	R	OF
Passerofpres	Artamidae	*Sturnus malabaricus*	Grey headed Myna	MR	OF
	Sturnidae	*Stunus pogodurum*	Black headed or Byahmnya Myna	MR	OF
		Sturnus roseus	Rosy pastor, or rosy starling	M	C.F.
		Sturnus contra	Pied Myna	R	O
		Acridotheres tristis	Common Myna	R	C.F.
		Acridotheres fuscus maharattensis	Jungle Myna	R	OF
		Gracula religiosa indica	Grackle or Hill Myna	S	U
		Dendrocitta vagabunda	Indian Tree Pie	R	O
	Corvidae	*Corvus splendens splendens*	House Crow	R	C.F.
		Corvus macrorhynahos culminatus	Jungle Crow	R	C
		Tephrodornis pondicerianus	Common wood shrike	R	C
	Campehagidae	*Coracina novachollandiae mecei*	Large cuchooshrike	R	O
		Coracina melanoptera sykesi	Blackheaded cuckooshrike	R	C
		Pericrocotus flammeus	Scarlet minivet	R	O
		Pericrocotus cinnamomeus	Small Minivet	R	C.F.
		Aegithina tipha multiculor	Common lora	R	C
	Trenidae	*Chloropsis aurifrons frontalis*	Gold fronted choropsis	R	O
		Chloropsis cochinchinensi jerdoni	Jerdons or Goldmantled chlopasis	R	O
	Trenidae	*Pycononofus jocosus fuscicaudatus*	Redwhiskered Bulbul	R	C
Passerofpres	Pycononotidae	*Pycononotus leucogenys leucotis*	White eared Bulbul	R	U
		Pycononotus cafer cafer	Redvented Bulbul	R	C
		Pycononotus luteolus luteolus	White browed Bulbul	R	O
		Pellorneum ruficeps ruficeps	Spotted Babbler	R	C.F.
	Muscicapidae	*Pomatarhinus schisticeps horsfieldii*	Slaty headed Scimitar Babbler	R	O

Order	Family	Scientific Name	Common English Name	Move-ment	Abun-dance
	Sub-family - Timalinae	*Dumetia hypezythra*	Rufous bellied babbler	R	C
		Chrysomma sinense siense	Yelloweyed Babbler	R	C.F.
		Turdoides caudatus	Common babbler	R	C
		Turdoides rnalcolmi	Large Grey Babbler	R	C
		Turdoies strlatus	Jungle Blabbler	R	C
		Alcippe poioicephala brucei	Quaker Babbler	R	C.F.
		Musciacapa pazva	Western Redbreasted flycatcher	M	O
	Sub-family - Musciapinae	*Muscicapa tickelliae*	Tickell's Blue flycatcher	LM	O
		Muscicapa thalassina	Verditer flycatcher	M	O
		Muscicapa latirostvs	Brown flycatcher	LM	O
		Culicicapa ceylonensis calochrysea	Grey headed flycatcher	M	O
		Rhipidura albicollis albogularis	White spotted fantail	R	C
		Terpsiphorie paradisi	Paradise flycatcher	MR	O
		Monarcha azurea styani	Blacknaped flycacher	R	O
		Cisticola juncidis cursitans	Stveaked fantail warbler	BM	O
	Sub-family - Sylviinae	*Prinia hodgsonii*	Franklin's wren warbler	R	C
		Prinia subflava inarnata	Plain wren warbler	R	C
		Prinia socialis	Ashy wren warbler	R	C
		Prinia sylvatica	Jungle wren warbler	R	C
Passerofpres		*Orthotornus sutorius gusuratus*	Tailor Bird	R	C
		Acrocephalus stentoreus brunnescens	Indian Great Reed warbler	MR	O
		Acrocephalus dumetorum	Blyth's Reed warbler	M	C
		Acrocephalus aqricola	Paddyfield warbler	M	O
		Hippolais caligata caligata	Booted Treewarbler	M	O
		Syivia curruca blythi	Lasser whitethroat	M	O
		Phylloscopus collybita	Brown leafwarbler or chiffchaff	M	O
		Phylloscopus tytleri	Tytler's leas warbler	M	O
		Phyllascopus inornatus	Yellow browed leaf warbler	M	O
		Phylloscopus biochiloides viridanus	Dull Green Leaf Warbler	M	O

Order	Family	Scientific Name	Common English Name	Move-ment	Abun-dance
		Erithacus avecicuc	Blue throat	M	C
	Sub-family - Turdinae	*Copsychus saularis saularis*	Magpie Robin	R	C
		Copsychus Malabaricus	Shama	R	O
		Saxicoloides fulicata intermedia	Indian Robin	R	C
		Monticola Cinclothynchus	Blue headed Rock Thrush	M	O
		Monticola Solitarius pandoo	Blue Rock Thrush	M	O
		Myiophonus horsfieldil	Malabar whisting Thrush	R	C
		Zoothera Citrina cyanotus	White throated Ground Thrush	R	O
		Turdus herula Nigropileus	Blackbird or Black caped	LM	O
		Anthus trivialis trivialis	Tree Pipit	M	C.F.
	Family - Motacillidae	*Anthus godlewskii*	Blythe pipit	M	OF
		Motacilla citreola citreola	Yellow headed wagtail	M	C.F.
		Motacilla alba dukhunensis	White or pide Wagtail	M	C.F.
		Dicaeum ezythrorhynchos	Tickell's flower	R	C
		Dicaeum agile	Thickbilled flower pecker	R	O
	Family - Nectarinida	*Nectarinia Zeylonica sola*	Purplerumped sunbird	R	C
		Nectarinia lotenia hindustanica	Lotn's sunbird	R	O
Passerofpres		*Nectarinia asiatica asiatica*	Purple sunbird	R	C
		Aethopyga siparaja vigorsii	Yellow backed Sunbird	R	U
		Passer domesticus indicus	House Sparrow	R	C.F.
	Family - Ploceidae	*Petonia xanthocllis zanthocllis*	Yellow throated Sparrow	R	C.F.
	Sub-family - Passerinae	*Ploceus philippinus*	Baya or weaver Bird	BM	C.F.
	Sub-family - Ploceinae	*Estrilda amandava amandava*	Red Munid or Avadavat	R	OF
		Lonchura malabarica	White throated Munia	R	C.F.
		Lonchura striata	White backed Munia	R	C
		Lonchura Punetulata	Spotted Munia	R	C.F.
		Lonchura malacca	Blackheaded Munia	R	OF
		Carpodacus erythrinus roseatus	Common Rosefinch or Scarlet Grosbeak	M	C.F.

Order	Family	Scientific Name	Common English Name	Move-ment	Abun-dance
	Family - Fringllidae	*Emberiza melanoc eahala*	Blackeaded Bunting	M	C.F.

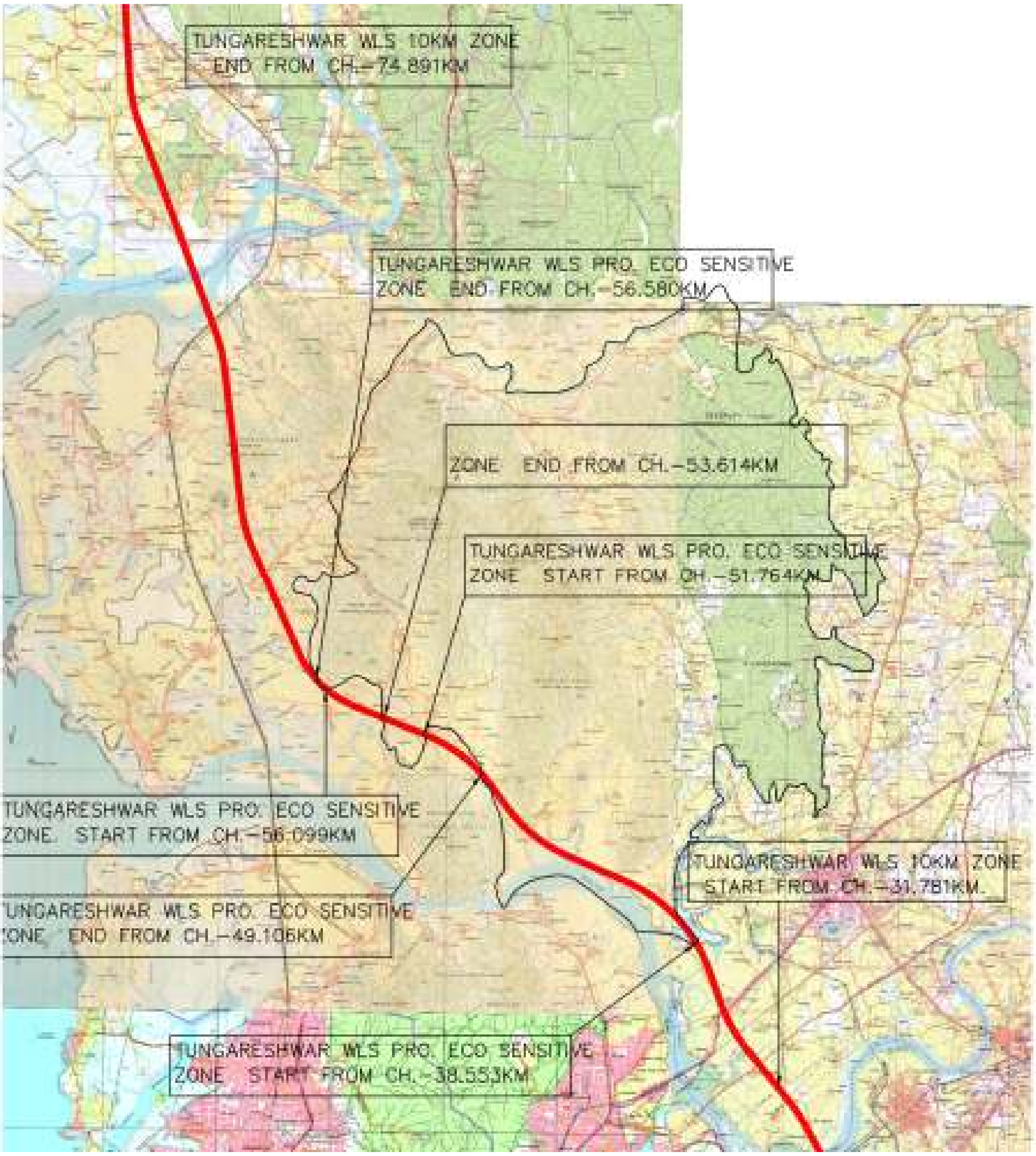
Source: SGNP Management Plan

R-Resident, M-Winter Migrant, MR-Migrant But Some Breed Here, LM-Local Migrant, BM-Breeding Migrant, PM-Passage Migrant, S-Stray or vagrant, RS-Stray Record(s) But Resident In Neighbouring Areas, C-Common, O-Occasional, U-Uncommon, F-In Flocks*

(15) Tungareshwar Wildlife Sanctuary (TWLS)

Another ESA through which the proposed MAHS Rpasses is TWLS. The TWLS falls between longitude $72^0$52’ E to 73^0 E and latitude 17^0 00′N to $19^0$28’ N. It is situated in Thane district of Maharashtra State and under the administrative control of Conservator of Forest and Director SGNP Division, Borivali (Mumbai).The total Notified area of 85.70 sq. km. has been declared by Maharashtra Government vide Resolution No.WLP 10-02lCR-47/F-1 dated 24th October 2003.The protected forest 917.305 ha. and unclassified forest 37.140 ha. in small patches around TWLS was handed over to Sanctuary staff for protection and management as per C.C.F. order dated 1.11.2003. Total area under management of TWLS is 95.24sq.km. ESZ of TWLS has not yet delineated. The authenticated map of Tungareshwar Wildlife Sanctuary showing the MAHSR alignment is depicted in Exhibit 4.15.6.

Exhibit 4.15.6: Tungareshwar Wildlife Sanctuary and MAHSR Alignment



Source: RITES Study Team

<u>Significance</u>

TWLS is a tiny green tract amid thickly populated and situated in Thane district. The area protects the catchments of Pelahar Dam, Juchandra M.I.Tank which supplies water to Vasai and Nallasopara Municipal Corporations.

<u>Biological Values</u>

The vegetation of this area ranges form semi evergreen forests to western sub-tropical hill forests. A large number of vertebrate and invertebrate speciesbelongs to various classes and orders are only indicators of immense biological diversity of this area. This area is a natural home for many endangered faunal species.

Ecological Values

This area represents unique and fragile ecosystem and it belongs to one of the least represented biogeographic zone *i.e.* Malabar Coast of Western Ghat. This area acts as a carbon sink for Vasai, Nallasopara, Virar and Bhivandi Corporation.

Archeological and Religious Values

The ancient Tungareshwar Mahadev Temple, Parashuram Kund, Ishwarpuri Mahadev Mandir are located within the sanctuary. Lakhs of pilgrims visit Tungrashwer Mahedev Temple during Mahashivratri and auspicious Shravsn month. Small caves like structure chiseled in volcanic rocks are popularly known as Parashuram kund. Ishwarpuri Mahadev temple is situated in northern part of sanctuary, near Chandip village.

Recreational and Educational Values

The unique location of this area makes it a center of attraction to thickly populated surrounding urban areas. A large number of visitors come to this area every year for religious reasons and hilly terrain covering up with thick forest and variety of fauna attracting researchers, and students. It is paradise for nature lovers. Visitors receive the message of wildlife conservation.

Biogeographical Zone

Within the context of the World Conservation Strategy (lUCN, 1980), a system of selecting protected areas on the basis of well-founded bio-geographic principles is an important tool in evaLuating conservation efforts and for determining priorities for future action. The bio-geographic classification developed at the WII, Dehradun has recognized 10 broad bio-geographical zones of India. Within these zones, there are 25 biotic provinces. TWLS belongs to 5 A - Malabar Plains.

Species of Conservation Importance

Dalbergia latifolia (Shisam) - It is sparsely found species in the TWLS. It is an evergreen species, *Panthera pardus (Leopard or Panther), Muntiaeus muntyale (Barking Deer or muntyle or Bhakar), Bubo zeylonenisis, Garcinia indica (Kokam), Leopard, Barking Deer (Bhekar), Brown fish owl, Mottled wood owl, Blue Mormon, Atlas Moth- The breeding site for atlas moth needs effective conservation.*

Forest Types

According to the revised classification of forest types of India by Champion and Seth, the forests of TWLS represent the following forest types:

3 B/C1Southern moist teak bearing forests

3 B/C2Southern moist mixed deciduous forests

8 A/C2Western sub-tropical hill forests.

3 B/C1 Southern Moist Teak Bearing Forests

The moist teak bearing forests exists where the soil condition is relatively better. Density of the crop is generally above 0.4 and it goes upto 0.7. The forests are mostly concentrated in Chinchoti and Majivali rounds.

Important tree species of this forest type include *Tectona grandis*(Teak),*Lannes grandis*(Shemat), *Schleichera oleosa* (Koshimb), *Mimusops hexandra* (Ranjan), *Mangifera indica* (Amba), *Adina cardifolia* (Hed), *Pterocarpus marsupium* (Bija), *Bombax malabaricum* (Sawar), and *Syzygium cumini* (Jambul).

Important shrubs include *Carissa carandus* (Karvand), *Helicteres isora* (Murudsheng), *Adhatoda vasica* (Adulsa), and *Thespesia lampas* (Ranbhendl). The climbers are *Abrus precatorius* (Gum), *Climatis triloba* (Ranjai), *Zizyphus rugosa* (Toria). Bamboo species found in the forests are *Dendrocalamus strictus* (Man vef), *Bambusa arundinacea* (Katas). Important grass species are *Cynodon dactylon* (Harall), *Dicanthium anulatum* (Ranbangdl), *Coix gigantean* (Ranjondhala), *Eragrostis spp.*(Darbha)and *Panicum glabrum* (Varai).

3 B/C2 Southern Moist Mixed Deciduous Forest

The Southern moist mixed deciduous forests are profusely found in the area. Teak is occasionally found in low proportions. The density varies from 0.4 to 0.7. Clumps of manvel bamboo (*Dendrocalamus strictus*) and Katas Bamboo (*Bambusa arundinacea*) are found in the area. The soil is deep, loamy, and generally rich in humus content. The semi evergreen species found in this forest type are mango, lokhandi, shendri, Khair, koshimb Bamboo is mostly localized along the nalla courses in Sativali and Majivali forests.

8 *AlC2* Western Sub-tropical Hill Forests

These are supposed to be few of the remnant patches of natural forests of higher elevations that occur on low lying hills.The western sub tropical hill forests are found in small patches at high altitude. Density is around 0.6. It is semi-evergreen type of forest with many evergreen species present in the crop. The Bamboo is typically absent. The floristic include, besides climbers, orchids and ferns: *Mangifera indica* (Mango), *Pongamia pinnata* (Karanj), *Gardenia indicia* (Kokomo), *Syzygium cuminii* (Jarnbul), *Calophyllum inophyllum* (Undi), *Sideroxyton tomentosum* (Kate Kumbal). *Ixora* (Lokhandi) and *Murraya paniculata* (Pandari) are noticed at higher elevation. Innumerable species of grasshoppers, bugs, mosquitoes, beetles, termites', mantises, bees, hornets, wasps, cockroaches, cicadas, aphids, moths and butterflies, dragonflies and damselflies, leaf insects and stick insects are seen in the area. This area boasts to harbour almost 150 butterfly species. September to January is the best time to observe them. The vertebrate fauna of the area includes 43 species of Mammals, 250 species of birds, including the migratory land and water birds, 38 species of reptiles and 9 species of amphibian.

Mammals

Wildlife Habitats in TWLS supports a number of species of herbivores, carnivores and omnivores. Nearly 43 species of mammals belonging to 7 natural orders and 17 families are seen in the Sanctuary. Out of these 8 species are of "Endangered Status" and are included in the Schedule-1 and Part-II of Schedule-II of the Wildlife Protection Act, 1972. The status of endangered species reported in the TWLS is presented in Table 4.15.9.

Table 4.15.9: Endangered Faunal Species

Sr. No.	Common Name	Scientific Name
1	Panther or Leopard	*Panthera pardus*
2	Rusty-Spotted Cat	*Felis rubiginosa*
3	Jungle Cat	*Felis chaus*
4	Small Indian Civet	*Viverricula indica*
5	Common Palm Civet	*Pardoxurus hermaphroditus*
6	Mouse Deer	*Tragulus meminna*

Source: Management Plan of TWLS

Small Herbivores

Small herbivores have not been studied in this area. The common is black-napped hare and crested porcupine.

Primates

Three species of monkeys *viz.* the Bonnet macaque, the Rhesus macaque and the common or Hanuman langur occur in the area. The Bonnet monkey is common in many parts.

Bats

This area has seven species of bat. Brosset (1962) studied extensively all the seven species of bats from this area and published his findings in his book - "The Bats of Central and Western India" (Published by the B.N.H.S.) His records include all three species of fruit-eating bats (Megachiroptera).

Avifauna

This area attracts summer and winter migratory birds. Two water bodies and Bazarmal plateu are ideal for bird watching. Black headed gulls, stilt, harriers *etc.* are commenly seen. In Compartment No. 1080, there is rocky place which is known as "Gidda kadak". Accouding to Shri Zanje, Round Officer, who is serving in this area for decades, "Gidda Kadak" rocks were nesting and perching site area of "Vultures" before 1995. Now hardly any vulture is seen in this area. This is subject matter of research.

Reptiles

The reptiles of the Sanctuary are covered under three orders and fourteen families. In the Sanctuary there are thirty-eight species of reptiles of which seven are of "Endangered Status" and are included in Schedule I and Part II of Schedule I of Wildlife Protection Act.1972. These are given in Table 4.15.10.

Table 4.15.10: Endangered Reptiles

Common English Name	Scientific Name
Indian Rock Python	*Python molurus*
Dhaman or Rat snake	*Ptyas mucosus*
Indian Cobra	*Naja Naja*
Russel's Viper	*Vipera russelli*
Checkered keel back	*Natrix piscatar*
Common monitor	*Varanus monitor*

Source: Management Plan of TWLS

Amphibian

The Tungar hill with its perennial pools of water has a variety of frogs and toads. Besides the common ones such as the tree frogs, the bullfrog and common toad, the uncommon toad (*Ramanella montana*) has been recorded in the area. In the cisterns in the rocks around the parshuram kund a few interesting species of frogs have been recorded including the six-toed frog and the skipper frog. Common during the rains are the extraordinary tadpoles of *Rana loithi* capable of swimming upstream. In all, nine species of amphibia belonging to four different families are seen in the area. Three species of tortoise have been reported in the Sanctuary. The eleven species of lizards found in this area includes the chameleon and the monitor lizard. There are twenty-three species of serpents seen in the Sanctuary. Out of which seven species are of "Endangered Status" and are included in the Schedule-I and Part-II of Schedule-II of Wildlife Protection Act, 1972.

(16) Site Specific Ecosystem

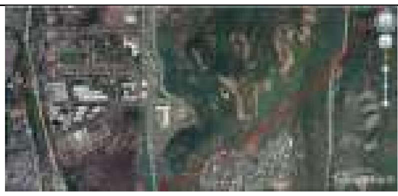
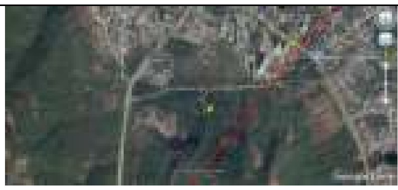
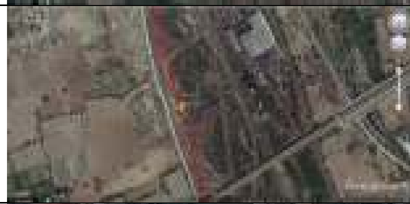
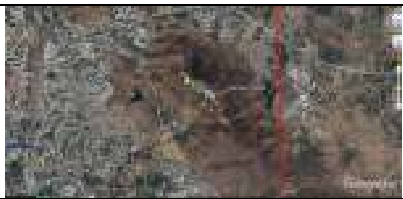
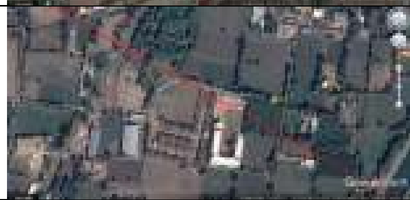
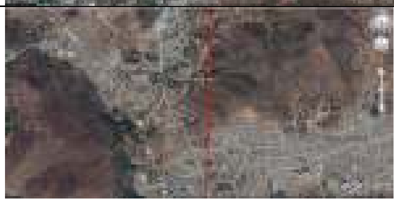
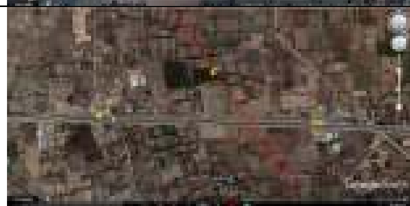
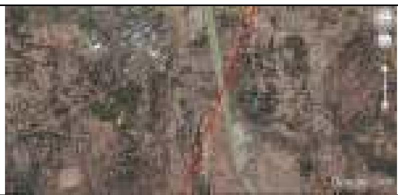
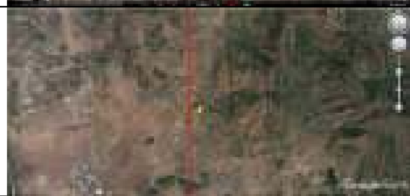
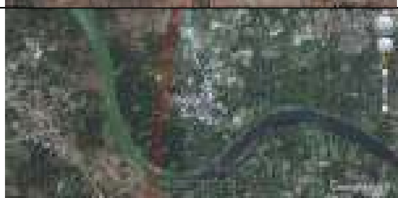
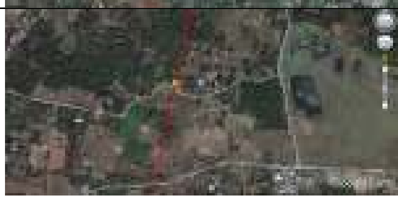
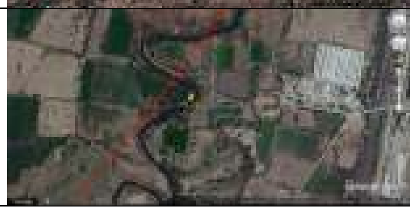
India represents great geological, geo-morphological, climatic, biotic and cultural diversity and so is the states Maharashtra and Gujarat to which the present project belongs. The vast diversity of climatic features and habitats has lead to the occurrence of a wide variety of flora and fauna, and agi-horticultural crop also. The details of the sites studied are enumerated in Table 4.15.11 and shown in Exhibit 4.15.7.

Table 4.15.11: Geographical location of the Study sites

Location Code	Location	District	State	Geo-Coordinates	
				latitude	Longitude
TE 1/I	Shilphata	Thane	Maharashtra	19° 7'30.66"N	73° 1'26.86"E
TE 2/II	Ganesh Mandir Pipeline Road	Thane	Maharashtra	19° 8'21.42"N	73° 2'27.23"E
TE 3/III	Jiv Dani, Virar	Thane	Maharashtra	19°28'0.43"N	72°51'42.71"E
TE 4/IV	Village Valaipada	Thane	Maharashtra	19°25'54.23"N	72°50'6.36"E
TE 8/V	NH8 X-ing near Amagaon village	Palghar	Maharashtra	20°11'12.16"N	72°53'8.77"E
TE 9/VI	Vajifa Falia- Panchayat	Navsari	Gujarat	20°44'49.83"N	73° 0'14.68"E
TE 10/ VII	Village Khajurdi	Valsad	Gujarat	20°38'52.94"N	72° 59'05.67"E
TE 12/ VIII	Village Rajupur Vasad, Near Experimental Farm Research Centre, ICAR, Vasad	Anand	Gujarat	22°27'28.07"N	73° 04'45.78"E
TE 13/ IX	Barejadi Village	Ahemdabad	Gujarat	22°53'39.98"N	72°39'45.96"E
TE 14/X	Sardar Patel Ring Road	Ahemdabad	Gujarat	22°56'28.95"N	72°38'6.73"E
TE 15/XI	EURO School Nadiad	Kheda	Gujarat	22°39'45.17"N	72°51'33.22"E
TE 16/ XII	NH-8 Near Zarol Village	Kheda	Gujarat	22°42'46.74"N	72°47'41.17"E
TE 17/ XIII	Padghe	Palghar	Maharashtra	19°44'46.66"N	72°47'32.60"E
TE 18/ XIV	Village Jalsar	Palghar	Maharashtra	19°32'3.79"N	72°48'38.80"E
TE 19/ XV	Vishwamitri rive, Village - Manje	Vadodhara	Gujarat	22°13'48.81"N	73°10'11.84"E

Source: Study Team

Exhibit 4.15.7: Ecolgical Study Sites

Location Code	Image	Location Code	Image
TE 1/I		TE 13/ IX	
TE 2/II		TE 14/X	
TE 3/III		TE 15/XI	
TE 4/IV		TE 16/ XII	
TE 8/V		TE17/ XIII	
TE 9/VI		TE 18/ XIV	
TE 10/ VII		TE 19/ XV	
TE 12/ VIII			

In this study out of 10 bio geographic zones, two *viz*., Semi-arid prominently in Gujarat and Deccan Peninsula are evidently present. Following Roy *et al* (2006), Tropical Moist Forest, Topical Dry Forest and Tropical Thorn Woodland biomes are evident in the area. According to the Ministry of Environment Forest and Climate Change (MoEF&CC), Government of India (MoEF&CC 2009), the study area belongs to the 4B Semi-arid and 6A Deccan Peninsular – Central Highlands. According to Champion and Seth (1968), the area has broadly the following major group and sub- group of forests:

1. Moist Tropical Forest: (i) Group Tropical Semi-evergreen Forest,
   Sub-group C2- West Coast semi-evergreen forest-*Terminalia paniculatess;*

   (ii) Tropical Moist Deciduous Forest,
   Sub-group 3B South Indian Moist Deciduous Forest (C_1 Moist Teak bearing Forest) E5 *Butea* Forest – *Butea monosperma*, 8a-*Phoenix savanna – Phoenix sylvertris.*

   (iii) Tropical Thorn Forest 6.7 General edaphic, degraded and seral types of moist deciduous forest.

In regard to grassland / grazing lands, the area includes tropical *Sehima – Dichanthium* cover and too sub-tropical covers, *viz*., *Dichanthium – Cenchirus – Lasiurus* and *Phragmites – Saccharum – Imparata.* Due to local variations in microclimate, topography, soil and biotic pressure a myriad and distinct or transitional community occur within the potential area of each of these major types.

Climate

The area enjoys the widespread monsoon climate with maximum rains falling between July and September, the post-monsoon period of October – November, a winter season of December to middle of February with low winter shower, and a dry hot summer season of April and June. Hail storms and fog occur to its least during winters.

Soil

The soils are red and yellow (laterites) that occur together in a large land area. The soils are acidic to alkaline in reaction. At places, skeletal soils, *i.e.* gravel soil of upland, also occur. Nutrient –wise, these soils are generally poor, though some patches of good black soils are also met with during the site study.

Land Use

It is predominantly forest, barren (degraded) and agricultural land. Forests are dense towards Maharashtra. The grazing lands / grasslands are generally available on degraded lands as (i) an outcome of deforestation, followed by grazing and burning, and (ii) abandoned cultivation. The thorn forests are hard leaved and dominated by *xerophytes species*. The canopy is more or less broken and less than 10 m high. The tree are short boled and have low branching crown. Number of species is usually small but mixed. The climbers and *epiphytes* are scarce. The grass growth is abundant during rainy reason only.

The on-site features of the study sites are illustrated in Exhibit 4.15.8.

Exhibit 4.15.8: On-Site Features of the Study Sites

Growth of *Citrullus Sp*. in waste land

Growth of *Gak* (*Calotropis Procera*) in xeric condition on waste land

A view of X*erophytic* species- *Capparis aphylla* in area around Anand

A view of *hydrophytic* species- *Typha angustifolia saccharum spontaneum* at river bank Vittal Nagar

Growth of *Livasivealien speciesConvolvulus* on the depression of roadway side

Seasonal water area- A potential source as habitat for water birds.

A view of Biswamitri river, near IDC Vittal Nagar, Vadodara.

Growth of *Polygonum Sp*. along Biswamitri River Bank

Growth of invasive alia species- water-*Hyaanth (Eichhornia craceps)* along Biswamitri river

Pipal (*Ficus religiosa*) religious species valued by local people in rituals.

A view of Tribal Village Uplar, Amgaon.

Growth of Palm (*Phoemix*) near tribal village Uplar, Amgaon

A view moist semi-evergreen forest at village Safale, near Palghar

Growth of Palm (*Phonexi*) around village Safale.

An unidentified Shrub species common in and around village Safaleon way riders

Growth of complete *parasitic species* Vanda a tree branch in degraded forest at village Safale Palghar

Gap Plantation activities a degraded forest land at and near Osarvira area in planted teak site.

A panoramic view of National recovery of tree species an degraded site used as grazing land by the villagers

Source: Study Team

Flora

The species categories as recorded in the study sites, are enumerated in Table 4.15.12. In all 137 higher plant species were recorded comprising of Tree species (24), Grass and sedge species (24), Herbs (19), Shrubs (18), Leguminous herb (6) and Climbers (6).

Table 4.15.12: Floral Species of the study sites

Scientific Name	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
(A)Tree Species															
Acacia nilotica	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Acacia leneophloea	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ailanthes excelia	+	+	+	-	-	-	+	+	+	+	+	+	+	+	+
Albizza lebbelc	+	-	+	+	-	-	-	-	-	+	+	+	+	+	+
Angle marmelos	+	-	+	+	+	+	-	-	-	+	+	+	+	+	+
Anogeissun pendula	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Azadhirachta indica	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Buter nonosperma	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Dalbergia sissoo	+	-	+	+	-	-	+	+	+	+	+	+	+	+	+
Diospyros melanoxylon	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Emblica officinalis	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Ficus benglensis	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ficuc religiosa	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Holoptelia integrifolia	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
Lagestromia Parviflora	-	-	-	+	+	+	-	+	+	+	+	+	+	+	+
Madhuca indica	+	-	-	+	-	-	-	+	+	+	+	+	+	+	+
Melia azaderach	+	-	-	+	+	-	-	+	+	+	+	+	+	+	+
Pithocalobium Dulche	+	-	-	+	+	-	-	+	+	+	+	+	+	+	+
Syzygium cumini	+	-	+	+	+	+	-	+	+	+	+	+	+	+	+
Tectona grandis	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+
Terminalia arjuna	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+
Bombax ceiba	+	-	-	+	+	-	+	+	+	+	+	+	+	+	+
Toona sp.	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+
Phoenix sp.	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+
(B)Shrub Species															
Prosopis juliflora	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Dendrocalamus strictus	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Zizyphus mausitiana	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Zizyphus xylopara	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Adhatoda vasica	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+
Salvdora oleoroides	+	+	+	-	-	-	+	+	+	+	+	+	+	+	+
Euphorbia royleana	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+
Calotropis procera	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Convulvulus sp.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ipomola sp.	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Cassia tora	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Lantana camara	+	+	+	+	+	+	-	-	-	-	-	+	+	+	+
Nyctanthes-arbor-tritis	-	-	+	+	+	+	-	-	-	-	-	+	+	+	+
Woodfordia sp.	-	-	-	+	+	+	-	-	-	-	-	+	+	+	+
Bauhinia vahlii	-	-	-	+	+	+	-	-	-	-	-	+	+	+	+
Erythrina sp.	-	-	-	+	+	+	-	-	-	-	-	+	+	+	+
Capparis aphaylla	+	+	+	-	-	-	-	+	+	+	+	+	+	+	+

Scientific Name	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
Jatropha curcas	-	-	-	+	-	-		+	+	+	+	-	-	-	-
(C) Climber Species															
Vilis	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
Cissampelos sp.	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
Tinospora cordifolia	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Smilex sp.	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Dioscorea bulbifera	-	-	+	+	+	+	+		-	-	-	-	+	+	+
Cuscuta reflexa	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+
(D)Herb Species															
Asparagus filicinus	+	+	+	-	-	-		+	+	+	+	+	+	+	+
Datura stramonium	+	+	+	+	+	+		+	+	+	+	+	+	+	+
Datura metel	+	+	+	-	-	-	-	+	+	+	+	+	+	+	+
Dicliptera spp.	+	+	+	+	-	-	-	+	+	+	+	+	+	+	+
Oxalis corniculata	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+
Solanum nigrum	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+
Ageratum conyzoides	+	+	+	+	+	+		+	+	+	+	+	+	+	+
Euphorbia hirta	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Euphorbia emochi	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sonchus spp.	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Commelina benghalensis	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Ranunculus acris	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Galium sp.	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Lathyrus aphaca	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+
Argemone mexicana	+	+	+	-	-	-	+	+	+	+	+	+	+	+	+
Polygonum plebeium	-	-	+	+	-	-	-	+	+	+	+	+	+	+	+
Eichhornia crassipes	-	-	+	+	-	-	-	+	+	+	+	+	+	+	+
Cardamine sp.	-	-	-	+	+	+	-	-	-	-	+	+	+	+	+
Typha angustifolia	-	-	+	+	-	-	-	-	-	-	+	+	+	+	+
(E)Leguminous Herbs															
Astragallus spp.	-	-	+	+	+	-		+	+	+	+	+	+	+	+
Desmodium multiflorum	-	-	+	+	+	+	-	+	+	+	+	+	+	+	+
Indigofera sp.	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+
Medicago sp.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Mallotus sp.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Vigna sp.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
(E)Grass and Sedges															
Agrostic sp.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Apluda mutica	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
Bothriochloa intermedia	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
Cenchrus ciliaris	+	+	+	+	+	+		-	-	+	+	+	+	+	+
Chrysopogon fulvus	+	+	+	+	+	+		-	-	+	+	+	+	+	+
Cynodon dactylon	+	+	+	+	+	+		-		+	+	+	+	+	+
Cymbopogon sp.	-	-	-	+	+	+		-		+	+	+	+	+	+
Dichanthium annulatum	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cenchrus setigerus	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Scientific Name	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
Digitaria spp.	+	+	+	+	+	+	+	+		+	+	+	+	+	+
Eleusine indica	-	-	+	+	-	-	+	+	-	+	+	+	+	+	+
Eragrostis spp.	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+
Heteropogon contortus	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+
Imperata cylindrica	-	-	+	+	+	+	+	+	-	+	+	+	+	+	+
Panicum spp.	-	-	+	+	+	+	+	+	-	+	+	+	+	+	+
Saccharum spontaneum	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+
Themeda anathera	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+
Themeda quadrivalvis	+	+	+	+	+	+	-	+	+	+	+	+	+	-	+
Phragmites karka	-	-	+	+	+	+	-	+	+	+	+	+	+	-	+
Poa sp.	-	-	+	+	+	+	-	+	+	+	+	+	+	-	+
Cyperus rotundus	-	-	+	+	+	+	-	+	+	+	+	+	+	-	+
Cyperus sp.	-	-	+	+	+	+	-	+	+	+	+	+	+	+	+
Picrecus sp.	-	-	+	+	-	-	-	+	+	+	+	+	+	+	+
Fimbristylis dichotoma	-	-	+	+	+	+	-	+	+	+	+	+	+	+	+

Source: Study Team

FAUNA

A ground survey was carried out in the impact zone of the proposed project. Important animal groups: butterflies (insects), birds and mammals inhabiting the area were recorded.

For sampling butterflies, the standard 'Pollard Walk method'; for birds 'point sampling' along the fixed transect (foot trails) and for sampling mammals, 'direct count on open width (20m) transect', were used on fixed transects.

This section describes the terrestrial fauna including domestic animals. The description is based on the field investigation and literature review. The domestic animals reported in the study area are mainly mammals reported in Table 4.15.13. In absence of natural forest (National Parks and Sanctuary other than SGNP, TWLS, TCFS), there is a dearth of wild animals in the study area. A list of avifauna, reptiles, amphibians and rodents based on information gathered from local enquiries and State Forest Department is presented in the Table 4.15.14.

TE12

Peacock was found at this location in the Experimental Farm Research Centre established by Indian Council of Agricultural Research, Vasad. Peacock is under Schedule-I as per EPA Act, 1986 and is RET species. The site shows rich bio-diversity both floral and faunal. Langoors were also spotted with large numbers in bajra farm.

TE19

The location is on the outskirt of Maneja village, where industrial area is also located. There is a nallah which falls under the RoW of the proposed alignment. There is abundance of natural vegetation along the bank of nallah which carries the effluent of the industries located in the upstream. With the interaction of a local old man, he informed that there are a number of crocodile in the nallah. Although, we could not visualize it during the visit. He further informed that the crocodile killed a boy few months back at the same spot.

Table 4.15.13: List of Mammals and Livestock reported in the Study Area

S. No.	Zoological Name	Common Name	WPA, 1972 Schedule
1.	*Macaca mulata*	Rhesus macaque	II
2.	*Lepus nigricollis*	Indian Hares	IV
3.	*Vulpes bengalensis*	Indian fox	II
4.	*Semnopithecus entellus*	HanumanLangur	II
5.	*Bandicota indica*	Bandicot rat	IV
6.	*Mus booduga*	Little Indian Field Mouse	V
7.	*Rattus rattus*	House rat	IV
8.	*Funambulus pennantii*	Five Striped Palm Squarrel	IV
9.	*Rhinopoma hardwickii*	Mouse tailed Bat	IV
10.	*Herpestes edwardsii*	Indian Grey Mongoose	II
11.	*Bos indicus*	Zebu Cattle (Cow)	
12.	*Bubalus indicus*	Buffalo	
13.	*Cains familieris*	Dog	
14.	*Capra hircus*	Goat	
15.	*Equus caballus*	Horse	
16.	*Equus hemionus*	Ass	
17.	*Felis domesticus*	Common Cat	
18.	*Ovis areas*	Sheep	
19.	*Sus scrofa domesticus*	Pig	

Source: Study Team

Table 4.15.14: Avifauna, Reptiles, Amphibians, Insects reported in the Study Area

S. No.	Zoological Name	Common Name	WPA,1972 Schedule	IUCN Status
Birds				
1	*Alcedo atthis*	Common Kingfisher	IV	LC
2	*Cuculus micropterus*	Indian Cuckoo	IV	LC
3	*Columba livia*	Rock Pigeon	IV	LC
4	*Corvus splendens*	House Crow	V	LC
5	*Eudyna mysscolopaceae*	Asian Koel	IV	
6	*Prinia hodgsonii*	Grey-breasted Prinia		LC
7	*Pycnotus jacosus*	Red-whiskered Bulbul	IV	
8	*Ploceus philippinus*	Baya Weaver	IV	LC
9	*Pavo cristatus*	Peacock pheasants	I	LC
10	*Streptopelia chinensis*	Spotted Dove	IV	
Reptiles				
1	*Calotes versicolor*	Garden lizard	IV	
2	*Varanus salvator*	Water Monitor lizards	I	LV
3	*Bangarus caerulus*	Common Krait	IV	
3	*Naja naja*	Spectacled Cobra	II	LV
4	*Ptyas mucosa*	Rat Snake	II	
Amphibian				
1	*Bufo melanostictus*	Toad	IV	LC

S. No.	Zoological Name	Common Name	WPA,1972 Schedule	IUCN Status
2	*Rana cyanophlyctis*	Skipper Frog	IV	LC
3	*Rana tigrina*	Indian bullFrog	IV	LC
Butterfly and Insect Species				
1	*Coccinella transversalis*	Lady beetle	IV	
2	*Musca domestica*	Common housefly	V	
3	*Camponotus sp.*	Carpenter Ant	V	
4	*Apis dorsata*	Giant Honey Bee		
5	*Atteva fabricella*	Moth	I	
6	*Hypolimnas missippus*	Danaideggfly	II	
7	*Acraea violae*	Tawny Coster	II	
8	*Catopsilia pyranthe*	Mottled emigrant	II	
9	*Eurema brigitta*	Small grass yellow	II	LC
10	*Atrophaneura aristolochiae*	Common Rose	I	
11	*Graphium agamemnon*	Tailed Jay	I	
12	*Tarucus nara*	Striped Pierrot	I	
13	*Diplacodes trivialis*	Dragonfly	V	LC
14	*Ictinogomphus rapax*	Dragonfly	V	LC
15	*Hippa salycosina*	Spider	V	
16	*Danaus genutia*	Tiger	I	
17	*Junonia lemonias*	Lemon Pansy	I	
18	*Papiliode moleus*	Common Lime Butterfly	I	
19	*Graphium nomius*	Spot swordtail	II	
20	*Aporia agathon*	Blackvein	IV	
21	*Pieris brassicae*	Large white	II	
22	*Ceporanerissa phryne*	Gull	II	
23	*Ixias pyrene*	Yellow orange tip	I	
24	*Surendra quercetorum*	Common acacia blue	II	
25	*Tirimala septentrionis*	Dark blue tiger	II	
26	*Neptis hylas*	Common sailor	II	
27	*Byblia ilithyia*	Spotter joker	II	

Source: Study Team

AGRI-HORTICULTURAL DIVERSITY

Table 4.15.15 summarizes domesticated species diversity across study sites, unfortunately, the cultivation of soil fielding species is least whereas a good species number (7) of forest – fielders exist in the area.

Table 4.15.15: Agri-horticultural crops in the study area

Scientific Name	Local Name	Economic Use
Allium capa	Piaz	Vegetable
Allium sativum	Lahsun	Vegetable
Brassica juncea	Rai	Condiment
B. oleracea	Gobhi	Vegetable
Capsicum annum	Arhar	Pulse
Carica papaya	Papita	Fruit

Scientific Name	Local Name	Economic Use
Ricinus communis	Arandi	Oil
Lens esculenta	Masur	Pulse
Triticum aestivum	Gehu	Cereal
Sorghum volgave	Jawar	Cereal
Pennisetum typhoides	Bajra	Cereal
Zea mays	Makka	Cereal
Panicum sp.	Kodo	Pscudo-Cereal
Vigna angularis	Mung	Pulse
Vigna cenguiculata	Kulhi	Pulse
Musa sp.	Kela	Fruit
Psidum greajawa	Armud	Fruit
Citrus sp.	Nimbu	Fruit
Emblica officinalis	Amla	Fruit
Zizyphus nummularia	Ber	Fruit
Syzygium curnini	Jamun	Fruit
Artocarpus	Kathal	Vegetable

Source: Study Team

(17) AQUATIC ECOSYSTEM

There are a number of rivers/nallahs/estuaries; small *nallahs* (rivulets) and ponds which cross the proposed alignment of Mumbai-Ahmedabad High Speed Railway Corridor and represent the natural water aquatic ecosystems in the study area. Aquatic ecosystems provide home to many species including phyto-planktons, zooplanktons, aquatic plants, insects, molluscs, *etc.* They are organized at many levels from smallest building blocks of life to complete ecosystems, encompassing communities, populations, species and genetic levels. All aquatic ecosystems are generally colonized by the representatives of Arthropoda and Mollusca. Benthic invertebrates occupy the bottom of the water body. The functional role of benthic communities in the trophic dynamics of river ecosystem is well-acknowledged. The composition and distribution of benthic organisms over a period of timeprovide index of an ecosystem. In recent years, there has been greater emphasis worldover for better understanding of benthic environment. Clarke (1979) attempted to show the utility of molluscs in primary classification of the rivers in their various trophic status stages. Choubisa (1992) collected 32 species of molluscs from various freshwater habitats of southern Rajasthan. Harman (1974) has also pointed out that molluscs are bio-indicators of freshwater pollution. Molluscs are, thus, of great significance because they serve as food for fishes. Benthic organisms are detrivores and form an important link in the food chain. On account of their ability to convert low quality and low energy detritus into better quality food for higher organisms in the food web with the unfolding of importance of benthos in food chain, benthic productivity has been correlated with fish resources. Mollusc communities are good indicators of localized conditions, indicating the water quality.

1) The Objectives

The biological species are the best indicators of environmental quality. These include different species, such as, phytoplanktons, zooplanktons, benthos, fishes, *etc.* Studies on biological aspects of aquatic ecosystems are important part of any EIA in view of the need for conservation of environmental quality and safety of aquatic life. The study was carried out with a view to:

- inventorise different aquatic species [plankton (phyto-and- zoo), benthos and fishes];
- study of population density of the macro-invertebrates and ichthyofauna in the river;

- identify the feeding and breeding grounds of economically -important fishes; and
- assess the existing status of endangered species.

2) Planktons

Importance and Roles

Plankton is a term used to designate any organism that lives in water column and incapable to swim against water current. However, the use of term has been confined to designate only the microscopic and free-floating organisms (Adoni 1985). Though many planktonic species are microscopic in size, planktons include organisms covering wide range of size. Plankton abundance and distribution are strongly dependent on factors, such as, ambient nutrient concentration, the physical state of water column, and the abundance of other plankton. Planktons are the basis of freshwater and saltwater ecosystem, meaning that the entire aquatic life is dependent on the energy and oxygen they provide. Phytoplanktons are the initial food source for every food chain and food web. Phytoplanktons respond immediately to the changes that take place in the surroundings and, hence, indicate the water quality. Fish production and composition are not only affected by primary production, but also by phytoplankton community structure (Cury *et al*. 2008). The maintenance of a healthy aquatic ecosystem depends on the abiotic properties of water and biological properties of the ecosystem (Harikrishnan *et al*. 1999). Plankton is primarily divided into the following broad groups:

i) Phytoplanktons

Phytoplanktons are chlorophyll-bearing suspended microscopic organisms, consisting of algae with representatives from all major taxonomic phyla; the majority of members belong to Chlorophyceae, Cyanophyceae and Bacillariophyceae (Adoni 1985). Phytoplanktons are, thus, photosynthesizing microscopic organisms that inhabit the upper sunlight-rich layer of almost all water bodies. Their unique ability to fix inorganic carbon to build up organic matter through primary production makes their study a subject of prime importance (Adoni 1985). The growth of phytoplankton population is dependent on light levels and nutrient availability.Phytoplanktons play an important role as food for herbivorous animals (primary production) and also acts as biological indicators of water quality in pollution studies (Bhoyar and Tamloorkar 2012).

ii) Zooplanktons

Zooplanktons are microscopic free-swimming animal component of aquatic ecosystems that feed on other planktons. They belong to wide array of taxonomic groups like protozoa, rotifera, cladocera, copepod, molluscs and chordate, *etc.* They constitute an important link between primary producers and consumers of higher order in aquatic food chain and web. Zooplanktons occupy central position between the autotrophs and heterotrophs and form an important link in food web of the fresh water ecosystem (Joshi 2011).

3) Selection of Sampling Locations for Study

The aquatic ecology study was carried out by selecting thirteen sampling locations in the different surface water sources of the study area (ZOI) intersecting the proposed alignment. Sampling depths ranged from 0.5 to 20 cm below the surface. Samples collected were then preserved in 4.0 per cent formaldehyde solution. The sampling locations are same as for the water quality.

4) Methodology

Zooplanktons Study

For zooplankton analysis, 20 litre of sub-surface water was strained through 53µ Nytex plankton net, and the concentrate was transferred to labelled plankton bottle after rinsing the net with distilled water. The planktons were immediately preserved in 4.0 per cent neutral formaldehyde solution for subsequent examination and quantification.

Zooplankton samples were observed in a sedimentation chamber under an inverted plankton microscope. Planktons were identified with the help of standard keys and references. For quantification, an aliquot of the concentrate was suitably diluted. After thorough mixing, 1.0 ml of the sample was transferred to a clean Sedgwick-Rafter cell and examined under the inverted microscope. Planktons were counted genera-wise. Three replicates were taken and averaged. The number of organisms per litre under each genus was calculated by the following formula:

No. of organism per litre = Vol. of Conc. (ml) x No. of organism/Vol. of Conc. examined (ml) x Vol. of water filtered (l)

<u>Phytoplanktons Study</u>

Similarly, for phytoplankton analysis, sub-surface water samples were taken directly from the sites in 100 ml sampling bottles and preserved with Lugol’s solution immediately. The samples were then centrifuged in the laboratory, followed by removal of desired amount of supernatant from the centrifuge tube to make the required concentration. Phytoplanktons were then analyzed using a compound microscope and haemocytometer in the concentrates. The number of organisms per litre was calculated as follows:

No. of organisms per litre = No. of organism x 107 / Concentration factor x No. of slides examined

<u>Benthos Study</u>

Sediment samples were taken from the bottom of river Yamuna for benthic organism study manually and brought to laboratory for analysis. The samples were washed through sieves to harvest the organisms and then preserved in sampling vials using formaldehyde as preservative. Benthic organisms were enumerated using a simple microscope/ hand lens.

<u>Ichthyofauna Study</u>

Information about the local fishes was collected through consultation with the local fishermen. Fish occurrence was determined by collecting samples using different fishing gears like cast net, scoop net, hand net, hook-line, pot and open local devices methods. Also, visual observations in different habitats were made. Fishes were identified upto the species level following Jayaram (1981), Menon (1987) and Talwar and Jhingran (1997). IUCN Red Data list (2006) was used to assess threatened, endangered and vulnerable species in the study area.

<u>Macrophytes Study</u>

Macrophytes were studied visually in the field. The diversity was noted following 1-5 grade point scale.

<u>Phytoplanktons Productivity Study</u>

It was measured using Light and Dark bottle method of Gaarder and Grann. The dissolve oxygen measurement for this purpose was done by Winkler’s Iodometric method.

5) Result and Discussion

Phytoplankton

The phytoplankton species recorded in river water and estuarine water in the month of May 2017 (pre-monsoon season) is presented in Table 4.15.32.

Table 4.15.32: Phytoplankton Species

Bacillariophyceae	Cyanophyceae	Chlorophyceae
Consinodiscus sp.	*Anabaena* sp.	*Actinastrum* sp.
Cyclotella sp.	*Gleocapsa* sp.	*Chlorococcum* sp.
Cymbella sp.	*Lyngbya* sp.	*Cosmarium* sp.
Diatoma sp.	*Nocticuluca* sp.	*Gyrosigma* sp.
Leptocylindrus sp.	*Phormidium* sp.	*Penium* sp.
Melosira sp.	*Tribonema* sp.	*Selenastrum* sp.
Navicula sp.		*Spirulina* sp.
Nizschia sp.		*Spirogyra* sp.
Pinnularia sp.		*Staurastrum* sp.
Rhizosolenia sp.		*Triceratum* sp.
Synedra sp.		*Volvox* sp.
Surirella sp.		
Thalassiosira sp.		

Source: Study Team

Zooplankton

Among the zooplanktons, Rotifera, Copepoda, Cladocera and Nematoda were observed. The zooplankton species recorded in the pre-monsoon season is presented in Table 4.15.33.

Table 4.15.33: Zooplankton Species Identified

Phylum	Copepoda	Rotifera	Cladocera	Nematoda
Species	*Cyclops sp.*	*Keratella* sp.	*Daphnia* sp.	*Rabditiform larva*
	Cypris	*Brachionus* sp.		
	Herpactocoid	*Monostyla* sp.		
	Nauplius larva	*Lepadella* sp.		
	Ostracod	*Euchlanis* sp.		
		Filinia sp.		
		Aspelta sp.		

Source: Study Team

6) Primary Productivity

Primary production is the basis of the entire biogenous cycle in aquatic environment, the organic substance produced by photoautotrophic organisms (plants, algae *etc.*). The Gross Primary Productivity represents the amount of plant substance produced per unit of time and space. *In situ* measurement was performed by measuring the oxygen production in light and dark bottles exposed in the water during a known period of time. Gross primary production rate was measured for all nineteen sites in mg C/m^2/day. The intensity of the primary production reflects the trophic level of water. The primary productivity examined at all the statiosn during pre-monsoon season is given in Table 4.15.34.

Table 4.15.34: Primary Productivity

Stations	Gross Primary Productivity (mg C/m^2/day)
	Pre-Monsoon Season
SW1	52.4
SW2	56.2
SW3	85.2
SW4	78.6
SW5	72.5
SW6	70.5
SW7	68.5
SW8	72.5
SW9	74.6
SW10	72.8
SW11	61.2
SW12	71.2
SW13	72.6
Average	**69.9**

Source: Study Team

7) Benthic Macro-Invertebrates

The benthic macro-invertebrate communities or mud-dwelling invertebrate communities have proved useful in the biological surveillance of water quality in streams reservoirs. These are sufficiently large (> 0.5mm) to make them clearly observable without the aid of microscope. They dwell at least part of their life-cycle in association with the substratum of aquatic habitat. Benthic macro-invertebrates are recognized as very important group in water quality surveillance as these organisms which move from the site of pollution and show considerable sensitivity to pollution (Mason, 1987). The Benthic macro-invertebrates recorded in the sediment sample are given in Table 4.15.35.

Table 4.15.35: Benthic Micro-Invertibrates

Sea Anemones	Crustaceans	Bivalves	Gastropodes
Cribrnopsis sp.	*Aceteus* sp.	*Perna viridis.*	*Bullia lineolata*
Anemonis sp.	*Emerita ulthusia*	*Meretrix* casta	*Trochus radiatus*
Neoaiptasis sp.	*Squilla* sp.	*paphia* sp.	*Umbonium vestiarum*
	Eurydice sp.	*Donax scortium*	*Turbo intercostalis*
Polychaeta	*Cirolona* sp.	*Gifrarium* sp.	*Babylonia spirata*
Glycera alba	*Mysidopsis* sp.	*Sunetta* sp.	*Terebra* sp.
Nereis costae	*Dotilla* sp.	*Modiolus* sp.	
Cirratula sp.	*Ocypode* sp.	*Gelonia* sp.	**Pisces**
Dioptera sp.	*Portunis* sp.	*Crassostrea cucullata*	*Therapon jatbua*
Prionospio sp.	*Charybdilis* sp.	*Solen truncata*	*Batrachus* sp.
Terebella sp.	*Thalamita* sp.	*Triceratum* sp.	
Onuphis sp.	*Uca* sp.	*Volvox* sp.	
Syllis sp.	*Scylla serrata*		**Echinderma**
Thalassiosira sp.	*Penaeus* sp.		*Ophiactis* sp.
	Thallasina sp.		

Source: Study Team

8) Ichthyofauna

The study area represents the amalgamation of coastal part of Maharashtra and mainland of Gujarat one. It has sea fishing as prominent activity. Fishing season commences from September and lasts till the end of May. There is practically no fishing in monsoon except in the creek, estuary and rivers. The important fishes found in the coastal stretch of the study area are presented in Table 4.15.36.

Table 4.15.36: Fishes Found in the Coastal Stretch

Scientific Name	Common Name	IUCN Status	Scientific Name	Common Name	IUCN Status
Family: Orectolobidae			***Family: Dussumieridae***		
Chiloscyllium indicum	Sunera	NT	*Dussumieria acuta*	Toak	LC
Chiloscyllium griseum	Sunera	NT	*Dussumieria hasselti*	Toak	
Family: Carcharinidae			***Family: Engraulidae***		
Galeocerda cuvieri	Waghbeer		*Coillia dussmieri*	Mandeli	
Scoliodon sorrakowah	Sonmushi		*Thrissocles malabarica*	Kati	
Eulamia melanoptera	Balda		*Thrissocles mystax*	Dandetar	LC
Eulamia limbatus	Mushi		*Thrissocles setirostris*	Dandetar	
Family: Sphyrnidae			*Thrissocles dussmieri*	Kati	
Sphyrna blochii	Kanmushi		*Thrissocles purava*	Kaval	
Sphyrna tudes	Kanmushi	VU	*Anchoviella tri*	Dindas	
Sphyrna zygaena	Kanmushi	VU	***Family: Chirocentridae***		
Family: Rhinobatidae			*Chrocentrus dorab*	Karli	
Rhynchobatus djiddensis	Lanj	VU	***Family: Synodontidae***		
Rhinobatos granulatus	Ranja	VU	*Trachinocephalus myops*	Chor-Bombil	LC
Family: Pristidae			***Family: Plotosidae***		
Pristis cuspidatus	Nali	Endangered	*Plotosus anguillaris*	Nar Shingali	
Family: Trygonidae			*Plotosus canius*	Nar Singali	
Gymnura poesilura	Pakat		***Family: Tachysuridae***		
Pastinachus sephen	Pakat	NT	*Osteogeneiosus militaris*	Shingala	
Amphotistius zugel	Pakat		*Tachysurus sumatranus*	Shingala	
Himantura uarnak	Waghya pakat	VU	*Tachysurus caelatus*	Shingala	
Family: Myllobatidae			*Tachysurus nenga*	Shingala	
Aetobatus narinari	Bolad	NT	*Netuma thalassinus*	Shingala	
Aetomylaeus nichofii	Bolad	VU	*Ariodes dussumieri*	Shingala	LC
Aetomylaeus maculates	Waghali		*Pseudarius jella*	Shingala	
Family: Mobulidae			*Hexanematichthys sona*	Shingala	
Mobula diabolus	Bolad		***Family: Muraenidae***		
Family: Torpedinidae			*Muraenosox talabonoides*	Wam	
Narke dipterygala	Bijali		***Family: Ophichtyidae***		
Family: Elopidae			*Ophichthys bora*	Mundri	
Elops machnata	---	LC	***Family: Belonidae***		
Megalops cyprinoids	Chiral		*Tylosurus strongylurus*	Tali	
Family: Clupeidae			*Tylosurus choram*	Tali	
Kowala coval	Bhiljee		***Family: Hemirhamphidae***		
Tenuahsa	Bhing		*Hyporhamphus xanthopterus*	Sumb	VU
Tenualosa ilisha	Palla	LC	*Hyporchmphus gaimardi*	Sumb	
Saurida tumbli	Chor-		*Hemiramphus cantori*	Sumb	

Scientific Name	Common Name	IUCN Status	Scientific Name	Common Name	IUCN Status
	Bombil				
Harpodon nehereus	Bombil		*Hemirhamphus leucopterus*	Sumb	
Sardinella longiceps	Tarli, Haid	LC	***Family: Exocoetidae***		
Sardinella fimbriata	Pedwa		*Cypselurus poecilopterus*	Pakharu	
Euplatygaster indica	Gubar				
Family: Ggaddidae			***Family: Carangidae***		
Asthenurus atripinnis	---		*Caranx carangus*	Shitap	LV
Family: : Fistularidae			*Decaterus russelli*	Shitap	
Fistularia villosa	---	LC	*Chrinemus lysan*	Dogal	
Family: Syngnathidae			*Chorinemus tol*	Dogal	LC
Hippocampus trimaculatus	Ghoda Masa	VU	*Chorinemus tala*	Dogal	LC
Hippocampus kuda	Ghoda Masa	VU	*Trachinotus blochi*	Ladgoo	
Family: Cyprinodontidae			*Trachinotus bailloni*	Lodgoo	
Panchax lineatus dayi	Piku		***Family: Rachycentridae***		
Family: Sphyraenidae			*Rachycentron canadus*	Modusa	
Sphyraena jello	Badvi		***Family: Menidae***		
Family: Mugilidae			*Mene maculate*	Chand	
Mugil kelaartii	Boi	LC	***Family: Lutianidae***		
Liza waigiensis	Boi		*Lutianus johni*	Chavri Tamb	LC
Mugil carinatus	Boi		*Lutianus arentimaculatus*	Tamb	
Mugil cunnesius	Boi		*Lutianus rivulatus*	Tamb	
Mugil cephalus	Boi	LC	*Lutianus chrysotaenia*	Tamb	
Family: Latidae			*Lutianus quinquillneatus*	Tamb	
Lates calcarifer	Jitada		***Family: Nemipteridae***		
Ambassidae		LC	*Nemipterus japonicus*	Bamnl.	
Ambassis commersoni	Kachki		***Family: Gerridae***		
Family: Serranidae			*Gerremorpha setifer*	Charbat.	
Promicrops lanceolatus	Gobra		*Pertica filamentosa*	Charbat.	
Epinephelus dicanthus	Gobra		*Genes abbreviatus*	Charbat.	
Epinephelus malabaricus	Gobra	NT	***Family: Leiogmathidae***		
Epinephelus maculates	Gobra		*Secutor insidiator*	Kap	
Epinephelus undulosus	Gobra	DD	*Leiognathus brevirostris*	Kap	
Epinephelus tauvina	Gobra	DD	*Leiognathus bindus*	Kap	
Family: Theraponidae			*Leiognathus fasciatus*	Kap	LC
Therapon jarbua	Naveri		***Family: Plectorhynchidae***		
Autisthes puta	Naveri		*Pseudopristipoma nigra*	Harvil	
Eutherapon theraps	Daddada		*Spilotichthys puctus*	Harvil	
Family: Apogonidae			***Family: Sciaenidae***		
Apogon fasciatus	Kombada		*Johnius dussumieri*	Dhoma	
Apogon frenatus	Kombada		*Johnius diacanthus*	Ghal	
Archamia macropterus	Kombada		*Johnius sina*	Ghal	

Scientific Name	Common Name	IUCN Status	Scientific Name	Common Name	IUCN Status
Apogon kalasoma	Kombada		*Otolithus argenteus*	Dhoma, Dhodi	
Family: Sillaginidae			*Otolithus rubber*	Dhoma	
Sillago sihama	Renvi	LC	*Otolithoides brunneus*	Koth	
Family: Lactariidae			***Family: Mullidae***		
Lactarius lactarius	Sundala		*Upeneus sulphureus*	Chiri	LC
Family: Carangidae			***Family: Pempheridae***		
Magalaspis cordyla	Katkata Bangada		*Pempheris moluca*	Kombada	
Atropus atropus	Kat Bangada		***Family: Ephippidae***		
Selar kalla	Kat Bangada		*Ephippus orbis*	Chand	
Selar mate	Kat Bangada		***Family: Scorpaenidae***		
Selar djeddaba	Shitap		*Pterois russelli*	Kombada	
Caranx melampygus	Shitap	LC	*Scorpaenopsis*	Kombada	LC
Carangoides malabaricus	Shitap	LC	*Scorpaenopsis cirhosus*	Kombada	
Family: Platacidae			***Family: Platycephalidae***		
Platax teira	Kawala		*Suggrudus macracanthus*	Mench	
Family: Drepanidae			*Thysanophrys crocodiles*	Mench	
Drepane punctata	Chand	LC	***Family: Psettodidae***		
Family: Scatophagidae			*Psettodes erumei*	Bhakas	
Scatophagus argus	Wada	LC	***Family: Bothidae***		
Family: Pomacanthidae			*Pseudorhombus triocellatus*	Lep	
Pomacanthodes annularis	Chand	LC	*Pseudorhombus arsius*	Lep	
Pomacanthodes nicobariensis	Chand		***Family: Soleidae***		
Family: Chaetodontidae			*Zabrias quagga*	Lep	
Heniochus acuminatus	---	LC	*Solea ovata*	Lep	
Linophora auriga	Chandwa	LC	***Family: Cynoglossidae***		
Linophora vagabunda	Chandwa		*Paraplagusia bilineata*	Lep	
Chaetodontops collaris	Chandwa		*Cynoglossus brachycephalus*	Lep	
Family: Cichlidae			*Cynoglossus brevis*	Lep	
Etoplus suratensis	Kalundar		*Cynoglossus semifasciatus*	Lep	
Family: Pomacentridae			*Cynoglossus lingua*	Lep	
Abudefduf saxatilis vaigiensis	Kavandal		***Family: Mastacembelidas***		
Abudefduf leucopleura	Kavandal		*Mastacembelus armatus*	Ahir	LC
Family: Labridae			***Family: Echeneidae***		
Platyglossus dussumier	Popat		*Echeneis naucrates*	Lachuk	LC
Family: Acanthuridae			***Family: Triacanthidae***		
Acanthurus gahm	Suraiya	LC	*Triacanthus brevirostris*	Bail	
Family: Trichicuridae			***Family: Ostraciontidae***		
Thichiurus savala	Wagti		*Lactoria cornuta*	Gai	

Scientific Name	Common Name	IUCN Status	Scientific Name	Common Name	IUCN Status
Trichiurus haumela	Bala	LC	***Family: Lagocephalidae***		
Family: Scombridae			*Torquigener oblongus*	Kend	LC
Rastrelliger kanagurta	Bangda	DC			
Family: Kalsuwonidae					
Auxis thazard	Gedri	LC			
Euthynnus affinis	Bibbya Gedar	LC			
Family: Thunnidae					
Neothunnus macropterus	Khavlya Gedar				

Source: Department of Fisheries, Thane

(9) Spawning and Breeding Areas

Being the coastal stretch, fishing activity is prominent in the region. There is commercial fishing ground near Thane Creek and Vaitarna River. There are spawning and breeding areas of fishes along the coastal stretch.

(10) Conclusions

The main findings of the study can be outlined as follows:

- In general, the area around the proposed alignment in the Mumbai region harbours moderate diversity of marine organisms including the phyto and zooplankton, algae, higher plants, mangroves and faunal groups such as benthic organisms, macrofauna with the avian richness.
- The water is mesotrophic and shows sign of pollution especially in the Ulhas river.
- The fish catch is low near the shore, which increases towards mouth of the sea with increase in depth.
- In the Gujarat mailnad region, the water is free from any pollution except the river Sabarmati in Ahmedabad and Ghadvi.

Annexure 4.15 (a)

Report on
Integrated Mangrove Conservation and Management Plan

Prepared by

Mangrove Society of India
GOA

Draft Final Report

On
Integrated Mangrove Conservation & Management Plan

For
Mumbai-Ahmedabad High Speed Railway Project (MAHSR)

Prepared by

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M A Y 2018

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We would also like to put on record our sincere thanks to local team of MSI, Dr. Pramod Salaskar and Shri Hemant Karkhanis, Mumbai for carrying out survey of the sites in remote mangrove areas very systematically and keeping in view of the scientific methodology and techniques. At a time they have faced all odds of the environmental conditions, such as to reach remote places, thick mangrove coverage, soft mangrove mud *etc.* However, they left no stone unturned to collect valuable data and the information of the study area.

We are thankful to other members of MSI who have extended support and all possible help for this project.

Study Team

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Executive Summary

ES-1.0: RATIONALE

National High Speed Rail Corporation Limited (NHSRCL)-a Joint Venture of Government of India and Participating State Governments, a special purpose vehicle (SPV) formed by Government of India, intends to implement the first ever bullet train in the country-Mumbai-Ahmedabad High Speed Railway Project (MAHSR).

The MAHSR alignment having 508.17 km length, begins at Bandra Kurla Complex (BKC) in Mumbai and runs through Thane and Palghar districts of Maharashtra thereafter enters Gujarat in Valsad district and runs a short course of 2.0 Km through the UT of Dadra & Nagar Haveli and then re-enters Gujarat and runs through Navsari, Surat, Bharuch, Vadodara, Anand, and Ahmedabad districts of Gujarat before terminating at Sabarmati. The planned route is located between Latitude 19^{0}03’58.52”N-Longitude 72^{0}05’47.48”E and Latitude 23^{0}05’39.78” N-Longitude 72^{0}34’33.48”E.

The alignment is proposed on elevated viaduct and bridges and also has 25.48 km of underground tunnels. There are a total of 8 tunnels with the longest tunnel of 20.375 km under sea at the Thane Creek in Mumbai.

The proposed MAHSR alignment passes through mangrove patches in the States of Maharashtra at several locations. Environmental Impact Assessment (EIA) studies including preparation of an Environmental Management Plan (EMP) have been conducted in order to ascertain the impact of the MAHSR project on the mangrove. In this connection, M/s. GPS Technologies Pvt. Ltd, New Delhi, a multidisciplinary engineering consultancy organization appointed by JIC Consortium (JICC) for the Environmental Consultancy at the Detailed Design Engineering Stage, approached the Mangrove Society of India (MSI), Goa to take up the detailed study in mangrove areas and prepare a Integrated Mangrove Conservation and Management Plan for the section it passes through the mangrove areas as part of the EIA study.

ES-2.0: LEGISLATIVE FRAME WORK

In India, a legislative framework for the conservation and management of mangroves is already in place. The Indian Forest Act, 1927 and the Wildlife (Protection) Act, 1972 provide protection to flora and fauna. The Environment (Protection) Act, 1986 has a crucial role in the conservation and management of mangrove ecosystems. It declared a Coastal Regulation Zone in which industrial and other activities such as discharge of untreated water and effluents, and other activities are restricted in order to protect the coastal environment. Coastal stretches are classified into four categories, and mangroves are included in the most ecologically sensitive Category – CRZ - 1(A).

ES-3.0: COASTAL REGULATION ZONE (CRZ) NOTIFICATION, 2011

The definition of CRZ has been widened to include the land area from “High Tide Line” (HTL) to 500 m on the landward side, as well as the land area between HTL to 100 m or width of the creek, whichever is less, on the landward side along tidal influenced water bodies connected to the sea. On perusal of the HTL/LTL demarcation map prepared by National Institute of Oceanography (NIO), Vishakhapatnam for MAHSR project, it is evident that the proposed MAHSR alignment passes through the CRZ at seven locations and also through the dense patches of mangroves.

ES-4.0 BOMBAY HIGH COURT ORDER

The Mumbai High Court has recently banned non-forest activities in the coastal areas of Maharashtra where mangroves are growing. A division bench of the Court ruled that "no non-forest activities shall be permitted throughout the state in mangrove areas" and such areas shall be treated as deemed 'reserved forests' and attract all provisions of the Forest (Conservation) Act, 1980.

ES-5.0: HYDROLOGY

Hydrological conditions in mangrove ecosystem control structure and production and regularly cause changes in hydro-geo-chemical signatures of waters and suspended matter. Waters inundating mangrove regularly can have salinities up to 37 ppt. without adversely impacting the function and processes of the mangrove ecosystem. Research has shown that inundation, duration and frequency are important hydrological factors in the distribution of mangrove species.

ES-6.0: METHODOLOGY

Information was gathered from secondary sources on the existing physical environment, particularly as related to geology, topography, soils, hydrology and drainage, coastal dynamics, riverine water quality, noise *etc*. The status of the flora and fauna of the study area were determined by a review of literature relevant to the area and an assessment of both terrestrial and aquatic environments.

For quantitative assessment a horizontal line transect was established. Each mangrove areas were subdivided into smaller groups to facilitate access and to ensure accurate observations. A Simple Random Sampling (SRS) approach was adopted. At each station 10 m x 10 m quadrant was used to assess visually for the parameters like density, species composition, assemblages, dominance, height of the plants, establishment *etc*. For qualitative and quantitative assessment mangrove area was surveyed randomly for mangrove species recording, association, abundance and for the forest structure and dynamics of the mangrove community the basal area and height have been used to determine the maturity of the mangrove forest.

ES-7.0: STUDY AREA

A detailed description of the existing mangrove habitat along the MAHSR alignment at each site has been described in details. The intertidal habitats at the banks of the estuaries and creeks are characterized by dense stands of mangroves along the seaward margins. Although the MAHSR alignment is 508.17 km long from Mumbai to Gujarat only at six sites MAHSR passes through the mangrove forest and all of them in Maharashtra.

ES-8.0: FINDINGS

A) Mangrove

On perusal of the complete alignment of MAHSR, the following mangrove area shall be affected and need to be cleared (Table ES -1)

Table ES-1: Mangrove Area to be Affected by MAHSR Alignment

Start Chainage (Km)	End Chainage (Km)	Length (m)	Location	Affected Area (Ha.)	No. of Mangrove Trees to be Cut
7245	9800	2555	Thane Creek/ Thane	Under Tunnel	Nil
12750	14791	2041	Koparkherana / Thane	Under Tunnel	Nil
27750	28460	710	Mahatardi, Bharodi / Thane	10.6498	92653
28955	29596	641	Bharodi/ Thane	0.99	8613
38411	39379	968	Kharbav, Kewani, Diva/ Thane	1.307	7450
43535	45916	2381	Malodi/Thane	4.419	31375
71280	71728	448	Shirgaon, Gaskopari/ Palghar	0.705	4794
72309	72570	261	Vaitarni Khadi / Palghar	0.454	3087
72839	72970	131	Vaitarni Khadi / Palghar	0.179	1271
73485	73649	164	Vaitarni Khadi, Jalsar/ Palghar	0.222	1509
			Total	**18.9258**	**150752**

Source: Study Team (MSI and GPSTPL)

Site I–Kopar Khairane (Thane Creek):- This site is near Bhagwan Parshuram Ghat Lake, Kopar Khairane on the eastern bank of Thane Creek. Kopar Khairane is a node of Navi Mumbai which was built mostly on reclaimed land by City and Industrial Development Corporation (CIDCO). The area has well developed mangroves representing number of unique species. The intertidal area along the estuaries and creeks is characterized by dense stands of fringing mangroves along the margins.

The dominant species of this site was *Avicennia marina var. acutissima* and *A. marina* var. *marina*. The trees were well developed with thick girth indicating well matured trees. A stretch of mangrove strand measuring about 3400 m on either side of the proposed MAHSR alignment was surveyed by line transects. At this site, MAHSR alignment will run under the tunnel around 30 m below the mangrove forest. It has been informed by the project authority that no ventilator/shaft has been planned in the Thane Creek Mangrove area. Therefore, no mangroves will be cleared.

Site II–Diva (Near Diva Railway Track):- This site is along the bank of the Ulhas River which originates in a valley north of the Rajmachi hills. Beyond Kalyan, the river nearly flows at sea level, merges with the creek waters and is influenced by the tidal forces. From here on it forms an estuary and also supports a mangrove forest near Diva-Dombivali stretch. The main branch turns northwestward to Ghodbunder, where it opens into the estuary of Vasai Creek.

The stretch had around 700 acres of verdant mangroves but half of it has been destroyed and slum colonies sprung up. *Sonneratia apetala* was found to be most dominant followed by *Avicennia* spp. and *Acanthus ilicifolius* that showed moderate presence. *Excoecaria agalocha* and *Aegiceras coenuculata* were poorly represented. At this site, the MAHSR alignment will cross Ulhas river on viaduct. About 116398 sq. m of mangrove area shall be cleared. Therefore, about 101266 mangrove trees shall require to be cleared with density of 87/100 m^2.

Site III- Near Anjur Phata, Kharbav, Kewani:- Comparatively well-developed mangroves were seen at the bank of the Ulhas river**.** The total length of the mangrove patch at this site is around

750 m. *Sonneratia apetala* was found to be most dominant species followed by moderate representation by *Avicennia spp.* and *Acanthus ilicifolius*. The trees were fruiting and large number of fruits was seen spread all over the places.

The area falling within the ROW of 17.5 *i.e.* 8.75 m each side of the center line of the alignment would be cleared all along the viaduct. About 968 m of MAHSR alignment passes through the patch of mangrove at this location. Therefore, the total mangrove area to be cleared will be 13070 sq. m. and around 7449 nos. of mangrove trees required to be cleared.

Site IV–Brahmangaon (Bhiwandi):- Brahmangaon is a Village in Murbad Taluka in Thane District of Maharashtra State. It belongs to Konkan region. It is located 54 km towards East from District headquarters Thane and 70 km from State capital Mumbai. Brahmangaon is surrounded by Ambernath Taluka towards west. At this site there is a well-developed mangrove patch bordering the creek. *Sonneratia apetala* was found to be most dominant followed by *Avicennia marina*. The trees were quite tall and densely populated. *Sonneratia – Avicennia* association was seen at most of the places with height ranging from 10 m to 15 m.

The MHASR alignment passes through the mangrove area on viaduct. The total length of the mangrove stretch at this site is 2381 m and the total area required to be cleared would be 44190 sq. m. Therefore, total mangrove trees to be cleared will be around 31375 nos. of trees.

Site V–Saphale, Tembhikhadave (Vaitarna River):- Saphale is a Village in Palghar Taluka in Palghar District of Maharashtra State. It belongs to Konkan region. The surrounding area includes an industrial area and several power stations. The Saphale Palghar belt also has many salt works.

The total length of mangrove patch measures around 1004 m long. In the middle of the creek there is a small semicircular island. The island has small mangrove patch towards the periphery. *Avicennia marina var marina* and *Avicennia marina var acutissima* and *Soneratia apetala* were abundantly found at this site. *Avicennia officinalis* was found to be moderately present. The average height of the mangrove trees is 4 to 5 m. Some well grown and tall mangrove trees were seen in the middle and towards land ward side of the island. The proposed MAHSR alignment will run on viaduct structure and on bridge on the mangrove patch for which around 10662 nos. of mangrove trees will be cleared.

Site VI-Bharuch, Narmada River, Gujarat:- Bharuch, formerly known as Broach, is a city at the mouth of the river Narmada in Gujarat in western India. Bharuch is the administrative headquarters of the Bharuch District. Being one of the biggest industrial areas including Ankleshwar GIDC, it is at times referred to as the chemical capital of India.

This area was surveyed in detailed along the proposed MAHSR alignment along the Narmada estuary**.** During site visit it was confirmed that there is no mangrove. Hence no further study for conservation and management plan was undertaken.

B) Mangrove Associates

Floral Association: Other associate mangrove species recorded from the study area were *Salvadora persica, Derris heterophylla, Sesuvium portulacustrum etc.* They were present towards the landward side. Some of these species such as *Derris heterophylla* was growing as epiphytes on the *Sonneatia apetala* and *Avicennia* spp. sometimes covering entire canopy of the plant.

The number of macrophyte (seaweed) species grows on mangrove tree trunks, pneumatophores, stilt and prop roots at water level and at the level on the trunk where moisture is available. These seaweeds form microhabitats for number of invertebrate species such as polychaete worms, amphipods, isopods, barnacles, snails, gastropods etc. who feed and breed and take shelter from predators.

Faunal Association:- Mangroves forest provides both hard and soft bottom habitats for variety of invertebrate life such as worms, clams, crustaceans, crabs, bivalves, sponges, juvenile fish and other tiny organisms that live in the bottom sediments. The extensive mangrove root systems, muddy bottoms and open waters are all favourable habitats to invertebrates that are well adapted to the temperature and salinity variations as well as tidal influences to mangroves. Benthic organisms play an important role in regulating and maintaining the detritus food chain of estuarine ecosystem.

Wildlife:- Birds are prominent part of most mangrove forests and they are often present in large numbers. The shallow waters and exposed mudflats of the mangroves offer rich feeding grounds for many of the large and more spectacular species of birds. These forests make an excellent habitat for number of bird species, from the smallest Kingfisher and Plovers to the large Heron. About 177 species of resident and migratory birds have been reported from the mangrove forests.

A large population of otters has also been reported from mangroves feeding on fishes, crabs, oysters *etc*. Apart from this, animals such as wild boar, monkeys, flying fox, fishing cats, civets, mongooses, monkeys (rarely), wild cats *etc*. frequently enter the mangroves for feeding and shelter.

ES 9.0: ANTICIPATED IMPACTS AND MITIGATION MEASURES

Any developmental project is likely to affect the quality of surrounding environment during the construction and operational phases. The nature and magnitude of impacts on different components of the environment *i.e.* biological - ecological, socio - economic vary depending on the nature and size of the project. In order to estimate the magnitude of impacts, assumption has to be made about the natural change in the system and functioning of the environment.

The assessment of the impact requires general and detailed information of the mangrove environment and associated components. During reclamation of mangrove area, construction and operation phases will be subjected to various short and long term impacts. Adequate project specific mitigation measures have been suggested to mitigate these impacts.

ES 10.0: MANGROVE CONSERVATION AND MANAGEMENT

To restore reclaimed mangroves areas conservation and management measures have been suggested. During the implementation of the MAHSR project, about 150752 mangroves shall be cut in the viaduct section where structures such as bridge, piers, station and maintenance road to be constructed. A compensatory afforestation is required to be carried out in 1:5 ratios in line with the MoEFCC guidelines. Therefore, total mangroves to be planted are 753764 trees over an area of 94.629 ha. A management and conservation plan has been formulated and plan for mangrove compensatory afforestation has been included in this report.

In the end, some recommendations have been suggested to restore the degraded area and probable solutions have been included to mitigate the impacts.

Finally, on the basis of above mentioned factual observations, it can be inferred that there will not be major adverse impact on the environment except cutting of mangrove which can be compensated by mangrove plantation. Whatever impacts that have been envisaged are short term duration and can be eliminated or minimized in due course of time, provided the recommendations and suggestions offered in this report are adhered to.

1.0 RATIONALE

The mangrove ecosystem has unique functional, interactive and structural characteristics. It is a relatively simple food chain containing a combination of marine, brackish water, estuarine and terrestrial species. It is a nursery grounds for variety of organisms and breeding and feeding sites for mammals, reptiles, birds *etc*. Mangrove communities also perform several other important ecological functions such as providing eco system services, maintaining balance in coastal geomorphology by stabilizing coast and estuaries, reclaiming margins, retard tide and prevent erosive influences.

Despite the relatively low plant diversity, plants in mangrove have undergone a wide range of structural, anatomical and functional modifications that ensure their survival and propagation under the harsh environmental conditions in the intertidal region. Mangrove trees have unique morphological, eco-physiological and reproductive traits, including aerial roots, viviparous germination, dispersal of propagules by tidal waters, rapid rates of canopy production, an efficient nutrient retention system, ability to deal with salt and to maintain water and carbon balance.

In spite of all these important benefits and ecological services offered by mangroves, they are under constant threat due to anthropogenic activities such as release of sewage and industrial wastes in the creek, dumping of solid waste, garbage, reclamation activities for housing, roads, bridges and infrastructure developments and most importantly population pressure.

2.0 OBJECTIVES AND SCOPE OF THE STUDY

- To survey the identified mangrove areas across the entire stretches of the MAHSR alignment from Mumbai to Ahmedabad;
- To follow Standard ecological and oceanographic methods;
- To collect and use secondary environmental and biological data for comparison;
- To document the diversity and ecological status of mangrove ecosystem and other mudflats/wetlands in the study area;
- To record occurrence of any ecologically sensitive/threatened species in the study area;
- To assess the impacts of MAHSR project on mangrove flora and fauna and provide mitigation measures to minimize the impacts by following international guidelines, notational legislation and best practices in the industry;
- To formulate Site specific integrated management and conservation plan for the existing mangrove cover within the study area.

3.0 PROJECT DESCRIPTION

As for passenger transport, in December 2009, Ministry of Railways (MoR), Government of India, formulated the “Indian Railway Vision 2020”. This vision aims to modernize existing conventional lines and enhance capacity as well as develop high speed railway lines. Seven routes were selected as candidates for the high speed railway system. Among them, the Mumbai-Ahmedabad route was given top priority by the Experts Committee on Modernization of India’s National Railway. Based on further prefeasibility and feasibility studies, the Mumbai-Ahmedabad High Speed Railway Project (MAHSR) is being implemented.

The Government of India has formed a Special Purpose Vehicle (SPV)-National High Speed Rail Corporation Limited (NHSRCL)- A Joint Venture of Government of India and

Participating State Governments, to implement Mumbai-Ahmedabad High Speed Railway Project on a new dedicated alignment of about 508.17 km.

The MAHSR alignment having a length of 508.17 km, begins at Bandra Kurla Complex (BKC) in Mumbai Suburban District and runs through Thane and Palghar districts of Maharashtra thereafter enters Gujarat in Valsad district and runs a short course of 2.0 Km through the UT of Dadra & Nagar Haveli and then re-enters Gujarat and runs through Navsari, Surat, Bharuch, Vadodara, Anand, Kheda and Ahmedabad districts of Gujarat before terminating at Sabarmati. The planned route is located between Latitude 19^{0}03'58.52"N-Longitude 72^{0}05'47.48"E and Latitude 23^{0}05'39.78" N-Longitude 72^{0}34'33.48"E.

Recently on 14th September 2017, the Prime Minister of India, Mr. Narendra Damodardas Modi and Prime Minister of Japan, Mr. Shinzo Abe laid the foundation stone for the first high speed railway project of India.

The proposed MAHSR alignment passes through mangrove patches in the States of Maharashtra at several locations. Environmental Impact Assessment (EIA) studies including preparation of an Environmental Management Plan (EMP) have been conducted in order to ascertain the impact of the MAHSR project on the mangrove. In this connection, M/s. GPS Technologies Pvt. Ltd., New Delhi, a multidisciplinary engineering consultancy organization appointed by JIC Consortium (JICC) for the Environmental Consultancy at the Detailed Design Engineering Stage, approached the Mangrove Society of India (MSI), Goa to take up the detailed study in mangrove areas and prepare an Integrated Mangrove Conservation and Management Plan for the section it passes through the mangrove areas as part of the EIA study.

4.0 LEGISLATIVE AND REGULATORY FRAMEWORK

In India, a legislative framework for the conservation and management of mangroves is already in place. The Indian Forest Act, 1927 and the Wildlife (Protection) Act, 1972 provide protection to flora and fauna. Although, they do not specifically mention mangroves, these acts can also apply to the conservation of the flora and fauna of mangrove ecosystems.

The Forest Conservation Act, 1980 states that no forest area shall be diverted for any non-forestry purpose without prior approval of the Government of India. This act has proved very effective in preventing diversion of mangrove forest areas for non-forestry purposes as the mangrove forest has been notified as Protected Forest.

The Environment (Protection) Act, 1986 has a crucial role in the conservation and management of mangrove ecosystems. It declares a Coastal Regulation Zone in which industrial and other activities such as discharge of untreated water and effluents, dumping of waste, land reclamation and bunds are restricted in order to protect the coastal environment. Coastal stretches are classified into four categories, and mangroves are included in the most ecologically sensitive category – CRZ - 1(A).

4.1 Coastal Regulation Zone (CRZ) Notification, 2011

The definition of CRZ has been widened to include the land area from "High Tide Line" (HTL) to 500 m on the landward side, as well as the land area between HTL to 100 m or width of the creek, whichever is less, on the landward side along tidal influenced water bodies connected to the sea. The CRZ also includes, for the first time, water area up to 12 nautical miles in the sea and the entire water area of a tidal water body such as creek, river, estuary without imposing any restrictions of fishing activities. On perusal of the HTL/LTL demarcation map prepared by National Institute of Oceanography (NIO), Vishakhapatnam, it is evident that the proposed MAHSR alignment passes through the CRZ at seven locations and also through the dense patches of mangroves at seven locations. In this case, both CRZ clearance and Forest clearance have to be obtained from the respective authority as per the detailed procedure described in the CRZ Notification, 2011 and Forest (Conservation) Act, 1980.

4.2 Bombay High Court Order

The Bombay High Court has recently banned non-forest activities in the coastal areas of Maharashtra where mangroves are growing. A division bench of the Court ruled that "no non-forest activities shall be permitted throughout the state in mangrove areas" and such areas shall be treated as deemed 'reserved forests' and attract all provisions of the Forest Conservation Act, 1980.

Permission from Hon'ble Bombay High Court is necessary for cutting of mangroves as per Hon'ble Bombay High Court in order dated 27/1/2010 in PIL 87 of 2006. Mangrove area is included in the forest area user agency is required to take permission from Hon'ble High Court for Mangrove cutting before diversion of the forest area.

5.0 HYDROLOGY

5.1 Thane Creek

Hydrological conditions in mangrove ecosystem control structure and production and regularly cause changes in hydro-geo-chemical signatures of waters and suspended matter. Mangroves are subjected to either regular or occasional inundation by water coming from riverine, estuarine or ocean. Waters inundating mangrove regularly can have salinities up to 37 ppt. without adversely impacting the function and processes of the mangrove ecosystem.

Research has shown that inundation duration and frequency are important hydrological factors in the distribution of mangrove species and that these inundation characteristics are related to elevation. Successful restoration often comes down to site conditions suitable for mangrove survival of which the most important are salinity, soil conditions and hydrology. An extensive work has been carried out on the physico-chemical characteristics of Thane creek, Mumbai. The Thane creek along the central west coast of India is one such ecosystems, which is subjected to the heavy industrialization and urbanization that has been flourishing along its banks. The Industrial belt and residential complexes have increased human aggression in this area causing stress to the marine ecosystem. The aggression is not only in the form release of sewage and industrial wastes in the creek but it is also in the form of dumping of solid waste, garbage and reclamation activities for different purposes. Over the years, water quality of the Thane creek has been deteriorated, however, mangroves do flourish and supports and maintains biological diversity. A range of physico-chemical parameter of the Thane creek is given in **Table 1.**

6.0 SIGNIFICANCE OF MANGROVES

- The term "mangrove" refers to an assemblage of tropical trees and shrubs that grow in the zones that are frequently inundated with salt water due to tidal activity of seas and oceans.
- The important aspects of mangrove ecosystem is that it is self-maintaining, self-repairing, renewable, most productive, rich in biodiversity and sustainable provided that the ecological processes governing this ecosystem are maintained.

- Mangroves form very important part of the marine food chain.
- Mangrove ecosystem being a detritus based ecosystem, it is a nursery, breeding and feeding grounds and supports variety of organisms such as crustaceans, molluscs, shell fish and fishes that inhabit mangroves or at least spend some part of their life span in mangroves.
- Many commercial and non-commercial fish species feed and breed in mangroves. The estimated fishery yield from mangrove found to be around 30,000 m tons of which 13,000 m tons of crabs and prawns per annum. About 10 % of the India's coastal marine fisheries depend on the estuarine complex.
- Mangrove provides diverse structural habitats for several species of avifauna. About 121 bird species belonging to 82 genera and 39 families have been recorded from mangroves. Birds visit mangrove for feeding, roosting and transit purpose and very few for breeding and other activities.
- Number of terrestrial animals such as monitor lizards, crocodiles, flying foxes, wild cats, otters, several species of snakes, wild boars, crab eating macaques, cattle, camels etc. visit mangroves for food, feeding and shelter.
- Mangroves and their associated rich biodiversity help to deliver important goods and service that play a critical role in supporting human well-being through climate regulation, food security and poverty reduction.
- Mangroves help to recycle nutrients in coastal waters.
- Mangroves help to control pollution, including excess amounts of nitrogen and phosphorous, petroleum products, and halogenated compounds through a process called rhizo-filtration.
- Mangroves protect coastland by absorbing the energy of storm-driven waves and wind action, tsunami, cyclones, and other storms creating an effect of a natural breakwater that helps stop erosion, preventing a great deal of property damage and sometimes even human death.
- Mangroves can act as carbon sequestration i.e. removing carbon dioxide from atmosphere (an important component (CO_2) responsible for global warming) and store it in organic rich soil thus mitigating impact of global warming.
- This ecosystem has a very large unexplored potential for natural products useful for medicinal purposes & also for salt production, apiculture, fisheries products, fuel and fodder *etc*.

6.1 Biodiversity of Mangroves

6.1.1 Floral Diversity

The mangroves in India is spread over an area of 4,639 sq. km. occupying only 0.14 % of Asian mangrove coverage. Around 80 % of mangroves are along the east coast and 20 % along the west coast of India. Maharashtra has a long coast line of about 720 km, intercepted by several rivers/estuaries, creeks and backwaters. There exists an intricate network of creeks and backwaters. A luxuriant growth of mangroves and associated swamps can be observed along most of the water bodies within the estuarine reaches. There are about 30,000 hectares of mangroves along the coast with 20 mangrove species indicating rich in terms of species diversity along the west coast of India. Out of these, around 40 % of mangroves are in private land.

Series of conservation measures were initiated along the Maharashtra coast for conservation of mangroves, from raising mangroves in nurseries and organizing large scale plantation in degraded mangrove areas. Saplings of 15 rare species of mangroves including some threatened and endangered species were raised in the nurseries. As a result of these plantation measures the mangrove cover of Maharashtra has increased from 186 sq. km to 222 sq. km in 2015, nearly 20 % increase (Forest Survey of India Report, 2015).

6.1.2 Faunal Diversity

The mangroves forest provides both hard and soft bottom habitats for variety of invertebrate life such as worms, clams, crustaceans, crabs, bivalves, sponges, juvenile fish and other tiny organisms that live in the bottom sediments. These invertebrates feed on leaf litter, detritus, plankton, microorganisms and other small animals. Some of these animals reside in mangroves, some visits during the seasons or when food is plenty while some visit for feeding and breeding.

The main food sources for the benthos are algae and organic runoff from land. Filter feeders, such as sponges and bivalves, dominate hard, sandy bottoms. Deposit feeders, such as polychaetes, populate softer bottoms. Fish, sea stars, snails, cephalopods and crustaceans are important predators and scavengers.

Despite the presence of the more spectacular mammals and reptiles, indications are that the animals which contribute the greatest biomass in the mangroves are the shellfish a collective term for crustaceans (crabs and prawns) and molluscs (bivalves and gastropods).

Birds are a prominent part of most mangrove forests and they are often present in large numbers. The shallow waters and exposed mudflats of the mangroves offer rich feeding grounds for many of the large and more spectacular species of birds. These forests make an excellent habitat for number of bird species, from the smallest Kingfisher and Plovers to the large Heron. About 177 species of resident and migratory birds have been reported from the mangrove forests.

7.0 METHODOLOGY

7.1 Literature Review and Analysis of Data

Information was gathered from secondary sources on the existing physical environment, particularly as related to geology, topography, soils, hydrology and drainage, coastal dynamics, riverine water quality, noise *etc*. The literature survey and analysis of published data and other documented data on wildlife and other fauna, flora, climate, pollution *etc*. pertaining to the project were collected. The status of the flora and fauna of the study area were determined by a review of literature relevant to the area and an assessment of both terrestrial and aquatic environments.

Investigations were also conducted on the socio-economic environment which included housing settlements, zoning and land acquisition, land use and Municipal Status, Traffic, Transportation and Access Roads, Demographics, Livelihoods, Fisher folk, Community Facilities, Solid Waste Management, Proposed Developments, Recreational Activities, and Archaeological and Cultural Heritage.

7.2 Community Consultation

Consultations with concerned officials of Govt. agencies, officials of GPS Technologies Pvt. Limited and JICC, potentially affected persons due to proposed MAHSR project were undertaken. During the field visit locals from each site were interviewed on their livelihood, settlements, land and their impression on the proposed MAHSR project to get clear picture of the anticipated impacts.

7.3 Reconnaissance Surveys

Reconnaissance surveys were undertaken by the team of scientists of Mangrove Society of India (MSI), Goa, study team of GPS Technologies Pvt. Limited and experts from JICC at all proposed sites through which MAHSR alignment passes. After preliminary survey, detailed discussion was held with GPS Technologies Pvt. Limited and JICC regarding the layout of the alignment, construction of underground tunnel, bridges and *viaduct*. Length of mangrove stretch at each site and number of mangrove trees that are going to be affected were also discussed.

Later, detailed survey of the each proposed site was carried out by MSI study team to collect data on the mangrove species diversity, number of trees, density, height of trees, Diameter at Breast Height (DBH), composition and distribution and other parameters required for the project. The team made an attempt to reach remote and difficult places of the said sites to gather environmental data and take measurements required to assess forest structures and age class distribution.

7.4 Density and Species Composition

The assessment and evaluation of the mangrove is a daunting task in terms of their inter-tidal characteristics and remoteness which are subject to tidal phenomena thus limiting access to these areas. Hence, the ability to access and monitor mangrove areas is subject to suitable tide and weather conditions. In mangrove area, movement during the survey was made difficult by the presence of pneumatophores, soft mud, dead oyster and bivalve shells, deep channels, standing water and extremely dense thickets composed of stilt roots and main stems. It is important to consider these ecosystem attributes in sample design and layout. It is also necessary to minimize trampling damage resulting from measurements and movement in mangrove area.

Survey and field evaluation was conducted to assess, distribution, abundance, species composition, density, as well as their physical and physiological status of the mangroves from the study areas. The study areas were demarcated into number of stations depending on the presence of mangroves in the area. Mangroves which were solitary/ single isolated ones as well as small patches here and there have not been considered, however, those patches which were more than 100 sq. m having specialized characteristics were considered for assessment. The standard methodology for the assessment of mangroves was followed.

For quantitative assessment a horizontal line transect was established. Each mangrove areas were subdivided into smaller groups to facilitate access and to ensure accurate observations. A Simple Random Sampling (SRS) approach was adopted. At each study site 10 m x 10 m quadrant was used to assess visually for the parameters like density, species composition, assemblages, dominance, height of the plants, establishment *etc*. For qualitative assessment mangrove area was surveyed randomly for mangrove species recording, association, abundance *etc*.

7.5 Mangrove Forest Structure and Maturity

Description of a forest's structure include measures of stem height, stem diameter, basal area, tree density and the age-class distributions and spatial distribution patterns of the component species in the forest. A noted feature of mangrove forest structure is the often-conspicuous zonation of tree species into mono specific bands parallel to the shoreline.

The data collected was subjected to statistical analysis to determine the forest structure and dynamics of the mangrove community. The basal area and height was used to determine the maturity of the mangrove forest. The higher strand basal area, diameters and lower densities indicate more mature forest. Tree height will also indicate more mature forest as high heights can only be achieved over a long period of time.

The development of a mangrove's forest structure is associated with the intensity and number of environmental factors. The maximum structural development of mangrove forests occurs in regions where appropriate topography is subject to large tidal range, ample freshwater input, precipitation, nutrients, and types of sediments. The intertidal habitat along the estuaries and creeks is characterized by dense stands of fringing mangroves along the margins.

In addition, natural regeneration and old naturally growing mangrove plants were also counted, besides recording of general topographical, biological conditions *etc*. As mangroves were growing on the edges of the bunds of the fish farms and paddy fields, most of the time they were submerged in the water. Secondly, mangroves growing in this area were found covered with dense epiphytic growth of creepers. These creepers were either mangrove associates or land creepers. At some places due to this it was difficult to approach mangrove trees for DBH measurements.

It is necessary to keep in mind that evaluation and assessment are a continuous process and data and findings of this report will continue to evolve. The findings and analysis presented in this report pertain specifically to on ground situation at the point in time when the evaluation assessment was undertaken. The findings and analysis may vary during subsequent monitoring and evaluation of the same area. A detailed description of the existing mangrove habitat, their distribution, species composition, density of the study area is presented here. The survey data has been assessed and compared with earlier studies and published review papers and reports on mangroves and related aspects.

8.0 DESCRIPTION OF STUDY SITES

A description of the existing mangrove habitat along the MAHSR alignment at each site has been described in details. The intertidal habitats at the banks of the estuaries and creeks are characterized by dense stands of mangroves along the seaward margins. The density and height of mangroves decrease with distance away from the waterline, while towards the land ward side mangrove associates, algae (microalgae and seaweeds) and cyanobacterial mats are present.

The summary of the mangrove area falling within the limit of RoW of MAHSR alignment and other facilities is presented below.

Start Chainage (Km)	**End Chainage (Km)**	**Length (m)**	**Location**	**Affected Area (Ha.)**	**No. of Mangrove Trees to be Cut**
7245	9800	2555	Thane Creek/ Thane	Under Tunnel	Nil
12750	14791	2041	Koparkherana / Thane	Under Tunnel	Nil
27750	28460	710	Mahatardi, Bharodi / Thane	10.6498	92653
28955	29596	641	Bharodi/ Thane	0.99	8613
38411	39379	968	Kharbav, Kewani, Diva/ Thane	1.307	7450
43535	45916	2381	Malodi/Thane	4.419	31375
71280	71728	448	Shirgaon, Gaskopari/ Palghar	0.705	4794
72309	72570	261	Vaitarni Khadi / Palghar	0.454	3087
72839	72970	131	Vaitarni Khadi / Palghar	0.179	1271
73485	73649	164	Vaitarni Khadi, Jalsar/ Palghar	0.222	1509
			Total	**18.9258**	**150752**

8.1 Site–I: Kopar Khairane (Thane Creek)

8.1.1 Description of Study Site

The site is near Bhagwan Parshuram Gaht Lake, Kopar Khairane. Kopar Khairane is a node of Navi Mumbai which has been built mostly on reclaimed land by City and Industrial Development Corporation (CIDCO). The lake is surrounded by Jogging Park and Children Park. Large number of local people visit this area for recreation.

The area has well developed mangroves representing number of unique species **(Plate – I)**. The dominant species of this site was *Avicennia marina var. acutissima* and *A. marina var. marina*. The trees were well developed with thick girth indicating well matured trees.

The dense mangroves stretch between Kopar Khairane and Ghansoli along Thane-Vashi creek is under threat from dumping of debris, discharge of sediments and solid wastes into the creek from drains and construction activities. This has resulted into decrease in current velocity and depth in coastal waters of Thane creek and Ulhas estuary. The proposed MAHSR alignment runs through tunnel below 30 m of the bed of the creek and mangrove forest by the side of Bhagwan Parshuram Ghat Lake.

8.1.2 Observations

The intertidal area along the estuaries and creeks is characterized by dense stands of fringing mangroves along the margins **(Plate–I).** A stretch of mangrove strand measuring about 3400 m on either side of the proposed MAHSR alignment was surveyed by line transect and employing a Simple Random Sampling (SRS) methods.

In all, 5 true mangrove species and 2 associate species have been recorded from this site **(Table–2).** The true mangroves species belong to *Aviceniaceae* and rest each from

Acantheceae and Euphorbiaceae, respectively. Although, these genera are extremely different from each other in terms of their morphology, anatomy, physiology, reproduction *etc*. they do share common traits of dispersal by seawater and vivipary.

At this site two quadrants **(Map–1)** were taken for qualitative, quantitative and vegetation structure studies as follows:-

1) Quadrant–I

Dense and luxuriant mangroves were seen at this locality. Mangroves of these locality comprised of *Avicennia marina* var. *marina* and *Avicennia marina* var. *acutissima* which were abundantly found in this area. *Avicenia officinalis* was moderately present at most of the places. These species were found in association giving single strand appearance. Other two species present at this site were *Acanthus ilicifolius* and *Excoecaria agallocha* which showed rare presence. The average density of the plants was found to be 75 nos. /100 m^2 and maximum area of 46.67 % was covered by *Avicennia marina* var. *marina* and 18.67 % by *Avicennia marina* var. *acutissima* **(Fig.-1).** The average height of *Avicennia marina* var. *marina* was 10 m to 15 m tall and *A. officinalis* was 10 m to 12 m in height, while *Avicennia marina* var. *acutissima* was smaller in height. These two species indicate that their presence in this area was for quite some time and they were more matured than *Avicennia marina* var. *acutissima* as per their basal area **(Table – 3).**

2) Quadrant-II

At this locality the composition of mangrove species was similar to that of Quadrant-I. However, it varies considerably with regards to the forest structure **(Table-4).** The average density of the plant was found to be 70 nos. /100 m^2 and maximum area of 45.71 % was covered by *Avicennia marina* var. *marina* and 31.43 % by *Avicennia marina* var. *acutissima* **(Fig.-2).** Overall at these two quadrants the species composition, density and species association in the strand was similar.

3) Number of Mangroves to be Affected

At this site, MAHSR alignment will run through the tunnel around 30 m below the creek bed and mangrove forest, the mangrove trees shall be unaffected. It has been informed by the project authority no ventilator/shaft has been planned in the Thane Creek Mangrove area. Therefore, no mangroves will be cleared.

8.2 Site – II: Diva (Near Diva Railway Track)

8.2.1 Description of Study Site

This site is along the bank of the Ulhas River which originates in a valley north of the Rajmachi Hills formed by mountain streams draining the northern slope of those hills which are part of the Sahyadri range of the Western Ghats in the Raigad district of Maharashtra. It receives most of its water from the South-West monsoon from June to October when average rainfall in the basin area is about 2,943 mm. The Kalu and Bhasta tributaries of Ulhas are the major right bank tributaries which together accounts for 55.7% of the total catchment area of Ulhas River.

Beyond Kalyan the river, nearly flowing at sea level, merges with the creek waters and is influenced by the tidal forces. From here on it forms an estuary and also supports mangrove forest near Diva-Dombivali. The main branch of the creek turns northwestward to Ghodbunder, where it is influenced by tide that opens into the Vasai

Creek, later, the creek runs along the Central Railway line. The Ulhas estuary is the site of the historical importance having ports of Kalyan, Kopri and Sopara. The total length of the estuary from its origin to its outfall into the Arabian Sea is around 122 km.

8.2.2 Observations

The stretch had around 700 acres of verdant mangroves but half of it has been destroyed and slum colonies sprung up **(Plate–II).** Besides this, concrete debris has been dumped to pave way for new residential buildings. Ulhas River is more dynamic and fluvio-estuarine in nature. The surrounding is best suitable for proliferation of mangroves because of the salinity of water and tidal impact. Ulhas Estuary comprises a network of channels of various depths, mud flats, tidal marshes and isles.

Two quadrants **(Map-2),** on either bank of the creek along the proposed MAHSR alignment were selected to study quantitative, qualitative and forest structure analysis**.**

1) Quadrant–I

In all six true and two associate mangrove species recorded from this site **(Table-5).** *Sonneratia apetala* was found to be most dominant followed by *Avicennia* spp. and *Acanthus ilicifolius* showed moderate presence. *Excoecaria agalocha and Aegiceras coenuculata* were poorly represented. These two species were found to grow towards the landward side. The average density of the plants was found to be 87 nos. /100 m^2 and species composition at this site was dominated by *Sonneratia* covering 42.53 % while *Avicennia marina* (16.09 %), *A. officinalis* (19.54 %) and *Acanthus ilicifolius* (10.34 %) coverage **(Table - 6 & Fig.-3).**

Sonneratia apetala found to be most matured trees with mean basal area of 0.037 m^2 and complexity index 0.09, respectively. This indicated that these trees have been around for more than 70 to 80 years. These trees were flowering and number of seeds was seen scattered on the substrate. *A. officinalis* was second mature tree with basal area of 0.012 m^2.

2) Quadrant- II

The species composition and distribution pattern was similar to that of Quadrant–I. Except that the density of the tree was little less *i. e.* 79 nos./100 m^2 and mixed seedlings were more than 100/m^2 **(Table - 7).** The species composition at this site was dominated by *Sonneratia* covering 32.91 % while *Avicennia marina* 20.25%, *A. officinalis* 15.19 % and *Acanthus ilicifolius* 16.46 % coverage **(Fig.-4).** The regeneration capacity at this site was found to be more which was evident from the presence of number of seedlings in the vicinity. It has been observed that over all seed/propogule production in *Sonneratia apetala* was tremendous than other species present in the area this demonstrates the success of the regenerative strategies of this species.

3) Number of Mangroves to be Affected

The MAHSR alignment shall run on the viaduct, across the Ulhas river, about 116398 sq.m of mangrove area shall be cleared. Therefore, about 101266 mangrove trees shall require to be cleared taking into account the average density of 87/100 m^2.

8.3 Site–III: Near Anjur Phata, Kharbhav, Kewani

8.3.1 Description of Study Site

Kevani village is located in Bhiwandi Tehsil of Thane district in Maharashtra. The proposed MAHSR alignment runs on viaduct that passes through the mangrove forest. A number of mangrove trees will be required to be cleared for the construction of maintenance road and piers.

The average height of the mangrove trees is about 6 m to 9 m. Some old mangrove trees of *Sonneratia apetala* were found to be most dominant and about 20 m to 25 m in height **(Plate–III).** This indicates that the trees are well matured and more than 70 to 80 years old. At some places mono species strand of *S. apetala* have been observed. The trees were fruiting and large number of fruits was seen spread all over the places. Some young seedlings were seen in plenty around most of the trees although the pneumatophores were thick covering the mangrove substrate. Mangrove trees on the landward side were found covered with epiphytes. Extensive sand mining is seen in this area. A number of mining boats were found anchored and some sand dumps were also seen.

8.3.2 Observations

Comparatively well-developed mangroves were seen at side of the Ulhas creek **(Plate - III).** The creek encloses luxuriantly grown mangrove patch spread over 1980 m stretch. The heights of some mangrove trees were quite tall about 25 m to 30 m. Two quadrants were selected to study quantitative, qualitative and forest structure analysis **(Map - 3).**

1) Quadrant–I & II

In all six species and two associates were found at this site **(Table - 8).** *Sonneratia apetala* was found to be most dominant species followed by moderate representation by *Avicennia* spp. and *Acanthus ilicifolius.* Towards the landward side a well-developed *Acanthus ilicifolius* strand was seen. The trees of the strand were more than 1.5 m in height. The trees were flowering. Other species present here were *Exoceria agalocha* and *Aegiceras corniculata* showed rare represents at this site. The trees were fruiting and large number of fruits was seen spread all over the places. Although, the pneumatophores were quite thick covering the substrate, some young seedlings were seen in plenty around most of the trees.

The average density of the plants in two quadrants was found to be 85 nos. and 57 no. /100 m^2, respectively. *Sonneratia* was found growing luxuriantly and the average height of trees was 25 m to 30 m in Quadrant–I and 20 m to 25 m in quadrant – II. Similarly, the mean basal area were 0.039 m^2 and 0.019 m^2 and Complexity Index were 0.476 and 0.180, respectively **(Table-9 & 10**). This indicates that the trees of *S. apetala* in Quadrant-I were more matured than the Quadrant-II and their presence in this area was more than 80 to 90 years. The coverage of *S. apetala* was 45.88 % and *Acanthus ilicifolius* was 24.71 % in Quadrant–I while in Quadrant–II, it was 40.35% and 22.80 %, respectively **(Fig. -5 & 6).**

2) Number of Mangroves to be Affected

The total length of the mangrove stretch at this site is around 968 m. The area to be cleared is 8.75 m each side of the center line of the alignment. The designed RoW shall be able to accommodate the road required for the movement of heavy construction equipment during the construction stage of the project. Considering the length of the alignment 968 m, 13070 sq. m of the mangrove area shall be cleared. In 10 m x 10 m area the average density of mangrove trees in quadrants studied was 57 nos. hence total mangrove trees to be cleared will be around 7450.

8.4 Site–IV: Brahmangaon (Bhiwandi)

8.4.1 Description of Study Site

Brahmangaon is a Village in Murbad Taluka in Thane District of Maharashtra State. It belongs to Konkan region. Brahmangaon is surrounded by Ambernath Taluka towards west. Thane Railway Station is the nearest railway station about 46 km from Brahmangaon.

8.4.2 Observations

At this site there is a well-developed mangrove patch spread over around 250 m stretch bordering the creek **(Plate–IV).** Mangroves were found to be luxuriantly growing and well branched. Two quadrants **(Map–4),** one in the thick mangrove patch and other on the edge of the creek were selected to study quantitative, qualitative and forest structure analysis.

1) Quadrant-I

At this site there is a well-developed mangrove patch along the Vasai creek. In all six true species and two associate species have been recorded **(Table – 11).** *Sonneratia apetala* was found to be most dominated followed by *Avicennia marina*. At this site trees were quite tall and densely populated. *Sonneratia – Avicennia* association was seen at most of the places with height ranging from 10 m to 15 m. The maximum height was recorded in *Sonneartia* sp. Trees were fruiting and large number of seed were found scattered all along the substrate. Some seedlings of *Sonneratia* species were found along the Pneumatophores.

The average density of the plants was found to be 79 nos. /100 m^2 and maximum area of 45.56 % was covered by *Sonneratia apetala,* 16.45 % by *Avicennia marina* var. *marina* and 12.65 % by *Avicennia officinalis* **(Table-12; Fig.-7).** *Sonneratia apetala* was found to be more matured and this was growing here for more than 70 to 80 years which is evident from the basal area and from high values of Complexity Index.

2) Quadrant-II

At this site seven true mangrove and two associate species have been reported. *Sonneratia apetala* was most dominant species followed by *Avicennia marina* and *A. officnalis* showed moderate presence. *S. apetala* showed solitary strand at most places while *A. officinalis* and *A. marina* were associated with each other at some isolated places. At this site *Sonneartia* was found to be most matured plants as compared to *Avicennia* species. The average density of the plants was found to be 72 nos. /100 m^2 and maximum area of 33.33 % was covered by *Sonneratia apetala,* 18.03 % by *Avicennia officinalis* and 15.23 % by *Acanthus ilicifolius* **(Table - 13; Fig.-8).**

3) Number of Mangroves to be Affected

The total length of the mangrove stretch at this site is 2381 m and the total area required to be cleared would be 44190 sq. m. In 10 m x 10 m sq. m average density of trees in quadrants studied was 71 nos./100 m^2 Therefore, total number of mangrove trees to be cleared will be around 31375.

8.5 Site–V: Saphale, Tembhikhodave (Vaitarna Estuary)

8.5.1 Description of Study Site

Saphale is a town in Palghar Taluka in Palghar District in Maharashtra, north of the mouth of the Vaitarna River. It belongs to Konkan region. The Saphale-Palghar belt also has many salt works. There are more than 40 villages in the area. Some scenic spots of tourist interest are Tandulwadi Fort, Karwale Dam, Kore Vartak beach and Advan Ashapuri Mamndir. Saphale railway station is on the Western Line of the Mumbai Suburban Railway.

In the middle of the creek there is a small semicircular island **(Plate–V**). The island has small mangrove patch towards the periphery. The average height of the mangrove trees is 4 m to 5 m. Some well grown and tall mangrove trees were seen in the middle and towards land ward side of the island. The proposed MAHSR alignment will run on viaduct and on bridge on the mangrove stretch for which a number of mangrove trees be cleared.

8.5.2 Observations

There is a small patch of mangrove on the edge of the creek and comparatively bigger patch was seen on the Island **(Plate–VA).** The total length of mangrove stretch measures around 1004 m long. Some tall mangrove trees were seen in the middle of the patch while smaller ones on the periphery with average height of 4 m to 5 m. There is a small jetty or ramp where fishing boats and sand extraction boats are anchored. Sand mining dumps were seen at some places and number abandoned aquaculture farms were also present in the vicinity of the area **(Plate–VB).** Two quadrants were selected to study quantitative, qualitative and forest structure analysis **(Map -5).**

1) Quadrant–I

In all nine true mangrove and three associate species have been recorded from this site **(Table - 14).** *Avicennia marina* var. *marina* and *Avicennia marina* var. *acutissima* and *Soneratia apetala* were abundantly found at this site. *Avicennia officinalis* was found to be moderately present. The clear cut association was seen with *Avicennia marina var marina* - *Avicennia marina* var. *acutissima* - *Soneratia apetala.* The average height of the *Avicennia* spp. ranged from 10 m to 15 m while *S. apetal* was much taller and height ranged from 15 m to 20 m. *Sonneratia* and *Avicennia* were found growing at this locality for quite some time and were well matured trees. This was evident from their tall height and basal area as well as high Complexity Index.

The average density of the plants was found to be 70 nos. /100 m^2 and maximum area covered was 20 % by *Avicennia marina* var. *marina* and 14.28 % by *Avicennia marina* var. *acutissima,* while *S. apetala* covered about 15.71 % area **(Table - 15; Fig.-9).** Other species present were *Rhizophora mucronataa, Aegiceras corniculata, Ceriops tagal etc.*, although in small number their presence was noteworthy. They were found mostly towards the landward side.

2) Quadrant – II

At this site in all eight true and four associate mangrove species were recorded. The species composition at this quadrant was similar to that of Quadrant–I. Overall average height of the trees at this quadrant was smaller than Quadrant–I. At this site interspacing between the trees was found to be more and trees were found to be quite spaced. This has resulted in regeneration of more mangrove seedlings than the Quadrant–I. The average density of the plants was found to be 66 nos. /100 m^2 and maximum area of 30.30 % was covered by *Avicennia marina* var. *acutissima and* 24.24 % was covered by *Avicennia marina* var. *marina,* while *S. apetala* covered about 13.63 % area **(Table - 16; Fig. -10).**

3) Number of Mangroves to be Affected

At this site the MAHSR alignment shall run on viaduct and bridge to be built across Vaitarna River. The total length of the MAHSR alignment is 1004 m. and the total area required to be cleared would be 15600 sq. m. In 10 x 10 m sq. m average density of trees in quadrants studied was 68 nos. Therefore, around 10661 mangrove trees shall be cleared.

8.6 Site–VI: Bharuch (Narmada River), Gujarat

8.6.1 Description of Study Site

Bharuch, formerly known as Broach, is situated at the mouth of the river Narmada in Gujarat in western India. Bharuch is the administrative headquarters of Bharuch District and is a municipality of about 370,000 inhabitants.

Being one of the biggest industrial hub including Ankleshwar, Gujarat Industrial Development Corporation (GIDC), at times referred to as the chemical capital of India. It was a ship building centre and sea port in the pre-compass coastal trading routes to points west, perhaps as far back as the days of the Pharaohs. The route made use of the regular and predictable monsoon winds or galleys. Many goods from the Far East (the famed Spice and Silk trade) were shipped there during the annual monsoon winds, making it a terminus for several key land-sea trade routes. Modern Bharuch is one of the most heavily industrialized areas, not only in Gujarat but in India as a whole, with many large chemical plants producing fertilizers, paints, dyes, cotton, textiles, and dairy products.

8.6.2 Observations

This area was surveyed in detailed along the route of proposed MAHSR alignment across the Narmada estuary**.** No mangrove was seen in this area along the proposed MAHSR alignment **(Map – VI).** Therefore, no further study was undertaken**.**

9.0 MANGROVE ASSOCIATES

9.1 Floral Association

Other associate mangrove species recorded from the study area were *Salvadora persica, Derris heterophylla, Sesuvium portulacustrum etc.* They were present towards the landward side. Some of these species such as *Derris heterophylla* was growing as epiphytes on the *Sonneatia apetala* and *Avicennia* spp. sometimes covering entire canopy of the plant. Other species were found growing in isolation on the bunds **(Plate–X).**

The number of micro algae and macrophyte (seaweeds) species grows on mangrove tree trunks, pneumatophores, stilt and prop roots at water level and at the level on the trunk where moisture is available **(Plate–XI).** The most dominant seaweed species found in mangroves were *Chaetomorpha linum, Ulva fasciata, U. lactuca, Centroceras clavulatum,* *Sphacelaria furcigera, Bostrychia* spp*. Catenella repens, Caloglossa leprieuri* etc*. Enteromorpha* spp*.* grows abundantly on the mangrove pneumatophores and young mangrove seedlings. These seaweeds form microhabitats for number of invertebrate species such as polychaete worms, amphipods, isopods, barnacles, snails, gastropods *etc*. who feed and breed and take shelter from predators.

9.2 Faunal Association

9.2.1 Insects in Mangroves

Insects play a very important role in ecology of mangrove ecosystem. Insects such as different types of ants, beetles, flies, moths, butterflies, grass hoppers, dragonflies *etc*. are found in mangroves feeding, breeding and detritus formation and pollination. Herbivore insects feed on leaves, flowers, seeds or mangrove propagules while detritivores insects eat dead wood or decaying leaves. Some species are beneficial in their ecological roles as predators and parasites and as pollinators of economically important plants.

Along the Indian coast line, *Avicennia* species is attacked by the insect *Pablia* sp. during September to November every year to complete its life cycle. When in caterpillar stage this insect becomes voracious eater and consumes large quantities of leaves. Once this stage is complete, it leaves the tree as a full-fledged insect. Once insect leaves, the tree regenerates its foliage. This phenomenon is very common along the Indian coast.

Among the insects, those in the order Diptera (flies) are prominent in their numbers and influence and play important ecological roles (Kathiresa, 2002; Grampurohit and Karkhanis, 2013). Pollination by insect varies with mangrove species. *Sonneratia* spp. is pollinated by hawk moth, *Bruguiera* by butterfly, *Xylocrapus, Excoecaria, Aegiceras, Avicennia* and *Acanthus* by bees and *Ceriops* and *Kandelia* by other small insects.

Honey is made by the bees from the nectar of the mangrove flowers. Honeybees, from the genus *Apis*, have been exploited by man for thousands of years. *Apis mellifera*, which is native throughout Africa, most of Europe and the Middle East, is the best known and most widely spread species. Honey collected from *Cynometra ramiflora* and *Aegialitis rotundifolia* has a good market value and is in demand.

9.2.2 Benthic Fauna

The survey and interviews conducted during the field investigation survey indicated presence of rich invertebrate fauna in and on the mud flats, as epiphytes on the tree trunks, pneumatophores, stilt roots and in the canopy of the trees.

Mangrove forest provides both hard and soft bottom habitats for variety of invertebrate life such as worms, clams, crustaceans, sponges, juvenile fish and other tiny organisms that live in the bottom sediments **(Plate–XII).** The extensive mangrove root systems, muddy bottoms and open waters are all favourable habitats to invertebrates that are well adapted to the temperature and salinity variations as well as tidal influences to mangroves. These invertebrates feed on leaf litter detritus, plankton, microorganisms and other small animals. Some of these animals reside in mangroves, some visits during the seasons or when food is plenty, while some visit for feeding and breeding.

Benthic organisms play an important role in regulating and maintaining the detritus food chain of estuarine ecosystem. Predominant species of macro benthos such as crustaceans, molluscs and annelids were studied in Thane creek and adjoining areas

(Athalye, 1988; Deshmukh, 1990; Gokhale and Athalye, 1995; Quadros Goldin, 2001). In the lower stretches of the Thane creek the pollutants get diluted hence it supports relatively higher benthic diversity. The creek supports good diversity of mangroves and birds population including Flamingos.

These observations suggest that in spite of the polluted status of the creek, it is possible to revive the creek ecosystem if remedial measures such as reduction of sewage and solid wastes at source, de-siltation of the creek, plantation of mangroves, prevention of silt in runoff are implemented. The local fishermen can be encouraged to practice creek and mangrove based productive activities.

9.2.3 Wood Borers

It has been reported that the mangrove trees are relatively resistant to borers due to presence of tannic acid. It is considered that resins, silica, alkaloids, oil and acid present in the mangroves resist wood borer, however, increased incidences of boring on dead as well as living trees do not support such an assumption. Perhaps, mangroves provide suitable habitats for the borers and presence of thick calcareous tubes around their bodies may be one of the protective devices produced by the borers.

Marine wood borers fall under two main groups–mollusks and crustaceans. The mollusks belong to family *Teredinidae* and crustacean come under family *Sphaeromalidae*. Borers are widely distributed in the mangroves and are reported to occasionally attack living but injured trees. Wood borer like *Martesia* sp., *Nausilora hedleyi* and member of *Sphaeroma terebrans* have destroyed *Avicennia* spp.

9.2.4 Mangrove Fishery

The important ecological role of the mangroves is the detritus, which help in feeding and provides breeding and nursery grounds for the juveniles of many commercially important shrimps and fishes. The mangrove water, usually rich in detritus are highly suitable for fishing. The major fishery resources found in these waters are detritivorous species of fishes, crabs, crustaceans and molluscs. Roughly about 60% of India's coastal marine fish species is dependent on the mangrove estuarine complex. Some of the most common fishes in Indian mangrove waters are *Liza, Mugil cephalus, Lates calcarifer, Sciaena, Hilsa, Ilisha, Silago sihama, Etroplus suratensis etc*. **(Plates-XIII).**

Prawns are represented by the species of giant freshwater prawn, *Macrobrachium rosenbergii* and the marine penaeid prawns *Penaeus indicus, P. merguiensis, P. monodon* and *Metapenaeus brevicornis.* Shrimps are usually caught with push nets along shallow creeks within the mangroves **(Plate-XIV).**

The crabs are represented mainly by *Scylla serrata, Thalamitta crenata* and *Portunus sanguinolentus* and they are caught in large quantities **(Plate - XV).** .*Scylla serrata*, is the key mangrove species and is a large edible swimming crab, inhabits the muddy bottom of mangrove estuaries, as well as coastal brackish water. *Thalassina anomala*, the mud lobster is also found in mangroves.

The mangrove clams are mainly represented by *Crassostrea madrasensis, C. gryphoides* and *C. cucullata.* These species are found growing on the mangrove stem, roots and on the rocks. Other bivalves such as *Meretrix casta, M. casta, Velorita cyprinoides, Perna viridis, Polymesoda erosa* etc. are found in the estuarine system of the Maharashtra coast **(Plate - XIII).** *Polymesoda erosa* also grow abundantly in mangroves and are harvested on regular basis. During monsoon season when fishing is banned, these bivalves are in demand in local markets.

9.2.5 Wildlife in Mangroves

1) Reptiles

Reptiles are also common in mangroves and can include snakes, turtles and lizards. Indian monitor lizard, *Varanus salvator* is found in mangroves and also on the land ward fringe **(Plates – XXII).** There are number of other lizards are also found in the mangroves, however, not much work has been done.

2) Snakes

A number of snakes can also be found in mangrove areas especially in the landward fringe. They inhabit the aquatic environment right from swimming to salt tolerance, to diving ability and breathe holding capacity. Dog faced water snake is commonly found in the mangrove areas and feeds on small fishes.

3) Turtles

The loggerhead (*Caretta caretta*) and green sea turtle (*Chelonia mydas*) utilize the mangroves as juvenile nurseries, feeding ground and receives protection from predators. The green sea turtle and Hawksbill sea turtles (*Eretmochelys imbricata*) have been observed feeding on mangrove roots and associated submerged vegetation **(Plate–XII)** The Ridley sea turtle (*Lepidochelys kempii*) is commonly observed in mangroves. The occurrence of three species of marine turtles i.e. Hawksbill, Green and Loggerhead has been reported from Maharashtra region and Olive Ridley turtle is known to nest all along the Maharashtra coast (Shaikh, 1983; Giri and Chaturvedi, 2003).

4) Birds

Birds are a prominent part of most mangrove forests and they are often present in large numbers **(Plate–XVII).** Thane Creek is one of the unique mangrove ecosystems, and maintains a large population of sediment-dwelling organisms that support migratory and non-migratory bird populations. In total 95 species of birds were recorded and distinguished as per the pattern of their foraging (Chaudhari & Pejaver, 2016). The mudflats exposed during low tide are used as the foraging grounds by a variety of wading birds mainly a huge flock of lesser flamingo, greater flamingos and a multitude of water birds during the winter season. Most of the birds have specific habitat requirements from season to season, a loss of which may lead to their local extinction.

A healthy diversity of bird species observed indicates the high productivity of the creek. In spite of several anthropogenic stresses, the mudflats of the creek provide the food requirement for diversity of bird species mainly waders. Past and present researchers stated that, Thane Creek is heavily polluted with wastes from both industrial and domestic sources discharged into the creek through several outlet (Nitsure and Pejaver, 2002; Chauhan, Shingadia and Sakthivel, 2008; Chaudhari and Pejaver, 2016). However, it still supports thousands of birds including the small waders and the flamingos. Flamingoes serve to be the major attraction of the creek that has led the Forest Department, Government of Maharashtra to declare certain parts of the Thane Creek as Thane Creek Flamingo Sanctuary. This part of the sanctuary needs special attention for improving, protecting and conserving the sanctity of the creek.

5) Mammals

Many mammals frequently visit mangrove habitats but only a few live there permanently and fewer are restricted to them. In many countries however, the mangroves represent the last refuge for a number of rare and endangered mammals. There are number of terrestrial animals that inhabit mangroves for feeding, breeding and shelter **(Plate–XVI).** Mammals visiting mangroves frequently are Jackals, Otters, flying fox, fishing cats, Civets, Mongooses, Wild Pigs, Monkeys (rarely) *etc*. for feeding. Most of these mammals are opportunistic hunters and mostly eat fish, but will also eat crustaceans, insects, amphibians, birds and small rodents. These aquatic mammals face many threats from humans because of destruction of habitat for aquaculture and construction of roads, jetties, housing, industrial and domestic pollution, pesticides, reduction in prey and indiscriminate killing.

10.0 ANTICIPATED IMPACTS & MITIGATION MESAURES

10.1 Altered Tidal Flushing

1) Impacts

- Proposed MAHSR alignment crosses the creek and water channel at many places and may obstruct or reduce the water flow in to the mangroves.
- Some areas of mangrove may experience altered tidal flushing due to the infill during construction activities, particularly where causeway crosses the creek. Some channels may also disrupt the water flow reducing flow of water to mangroves.
- From chainage Km 43+535 to Km 45+916 the alignment passes south of a thickly vegetated and healthy mangrove patch. The construction of a service/access road during the construction phase is expected to cut off the northern area of the mangroves completely from tidal exchange and threatens the long term survival of the mangroves.

2) Mitigation Measures

- Drainage structures at cross way has to be designed to ensure continuous flow thus preventing ponding and flooding.
- Balancing culvert should be provided from Km 43+535 to Km 45+916.

10.2 Mangroves

1) Impacts

- Proposed MAHSR alignment passes through mangrove areas at various places. At some places it will run through the tunnel below 30 m of the mangrove forest (Thane Creek), and other places it will run over the bridge and viaduct that will be constructed in the mangrove forest due to which a number of mangroves will have to be cleared.
- The footprint of the piers for bridge warrants removal of mangroves. As per specification of the footprint area of the respective piers a number of mangrove trees will be cleared. Similarly, for duck an area to be cleared is around 15 m x 15 m on each side of the centre line of the alignment irrespective of the pier location. The mangrove falling within the RoW of 17.5 meter *i.e.* 8.75 meter each side of the centre line of the alignment would be cleared all along the viaduct. The RoW has been designed to accommodate the space required for the movement of heavy

machinery and equipment for construction purpose. Therefore, the mangrove falling within the limit of RoW *i.e* 17.5 m shall be required to be removed.

- Some areas of mangrove may experience altered tidal flushing as a result of construction of the proposed MAHSR alignment, particularly where a causeway will cross the creek like on the northern bank of Ulhas river from chainage Km 43+535 to Km 45+916. Some small intertidal channels may experience disrupted flows while other channels may be completely in filled.
- There is a possibility that earth fill used during the construction of the corridor may slip down slope and spread out over the tidal flat. This will bury mangrove pneumatophores choking breathing holes that may lead to tree mortality. The areas where slippage of fill is most likely to occur are on the banks of the creek where the MAHSR alignment will cross the channel.
- Insects and invertebrates that are associated with mangrove habitats will be impacted by the direct loss of habitat as these fauna rely on mangrove for food and shelter. There will also be some direct mortality of insects and other epiphytic invertebrates during the clearing of mangrove vegetation.
- It is expected that mobile species and individuals will move away from the project area during construction, particularly in the case of some species of mangrove crabs and mudskippers while non - motile species, it will lead to direct mortality
- Apart from this, during construction and operation the existing mangroves will also be subjected to the temporary impact till the environment is stabilized.
- The loss of mangrove vegetation may have some impact on benthos, fisheries, birds and wildlife and ecosystem services provided by the mangroves.
- During construction stage the mangrove tree cover within the proposed HSR corridor will be removed in phases as work progresses. This will affect the aesthetic of the corridor as well as the benthic and epiphytic population of the area.
- Fruiting mangrove trees will lose propagules once we clear the mangrove trees thus it will impact regenerative capacity of the area.
- During the MAHSR operation stage the mangroves will be subjected to thrust caused by the high speed of the train. Mangrove trees will be shaken with tremendous pressure caused by the high speed. This will impose physical stress on the mangrove plants.

2) Mitigation Measures

- For construction of piers, mangrove will be cleared for which compensatory afforestation has been suggested. Compensatory afforestation of the cleared mangroves should be undertaken with 1:5 ratios at the suitable and environmentally acceptable location in the mangrove areas in consultation with the Mangrove Cell, Thane. The suitable land shall be identified and allocated by the District Collector, Thane and Palghar based on the available adequate land parcel.
- The effects on the mangrove ecosystem are not preventable but a full-fledged afforestation activity in the vicinity should be undertaken during the construction phase itself, so that the ecosystem of the development area will be restored to a certain extent, which will make the new habitat unique.
- Balancing culvert should be provided along the north bank of Ulhas River from Chainage Km 43+535 to Km 45+916 for securing the uninterrupted exchange of tidal water.
- The afforestation plan should be drawn up based on the topography of the planting area and decided on the pattern of planting. During afforestation, zonation and diversity of mangrove species should be maintained at all level.
- To protect remaining mangroves during construction activities, a silt screen should be placed around the entire perimeter of the construction site to prevent the

accumulation of dust and fine particulate on the mangrove trees. This is particularly applicable due to changing environmental conditions in the surroundings.

- The causeway should be designed to maintain adequate tidal flow for the support of mangrove habitat.
- The loss of insects and invertebrates considered a relatively minor impact since the area to be cleared is small, relative to the mangrove habitat.
- As surrounding mangrove area that will not be cleared is expected to support sustainable populations of all species such that there will be no long-term impacts on populations or species in the area.
- Compensatory afforestation should be undertaken by NHSRCL or by the Mangrove Cell, Thane and aesthetic and benthic and epiphytic population should be restored in due course of time. In the event of compensatory afforestation is undertaken by the Mangrove Cell, Thane the cost of compensatory afforestation and cost of the land should be borne by the NHSRCL as decided by the District Collector and Mangrove Cell, Thane.
- The impact on regeneration will be temporary and will be restored once mangrove starts growing after afforestation.
- Although, mangrove trees will be subjected to thrust caused by the speed, it will be for short term during the running of the train and hence impact will be temporary.
- Impact on epiphytic organisms will be short term and temporary in nature.

10.3 Changes in Topography

1) Impacts

- The MAHSR alignment corridor may alter the topography of the surrounding area due to construction of flyovers piers, viaduct and other structures *etc*. These changes will result in temporary loss of habitats and will also cause some temporary ecological changes at micro level.
- There will be substantial cutting required at or near hilly areas, filling of low lying areas, elevation of roads, rail lines, disposal of cutting material *etc*.
- There is a possibility that earth fill used for the construction of the corridor may slip down and spread out into the mangrove area causing burial of mangrove pneumatophores which will block the breathing system and ultimately would lead to mortality of mangroves.
- Similarly, benthic invertebrate filter feeders such as clams, oysters, barnacles and fishes may clog their gills and other breathing apparatus leading to mortality.

2) Mitigation Measures

- The paving of surfaces will also lead to very minor changes in temperature. The changes in topography will have temporary and minimal impacts on the project corridor.
- Cutting material will be utilized in raising embankment, leveling of the proposed corridor. However, the storage of materials at identified sites may cause very minimal changes in physiography only for a temporary period. The impact therefore will be very low and insignificant. The overall topography of vicinity of the project will have little impacted in terms of change in land use.
- Care should be taken and ensured that the proper blockage to be implemented so that landfill slid does not occur. Erosion control retaining wall and slope pitching measures need to be taken by the contractor.

10.4 Dust Pollution

1) Impact

- The only major impacts are caused due to airborne dust arising from the construction activities as well as gaseous pollutants from vehicles used for transportation of construction materials and emission from equipment used during construction phase. The dust particles in the form of particular matters will strongly depend on various activities like movement of vehicles, their speed, excavation of earth, back filling *etc*. during the construction phase.
- Dust generated during the construction and operational phases of the proposed HSR corridor will result in dust being deposited on surrounding mangroves. Dust deposition on mangroves and other vegetation may negatively impact photosynthesis.
- Impact of dust on mangrove will affect the feeding and breeding of the epiphytic organisms such as insects, crabs, gastropods *etc*. that are present on the mangroves.

2) Mitigation Measures

- It is necessary to incorporate appropriate dust management strategy. This is a short term impact which can be mitigated by using water sprinkler system and covering the excavated materials.
- Insects will avoid leaves with dust accumulation if it interferes with their foraging, breeding or habitat provision and will migrate and utilize nearby areas that are unaffected by dust accumulation. It is not known whether the absence of particular insects will affect the ecology of the mangroves themselves, e.g. with respect to pollination, herbivory, *etc*. It is also likely that different species of insects will have different tolerance.

10.5 Solid Waste

1) Impact

- Solid waste generated during the construction activities of MAHSR will include construction debris, cleared vegetation, solid waste dump, the demolished structures and solid waste generated from the construction camp.
- The construction of MAHSR will involve the use of machinery and equipment which may generate pollution at various levels which ultimately find its way into the mangrove area. This problem may have serious consequences on the general health of mangroves.

2) Mitigation Measures

- Construction sites generate considerable waste and provision must be made for suitable segregation and storage of waste in designated and labeled areas on the site and site camp. Care should be taken not to dump waste in the untouched mangroves present in the vicinity.
- Collection of waste by certified contractors and disposal of the waste as recommended and approved by the National Solid Waste Management Authority.
- Any hazardous waste should be separated and stored in areas clearly designated and labeled for future entombing and disposal as directed by the National Solid Waste Management Authority.
- Worker training should include instructions on how to dispose of food and drink containers emphasizing the need to protect the environment.

- Construction camps and work areas along the proposed alignment must be adequately equipped with portable chemical toilets.

10.6 Mangrove Fauna

1) Impact

- During the field survey and interviews conducted, there exists presence of wild animals along some part of the proposed HSR corridor which may get temporary disturbed due to high speed and sound of the train.
- Epiphytic organism such as insects, crabs, gastropods, birds *etc*. present on mangrove trees will be blown away or disturbed by the speed of the train.

3) Mitigation Measure

- The wild animals present may get disturbed due to speed and sound of the high speed train. This will be temporary impact. Apart from this both side of the of the project corridor will be well protect to avoid any direct contact with the wild life by boundary wall or elevated corridor with noise protection or protection measure shall be taken as advised by the Wildlife Department, Maharashtra.
- The impact on benthic fauna and epiphytic fauna such insects, crabs, birds will be temporary and short lived. Perhaps, over the time these organisms may develop mechanism to hold on to the substrate to get rid of the thrust caused by train speed at the time of the train operation.

10.7 Marine Ecology

1) Impact

- The marine environment can be affected by increased levels of sedimentation and siltation through clearing of mangrove vegetation and exposure of top soil, terrestrial wash down of stock piled earth materials and release of fines during construction and the reclamation.
- The sediments suffocate fish and shellfish populations by covering fish spawning areas and clogging the gills of bottom fish and shellfishes. Additionally, construction of revetments and retaining walls will permanently alter the area, changing tidal flushing and resulting in loss of benthos and associated marine flora and fauna. However, the revetments themselves may create a new habitat resulting in the establishment of other species.
- For healthy mangrove forest to survive, it is necessary to fully understand to what extent the fresh and sea water needed to mix. There is a possibility that mangrove forest may suffer due to non-mixing of the water, proportionately. This will have devastating effect on the ecosystem as a whole and in turn on the local population who use mangrove forest area for their livelihood.

2) Mitigation Measure

- During site preparation and construction, earth materials stock piled should be contained by a berm to prevent this material being carried in to the mangrove area in the vicinity by terrestrial runoff during rainfall. Additionally, during land reclamation and construction of the revetments, appropriate measures should be taken to reduce suspended solids loading. This could include the use of silt screens and sediment traps.

- Oil and grease which may be generated from construction equipment should not be allowed to run into the adjoining mangrove area and should be properly stored and disposed off.
- The variation in adaptations in water conducting pathways among mangroves are likely contributes to the maintenance of high levels of productivity in heterogeneous saline environments that occur in mangrove habitats. Mangroves adapt different strategies to regulate water balance in saline environment.

11.0 INTEGRATED MANGROVE CONSERVATION AND MANAGEMENT

Mangrove biodiversity, conservation and management have received considerable attention in recent times because of the extensive degradation of mangrove areas along the Indian coast. Restoration of mangroves has also greatly improved over the years. Today mangroves have become global concern as about 120 countries worldwide have mangrove resources.

At the International level, the common approach to major environmental policy issues has been to formulate conventions, treaties and agreements with all concerned countries become signatories. Mangroves are today global issues and many countries have undertaken rehabilitation initiatives, establishing nurseries and attempting afforestation and re-planting in degraded areas.

In India, the responsibility of mangrove management at the national level has been assigned on sectorial basis to executing agencies of the government institutions for example Forest Deptt., Fishery or Agriculture Departments. In some of the states, a special Mangrove Cell has been created. In Maharashtra, a separate Mangrove Cell under Thane Forest Circle has been established for the protection and conservation of Mangrove in Maharashtra.

Considering the magnitude of the MAHSR project, an Integrated Mangrove Conservation and Management Plan is of immense importance. About 18.9258 ha. of mangrove area shall be cleared for the construction of MAHSR alignment and its associated facilities. To ameliorate and compensate the loss of mangrove, compensatory afforestation should be taken up in an area equivalent to five times of the mangrove area i.e. 94.629 ha. The compensatory afforestation shall be undertaken at the identified and allocated degraded forest land by the District Collector. The cost of the land and expenditure for compensatory afforestation shall be borne by the NHSRCL.

12.0 MANGROVE AFFORESTATION

More than half a dozen international agreements and various regional agreements are directly relevant to the conservation of mangrove biodiversity. The destruction and depletion of mangroves forest, pose one of the most serious social problems in the world. The problem in India is particularly observed along the west coast where the extent of the remaining mangrove forests is under constant threat. Conservation measures and afforestation are therefore, essential.

The mangroves are slow to recuperate from cutting. Several species do not re-sprout after being cut. So, once they have been cut down, they will never regenerate unless replanted. When a large section of mangrove forest is cut, the roots can no longer oxygenate, the oxygen-deficient soil and the large amount of bacteria in the soil begins to churn out hydrogen sulphide. This makes the soil extremely acidic which does not support any mangroves, even if they are replanted.

In the present proposal, the compensatory mangrove afforestation shall be undertaken by the Mangrove Cell, Thane on the land identified and allocated by the District Collector as discussed in the previous section 11.0.

13.0 MANGROVE RESTORATION

For successful mangrove restoration following points should be taken into account:

- To undertake restoration work following information of the restoration site is pre-requisite :-
  - Information on biophysical features of the site;
  - Climatic parameters such as rainfall, temperature *etc.*;
  - Information on water chemistry (salinity, pH, transparency, nutrients *etc.*);
  - Soil type; and
  - Tidal flushing *etc*.
- The attention should be given to hydrological patterns that control the distribution, successful establishment and growth of mangrove species. Each mangrove species grows in different substrate, which decides the amount of exposure mangroves, will have to tidal waters. Therefore, the understanding of hydrological patterns that influence the distribution and growth of natural mangrove plant communities in the restoration area is very much essential.
- It is necessary to understand both the autecology (individual species ecology) and synecology (community ecology) of mangrove species at the particular site.
- Particular attention should be given to patterns of reproduction, propagules and their distribution, regeneration and successful seedling establishment. Mangrove seedlings have various shapes and sizes and floats differently.
- Selected site should be both hydrological and ecological likely to succeed in rehabilitating a healthy mangrove ecosystem.
- Another important factor is to ensure uninterrupted flow of tidal water through the entire restoration area.
- Design restoration programs at appropriate sites to initially restore the appropriate hydrology and take advantage of natural recruitment of mangrove propagules for plant establishment.
- For planting, utilize available propagules, collected seedlings or nursery raised cultivated seedlings as natural recruitment will not provide sufficient quantity for plantation.
- Monitoring of the planted seedlings should be carried out at least for two years and whole plantation should be protected for a period of ten years or till it is fully established.

14.0 TECHNIQUES FOR MANGROVE RESTORATION

14.1 Direct Seedling Plantation

For high density planting, direct sowing of propagules collected from the mangrove plants with 1 m x 1 m spacing should be adopted in open mud flats. It should be ensured that the seedlings are healthy, not damaged by insect or borers may be collected from the naturally grown mangrove plants and planted in mudflats.

14.2 Nursery

Nursery is raised in the intertidal areas where there is regular tidal inundation takes place. Seedlings collected from naturally grown mangrove plants are planted in the polyethylene bags filled with mangrove mud. Seedlings are raised till they attain three four leaf stage and then planted with 1 m x 1 m spacing where direct sowing of propagules are difficult.

14.3 Enrichment Plantation

The main objective of this technique is to improve biodiversity of the area and also to improve genetic resource conservation. Under this technique, threatened mangrove species are replanted at appropriate sites. The preference should be given to those species that have been exterminated from the area. While planting other species, zonation pattern of the respective species should be taken in to account. If necessary seeds or propagules required for restoration should be imported from other areas to raise nursery.

14.4 Planting with Trenching

This technique is used in saline blanks or mud flats with *Suaeda* cover, where the tidal amplitude is less than 12 inches. In hyper saline area, tidal water reaches occasionally due to the marginal elevation of land from the mud flats of mangrove area. Formation of hyper saline mudflats is a natural process which occurs as a result of deposition of silt and high evaporation rate. This process is accelerated when estuary and streams discharge high quantity of silt in the sea creating "Saline Blanks" where tidal water cannot reach and soil salinity remain high.

In mangrove area, acid sulphate soils result from the oxidation and subsequent acidification of pyritic sediments upon excavation and drainage. Acid sulphate soils can develop a pH as low as 2 with untested effects on the growth of replanted mangrove trees. The hydrological rehabilitation by trenching will support normal tidal flow in the entire restoration area **(Plate-XVIII).**The natural exchange and flow of water through the whole mangrove area from the terrestrial edge to the sea is essential, as the streams create the site, including its zone-specific composition of fresh water and salinity in the area.

15.0 MANGROVE AFFORESTATION (PLANTATION) PLAN

The afforestation should be carried out in two ways:-

a. Direct planting in the intertidal area, swamp or soft mud.
b. Raising seedlings in the nursery

15.1 Direct Seed Plantation

Seeds or naturally grown seedlings which are healthy, non-infected and fully matured should be collected from the wild and are used for direct planting. Any intertidal area (between the high tide and low tide) where mangroves are absent and the substratum is of soft clay or mud and is inundated by regular tidal waters every day is suitable for direct mangrove seed planting. The collected seeds or seedlings to be planted in to a hole made in a mud along the line transect. A hole should be made in to the mud two times wider and two times deeper than the root ball of the seedling. While placing the seedling in the hole, care should be taken that roots should dangle freely without touching the bottom of the hole. Roots in contact with the bottom will curl up wards that will lead to stunted growth of the seedlings.

The spacing between each seed or seedlings should be maintained at 1 m x 1 m along the line transect. It is necessary to understand the normal hydrologic patterns that influence the distribution and growth of mangrove plant communities in the restoration area. Therefore, a sufficient understanding of the determining factors such as depth, duration and frequency of tidal inundation of tidal flooding is vital.

15.2 Raising Seedlings in the Nursery

1) Site Selection for Nursery Development

A suitable site in the intertidal area should be selected in consultation with District Collector and Mangrove Cell, Thane to raise mangrove nursery. An appropriate site, that is both technically and ecologically likely to succeed in rehabilitating a healthy mangroves should be selected.

Preferred sites should be characterised by:-

- Relatively flat land preferably in the intertidal area;
- Should be gradual in slope;
- Site should be a sheltered area with low wave action;
- Easy transportation access;
- Good drainage (not waterlogged);
- Close proximity to planting site;
- Receives tidal water once in a day with tolerable salinity range;
- Site should be easily manageable.

2) Preparation of Nursery Plot

Once site for mangrove nursery is selected, it is cleaned of debris and other unwanted material. Plots of 10 m x 1 m are to be made in the intertidal area to raise the seedlings. Like this series of plots should be made as per the requirement of the seedling production for planting. The distance between each plot should be kept 1 m in such a way that every plot is accessible for supervision and maintenance. The plot is required to be strengthened with bamboo poles to be kept intact and not to get washed off during the incoming /outgoing tides. Polyethylene bags of 4” x 10” size to be used to raise mangrove seedlings. The size of the nursery will depend on the number of seedlings to be raised for plantation.

3) Technical know-how for Seed Collection

The seeds for nursery are required to be collected from nearby mangrove area and also from other far of places for the species of mangroves which are not available in the vicinity. Although, mangrove seeds are available throughout the year the best season to collect seeds is June to September. It is necessary to have a look at the individual species autecology of the mangroves as well as their synecology depending on the variety of species to be raised.

The different mangrove species have varying size and shape of seeds/seedlings with typical morphological characteristics. Some seeds are pod like with tapering end as in case of *Rhizophora* spp., radicle in *Bruguiera* spp. Is triangular in shape as in *Avicennia* spp. while, round ball like in *Sonneratia* spp. *etc*. The seedlings of various shapes and sizes of propagules can float differently and changes that seeds/ seedlings are undergoing during afloat vary with the species.

It is important to consider the different plant zonation which is characterized by different conditions, depending on the tidal zone and the position of the restoration site, such as the scope of tidal inundation, salinity and the amount of fresh water available.

Collected seeds should be examined for the presence of diseases or pests or borer before being brought to the nursery site. Only mature, healthy, without any injuries, non-infected with insects and seed complete in all respect should be selected**.**

4) Seed Storage

Collected seeds to be stored wet till planting. The storing capacity of seeds varies with the species *i.e. Rhizophora* spp. and *Bruguiera* spp. can be stored moist for 6-7 days, *Sonneratia* can be stored for longer period, while species of *Kandelia* should be transplanted immediately either to the nursery or in the field. While storing the seeds it should be ensured that during handling and storing seeds are not damaged if they are placed in the intertidal area due to incoming and outgoing water movement. It is however, always advisable to store these seedlings partially immersed (pointed end root side in water) in seawater.

5) Raising Seeds in Nursery

Mangrove nurseries can be developed in the upper part of the intertidal region where seedlings can be grown in polyethylene bags supported with bamboos. The mangrove nursery may be located near the estuary or sea where seawater or estuarine water is available. The nursery may be on the open ground or in the low lying protected areas where seawater reaches. The area of nursery should receive water once in a day.

The polyethylene bags should be filled with soft mangrove mud without shells, stones and other debris and staked in the rectangular frame made by bamboo so that the bags are not washed away by the outgoing tide **(Plate-XIX).** Perforations in the bags are made to drain excess water from the bag. Then the collected seeds (pod like seedlings) are planted upright in each polyethylene bags while other seedlings which are round or small seeds are placed directly in the polyethylene bags filled with mud and left to grow. It takes about 6 to 8 months or a year or sometime more for seeds to grow depending on the mangrove species.

6) Seed Management and Maintenance of the Nursery

Planted seeds should be checked regularly for pest, borer and damage, especially, when they are sprouting as seeds are more susceptible to damage at this stage. Regular monitoring of the planted seeds are required to be done to replace dead and affected seeds with new seeds and also to replace washed off bags by outgoing tide. Seeds will germinate after 7 to 8 days. Seeds should be checked for insect attack and fouler such as seaweeds especially, *Enteromorpha* spp., barnacles, gastropods and others.

7) Criteria for the readiness of Seedlings for Planting

About 4-5 months after planting, seedlings are ready for transplanting:

- Seedlings should be healthy
- Height: 60-80 cm and bearing 7- 9 leaves
- Stem: upright with profuse root system
- Healthy with no symptoms of disease or insect attack.

15.3 Criteria for Seedling Plantation

Initially, a survey has to be carried out at various localities along the coast to select a suitable site for plantation. The site selection for plantation should be done on following criteria:-

- An intertidal area that is sheltered from high energy waves such as those in estuaries and lagoons;
- In area where the difference between the high and the low tides is large (2 m or more) and the intertidal area is flushed well every day;
- Suitable Hydrological conditions of intertidal zones;
- Availability of nutrients for plant growth.

1) Nursery Raised Seedling Plantation

Once a site for plantation is selected, nursery raised seedlings should be transported to the plantation site. The seedlings from the nursery should be collected carefully without any damage and transported to the plantation site. At the plantation site line transect should be marked with the help of rope perpendicular to the shore. Polyethylene bags of the seedlings to be cut open and seedling with root and mud to be removed carefully. The holes should be made along the line transect and then the seedlings should be planted firmly in the mud. The spacing between each seedling should be maintained at 1 m x 1 m or 2 m x 2 m depending on the locality along the line transects **(Plate-XX).**

The zonation pattern for different mangrove species has to be maintained. Before planting, it is necessary to find out at what position the mangrove species is being planted depending on the zonation. Plantation of seedlings may be undertaken according to length of the seedlings. For example, *Rhizophora* spp. can be planted towards waterfront followed by K*andelia, Bruguiera etc*. Species with smaller seeds like *Avicennia, Sonneratia etc*. could be planted towards landward side.

2) Survival Rate

If due care is taken in selecting the seedlings to be used for plantation, then the survival rate is very high (about 90 to 95%). However, in polluted areas the mortality may be high because of toxic substances discharged from the industries. Therefore, it will be advisable to avoid such polluted area. Sewage pollution or low level nontoxic pollutants may not have harmful effect on mangrove plants. On the other hand it has been found that mangrove trees can reduce the pollution by absorbing certain chemicals. Very high sediment load with fast current may also some time pose little problem.

16.0 MANGROVE CONSERVATION PLAN

Conservation of mangrove should be linked with sustained economic benefits of the coastal community. Ultimate goal of the mangrove conservation is to provide diverse products on sustainable basis to meet diverse need including ecological security to the coastal people.

16.1 Community Participation

The coastal community, especially fishermen is main stake holder and they have maximum interaction with tidal environment. They are directly and indirectly benefited by mangroves and there is no reason why they should not be involved in mangrove development. In most of the states, fishermen work as a laborer for mangrove plantation but they do not own the programme. It is necessary to develop understanding among coastal community about economic and ecological roles of the ecosystem. It is now essential to initiate joint forest management programme in mangrove areas. Community participation should be important component in mangrove development programme **(Plate-XXI).**

16.2 Capacity Building

Training locals in mangrove propagation techniques and nursery development and maintenance with different species of nursery-raised mangrove seedlings has to be a regular feature to rehabilitate mangroves in degraded areas. This programme can be conducted in a coastal village school, so the students will be the key players of local mangrove conservation **(Plate XXII).** The students will convey the conservation message of this event to their father and mother who are daily venturing into sea and local mangrove habitat for fishing and other livelihood activities.

16.3 Awareness and Education

Public awareness of the importance and value of mangroves has been identified as a critical factor in the conservation and restoration of mangrove ecosystem. Awareness can be raised in younger generations particularly school children by stimulating interest and passion for the environment through art, exhibition, essay and public speaking competitions and by encouraging them to discuss the importance of mangroves with their friends, colleagues, families, communities *etc*. It is necessary to hold consultations of like-minded people on important conservation issues in which people's decisions and actions are badly needed **(Plate-XXIII).**

16.4 Research

The government supports research by academic institutions for development of mangrove ecosystems on a sound ecological basis. The National Forest Policy, 1988 lists effective conservation and management of natural forest ecosystems (including the mangrove ecosystem) as a priority area for forestry research. Application of research in mangrove conservation was hardly visible and coordination between the Forest Department and other research institutes was absent in most of the states. As a result financial impact on mangrove research did not yield desirable result which needs to be reviewed.

16.5 Marine Protected Areas (MPA)

It is necessary to make coordinated efforts to preserve, conserve and manage mangrove areas and this is possible only through the establishment of Marine Protected Areas (MPA). During 1997-98, National Institute of Oceanography (NIO), Goa has identified and recommended seven sites along the Maharashtra coast as Marine Protected Areas. In Goa there is only one protected area and that is Sir Salim Ali Bird Sanctuary, at Chorao, Goa. This sanctuary was the outcome of the joint efforts of the mangrove work that was carried out by National Institute of Oceanography, Dona Paula and Forest Department, Govt. of Goa. Recently, Mangrove Society of India (MSI) has proposed "**Mangrove Park**" near Panaji bus stand, Patto to Govt. of Goa which has been approved and work is in progress.

In Maharashtra, Mangrove Cell of Forest Department, Thane Circle has played crucial role streamlining the conservation and management of coastal and marine biodiversity of Maharashtra coast. Recently, Mangrove Cell with the help of GIZ (German Agency) launched project that led to the notification of the "Thane Creek Flamingo Sanctuary".

This happens to be the second Marine Sanctuary after the "Malvan Marine Sanctuary" in Sindhudurg District.

In Maharashtra about 15,088 ha of mangroves on Govt. land in 7 coastal districts are notified as "Reserve Mangrove Forest". In addition to this a "Coastal and Marine Biodiversity Center" was developed at Airoli, Navi Mumbai as part of GIZ project, this project will serve and attract tourists and environmentalist to witness and enjoy mangroves and its biodiversity in natural condition. Apart from this, number of conservation initiatives and awareness programme were launched in the northern part of the Ratnagiri coast and the Thane creek.

16.6 Ecotourism

Many mangrove areas are potentially suitable for ecotourism. The indigenous biodiversity offers great attraction to tourists and poses as great assets in ecotourism economy. In recent years, many mangrove forests have become accessible through board walkways. Informative signage, arboretum, nature education centres, information on the biodiversity of flora and fauna will help tourists to know about mangrove in its natural environment. It is possible for tourists to spend an entire day in the mangroves looking and appreciating interesting and unique plants and animals.

The mangrove swamp is an ideal place for bird watchers as it serves as a bird sanctuary for indigenous attractive kingfishers, shrikes, flamingos and migratory birds *etc*. Canoeing and snorkeling in the mangrove swamps and appreciating wild life will attract many nature tourists. In Maharashtra,"Coastal and Marine Biodiversity Center" at Airoli, Navi Mumbai and "Thane Creek Flamingo Sanctuary "attracts thousands of tourists during the season.

17.0 MANGROVE MANAGEMENT AND PLANNING (MMP)

The Mangrove Management Plan (MMP) has been developed specifically to mitigate the impacts on mangroves from the proposed construction of MAHSR alignment from Mumbai (Maharashtra) to Ahmedabad (Gujarat). The MMP provides an overview of the potential direct and indirect impacts that may likely to occur to mangrove and its biodiversity. It includes in details of the management measures that will be implemented to mitigate the potential impacts and outlines the monitoring program that will be implemented during the project construction stage, operation stage and after completion of the project. The MMP will help to maintain the abundance, diversity, geographic distribution and productivity of mangrove communities at species and ecosystem levels in the area.

17.1 Planning Principles

- Given the many types of products and services which might be obtained from forest and aquatic resources in mangroves, a multidisciplinary approach towards their management is essential.
- Wood, non-wood and aquatic resources are managed in an integrated way and used to meet local, regional or national needs.
- Management of natural resources to meet people needs implies knowledge of what people want.
- An assessment of needs and public participation is an integral part of the planning process.
- This prioritization among the management objectives should be clearly reflected in the management plan's activities.

17.2 Objective

- Objectives should be quantifiable targets that serve to focus management efforts and measure performance.
- The ecological carrying capacity should never be exceeded and resource sustainability should be given high priority.
- The need for the conservation of biological diversity and wildlife should be recognized.

17.3 Planning Process

- The plan must provide for improvements in data collection to reduce areas of uncertainty associated with an incomplete or weak information base.
- The ultimate objective may be to apply a conservative approach where the uncertainty is perceived to be great.

17.4 Decision Making Process

- Involving the public in the decision-making process is necessary to get local support and acceptance for integrated management planning.
- Customary rights should be respected where possible.
- Decision-making should not marginalize the traditional incomes of local people nor their access to forest products.

18.0 LIMITATIONS IN MANAGEMENT

- The management of the restored site is pre-requisite for successful rehabilitation programme.
- Lack of knowledge of mangrove ecosystem, its extent, status and linkages to other ecosystems hamper efforts to conserve and manage mangroves.
- A comprehensive information database of mangrove biodiversity is critical in planning an effective management of mangroves.
- Although, true economic evaluation of mangrove diversity and natural resources is difficult to measure, it happens to be an important factor in conservation and management of mangroves.
- All development plans and policies should include economic valuations that fully reflect the sociological, ecological and environmental costs of resource use, physical developments and pollution.
- Sustainable management can only be achieved if evaluation of mangrove areas is undertaken on a site-by-site basis.

19.0 BUDGET ESTIMATE FOR PLANTATION

Sl. No.	Items	Estimated Cost (INR)
1	Cost of seedlings (Collection, Storage *etc.*)	60000.00
2	Spacing for plantation- 1 m x 1 m	-
3	Number of Seedlings in One Hectare- 7500	
4	Transportation for seedling collection	10000.00
5	Labour Charge (6 labours for	15000.00

Sl. No.	Items	Estimated Cost (INR)
	three days)	
6	Contingency	15000.00
	Total	**100000.00**

Source: MSI Study Team

N. B.:-1. Please note that the cost of seedlings varies from place to place.
2. Consultancy, manpower and other expenditure are not included in the above estimates

For direct plantation:-Approximately Rs. 1,00,000/- per hectare.

Approximate budget estimate for nursery development and plantation for one hectare area.

Sl. No.	Items	Estimated Cost (INR)
1	Consultancy	100000.00
2	Manpower (1 person @ Rs 15000/- per month for 2 months	30000.00
3	DA for two MSI experts @ Rs. 1000/- per day per expert (Two Experts for 4 trips of 3 days duration each	24000.00
4	Cost of seedling (collection, storage *etc.)*	60000.00
5	Cost of Nursery Development	
a)	Plot Preparation 10 m x 1m plots x 10 nos.	
	i) Consumables like polyethylene bags 4” x 10” size	20000.00
	ii) Bamboo poles, ropes, shovels, buckets and other consumable materials	10000.00
b)	Transportation	50000.00
c)	Labour Charges	
	i) Labour charges for nursery development, raising seedlings in nursery etc. for six labours for six days	30000.00
	ii) For maintenance of nursery 2 labours for twice a month for three months	10000.00
5	Contingency	50000.00
	Sub-Total	384000.00
6	25% overhead charges	96000.00
	Grand Total	**480000.00**

Source: MSI Study Team

N.B.:-

- *Above estimate of mangrove afforestation is for only one site. We have to undertake plantation at different sites depending on the availability of suitable site (mud flats) for plantations.*
- *Labour charges may vary from place to place.*
- *Cost of seedlings may vary from place to place and cost may increase.*
- *TA for MSI experts as and when required from Goa to Mumbai and back and hospitality, local transport etc. to be taken care by the NHSRCL.*

20.0 RECOMMENDATIONS

1. For the proposed MAHSR alignment where structures such as piers for the bridges and viaducts will be constructed in the mangrove areas which lead to felling of

mangrove trees approx. 150752 nos. A compensatory afforestation is required to be carried out in 1:5 ratios following MoEFCC guidelines and minutes of MCZMA, Govt. of Maharashtra (Minutes of 117 th MCZMA meeting held on 5 & 6 April, 2017). Therefore, total mangroves to be planted are around 753763 trees over an area of 94.629 ha..

2. Presently, no ventilator/shaft has been proposed in the Thane Creek Mangrove area where underground tunnel has been proposed. However, in future if need arises to construct ventilator/shafts in mangrove area number of mangrove trees required to be cleared should be assessed.
3. The sites for compensatory afforestation should be selected in the vicinity on the bases of ecological zonation and suitable and favourable environmental conditions.
4. On completion of the construction of MAHSR, ecological monitoring are required to be carried out to assess the magnitude of impact on existing mangroves in the vicinity. The detailed monitoring programme has been presented in the EIA Report. This will also help to identify critical environmental attributes required to be monitored.
5. The Contractors deployed on the construction of the MAHSR should adopt careful practices to ensure that their activities have minimum impact on the existing mangroves in the vicinity.
6. The contractor should observe careful procedures for any burials and use of any instruments or tools that would cut off water flow to the mangrove area.
7. The tidal water flow, channels and other inlets to mangrove area at any cost should not be blocked or diverted. Regular tidal water flow should be maintained.
8. All drains, pipes, culverts and bridges should be kept open at all times. These should be inspected thoroughly, repaired and maintained regularly.
9. Water quality of the all the creek/estuaries should be monitored regularly to see the impact of construction and reclamation activities.
10. The construction of MAHSR will involve the use of machinery and equipment which may generate pollution at various levels which ultimately find its way into the mangrove area. This problem may have serious consequences on the general health of mangroves. Regular inspection of trucks, machinery and equipment used for the project should be done to ensure that they are in good working condition, thus avoiding excessive discharge of carbon monoxide.
11. Construction activities will induce dust pollution at various levels. This dust will be discharged into the atmosphere and also will be deposited on the existing mangrove foliage in the vicinity. The dust may affect the photosynthesis and may create problem in both socially and environmentally. This needs to be looked into. Spraying of water two to three times a day should be considered. However, during rainy season rains would eventually wash out the dust.
12. The Contractor should maintain their equipment to contain or prevent any possible leaks of fuel, used oil, solvents, pesticides, petroleum products *etc*. These harmful materials may ultimately enter mangrove environment.
13. A site management plan should be developed by the contractor if the operation involves the use of these materials to include estimated quantities to be consumed in the process, storage plans, spill control plans, and waste disposal practices to be followed.
14. Improper post-construction site clearing (removal of construction waste, garbage and/or derelict machinery or equipment) can contribute to environmental degradation.
15. The contractor shall provide a trash and debris management plan that conforms to the solid waste management policies and regulations. Under no circumstances the contractor shall not allow construction wastes to accumulate so as to cause a nuisance or health risk due to the propagation of pests and disease vectors.

16. Sanitation facilities should be provided to site workers as per PHED norms. All sanitary wastes generated as a result of project activities should be managed by the contractor.
17. Use of hazardous materials, fuels, solvents, petroleum products *etc*. and their container are should be disposed off in a manner approved by the regulatory authorities.

21.0 CONCLUSION

Economic development and environment protections are two sides of the same coin. We required both for sustenance and most importantly we have to draw a line so that development with minimum damage to environment will help great deal. We need an economic growth with different economic, social and ecological qualities, such as high economic dynamism, social inclusion and ecological sustainability.

Present study reveals that the construction of MAHSR will help to ease traffic and also help in quick transportation of population to and fro from both metropolitan cities. However, the construction of the corridor will have adverse impact on mangroves at certain places along the alignment. For this purpose a number of mangrove trees are required to be cleared for construction of various structures like piers, maintenance road *etc*. Apart from this other side effects arising from these activities have also to be taken into account.

The destruction of mangroves will include (some of the important commercial) faunal and flora species, no doubt, the activities will have some impact on the environment and socio-economic aspects of the local population. However, all these, particularly, minor and major impacts can be mitigated by followings sound and appropriate scientific methodology and techniques. It should also be taken into account that while mitigating the impacts proper care and guidelines notified by the various concern authorities should be strictly followed.

On the basis of above mentioned factual observations, it can be inferred that there will not be major adverse impact on the environment after implementation of suggested mitigation measures. Whatever impacts that have been envisaged are short term duration and can be eliminated or minimized in due course of time, provided the recommendations and suggestion offered in this report are adhere to.

Annexure-1

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Annexure - 2

COUNTER MEASURES FOR MANGROVE IN CONSTRUCTION PHASE

Location -From chainage Km 43+535 to Km 45+916

- The tidal water flow, channels and other inlets to mangrove area at any cost should not be blocked or diverted. Regular tidal water flow should be maintained, if it is blocked in any case, the following two specific measures are advised
  - Drainage structures *i.e.* culverts for cross drainage should be designed to ensure continuous inter tidal flow thus preventing ponding and flooding.
  - Balancing culvert should be provided from Km 43+535 to Km 45+916 as per IRC guidelines.
- Compensatory afforestation of the cleared mangroves should be undertaken with 1:5 ratios at the suitable and environmentally acceptable location in the mangrove areas in consultation with the Mangrove Cell, Thane.
- The effects on the mangrove ecosystem are not preventable but a full-fledged afforestation activity in the vicinity should be undertaken during the construction phase itself, so that the ecosystem of the development area will be restored to a certain extent, which will make the new habitat unique.
- The afforestation plan should be drawn up based on the topography of the planting area and decided on the pattern of planting. During afforestation, zonation and diversity of mangrove species should be maintained at all level.
- To protect remaining mangroves during construction activities, a silt screen should be placed around the entire perimeter to preserve environment. This is particularly applicable due to changing environmental conditions in the surroundings.
- The causeway should be designed to maintain adequate tidal flow for the support of mangrove habitat.
- Water quality of the Ulhas River (Vasai Creek) has to be monitored regularly to see the impact of construction and reclamation activities.
- Regular inspection of trucks, machinery and equipment used for the project to be done to ensure that they are in good working condition, thus avoiding excessive discharge of carbon monoxide.
- Spraying of water on mangroves as well as on construction roads two to three times a day may be considered during the dry season.
- Contractor has to maintain their equipment to contain or prevent any possible leaks of fuel, used oil, solvents, pesticides, petroleum products *etc*.
- No labour camps /construction yards should be located within this stretch and within 2.0 km of the mangrove patch.
- Contractor has to observe careful procedures for any burials and use of any instruments or tools that would cut off water flow to the mangrove area.
- The construction activities should not be taken up in the night time (6.00 PM to 6.00 AM).
- Only machine with noise enclosures should be deployed in this area.
- The construction waste should not be disposed of in this stretch as it is part of the CRZ.
- A site management plan should be developed by the contractors for this stretch.

Counter Measures for Mangrove in Operation Phase

Location -From chainage Km 43+535 to Km 45+916

- There should be cap on speed within this stretch to minimize the impact of eddy current as the height of the mangrove varies from 10 m to 15 m.

- To protect the mudflat in this area from continuous shaking due to ground borne vibration, a trench shall be created which will be filled with rubber sheet between piers and maintenance road. This should be designed by Engineering Team.
- A wind screen of 2.0 m height shall be installed on the overhead structure along the track.
- Along the service road mangrove plantation should be done with *salicornia, casuarinas*, *red mangrove Rhizophora* spp. and appropriate species of halophytes will represent a “win-win” situation both for nature and coastal human habitations.

Annexure – 3

GOOD PRACTICES FOR MANGROVES

1) Awareness and Education

Mangroves are very valuable coastal resources therefore should be part of coastal habitat protection, conservation and management programs. Presently, less than one per cent of all mangroves worldwide are sufficiently protected; however, mangrove destruction continues to go unchecked at alarming rate. Therefore, the first step is to educate the public at large. Creating awareness is important so that developmental activities in mangroves, dumping habits and releasing of hazardous effluents could be effectively avoided.

Public awareness has been identified as a critical factor in the conservation and restoration of mangrove ecosystem. Awareness can be raised in younger generations particularly school children by stimulating interest and passion for the environment. In any case, creating awareness within local communities should foster the idea that the residents are stewards of the mangrove areas and thus, have a responsibility to actively work to protect and conserve it. Such steps toward protection require a multi-disciplinary approach, requiring the help of marine and terrestrial scientists, regional and environmental planners, local and national policy makers and many kinds of educators and political will for sustainable use of this resource.

The corporate sector should take up awareness programme by celebrating world mangrove day, Wold wetland day, world Environment day etc. During the celebrations, activities such as lectures, visit to mangrove areas, competitions *etc*. should be organized. Corporate sector undertaking afforestation programme should take the responsibility to monitor the mangrove plantation and look after mangroves at least for five to seven years or till they become mature.

2) Legislation

The Government of India had set up the National Mangrove Committee under the Ministry of Environment, Forest and Climate Change, New Delhi way back in 1976 to advise the government about mangrove conservation and development. It provided guidelines and financial assistance to states and Union territories for the preparation and implementation of Management Action Plans for the conservation and development of the mangrove ecosystems. Most of these plans are now being implemented.

In India, a legislative framework for the conservation and management of mangroves is already in place. The Indian Forest Act, 1927 and the Wildlife (Protection) Act, 1972 provide protection to flora and fauna. Since 1927, the Indian Forest Act has been applied to the mangrove forests of the Sunderbans, which have been declared as a reserved area.

The Environment (Protection) Act, 1986 has a crucial role in the conservation and management of the mangrove ecosystems. It declares a Coastal Regulation Zone in which industrial and other activities such as discharge of untreated water and effluents, dumping of waste, land reclamation and bunds are restricted in order to protect the coastal environment. Coastal stretches are classified into four categories, and mangroves are included in the most ecologically sensitive category – CRZ - 1(i).

3) Involvement or Participation

The coastal community, especially fishermen is main stakeholder and they have maximum interaction with tidal environment. They are directly and indirectly benefited by mangroves and there is no reason why they should not be involved in mangrove development. In most of the states, fishermen work as a labourer for mangrove plantation but they do not own the programme.

The Coastal communities are not often involved in development planning at either village or district levels. Although, participatory mechanisms exist in government planning processes, communities are for the most part not aware of their rights and these mechanisms are seldom utilized. This can result in planning and policy development that is biased in favour of interested parties. When there is involvement at the village level, government appointed village leaders dominate these processes.

It is necessary to develop understanding among coastal community about economic and ecological roles of this ecosystem. It is now essential to initiate Joint Forest Management (JFM) programme in mangrove areas.

4) Conservation and Management

Mangrove biodiversity management and conservation have received considerable attention in recent times because of the extensive degradation of mangrove areas along the Indian coast. Restoration of mangroves has also greatly improved over the years.

At the International Level, the common approach to major environmental policy issues has been to formulate conventions, treaties and agreements, which all concerned countries become signatories. More than half a dozen international agreements and various regional agreements are directly relevant to the conservation of mangrove biodiversity. The destruction and depletion of mangroves forest, pose one of the most serious social problems in the world.

The problem in India is particularly observed along the west coast where the extent of the remaining mangrove forests is under constant threat. Conservation measures and afforestation are therefore, essential. Activities sponsored by the UNDP/UNESCO Regional Mangrove Project have greatly contributed to mangrove awareness in India. It can be said that the mangrove afforestation experiments in Gujarat, Goa and Maharashtra are the results of this initiative.

5) Nursery

This method is useful where the mangrove species are not available in plenty. This also has many advantages like selected species are available in large quantities. Mangrove nurseries can be developed in the upper part of the intertidal regions where seedlings can be grown in polyethylene bags supported with bamboos.

The mangrove nursery may be located near the estuary or sea where seawater or estuarine water is available. The nursery may be on the open ground or in the low lying protected areas where seawater reaches.

These seedlings are allowed to grow up to the period of 6 months to 1 year and then depending on the requirement of species of the region, these can be transferred to the sites for plantation.

6) Plantation

a) **Direct Plantation**: When seedlings are collected should be checked for any insect borer or other infections and injuries. Select only healthy non-infected and fully matured seedlings. Any intertidal area (between the high tide and low tide) where mangroves are absent and the substratum is of soft clay or mud and inundated by regular tidal waters everyday are suitable for direct mangrove planting. Select the sites where intertidal expanse is more.

b) **Nursery Raised Seedling Plantation**: Before starting actual planting, it is essential to make a tentative plan of the operation. How much area is available? Which species to be planted and at what position or zonation pattern? All these information are prerequisite to undertake plantation.

The nursery raise seedlings are transported to the site of plantation and seedlings are removed from the polyethylene bags and inserted in to the hole made in the mud. A spacing of 2 m x 2 m should be maintained in between the seedlings. Plantation should be monitored till the plants become 2 to 3 m tall.

7) Training

Providing vital information on mangroves, their importance, techniques for developing nursery *etc.* are most essential part for the protection, restoration and conservation of mangroves. It is necessary to build the trained manpower of the coastal people as well as foresters, institutes and general public to take up conservation and management of mangroves.

The training is aimed to build the capacity of professionals and institutions in undertaking monitoring, research and conservation of mangrove forests. This is achieved through training in the scientific methodology and teaching of latest research work on related subjects. A secondary objective is to create a network of professionals working with mangroves.

8) Preservation and Restoration

In order to undertake restoration work, it is necessary to understand both the autecology (individual species ecology) and synecology (community ecology) of mangrove species at the particular site. Particular attention to be given to hydrological patterns that control the distribution, successful establishment and growth of mangrove species are required to be studied. Select an appropriate mangrove restoration site that is both hydrological and ecologically likely to succeed in rehabilitating a healthy mangrove ecosystem.

It should also be taken into consideration land ownership/use issues for ensuring long-term access to and conservation and management of sit. Design restoration programs at appropriate sites and take advantage of natural recruitment of mangrove propagules for plant establishment. Utilize collected seedlings or cultivated seedlings as natural recruitment will not provide the quantity of successfully established seedlings, rate of stabilization or rate of growth of saplings established.

9) Threats

Historically, mangrove forests have been perceived as desolate, unproductive regions along coastal areas. However, local communities now see mangrove ecosystems as an impediment to their economic practices. As a result, mangrove forests are now among the most threatened habitats in the world.

Developing nations also destruct mangroves through urbanization, agriculture, pollution (solid, sewage and industrial effluent), they are even more damaging in their direct exploitation. Often, mangrove forests are completely destroyed in order to provide places for residential, commercial, and industrial development. Many mangroves have been cut down to provide ocean-side land for local housing and tourist hotels. The most destructive process, however, has been the shrimp aquaculture industry.

A rise in mean sea-level may be the most important factor influencing the future distribution of mangroves but that the effect will vary dramatically depending on the local rate of sea-level rise and the availability of sediment to support re-establishment of the mangroves. The socio-economic impacts of the effects of climate on mangrove ecosystems may include increased risk of flooding, increased erosion of coast lines, saline intrusion and increased storm surges.

10) Conclusion

Mangrove forests are a very unique and complex kind of coastal wetland. In other words, they are an open system and thus, are directly related to all that is around them. In view of this, mangrove forests become even more complex and at the same time more difficult to protect. Perhaps, as some environmental engineers suggest, information technology can help to stop mangrove destruction.

With increasing technological advances, we can begin to better understand the delicate relationships between the marine and terrestrial worlds of mangrove forests. Computer technology can help advance multi-disciplinary research by making it possible to visualize the complex systems of a mangrove. This would allow all disciplines to better understand the many processes that must be taken into account in the management of this complex but no doubt very important ecosystem.

Political will is required to restore and better manage mangrove areas, especially when dealing with privatized inter-tidal areas for more equitable access to mangrove resources for conservation and sustainable utilization.

Table 1: Monthly Averages of the Hydrological parameters of Thane Creek

Para-meters Months	Water Tempe-rature °	Light Penetra-tion cms.	Suspended Solids gm/L	pH	Salinity ppt	Dissolved Oxygen mg/L	PO_4-P mg/L	NO_3-N mg/L
May 99	33.73	18.05	9.300	7.62	32.87	2.27	0.355	1.266
June 99	29.12	17.41	6.663	7.11	12.31	3.46	0.178	0.696
July 99	28.04	21.83	1.523	7.59	1.69	4.36	0.183	0.308
Aug 99	28.53	48.68	2.157	8.11	10.06	1.95	0.215	0.735
Sept 99	29.37	40.62	5.727	7.67	3.24	2.67	0.172	0.453
Oct 99	28.79	34.85	4.673	8.38	12.13	2.69	0.133	0.909
Nov 99	24.08	49.12	11.503	8.07	24.75	2.07	0.284	1.654
Dec 99	22.88	60.43	6.628	7.35	25.08	1.92	0.299	0.960
Jan 00	23.16	57.23	4.773	7.56	27.91	1.98	0.325	1.173
Feb 00	22.21	47.55	4.497	7.32	28.64	1.78	0.343	0.915
Mar 00	27.83	42.05	5.467	6.87	23.38	2.11	0.292	1.321
Apr 00	32.73	37.27	5.423	8.80	28.56	2.01	0.339	1.132
Mean	27.54	39.59	5.736	7.70	19.22	2.44	0.260	0.960
SD	3.575@	14.425	2.794*@	0.5493	10.722@	0.766@	0.079@	0.380
1992-93 x	27.18	31.57	0.865	7.52	25.35	2.63	0.24	6.482
SD	1.233	11.859	0.222	0.147	4.923	0.885	0.041	8.865
1984-85 x	28.42	--	0.731	7.57	25.13	4.89	0.197	0.855
SD	2.873	--	0.521	0.120	8.450	0.742	0.066	0.467

Source : Goldin Quadros, et.al., 2004)

X – Mean, SD – Standard Deviation

* -Statistically significant change with respect to 1992-93 data at 10% level of significance.

@-Statistically significant change with respect to 1984-85 data at 10% level of significance.

Table 2: Distribution of mangrove species at Near Bhagwan Parshuram Ghat Lake, Kopar Khairane (Thane creek), Site – I

Sr. No.	Name of Species	Quad-I	Quad-II
True Mangrove Species			
1	*Avicennia marina var. acutissima*	+M	+ M
2	*Avicennia marina* var. *marina*	+A	+A
3	*Avicennia officinalis*	+M	+ M
4	*Acanthus ilicifolius*	+F	+F
5	*Excoecaria agallocha*	+F	+F
Mangrove Associates			
1	*Salvadora persica*	+R	+R
2	*Derris heterophylla*	+F	+F
D: Dominant (>60%), A: Abundant (30-60%), M: Moderate (10-30%), F: Few (5-10%), R: Rare (<5%)			

Source: MSI Study Team

Table 3: Mangrove vegetation structure at Near Bhagwan Parshuram Ghat Lake, Kopar Khairane (Thane creek), Site – I, Quad – I.

Sr. No.	Name of Species	Density (No /100 m²)	Mean DBH (cm)	Mean Basal Area (m²)	Height (m)	Complexity Index (CI)
1.	*Avicennia marina var acutissima*	14	7.17	0.004	7 to 9	0.002
2	*Avicennia marina var. marina*	35	8.57	0.006	15 to20	0.018
4	*Avicennia officinalis*	10	11.94	0.011	10 to 12	0.006
3	*Excoecaria agallocha*	8	7.36	0.004	5 to 7	0.001
5	*Acanthus ilicifolius*	7 to 9	--	--	2 to 3	--
6	*Avicennia.* seedlings	10 to 15	--	--	1 to 1.5	--

DBH: Diameter at Breast Height *Source: MSI Study Team*

Table 4: Mangrove vegetation structure at Near Bhagwan Parshuram Ghat Lake, Kopar Khairane (Thane creek), Site–I, Quad – II

Sr. No.	Name of species	Density (No. /100 m²)	Mean DBH (cm)	Mean Basal Area (m²)	Height (m)	Complexity Index (CI)
1.	*Avicennia marina* var. *acutissima*	22	11.33	0.013	7 to 9	0.009
2	*Avicennia marina* var. *marina*	32	9.27	0.006	15 to 20	0.017
3	*Avicennia officinalis*	7	10.24	0.008	10 to 12	0.003
4	*Excoecaria agallocha*	3	7.66	0.005	5 to 7	0.000
5	*Acanthus ilicifolius*	5 to 7	--	--	2 to 3	--
6	*Avicennia.* seedlings	10 to 15	--	--	1 to 1.5	--

DBH: Diameter at Breast Height *Source: MSI Study Team*

Table 5: Distribution of Mangrove Species at Diva (Near Diva Railway Track), Site–II

Sr. No.	Name of Species	Quad-I	Quad-II
True mangrove species			
1	*Avicennia marina* var. *marina*	+M	+M
2	*Avicennia officinalis*	+M	+M
3	*Soneratia apetala*	+M	+M
4	*Aegiceras corniculata*	+F	+R
5	*Acanthus ilicifolius*	+F	+F
6	*Exoceria agalocha*	+F	+F
Mangrove Associates			
1	*Derris heteophylla*	+F	+F
2	*Sesuvium portulacustrum*	+F	+F
D: Dominant (>60%), A: Abundant (30-60%), M: Moderate (10-30%), F: Few (5-10%), R:Rare (<5%)			

Source: MSI Study Team

Table 6: Mangrove Vegetation Structure at Diva (Near Diva Railway Track), Site–II, Quad.–I.

Sr. No.	Name of species	Density (No. /100 m²)	Mean DBH (cm)	Mean Basal Area (m²)	Height (m)	Complexity Index (CI)
1	*Avicennia marina*	14	11.01	0.009	5 to 7	0.004
2	*Avicennia officinalis*	17	12.48	0.012	5 to 7	0.007
3	*Sonneratia apetala*	37	21.60	0.037	20 to 25	0.185
4	*Aegiceras corniculatum*	3	5. 57	0.002	2 to 3	0.000
5	*Acanthus ilicifolius*	9	--	--	1 to 1.5	--
6	*Exoceria agalocha*	7	8.14	0.005	3 to 4	0.001
7	Mixed seedlings	> 100	--	--	i	--

DBH: Diameter at Breast Height *Source: MSI Study Team*

Table 7: Mangrove Vegetation Structure at Diva (Near Diva Railway Track), Site–II, Quad.–II

Sr. No.	Name of species	Density (No. /100 m²)	Mean DBH (cm)	Mean Basal Area (m²)	Height (m)	Complexity Index (CI)
1	*Avicennia marina*	16	9.82	0.008	5 to 7	0.005
2	*Avicennia officinalis*	12	10.66	0.009	5 to 7	0.004
3	*Sonneratia apetala*	26	17.82	0.025	20 to 25	0.088
4	*Aegiceras corniculatum*	7	5.39	0.002	2 to 3	0.000
5	*Acanthus ilicifolius*	10	--	--	1 to 1.5	--
6	*Exoceria agalocha*	5	7.44	0.004	3 to 4	0.000
7	Mixed seedlings	20 to 30	--	--	i	--

DBH: Diameter at Breast Height *Source: MSI Study Team*

Table 8: Distribution of Mangrove Species Near Anjur Phata, Kharbhav, Kewani, Site–III

Sr. No.	Name of Species	Quad-I	Quad-II
True Mangrove Species			
1	*Avicennia marina*	+F	+F
2	*Avicennia officinalis*	+F	+R
3	*Soneratia apetala*	+A	+A
4	*Aegiceras corniculata*	+F	+R
5	*Acanthus ilicifolius*	+M	+M
6	*Exoceria agalocha*	+F	+F
Mangrove Associates			
1	*Derris heteophylla*	+M	+F
2	*Salvadora persica*	+F	+F
3	*Sesuvium portulacustrum*	+F	+F
D: Dominant (>60%), A: Abundant (30-60%), M: Moderate (10-30%), F: Few (5-10%), R: Rare (<5%)			

Source: MSI Study Team

Table 9: Mangrove Vegetation Structure Near Anjur Phata, Kharbhav, Kewani, Site–III, Quad.-I

Sr. No.	Name of Species	Density (No. /100 m²)	Mean DBH (cm)	Mean Basal Area (m²)	Height (m)	Complexity Index (CI)
1	*Avicennia marina*	7	7.32	0.004	5 to 7	0.001
2	*Avicennia officinalis*	9	9.72	0.007	5 to 7	0.002
3	*Sonneratia apetala*	39	30.65	0.074	25 to 30	0.476
4	*Aegiceras corniculatum*	4	5.49	0.002	2 to 3	0.000
5	*Acanthus ilicifolius*	21	--	--	1 to 1.5	--
6	*Exoceria agalocha*	5	7.79	0.005	3 to 4	0.001
7	*Sonneratia* seedlings	Abundant	--	--	-	--

DBH: Diameter at Breast Height *Source: MSI Study Team*

Table 10: Mangrove Vegetation Structure Near Anjur Phata, Kharbhav, Kewani, Site–III, Quad.-II

Sr. No.	Name of Species	Density (No. /100 m²)	Mean DBH (cm)	Mean Basal Area (m²)	Height (m)	Complexity Index (CI)
1	*Avicennia marina*	7	9.47	0.007	5 to 7	0.002
2	*Avicennia officinalis*	5	8.37	0.006	5 to 7	0.000
3	*Sonneratia apetala*	23	27.39	0.058	20 to 25	0.180
4	*Aegiceras corniculatum*	3	4.89	0.002	2 to 3	0.000
5	*Acanthus ilicifolius*	13	--	--	1 to 1.5	--
6	*Exoceria agalocha*	5	7.29	0.004	3 to 4	0.000
7	Mixed seedlings	20 to 30	--	--	i	--

DBH: Diameter at Breast Height *Source: MSI Study Team*

Table 11: Distribution of Mangrove Species at Brahmangaon (Bhiwandi), Site – IV

Sr. No.	Name of Species	Quad-I	Quad-II
True Mangrove Species			
1	*Avicennia marina var. acutissima*	+F	+F
2	*Avicennia marina* var. *marina*	+M	+M
3	*Avicennia officinalis*	+F	+ M
4	*Soneratia apetala*	+A	+A
5	*Aegiceras corniculatum*	--	+F
6	*Acanthus ilicifolius*	+ R	+F
7	*Excoecaria agallocha*	+ F	+F
8	*Sonneratia* Seedlings	>100	>50
Mangrove Associates			
1	*Derris heterophylla*	+F	+F
2	*Sesuvium portulacustrum*	+F	+F
D: Dominant (>60%), A: Abundant (30-60%), M: Moderate (10-30%), F: Few (5-10%), R: Rare (<5%)			

Source: MSI Study Team

Table 12: Mangrove Vegetation Structure at Brahmangaon (Bhiwandi), Site–IV, Quad.–I

Sr. No.	Name of Species	Density (No. /100 m²)	Mean DBH (cm)	Mean Basal Area (m²)	Height (m)	Complexity Index (CI)
1	*Avicennia marina var. acutissima*	7	14.01	0.015	10 to 12	0.007
2	*Avicennia marina var. marina*	13	10.45	0.008	7 to 9	0.005
3	*Avicennia officinalis*	10	16.28	0.021	10 to12	0.014
4	*Sonneratia apetala*	37	22.36	0.039	15 to 20	0.147
5	*Acanthus ilicifolius*	5 to 6	--	--	2 to 3	--
6	*Excoecaria agallocha*	5	7.65	0.004	2 to 3	0.001
7	*Soneratia* Seedlings	>100	--	--	1 to 1.5	--

DBH: Diameter at Breast Height *Source: MSI Study Team*

Table 13: Mangrove Vegetation Structure at Brahmangaon (Bhiwandi), Site–IV, Quad.–II

Sr. No.	Name of Species	Density (No. /100 m²)	Mean DBH (cm)	Mean Basal Area (m²)	Height (m)	Complexity Index (CI)
1	*Avicennia marina var. acutissima*	2	9.86	0.008	10 to 12	0.001
2	*Avicennia marina var. marina*	7	9.45	0.007	7 to 9	0.003
3	*Avicennia officinalis*	13	10.24	0.008	10 to12	0.008
4	*Sonneratia apetala*	24	15.56	0.019	15 to20	0.056
5	*Aegiceras corniculatum*	9	6.42	0.003	2 to 3	0.001
6	*Acanthus ilicifolius*	11	--	--	2 to 3	--
7	*Excoecaria agallocha*	6	7.32	0.004	2 to 3	0.001
8	*Soneratia* Seedlings	>100	--	--	1 to 1.5	--
9	*Avicennia seedlings*	>20	--	--	1	--

DBH: Diameter at Breast Height *Source: MSI Study Team*

Table 14: Distribution of Mangrove Species at Saphale, Tembhikhadave (Vaitarna River/Estuary), Site–V

Sr. No.	Name of Species	Quad-I	Quad-II
True mangrove species			
1	*Avicennia marina var. acutissima*	+A	+A
2	*Avicennia marina* var**.** *marina*	+A	+A
3	*Avicennia officinalis*	+M	+M
4	*Soneratia apetala*	+A	+A
5	*Rhizophora mucronata*	+ R	--
6	*Rhizophora apiculata*	--	+R
7	*Ceriops tagal*	+ F	--
8	*Bruguiera cylindrica*	--	+R
9	*Aegiceras corniculatum*	+R	--

Sr. No.	Name of Species	Quad-I	Quad-II
10	*Acanthus ilicifolius*	+F	+M
11	*Excoecaria agallocha*	+F	+F
Mangrove Associates			
1	*Salvadora persica*	+F	+F
2	*Derris heterophylla*	+F	+F
3	*Sesuvium portulacustrum*	+F	+F
D: Dominant (>60%), A: Abundant (30-60%), M: Moderate (10-30%), F: Few (5-10%), R: Rare (<5%)			

Source: MSI Study Team

Table 15: Mangrove Vegetation Structure at Island near Saphale, Tembhikhadave (Vaitarna River/Estuary) Site-V, Quad.–I

Sr. No.	Name of Species	Density (No. /100 m²)	Mean DBH (cm)	Mean Basal Area (m²)	Height (m)	Complexity Index (CI)
1	*Avicennia marina var. acutissima*	14	12.76	0.013	10 to 15	0.020
2	*Avicennia marina var. marina*	10	11.45	0.010	10 to 15	0.011
3	*Avicennia officinalis*	6	10.86	0.010	10 to15	0.007
4	*Sonneratia apetala*	11	18.56	0.027	15 to 20	0.047
5	*Rhizophora mucronata*	1	10.65	0.005	6 to 7	0.000
6	*Ceriops tagal*	3	7.82	0.004	5 to 7	0.000
7	*Aegiceras corniculatum*	6	5.32	0.002	2 to 3	0.000
8	*Acanthus ilicifolius*	8	--	--	2 to3	0.003
9	*Excoecaria agallocha*	5	8.66	0.006	5 to 7	0.001
10	Mixed seedlings	5 to 7	--	--	2 to 3	--

DBH: Diameter at Breast Height *Source: MSI Study Team*

Table 16: Mangrove Vegetation Structure at Island near Saphale, Tembhikhadave (Vaitarna River/Estuary) Site-V, Quad.–II (Island)

Sr. No.	Name of Species	Density (No. /100 m²)	Mean DBH (cm)	Mean Basal Area (m²)	Height (m)	Complexity Index (CI)
1.	*Avicennia marina var. acutissima*	20	12.05	0.011	10 to 12	0.020
2	*Avicennia marina var. marina*	16	10.45	0.010	7 to 8	0.010
3	*Avicennia officinalis*	7	9.76	0.007	10 to12	0.000
4	*Sonneratia apetala*	9	14.67	0.017	10 to15	0.015
5	*Rhizophora apiculata*	1	8.55	0.006	6 to 7	0.000
6	*Bruguiera cylindrica*	2	5.82	0.003	3 to 5	0.000
7	*Excoecaria agallocha*	6	7.32	0.004	2 to 3	0.001
8	*Acanthus ilicifolius*	5	--	--	2 to3	--
9	Mixed seedlings	15 to 20	--	--	1 to 2	--

DBH: Diameter at Breast Height *Source: MSI Study Team*

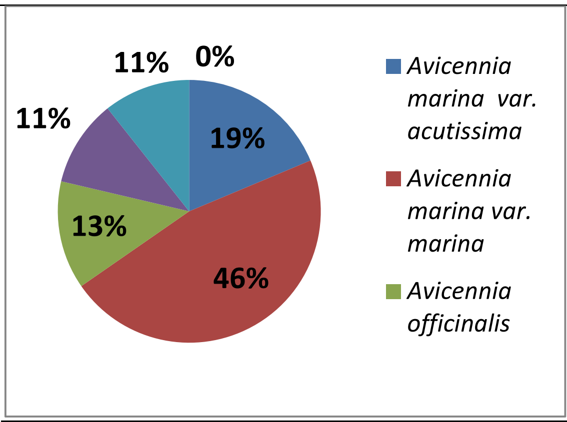


Figure 1: Kopar Khairane (Thane Creek), Site– 1, Quad–I

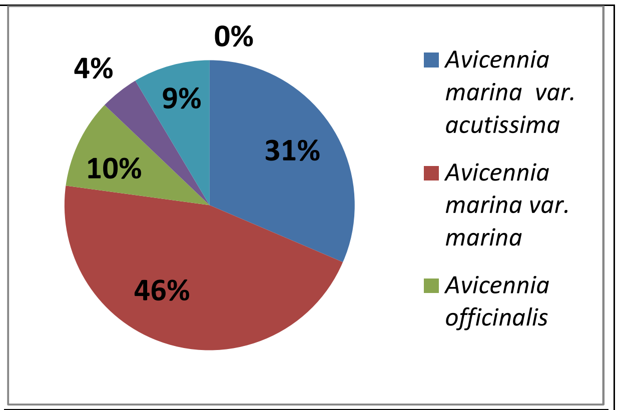


Figure 2: Kopar Khairane (Thane Creek), Site– 1, Quad–II

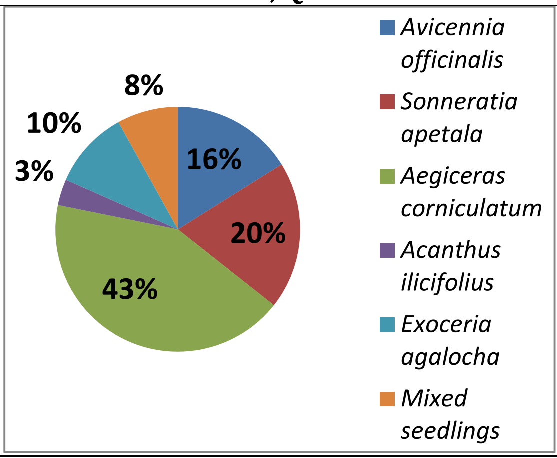


Figure 3: Diva (Near Diva Railway Track), Site – II, Quad.– I

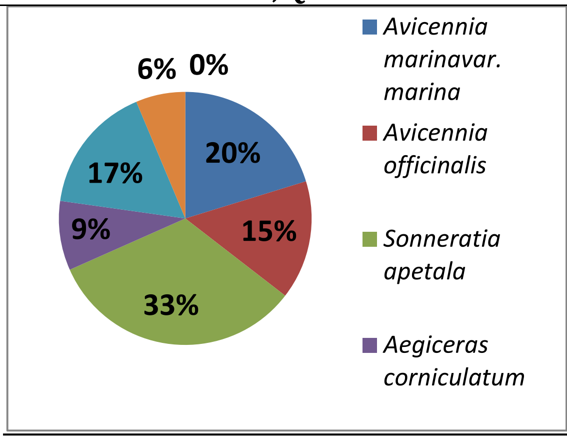


Figure 4: Diva (Near Diva Railway Track), Site–II, Quad.–II

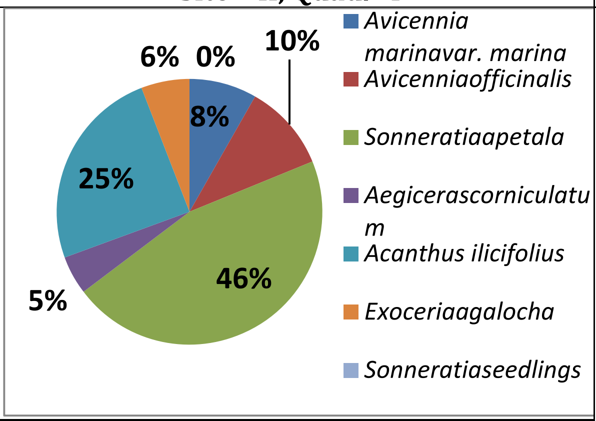


Figure 5: Near Anjur Phata, Kharbhav, Kewani, Site–III, Quad.–I

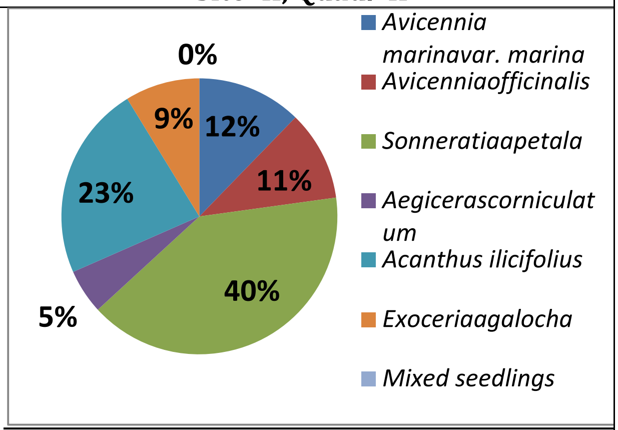


Figure 6: Near Anjur Phata, Kharbhav, Kewani, Site–III, Quad.–II

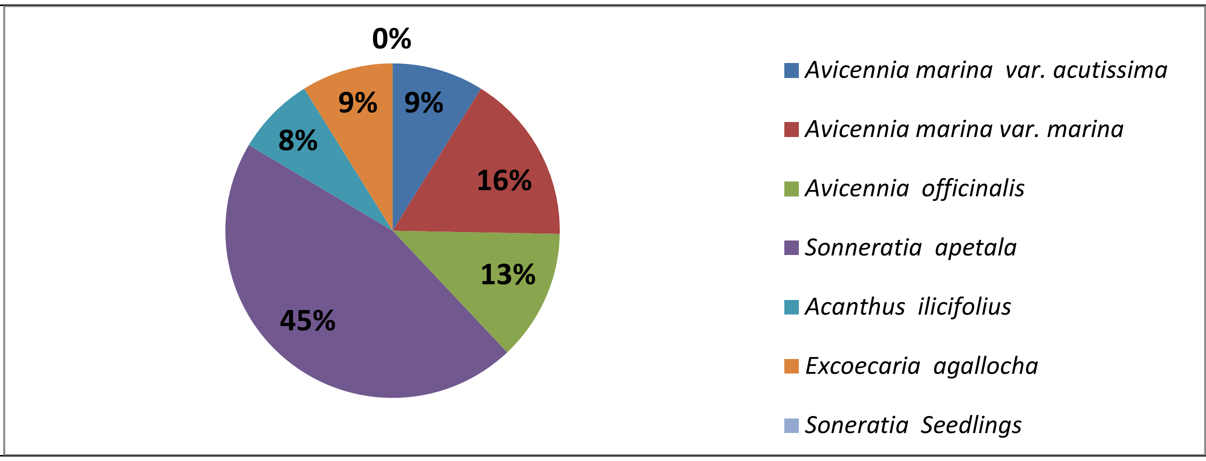


Figure 7: Brahmangaon (Bhiwandi), Site–IV, Quad.–I

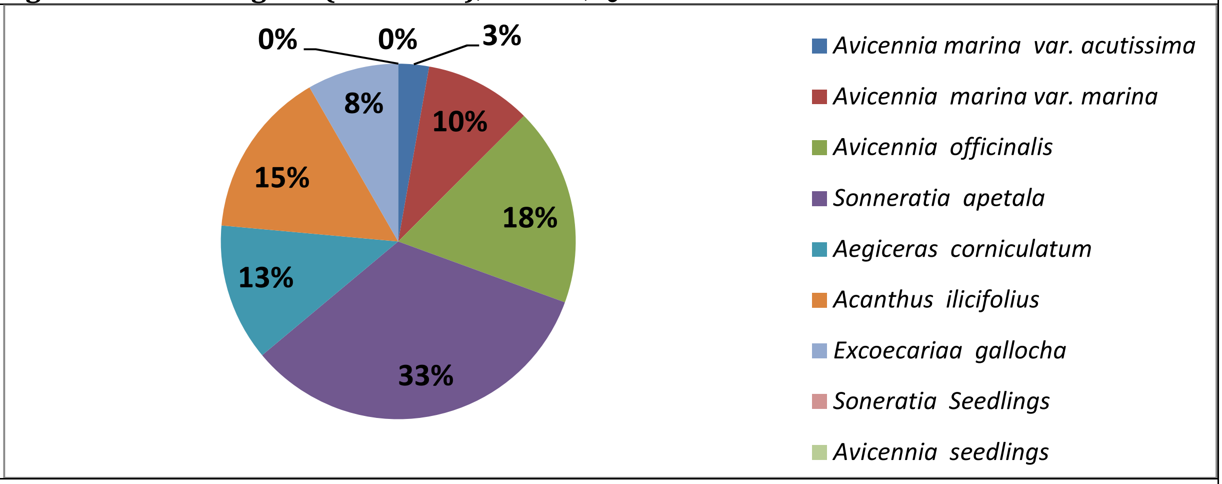


Figure 8: Brahmangaon (Bhiwandi), Site–IV, Quad.–II

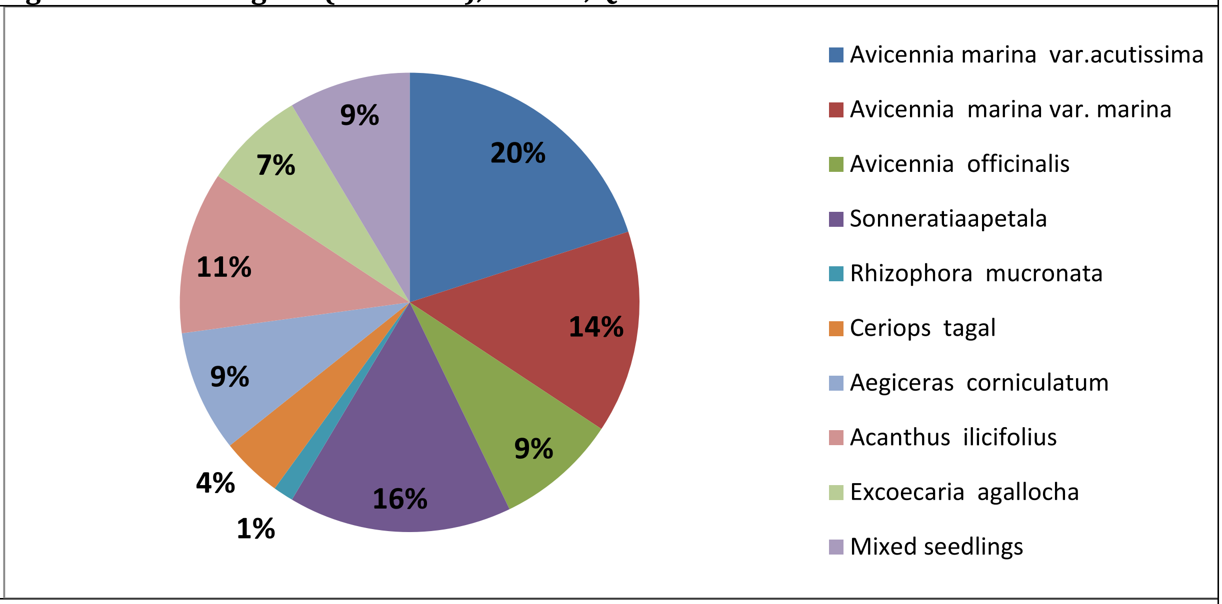
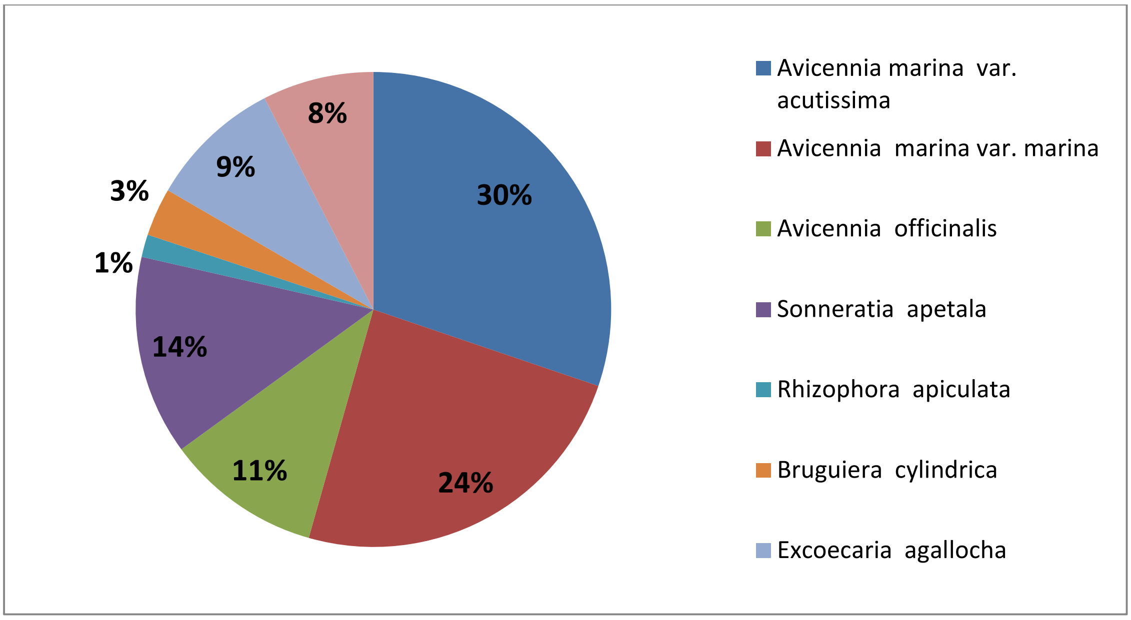


Figure 9: Saphale, Tembhikhadve, Site–V, Quad.–I

Figure 10: Saphale, Tembhikhadve, Site–V, Quad.–I



PLATES

Plate –I, Site - I:-Distribution of mangrove species Near Bhagawan Parshuram Ghat Lake, Kopar Khairane (Thane creek)

Plate –II, Site - II : Mangrove Vegetation at Diva (Near Diva Railway Track)

Plate –III, Site–III: Mangrove Vegetation Near Anjur Phata, Kharbhav, Kewani

Plate – IV, Site -IV:- Mangrove Vegetation at Brahmangaon (Bhiwandi)

Plate –V, Site–V: Mangrove Vegetation at Saphale, Tembhikhadave (Vaitarna River)

Plate – VI: Line Transect for Measuring Mangrove Forest structure at Diva

Plate – VII: DBH Measurement of *Avicennia* stem at Brahmangaon (Bhiwandi)

Plate – VIII: Reconnaissance Survey of Mangrove, Brahmangaon

Plate – IX: Field trip to Island near Narangi Village at Vaitarna River



Plate – X: Associated Flora recorded from Study Area

Plate XI: Seaweeds growing as epiphytes on pneumatophores, tree trunk, roots *etc*.

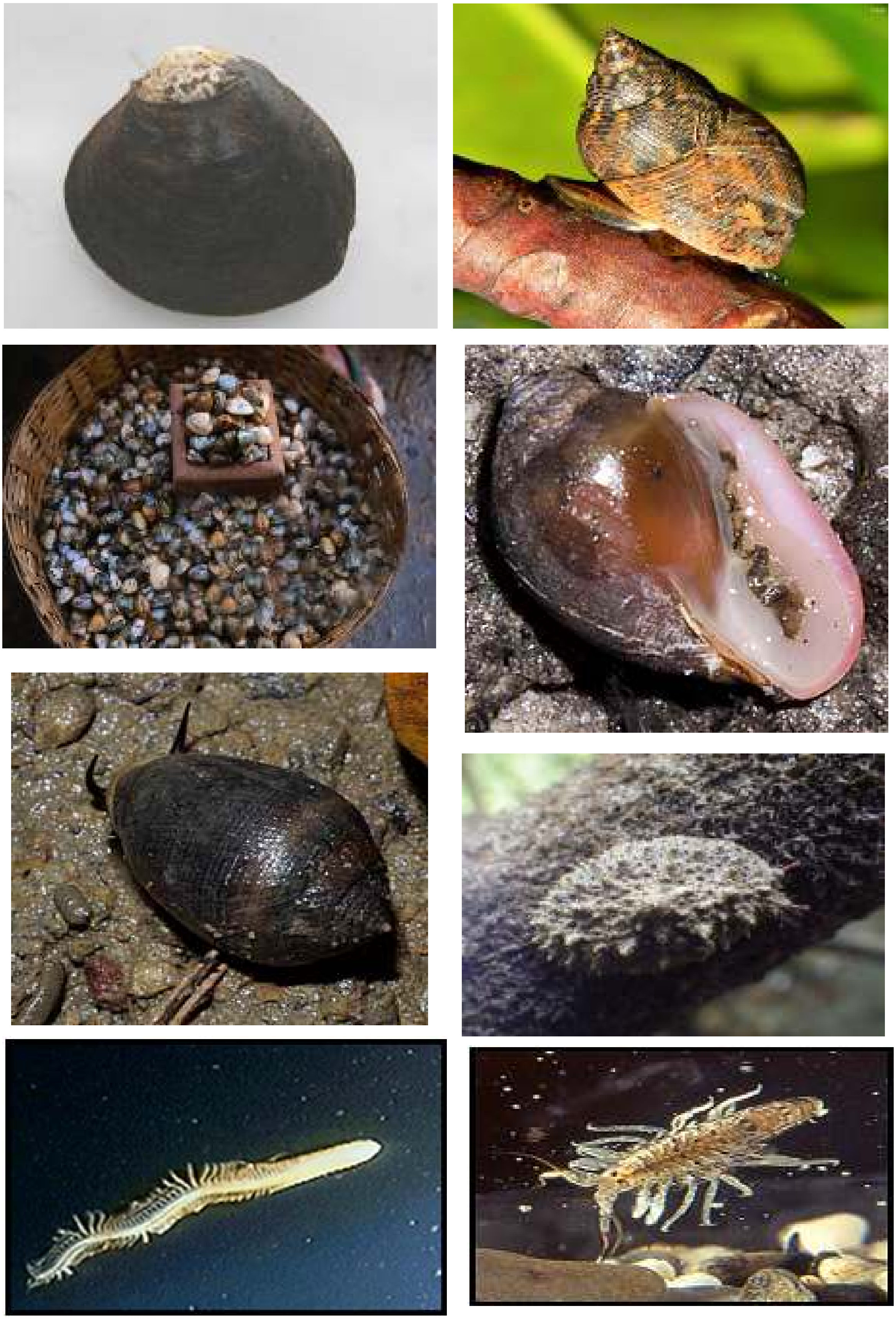


Plate XII: Benthic Fauna on Mudflats





Plate XIII: Commercially important Mangrove Fishes

Plate XIV: Shrimps encountered in the Mangrove

Plate XV: ***Crab, Scylla serrata*** **and Fiddler crabs in the Mangrove**

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Flying Foxes


Otters **Wild pigs**

Plate – XVI: Wild animals in mangrove forest for feeding and shelter






Plate –XVII: Birds visit mangroves for feeding, breeding, roosting and shelter

Plate – XVIII: The hydrological rehabilitation by trenching to support tidal flow in saline banks.

Plate – XIX: Mangrove Nursery Development Plots

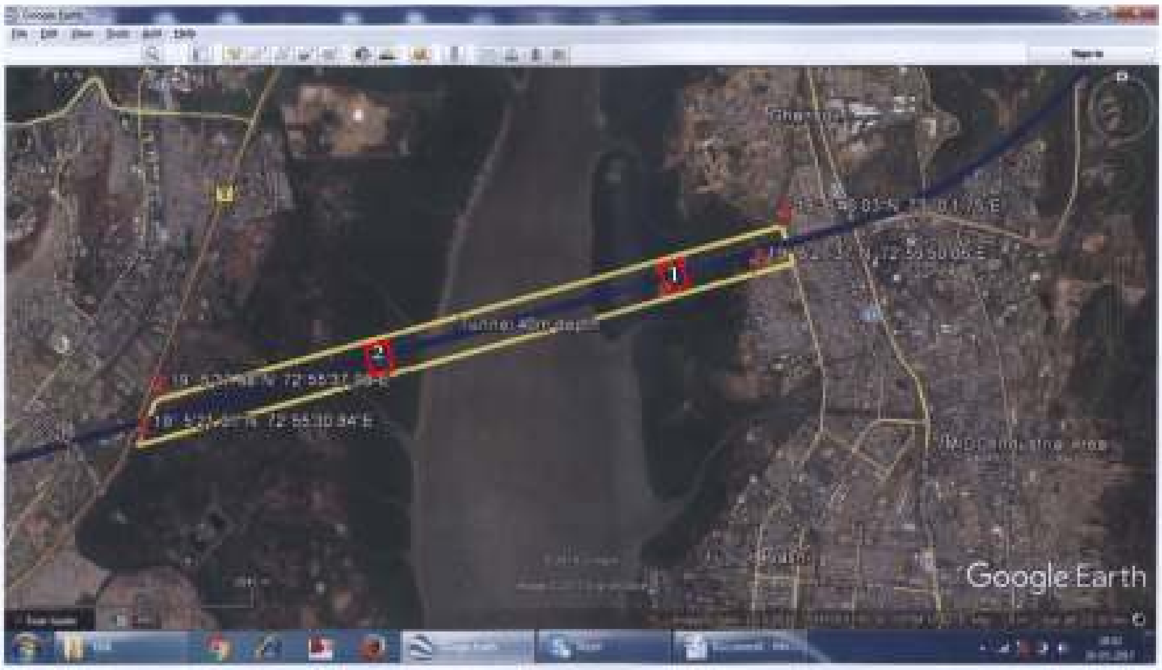
Plate – XX: Plantation of Nursery raised Seedlings

Plate – XXI:- Community participation in mangrove afforestation

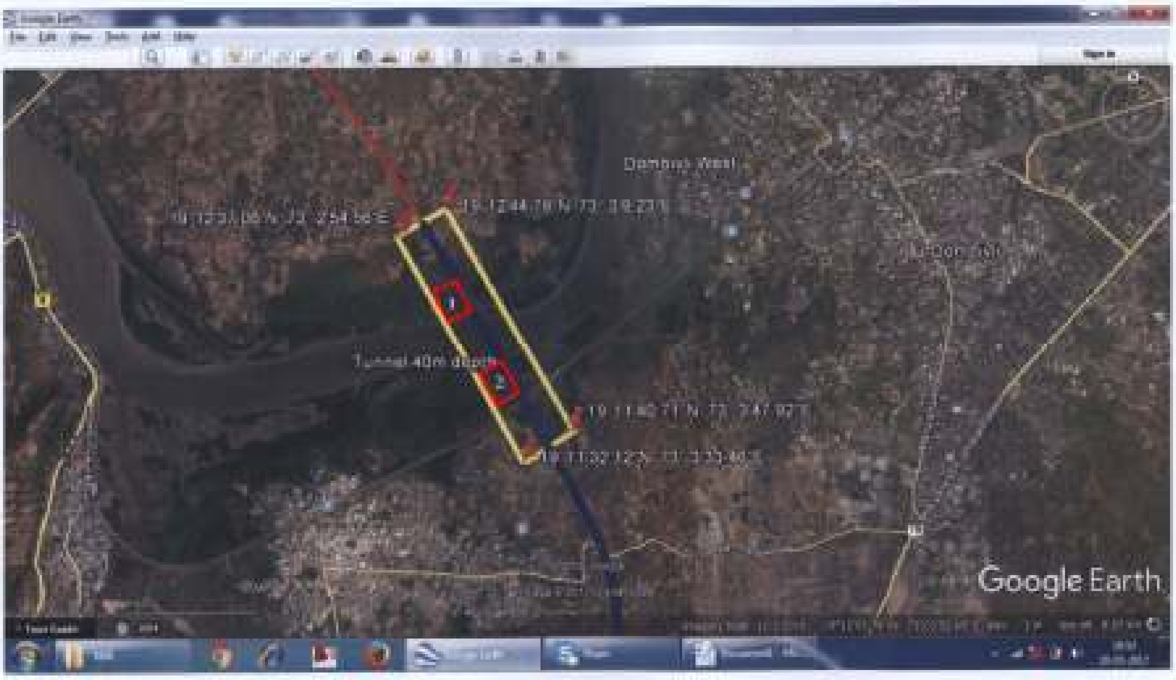
Plate – XXII: Students are trained in raising seedlings in nursery

Plate –XXIII: Mangrove awareness programme for school teachers and students.

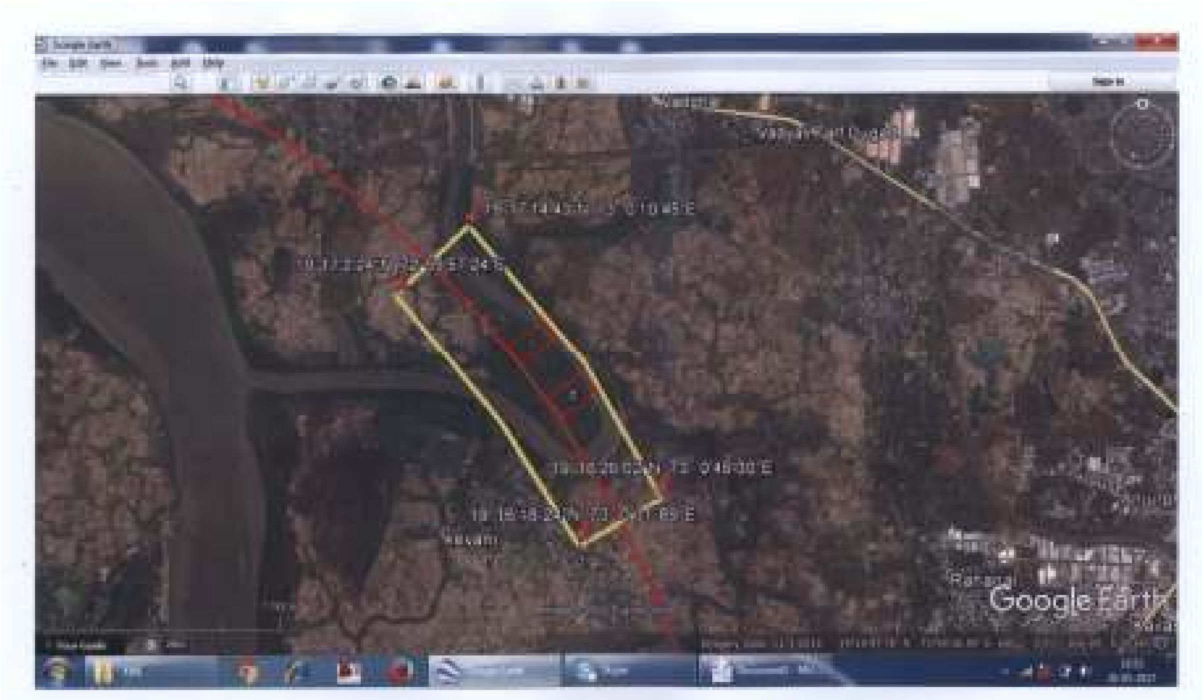
MAPS



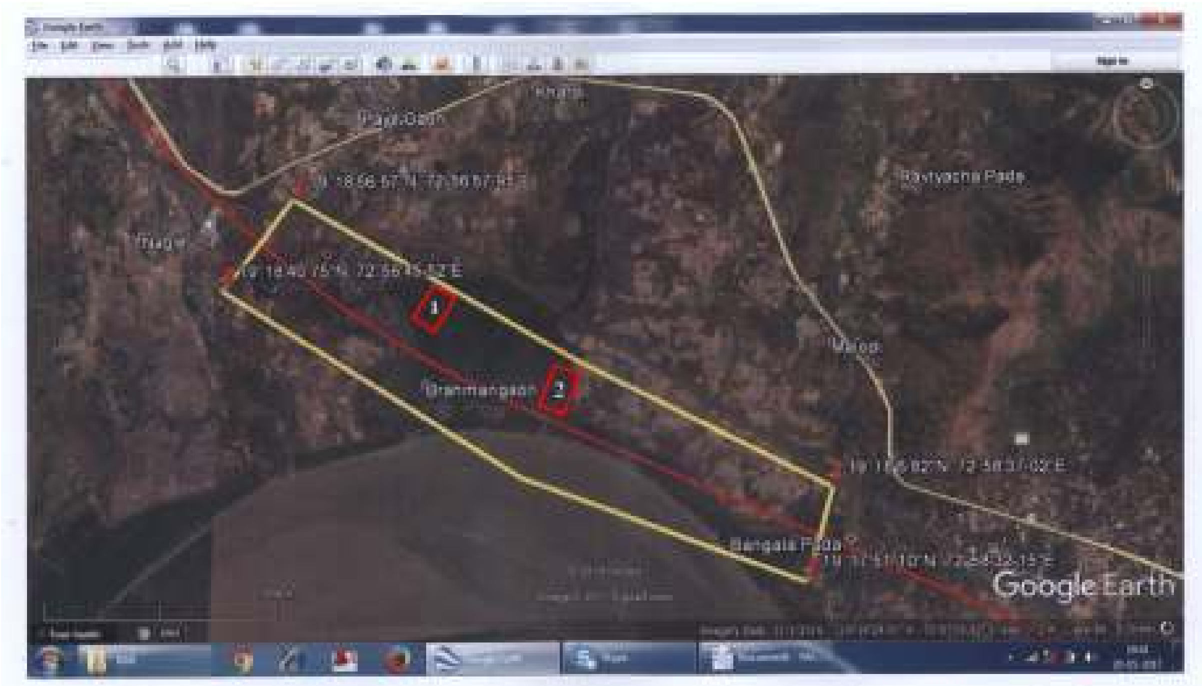
Map– I:- Google Image of Mangrove forest at Near Bhagwan Parshuram Ghat Lake, Kopar Khairane (Thane creek)



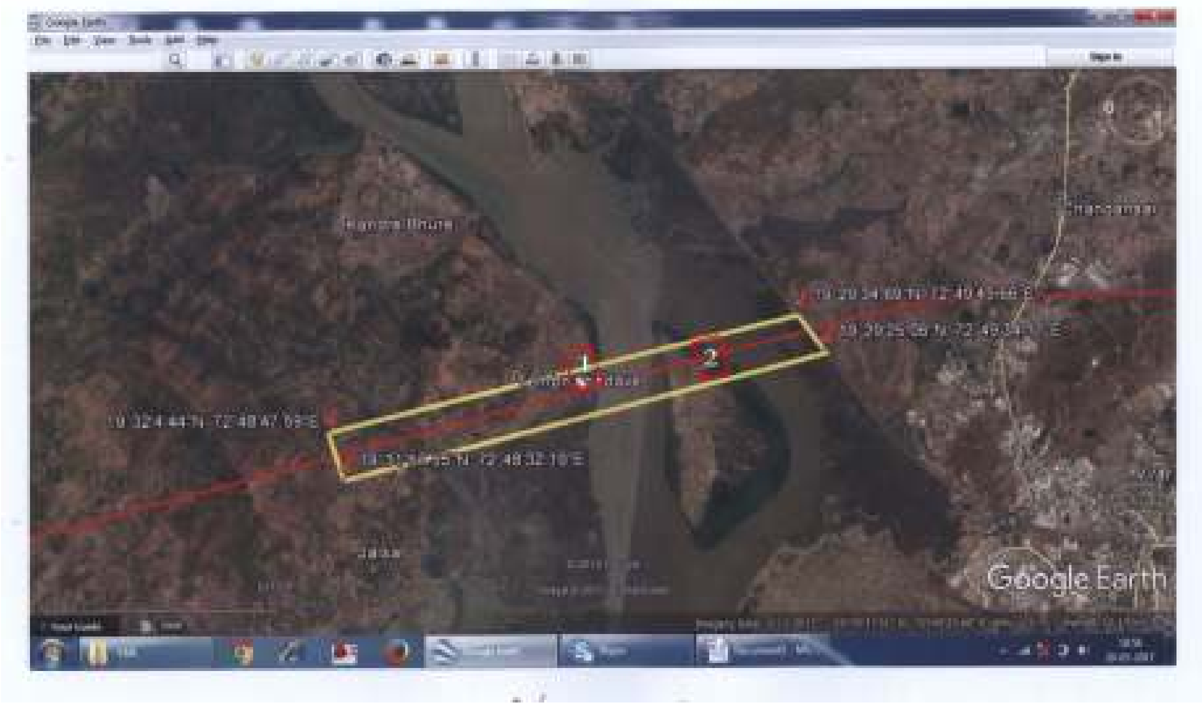
Map –II:- Google Image of Mangrove forest at Diva (Near Diva Railway Track)



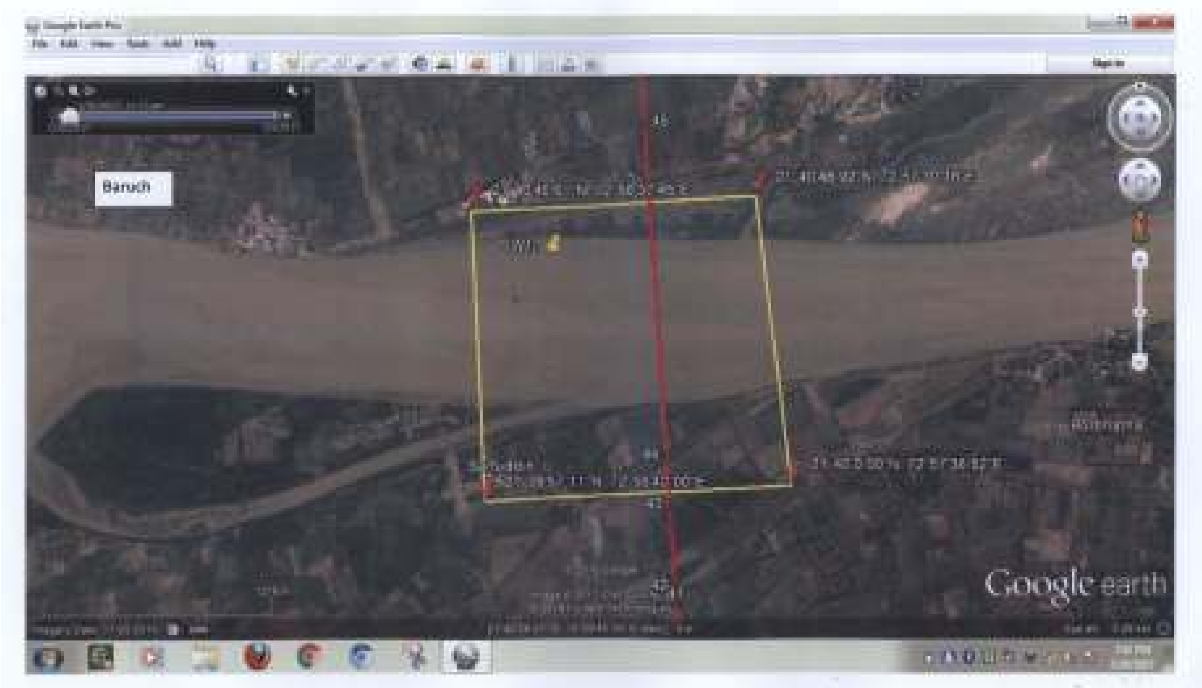
Map –III: Google Image of Mangrove Forest Near Anjur Phata, Kharbhav, Kewani



Map – IV: Google Image of Mangrove Forest at Brahmangaon (Bhiwandi),



Map –V: Google Image of Mangrove Forest near Saphale, Tembhikhadave (Vaitarna River)



Map –VI: Google Image of Bharuch - MAHSR Alignment across Narmada River

Annexure 4.15 (b)

Study on
Faunal Components and Preparation of Management and Conservation Plan for the Thane Creek Flamingo Sanctuary, Thane, Mumbai

Prepared by
Zoological Survey of India
Ministry of Environment, Forest & Climate Change,
Government of India,
Kolkata

1.0 Introduction

The National High Speed Rail Corporation Limited (NHSRCL), *A Joint Venture of Government of India and Participating State Governments* created by Government of India intends to implement the first high speed rail corridor between Mumbai and Ahmedabad in the country. In this regard, S-EIA study has been taken up by M/s GPS Technologies Pvt. Limited under the guidance of JIC Consortium for the proposed Mumbai-Ahmedabad High Speed Railway (MAHSR) Project (*Refer document of Joint Feasibility Study for Mumbai-Ahmedabad High Speed Railway Corridor*).

In this context, as a consultant of JICC, M/s GPS Technologies Pvt. Ltd., New Delhi requested the Director, Zoological Survey of India, Kolkata (vide Letter No. GPS/ZSI/2017/01, 19.05.2017) for conducting a "*Study of Faunal Components and Preparation of Management and Conservation Plan for Flamingo Sanctuary at Thane Creek in Mumbai*" covering 50 sq.km (10 km stretch with a width of 5 km) and accordingly ZSI agreed to undertake the project.The project was initiated from the date of signing the Work Order issued by M/s GPS Technologies Pvt. Ltd. to Zoological Survey of India *i.e.* on 1st June 2017 for a period upto February 2018, and based on which project field work was carried out.

In this report, ZSI has provided a detailed account of faunal diversity of in and around Flamingo Sanctuary at Thane creek including water birds around zone of possible impact along the corridors across the Thane creek, based on the field work carried out from June 2017 to February 2018. The report also highlighted the biodiversity importance of the area and conservation and management as well as mitigation measures for faunal components especially the water birds of Thane creek in Mumbai. Thane creek of Mumbai supports diverse life forms. Though, there are no systematic studies on this unique ecosystem, the creek is well known for its fishery resources. A variety of fishes, prawns, crabs, mudskippers, bivalves have been reported from the creek. The mangrove vegetation along the back of creek is ideal habitats for estuarine, coastal, intertidal and terrestrial organisms (CMPA Project Brief, 2016). However, there is no consolidated faunal account available from Thane Creek Flamingo Sanctuary. Therefore, the present study was conducted to document faunal diversity in and around Thane creek and Flamingo Sanctuary of Mumbai.

1.1 Project Background

National High Speed Rail Corporation Limited (NHSRCL)-a Joint Venture of Government of India and Participating State Governments, a special purpose vehicle (SPV) formed by Government of India, intends to implement the first ever bullet train in the country- Mumbai-Ahmedabad High Speed Railway Project (MAHSR) (*Refer document of Joint Feasibility Study for Mumbai-Ahmedabad High Speed Railway Corridor*).

The MAHSR alignment having 508.17 km length, begins at Bandra Kurla Complex (BKC) in Mumbai and runs through Thane and Palghar districts of Maharashtra thereafter enters Gujarat in Valsad district and runs a short course of 7.358 km through the UT of Dadra & Nagar Haveli and then re-enters Gujarat and runs through Navsari, Surat, Bharuch, Vadodara, Anand, and Ahmedabad districts of Gujarat before terminating at Sabarmati. The planned route is located between Latitude 19^{0}03'58.52"N-Longitude 72^{0}05'47.48"E and Latitude 23^{0}05'39.78" N-Longitude 72^{0}34'33.48"E (*Refer document of Joint Feasibility Study for Mumbai-Ahmedabad High Speed Railway Corridor*).

The alignment is proposed on elevated viaduct and bridges and also has 26.203 km of underground tunnels. There are a total of 8 tunnels with the longest tunnel of 20.375 km under sea at the Thane Creek in Mumbai.

2.0 Scope of the Study

By reason of its adequate ecological, faunal, floral, geomorphological, natural and zoological significance for the purpose of protection, propagating and developing wildlife therein and its environment, the Government of Maharashtra, in exercise of the powers conferred by sub-section (1) and (2) of Section 18 and Section 18B of the Wild Life (Protection) Act, 1972 (53 of 1972), declared the northern area of Thane creek as Flamingo Bird Sanctuary in August, 2015 (No. WLP-0315/CR-76/F-1, 6^{th} August 2015, Govt. of Maharashtra). The area also includes 896 ha of mangroves and 794 ha of adjacent water body (see Figure 1). The figure shows boundaries and eco sensitive zone, mangrove cover and mudflat (Adopted from Wildlife Institute of India document; Integrated Management of the Thane Creek Flamingo Sanctuary, 2016-25).

The Thane Creek Flamingo Sanctuary spreads from Thane city East coastal area to Mulund East, Bhandup East, Kanjurmarg and Vikhroli East, adjacent to Deonar Dumping

Ground with a small flowing river connecting this creek, Ramabai Nagar, Mandala with Jeejabai Bhosle Road Connecting the main road of Sion-Panvel Expressway (Airoli-Vashi bridge) that goes from borders of Yogayatan Port towards other side of creek which is Navi Mumbai, Vashi.

Source: ZSI

Figure 1 Map of Thane Creek Flamingo Sanctuary

The proposed work intends to survey in and around Thane Creek Flamingo Sanctuary, covering ~ 50 sq.km (10 km stretch with a width of 5 km) for documentation of the faunal diversity and suggest conservation and mitigation measures, with the following objectives.

2-1 Objectives

1. Determine and Map the impact zones (corridor of impact) due to potential vibrations (severe, moderate, mild and no impact) during construction and operational phases of the project based on the project alignment.
    a. It is expected that the vibration impact on avian fauna will be limited to 500m on each side of the proposed HSR alignment, however ZSI should also study and confirm the same
2. Estimate the occupancy and abundance of avifauna with focus on Flamingos and Waders specific to the impact zones (Corridor of Impact) and adjoining areas as per the Corridor of Impact
    a. Identification of resting and roosting area during high tide and major feeding area during low tide, including their mapping
3. Understand the movement pattern during high and low tide and population demographic of the Waders and Flamingos within the Thane Creek seascape.
4. Map the mudflat habitats in terms of its suitability with focus on waders and flamingos within the Thane Creek (primary data collection) seascape.
5. Understanding the biological parameters of the foraging grounds of Flamingos and Waders
6. Develop long term mitigation measures and conservation plan based on impact zones/maps
7. Develop protocols for long term monitoring plan of tracking occupancy and abundance of avifauna with focus on flamingo and waders specific to impact zones during pre-construction, construction and post-construction (operation) period of the MAHSR project.

2-2 Study Duration

The study was conducted from June 2017 to February 2018 and accordingly, field work was carried out at in and around Thane creek and Thane Creek Flamingo Sanctuary area from June 2018 onwards. Since, there were flocks of flamingos observed beyond February 2018, the field work continued upto end of March 2018, for enumeration of bird populations on the mudflats of the creek, however, data presented in the report is upto February 2018.

2-3 Description of the Study Area and Project Location

The creek is narrow and shallow at its commencement near Ulhas River, as there is geomorphic head present near the Thane city, whereas it gets broader and deeper towards its approach to the Arabian sea. Extensive mudflats are formed along the banks of the creek and the intertidal area of the creek get inundated, as a result of tidal influence by saline water of Arabian Sea with constant fresh water flow from Ulhas River or other land drainages except during monsoon. The substratum of the creek is reported to be consists of consolidated and unconsolidated boulders intermixed with slack rocks and little of sand and gravel. The local weather is with humid tropical climate temperature ranges between 40^0 C in summer to 16^0 C during peak winter. The dominant mangrove vegetation in and around Thane creek include species *Avicennia marina*, *Avicennia officinalis*, *Sonneratia* apetala, *Sonneratia alba*, *Bruguiera cylindrica*, *Aegeiceras corniculatum*, *Aleuropus lagopoides Excoecaria agallocha* and associate mangrove species such as *Acanthus iillicifolius*, *Salvadora persica*, *Derris trifoliate* and *Sesuvium portulacastrum* (Adopted from Wildlife Institute of India document; Integrated Management of the Thane Creek Flamingo Sanctuary, 2016-25).

Thane creek of Mumbai is known to be important habitat for Lesser Flamingo *Phoenicopterus minor* and Greater Flamingo *Phoenicopterus roseus*. The creek attracts these flamingos in large numbers every year from October - November onwards. Over 30,000 flamingos have been estimated to use the mudflats and the bordering mangroves of Thane creek during winter and then, migrate back to Gujarat or elsewhere for breeding by April-May, although a small resident population, live throughout the year (Pattanaik et al. 2010). Besides supporting a large congregation of flamingos, Thane creek and its adjacent landscape is refuge for more than 200 species of resident and migratory birds. The mudflats also inhibit several other species such as Greater Spotted Eagle (*Aqilia heliacal*) and Black-headed Ibis (*Threskiornis melanocephalus*). The mudflats on both banks of the creek exposed during the low tide and the intertidal area become foraging grounds for many Waders. The area is heavily polluted with wastes, both the creek through several inlets. Both banks of Thane creek are with luxuriant mangrove vegetation dominated with *Avicennia marina* species and *Rhizophora mucronata* and *Excoecaria agallocha* are in patches (Athalye, 2013; Chaudhari-Pachpande & Pejaver, 2016).

3-0 Methodology

3-1 Literature Review/ Secondary Sources of Information

The finding of the prior research by other institutions in the study area using available books, reports, scientific research notes and various theses have been assessed and incorporated. Critical analysis of compiled information has been used to identifying the gaps in existing knowledge for formulation of further research required.

The Thane creek is a 26 km long inlet from the Arabian Sea towards the landward connects the Ulhas River and sheltered between Mumbai and Uran. The bank of Thane creek is with wide mudflats and mangrove vegetation in the background and open creek waters support the main ecological features of the area (Athalye, 1988). The mangroves around the creek have been protected by the Mangrove Cell of Maharashtra Forest Department with smaller patches being conserved by the Soonabai Pirojsha Godrej Marine Ecology Centre. Part of the Thane creek has been identified as an IBA About 09 species of mangroves, 12 mangrove-associates, 206 bird species, 25 fishes, 7 prawns, 13 crabs, 30 reptilians and macrobenthos such as diverse polychaete worms have been documented from the Thane creek area. (Gokhale and Athalye, 1995; Quadros, 2001; Saravanan et al. 2013). Several studies have been conducted on avifauna of Thane Creek, however noteworthy work includes Quadros (2001) who had reported 55 species of birds in Thane creek are that of Vijayan et al. (2011), Walmiki et al. (2013) and anonymous publication of Mangrove Cell, Forest Department, Govt. of Maharashtra (2015).

3-2 Site Specific Data Collections and Observations

For proper designing of the field work and logistics for the project, an inception combined field visit by team from Zoological Survey of India (Dr. Kailash Chandra, Director, ZSI and Dr. Basudev Tripathy, Scientist-D) and M/s GPS Technologies Pvt. Ltd. (Shashank Sharma, Managing Director along with Mr. Vimal Kumar Singh and Mr. Akshay Tripathi) were made from 10th to 11th June 2017 to the project site in Thane creek of Mumbai. The Joint Feasibility Study for Mumbai-Ahmedabad High Speed Railway Project and the Environmental Impact Assessment Report prepared for the project was discussed.

Since, systematic field surveys need to be conducted, based on the field visit and preliminary assessment, a grid-based study was designed using the shape file of the area in which

1x1 km and 2x2 km study grids of the study area, which was marked in advance (refer to **Fig.2** and **Fig.3**). The GPS locations of the Grid Centroids were also identified and marked (**Fig.3**). Moreover, it is imperative to have a continuous survey to know the long-term transition of natural resources, and also for the viability of the proposed developmental project. Therefore, field survey was initiated in the project site from July 2017 onwards and assessment of faunal assemblages is being done both through visual observations as well as collection of fauna from the field site of 10 km x 5 km zone as described in Fig. 2 & 3.Grid based approach used to conduct benthos surveys in foraging areas of the flamingo and waders. The seascape and adjoining area was divided in to number of grid squares and using known locations and boundaries of foraging areas. Comprehensive surveys were conducted at selected sites. Macro-benthos samples from all the surveyed area were sieved on site and preserved with 10% formalin solution with prior treatment of Rose Bengal. The samples were brought to ZSI laboratory, washed, sorted and identified up to group/family level. Data analysis was carried out using MS Excel software. Comparative data from various sites has presented in the form of percentage to avoid error due to varied sample numbers at different sites.

There were two major areas focused for the sampling, the terrestrial and the mangroves. The terrestrial grids include habitats with ground vegetation *viz*. grass, bushes, trees and seasonal ponds and pools, whereas, the mangrove area are with mangrove vegetation and swampy muddy substratum. The field work and sample collections were carried out on foot and by boat.

3-3 Schedule for field work and data collection

Two field research personnel from ZSI stationed at the project site to conduct field work and systematic data collections till end February 2018, in and around the Thane Creek Flamingo Sanctuary, Thane. A team of scientists from ZSI HQ, Kolkata were deployed to conduct an intensive field surveys in the project area from 13th July 2017 to 19th July 2017. The team coordinated with the field personnel of M/s GPS Technologies Pvt. Ltd. Also for day-to-day schedule for field work any for any other logistic supports. Thereafter, another team of scientists also visited the site during first week on September 2017, for documentation of birds and other invertebrate fauna from the site. The scientists of ZSI subsequently visited in December 2017, for inspection and assessment of bird populations in and around the study area.

3-4 Field Survey Methodology and Faunal Collection

Since monsoon predominant (June – September) along the western coast and Maharashtra region, including in the study site of Thane Creek, field work in the selected grids were only possible during the reporting period of July – September 2017, due to inaccessibility. However, from October 2017 onwards, field visits were on a regular basis and extensive documentation of faunal including birds and other vertebrates and invertebrates were done. Similarly, fauna samples were collected, wherever feasible from the grids. Figure 2 and Figure 3 show the Grid Design for systematic data collection from in and around Thane Creek.

Figure 4 shows the inaccessible area (yellow color patches) for the survey of fauna, using roads, trails or boat with the grids of 2 x 2 Km. The followings are the details methodology adopted.

(1) Bird Counting

Bird congregation count was done by using the estimated-block method and snap shot method (Bibby *et al.* 2000). During the field survey observations, point counting was done during low/neap tide, using binoculars (Olympus and Nikkon; 10×50), for a fixed period of time, from the closest proximity to the bird congregation, from a country boat. Total count method was used wherever possible, by walking around the area from the landward side to the intertidal region and all the birds were counted, grouping species-wise, as method suggested by Vijayan (1991). The area covered for surveys along the Thane creek was approximately 9 km (5 km towards north and 4 km towards south from Vasi flyover). All the bird observation points were recorded with a hand-held GPS (Garmin 72H; Garmin Inc.). Bird species observed in the field were identified using standard field guides (Kazmierczak 2000; Grimmet 2013). Photo-documentation was done using SLR and fixed zoom lens camera (Nikon D5600 with NIKON 70-300mm ED VR Telephoto Lens, Canon 1300D with 55-250 mm IS II Telephoto Zoom Lens & Canon 70-400mm ISII L Series Lens).For herpetofauna (Reptiles and Amphibians *viz*. Snakes, Lizards, Skinks & Frogs), specimens were handpicked wherever possible and or using Snake Tongs, Hooks.

(2) Other Fauna

Along with vertebrates, as part of the faunal documentation of invertebrates, during the period, survey was conducted on protozoan and insects *viz*. Hymenoptera, Lepidoptera and

Diptera, since they also directly or indirectly contribute to the health of the ecosystem. Other faunal groups were also documented, collected and analyzed from selected location of the Thane Creek Flamingo Sanctuary. For insects, especially Dragonflies, Butterflies, Moths, Bugs, Beetles, Bees, Grasshoppers, *etc.*, sweeping insect net was used for collection, whereas for smaller dipterans (mosquitoes) Aspirator was used for collection. All the insect fauna collected were photographed, with geo-coordinates of collections noted with GPS.

Other coastal and intertidal fauna were also collected wherever possible from their natural habitat as well as collected from fisherfolk, directly on the site itself. The data collected from field were plotted on a GIS map, for enumeration and extracting desired results.

Table 1: GPS locations of the Grid Centroids identified and marked in and around Thane Creek Flamingo Sanctuary

Grid No.	Longitude	Latitude
B3	72:57:54.90 E	19:08:24.46 N
B4	72:59:03.33 E	19:08:25.22 N
C2	72:56:47.27 E	19:07:18.67 N
C3	72:57:55.70 E	19:07:19.43 N
C4	72:59:04.12 E	19:07:20.18 N
D2	72:56:48.08 E	19:06:13.63 N
D3	72:57:56.49 E	19:06:14.39 N
D4	72:59:04.91 E	19:06:15.15 N
D5	73:00:13.33 E	19:06:15.89 N
E1	72:55:40.47 E	19:05:07.83 N
E2	72:56:48.88 E	19:05:08.60 N
E3	72:57:57.29 E	19:05:09.36 N
E4	72:59:05.70 E	19:05:10.11 N
E5	73:00:14.11 E	19:05:10.85 N
F1	72:55:41.28 E	19:04:02.80 N

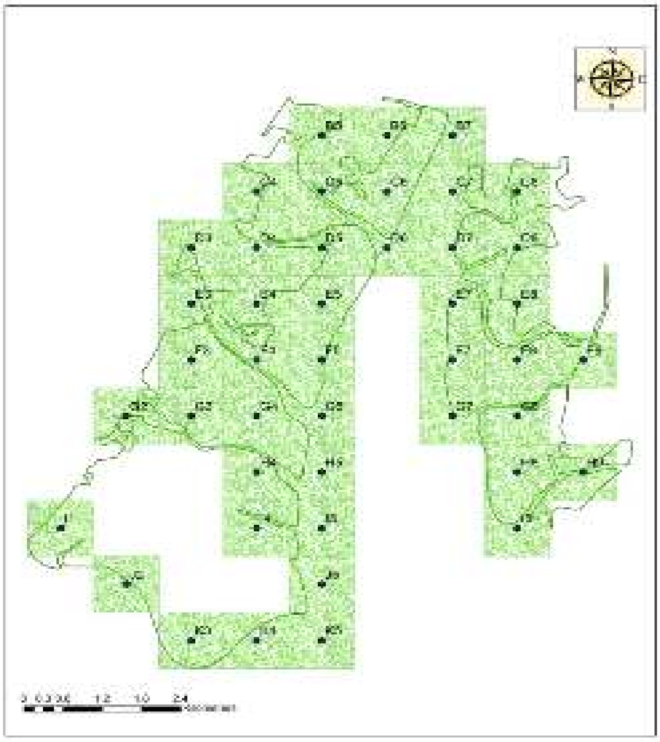


Figure 2: Grid Design (1x1 km) for systematic data collection from in and around Thane Creek

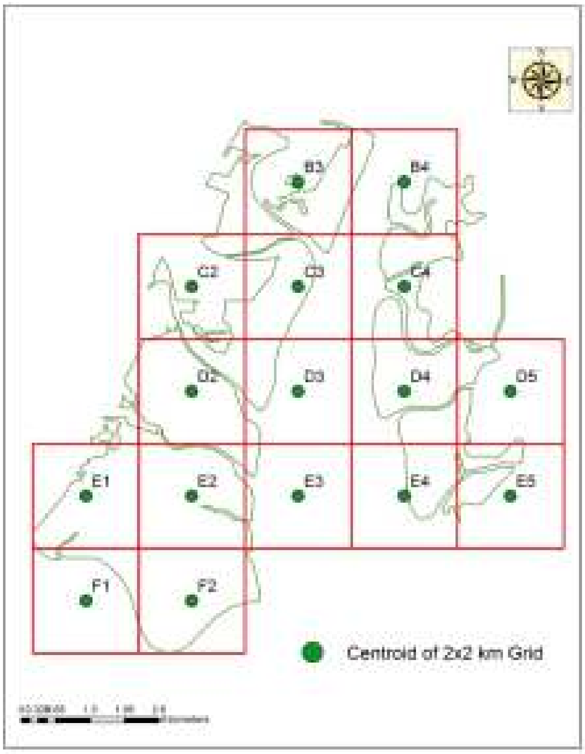


Figure 3: Grid Design (2 x 2 km) for systematic data collection from in and around Thane Creek

Table 2: Area covered during surveys from June 2017 to February 2018 in and around Thane Creek in Mumbai (as per the Grid)

Area Covered during Surveys	Geo-coordinates	Grid Area
Kopar Khairane Area	19^{0}.06’34.5’’ N 72^{0}59’51.2’’E	D4
Godrej Mangrove	19° 6'12.60"N 72°57'43.48"E	C2, D2
Bhandup Pumping Station	19^{0}.08’21.6’’ N 72^{0}57’26.2’’E	B3
Sagar Vihar Vashi	19° 4'56.70"N 72°59'29.57"E	E5
Godrej Mangrove	19° 6'12.60"N 72°57'43.48"E	
Sagar Vihar Vashi	19° 4'56.70"N 72°59'29.57"E	E5
Kopar Khairane Area	19^{0}.06’34.5’’ N 72^{0}59’51.2’’E	
Kopar Khairane Area	19^{0}.06’34.5’’ N 72^{0}59’51.2’’E	D4
Kopar Khairane Area	19^{0}.06’34.5’’ N 72^{0}59’51.2’’E	D5
Sagar Vihar Vashi	19° 4'56.70"N 72°59'29.57"E	E5
Bhandup Pumping Stn	19^{0}.08’21.6’’ N 72^{0}57’26.2’’E	B3
Bhandup Pumping Stn	190.08’21.6’’ N 72057’26.2’’E	B3
Kopar Khairane Area	19^{0}.06’34.5’’ N 72^{0}59’51.2’’E	D4
Sagar Vihar Vashi	19° 4'56.70"N 72°59'29.57"E	E5
Vashi Birdge Godrej outside area	19° 6'12.60"N 72°57'43.48"E	C2, D2
Bhandup Pumping Stn	19^{0}.08’21.6’’ N 72^{0}57’26.2’’E	B3
Kopar Khairane Area	19^{0}.06’34.5’’ N 72^{0}59’51.2’’E	D4

Table 2 (a): Details of the Grids with their locations and Accessibility

Grid	Location Details	Accessibility
B3	Bird watching area, Thane area having small pools, ponds, grassland, shrubs and trees	Accessible
B4	Fish ponds, mangroves	Accessible
C2	Solid waste management/ dumping site	Not accessible/not allowed
C3	Solid waste management/ dumping site	Not accessible from land/not allowed. Only accessible from sea side
C4	Ponds and pools, grassy land with shrubs and rocky land	Accessible
D2	Godrej site, terrestrial and mangrove sites. Terrestrial site contains butterfly park, heavy tree vegetation and grassy land.	Accessible with permission from Soonabai Pirojsha Godrej Marine Ecology Centre at Vikroli
D3	Entry from Godrej jetty and further assessed by boat	Accessible with permission from Soonabai Pirojsha Godrej Marine Ecology Centre at Vikroli
D4	Tunnel starting point and construction zone. Site with lake, ponds, grass land, trees and mangrove	Accessible
D5	Nursery and mixed vegetation	Accessible
E1	Water treatment plant	Not accessible/not allowed
E2	Soonabai Pirojsha Godrej Marine Ecology Centre at Vikroli - Site with dense trees and grassy land without proper roads and trails	Partially accessible with permission from Soonabai Pirojsha Godrej Marine Ecology Centre at Vikroli
E3	Entry from Godrej jetty and further assessed by boat	Partially accessible with permission from Soonabai Pirojsha Godrej Marine Ecology Centre at Vikroli
E4	SaharVihar area visited through road, not assessed by boat due to shallow depth of water and heavy rain	Accessible
E5	Urban area in Vashi, Navi Mumbai	Accessible
F1	Solid waste management/ dumping site	Not accessible/not allowed
F2	Next to dumping and sewage treatment plant. No roads and trails available	Not accessible

Table 3: Details of the study area covering all the Grids

Sl. No.	Locations	Geo-co-ordinates		Observation/ Remarks
		Latitudes	Longitudes	
1	Bhandup Pumping Station upto Airoli Forest (Saltpan Area)	19°09'02.8"N - 19°08'55.1"N	72°57'26.7"E - 72°57'45.8"E	Large water body surrounded with bushes and large saltpan
2	Airoli Forest to Bhandup Pumping Station	19°08'47.4"N - 19°08'32.4"N	72°57'45.9"E - 72°57'51.0"E	Moderately dense forest covered with mangrove vegetation and manmade ponds for aquaculture
3	Bhandup Pumping Station to Flamingo Viewing Point (appx. 2 Km)	19°08'33.0"N - 19°08'23.1"N	72°57'51.1"E - 72°57'27.2"E	A straight road covered with patches of mangrove vegetation and normal woodland trees. An artificial water canal is running along the road side.
4	Flamingo Viewing Point Waterway up to Entry into Thane Creek	19°08'21.4"N - 19°07'38.7"N	72°57'25.2"E - 72°58'16.5"E	Narrow Inlet to Thane creek covered with dense mangrove vegetation supports huge verities of avifauna diversity.
5	Airoli Forest to Upper Right Corner Road (alternate path	19°08'60.0"N - 19°08'57.1"N	72°57'53.2"E - 72°58'17.8"E	A straight road with large saltpans and crop fields around
6	Sagar Vihar Area Lake Rajiv Gandhi Jogers Park to near Hiranandani Hospital	19°04'32.8"N - 19°05'08.3"N	72°59'06.1"E - 72°59'32.9"E	A large water-body encircled by concrete roads. Dense mangrove vegetation along the north side of the road.
7	Sagar Vihar Area Municipal Water Tank to SivtirthMaidan	19°04'26.3"N - 19°04'18.8"N	72°59'03.8"E - 72°59'06.9"E	A large Municipal water tank. On the north side, a big patch of dense mangrove vegetation and small artificial water ponds around.
8	Thane Creek Flamingo Sanctuary Vashi Bridge Start - Godrej Site Opening - Airoli Bridge Grids Covered (H5,G5,F5,E5,D5,E7 ,F7,G 7)	19°03'50.2"N (H5, G5, F5, E5, D5, E7, F7, G7) - 19°07'13.3"N	72°58'40.7"E - 72°58'13.0"E	Thane Creek Flamingo Sanctuary water way covering pre-determined H5,G5,F5,E5,D5,E7,F7,G7 Grids

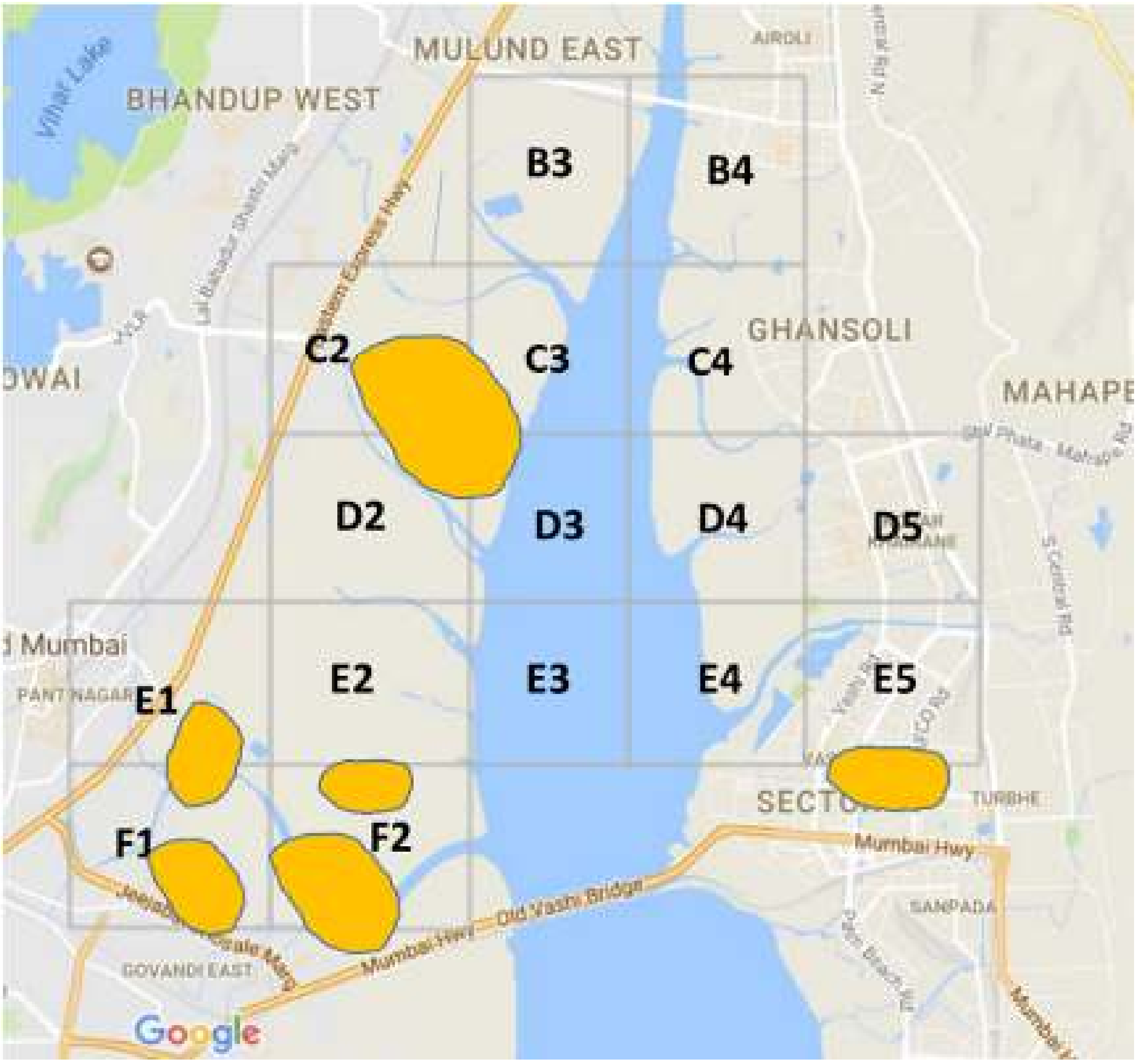


Figure 4: Inaccessible Area

4.0 Results of the Survey

4-1 Details of Data and Sample Collected

(1) Protozoa Collections:

A total of 36 samples (including 15 water and 21 soil samples) were collected for the study of protozoan from the above mentioned grid during the survey.

(2) Insect Collections

a) Diptera Collections

The collection methods were mainly focused on mosquitoes due to inclement weather conditions which reduced the activity of flies. For the collection of dipterans, sweep net and mouth aspirator were used to collect adults and dipper and pipette were used to collect water inhabiting larvae.

A major collection was conducted of larval stages in C4, D4, D5 and E2 grids and were allowed to emerge as adults for identification. No larvae found in C2 and B3. Adults were collected from C3 and C2 grids. A total of 218 specimens were collected including other dipterans.

Table 4: Diptera Collections

S. No.	Phylum & Class	Order	Family	Genus	Grid	Number of Examples
1.	Arthropoda Insecta	Diptera	Culicidae	*Culex*	C3	15
2.	Arthropoda Insecta	Diptera	Culicidae	*Aedes, Culex*	C4	49
3.	Arthropoda Insecta	Diptera	Culicidae	*Culex*	D2	10
4.	Arthropoda Insecta	Diptera	Culicidae	*Aedes*	D4	14
5.	Arthropoda Insecta	Diptera	Culicidae	*Aedes, Armigeres*	D5	45
6.	Arthropoda Insecta	Diptera	Culicidae	*Culex, Armigeres*	E2	11
7.	Arthropoda Insecta	Diptera	Culicidae	*Aedes*	E5	5
8.	Arthropoda Insecta	Diptera	--	--	--	69
			Total	**3**	**7**	**218**

Source: ZSI

b) Hymenopteran Collections

During the survey period, total of 325 hymenopteran specimens were collected with the help of Sweep net, yellow pan trap and hand picking methods.

c) Lepidoptera Collections

A total number of 62 lepidopteran specimens were collected during the survey. The details list of the collected samples of different families/genera/species of order Lepidoptera is provided below:

Table 5: Lepidoptera Collection

S. No.	Family name	No. of samples	No. of genera	No. of species
1	Nymphalidae	22	09	16
2	Papilionidae	08	02	04
3	Pieridae	12	05	07
4	Lycaenidae	04	02	02
5	Pyralidae	06	01	01
6	Sphingidae	03	02	02
7	Noctuidae	03	02	02
8	Arctiidae	02	01	01
9	Hesperidae	02	01	01
Total	**09**	**62**	**25**	**36**

Source: ZSI

d) Miscellaneous Insect and other Faunal Collections

Details of the specimens collected from Thane Creek Flamingo Sanctuary, Thane Creek, Mumbai, Maharashtra are as below:

Table 6: Miscellaneous Collection Details

S. No.	Name of the Section	Number of tubes/Bottle	Number of Specimens
1.	Apterygota	3	23
2.	Arachnida	5	37
3.	Coleoptera	9	59
4.	Crustacea	1	3
5.	Thysanoptera	4	37
6.	Hemiptera	3	50
7.	Formicidae	5	67
8.	Mollusca	1	6
9.	Orthoptera	-	21
10.	Odonata	-	06
1.	**Total**	**32**	**309**

Source: ZSI

(3) Other Aquatic Invertebrate and Vertebrate Fauna of Thane Creek

For aquatic invertebrates and vertebrate fauna, samples were collected from the fish landing centre present just below the Vasai Railway Bridge, where all the fishing boats aggregated for fish landing.

(4) Avifauna

The near threatened species namely Painted Stork, Lesser Flamingo, Black-headed Ibis (IUCN 2018) were observed during the study period from June-July to September at Thane Creek. Of these, flamingos were counted systematically. On sighting a flamingo flock, photographs were taken using a hand-held digital camera (Nikon DX-D7000) and the flock's position was recorded using a GPS (GARMIN-GPS 72H). Where the flock was too large to be captured on one photograph, a sequence of overlapping photographs was taken to record the flock entirely for details of taking and recording total count photographs. Wherever flocks were small and possible to count, photographs were taken for evidence along with direct counts were made. The number of individuals per photograph/exposure and direct counts made in the field were added up to determine the total population of flamingos in the surveyed area. Figure 5 shows flamingo inhabited area (red line).

Figure 5: Flamingo Inhabited Area

5.0 Ecological Assessment

5-1 Faunal Diversity

Detailed species list is provided in Annexures.

(1) Mammals

Mammals like the Jungle Cat *Felis chaus*, Golden Jackal *Canis aureus* and Common Mongoose *Herpestes edwardsi* reported to inhabit the area (Deshmukh 1990, Kulkarni 2000). A total of 5 species of mammals belonging to 5-genera, 4-families and 2-orders have so far been reported from in and around Thane creek Flamingo Sanctuary. Of the different species of mammals reported from the area, the sighting of Golden Jackal *Canis aureus* and Common Mongoose *Herpestes edwardsi* were frequent during the field study, in all the grids.

(2) Herpetofauna

A total 42 herpetofauna have been known from in and around Thane creek and among those, 50% are common, 36% are uncommon and 14% are rare (Walmiki et al. 2012) which include threatened species like Python *molurus molurus* and *Varanus bengalensis* recorded also. During the field survey, common lizard in the shrubs and skippering frog were commonly sighted in the pond and smaller waterpools. Among the geckos *Hemidactylus brooki* and *Hemidactylus flaviviridis* were commonly observed. However, except for the common species of lizards, skinks, gecko and toad, no rare species of reptiles recorded in the study area which suggests that due to urbanization and anthropogenic activities, reptilian biodiversity was low.

(3) Avifauna

In total 125 species of birds were recorded from Thane Creek during June 2017 to February 2018, against the earlier published record of 95 species (Chaudhari-Pachpande Pejaver, 2016). The bird species were further classified as resident, migratory, and resident migratory bird species (

Table 7). The vegetation of the mangrove ecosystem at Thane Creek supported the population of both waders and terrestrial bird species also. A maximum diversity of bird species was reported at Bhandup (Grid-B3) as it provides a mixed habitat that includes Saltpans, grasslands, planted trees, and mangrove vegetation. Among the bird species observed, 43% of birds were observed on mudflats and 43% birds in mangrove vegetation. This suggested that

86% of birds are dependent on mangroves and mudflats. The vegetation of mangrove ecosystem and mudflats of Thane Creek are used by waders as shelter belt, foraging, roosting and other purposes during spring migration.

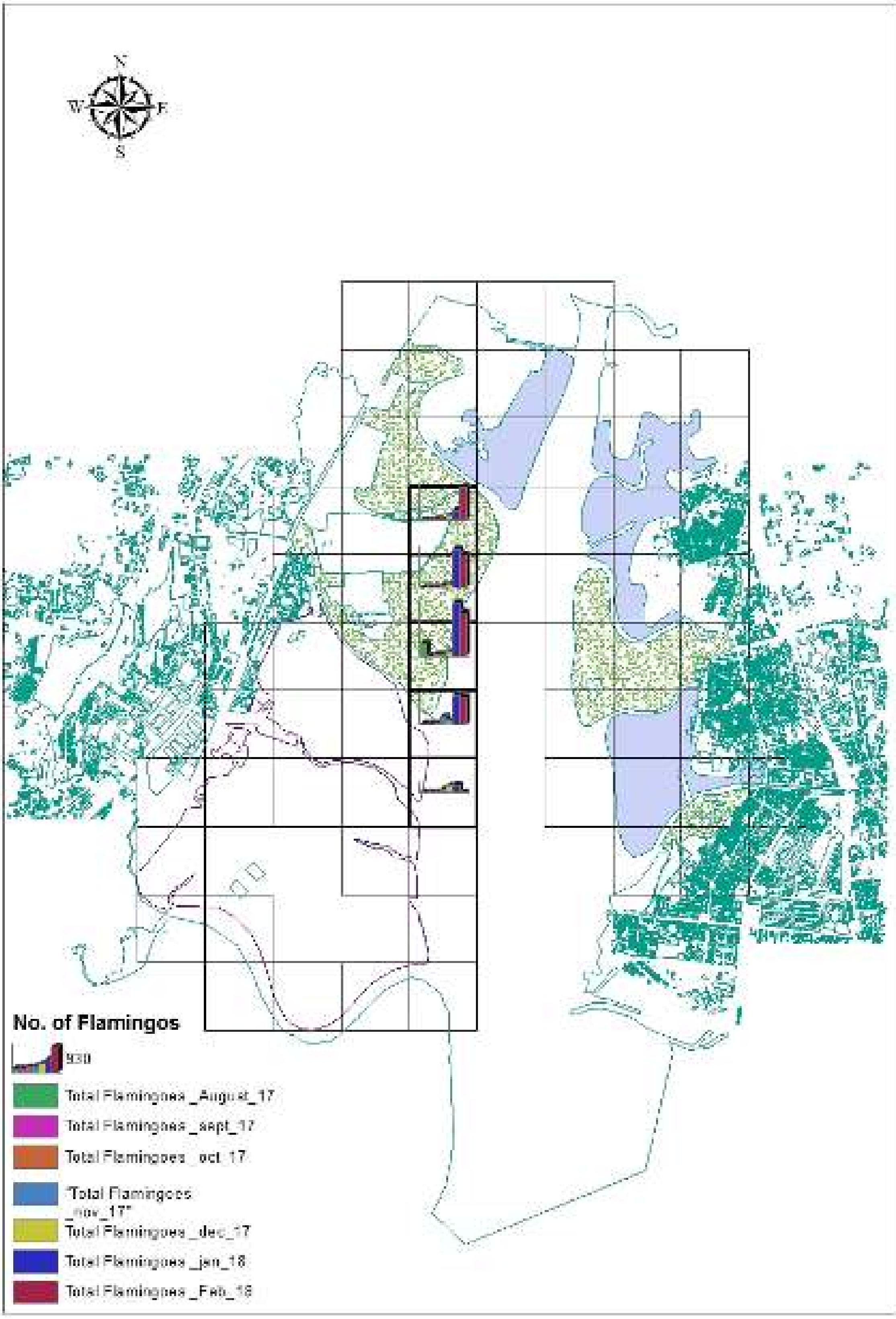
Table 7: Bird Species Categorization on Habitat Basis

Sl. No.	Status	Category	No.of Species
1	Resident widespread	(R)	41
2	Resident local sparse	(r)	28
3	Winter visitor widespread(W)		28
4	Resident as well as winter visitor widespread	(RW)	9
5	Resident as well as winter visitor local sparse	(RW)	12
6	Residential status not known (?)		7
		Total	**125 species**

Nevertheless, majority of bird species dominated in the area are flamingos with 90 per cent of the flamingo population consists of Lesser Flamingos (*Phoenicopterus minor*) and the remaining 10 per cent are Greater Flamingo (*Phoenicopterus roseus*). Other than the flamingos, the mangrove ecosystem of Thane Creek invariable supporting good population of Waders and terrestrial bird species observed all along the intertidal area. Therefore, the population estimation of Lesser Flamingos and Waders were carried out systematically, during the field visits.

The survey for enumeration of flamingo in the Thane Creek was carried out at different location based on their habitat, are illustrated and shown in Figure : 6, 7 & 8.

Enumeration of Flamingo population along the Thane creek mudflats between August 2017 and February 2018 is shown in Figure 6, Survey locations (patches) in and around the Thane creek Flamingo Sanctuary, Mumba are in Figure : 7 and Data collection points (Geo-coordinates) in and around Thane Creek Flamingo Sanctuary, Mumbai are in Figure 8.



Source: ZSI

Figure 6: Enumeration of Flamingo population along the Thane creek mudflats between August 2017 and February 2018

Source: ZSI Study Team

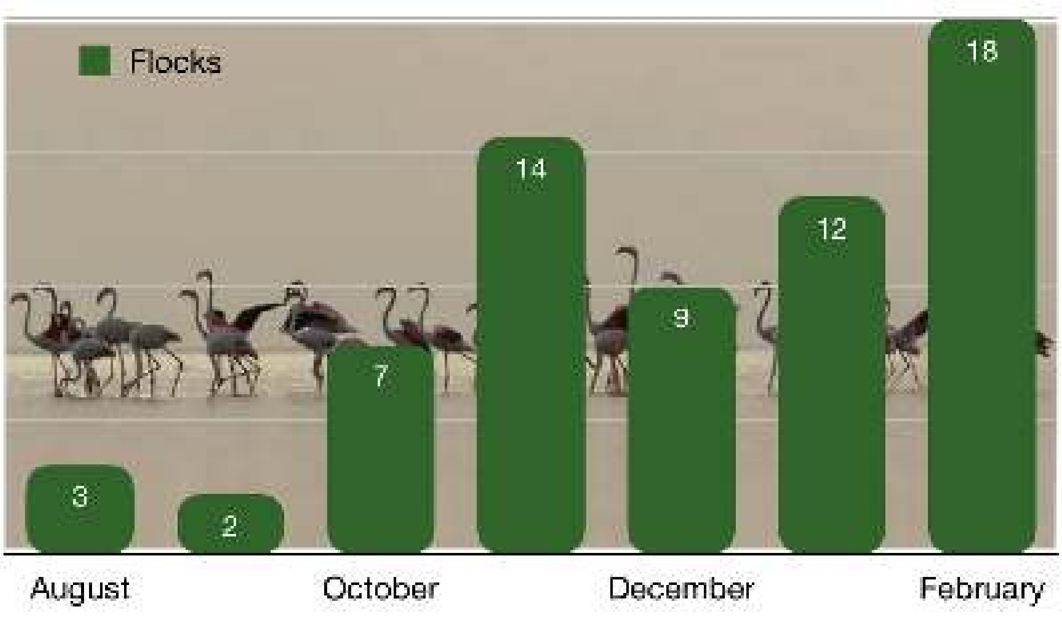
Figure 7: Survey locations (patches) in and around the Thane creek Flamingo Sanctuary, Mumbai

Source: ZSI Study Team

Figure 8: Data collection points (Geo-coordinates) in and around Thane Creek Flamingo Sanctuary, Mumbai

From photographs taken from the fixed geo-coordinate points along the western banks and eastern banks of Thane Creek, ~5500 Lesser Flamingos were counted and from direct counts of 65 flocks, with average of ~ 290 individuals were recorded/flock. Thus, the total population of Lesser Flamingos from aerial photographs and direct counts between June 2018 and February 2018 estimated to be around ~ 18,000 individuals in the stretch of 9 km intertidal mudflat of Thane creek. Distribution pattern of most of the Lesser Flamingos counted were concentrated in the northern and north-western parts of the Creek. Small numbers of individuals were counted in the southern and south eastern part also. The flamingos and waders were equally in large number during January and February 2018 (Refer Figure 9a & 9b).

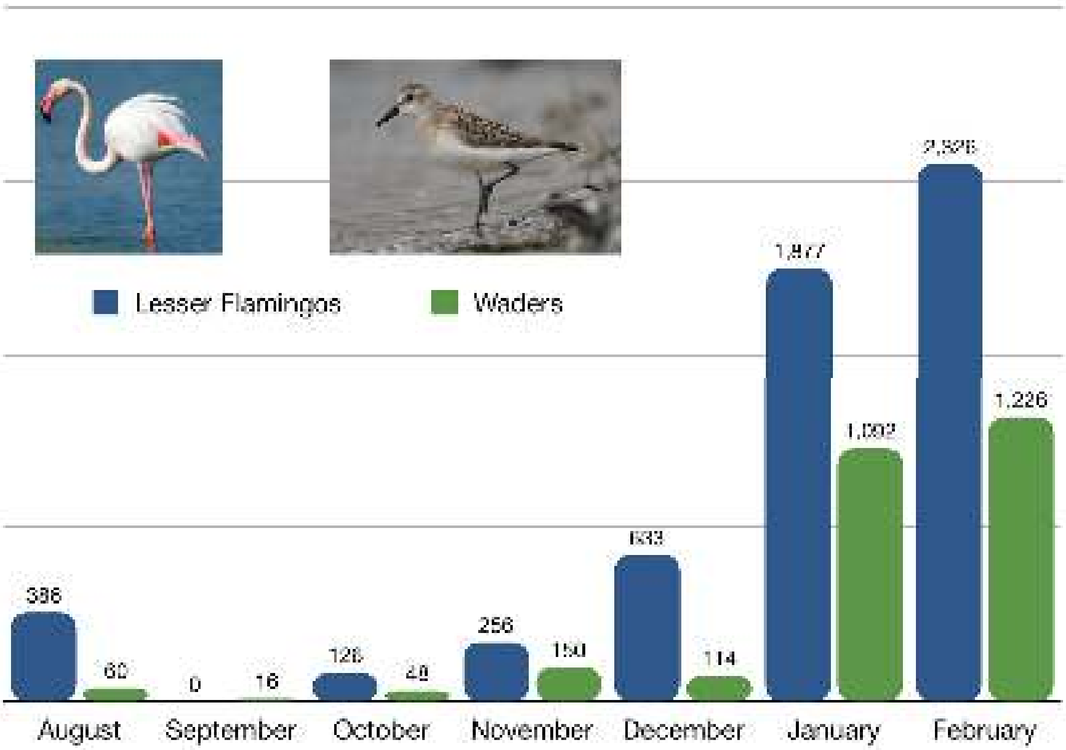
During the survey in and around the Thane creek, the maximum diversity of bird was reported from Bhandup Pumping Station, probably due to existing of saltpan, grassland, smaller water pools and mangroves which are ideal sites for feeding and rooting of birds. Bird species *viz*. Eurasean Collared Dove, Red-headed Bunting, White Stork were also reported from Bhandup. The near threatened species namely Painted Stork and Black-headed Ibis were observed during the survey in more than one grids, which suggests the area to be good feeding and roosting ground for migratory and resident birds.



*** Count for Flamingo average of whole month observation and exclude juveniles**

Survey period: August 2017- February 2018

Figure 9 a: Result of Flamingo Flock counting



*** Count for Flamingo average of whole month observation and exclude juveniles**

Survey period: August 2017- February 2018

Figure 9 b: Result of Flamingo & Wader counting

(4) Other Fauna

Apart from bird species, 5 sp. of mammals belonging to 2 orders and 5 families, 8 sp. of reptiles belonging to 8 genus and 7 families, 1 sp. of amphibian belonging to 1 genus and 1 family, 29 sp. of butterflies and moths belonging to 19 families and 5 families, beetles of 8 species belonging to 6 genus and 8 families, 3 sp. of grasshoppers belonging to 3 genus and 1 family and 39 sp. of fish and shellfish belonging to 34 genus and 29 families have been documented from Thane creek during the surveys. The details are presented in Annexure 3 to Annexure 11.

5-2 Anthropogenic Disturbances in and around Thane Creek

The Vashi Bridge on the Eastern Express Highway, also known as Thane Creek Bridge, is built across Thane creek that connects the city of Mumbai with Navi Mumbai. Similarly, the sub-urban rail link to Panvel runs parallel along with the Highway on the same bridge, with high level traffic round the clock and frequent movement of sub-urban railway services.

The Thane creek harbor is the Asia's biggest industrial belt and the Thane-Mumbai urban complex along its bank. As a result, large quantities of industrial and sewage effluents enter the creek. Treated and untreated domestic waste along with waste from chemical, petrochemical, fertilizer and atomic plants situated around the coast also contaminate the creek (Apte et al. 2014). The multi-functional industries along the creek bank contribute to high pollutants along with enormous volume of untreated sewage as well as solid waste and oil spills. Most of the industries and households in and around the creek are releasing their untreated sewages into the Thane creek and this untreated effluent goes into the creek unchecked which leads to increase in pollution. There is disturbance to flamingos and other wetland birds and waders due to frequency of fishing motor boats in the creek and the noise and ripples caused by the motor boats cause disturbance to the roosting/feeding shore birds.

Hunting and poaching of birds from Thane creek were reported to be a frequent event in the pasta, however, there is no known report of registered case of hunting/poaching, although, stray incidents do occur. Interview with local fishermen and secondary sources of information reveal that there are cases of injuries to the flamingos due to high tension power lines running across the creek.

The continuous silt deposition has led to increased changes in the creek profile mainly the expansion of intertidal formation that also led to increase in the mangrove cover of the creek. The creek also has issues such as salt pans, cutting of mangroves for housing purposes, sand mining and coastal protection work. The salt pans are invariably converting into prawn farm and thereby releasing untreated waters into the creek.

6.0 Mitigation Measures and Conservation Management of Thane Creek Flamingo Sanctuary

6-1 Mitigation Measures

The Mumbai-Ahmedabad High Speed Railway (MAHSR) Project of the National High Speed Rail Corporation Limited, Govt. of India project is reported to have alignment under the mangroves, mudflats in the Thane creek as evident from the record and this area has been categorized as CRZ-I(a). Therefore, the construction may not cause any physical damage/disturbance from construction point of view. The alignment of the proposed Mumbai-Ahmedabad High Speed Railway Project passes underground 30 m below the flamingo distribution. A detailed analysis of the spread of the flamingos along the Thane creek in relation to the proposed alignment of the MAHSR project indicate that the portion of the alignment along the Thane creek would pass through under the mudflats being used by the flamingos for feeding and roosting. However, since the corridor work is planned to be underground and will be performed through Tunnel Boring Machine (TBM), there will be no physical disturbance and civil work on the mudflats and mangroves on the ground.

The contractor should ensure minimum level of disturbance to the avaian faunal diversity, especially flamingo and other threatened birds in the influence zone. And if possible, the construction may be restricted to the time window when flamingos are not in large numbers (before November and after February), atleast not in large flocks along the Thane creek.

The indirect way of predicting the congregation patch could be monitoring the tide levels at Thane Creek as flamingos and other shore birds congregated in the area during low tide, when the mudflat expose, enable them better food availability. This would minimise any kind of major disturbances to the shore birds.

6-2 Conservation Plan

Keeping in view the magnitude and intensity of anticipated impacts due to construction and operation of Mumbai-Ahmedabad High Speed Railway Project, the specific conservation plan is presented below.

- Survey on flamingos and other migratory birds of Thane Creek should be given top priority; especially ecological aspects such as habitat requirement, habitat suitability, migratory corridors, feeding and breeding behaviours *etc*. and for this, funding should be available.
- Dedicated administrative and scientific staff required for monitoring as well as associating with scientific research and monitoring of specific taxon, events and status by professional scientific agencies.
- Regarding public awareness, there is already exist one Coastal and Marine Biodiversity Centre by the Mangrove Cell of Maharashtra Forest Department, Govt. of India. Such interpretation facilities should be utilized for outreach materials and regular awareness programmes, for habitants of nearby Thane Creek resident.
- The management plan for Thane Creek Flamingo Sanctuary need to be reviewed at a time interval of every five years through a review committee, for further suggestions and improvement for better conservation and management.
- Research should be prioritized both at landscapes and species level, with emphasis on ecological restoration aspects. For this, capacity building for research and monitoring involving community for documentation and database for Thane Creek Flamingo Sanctuary with regular funding for such activities should be ensured.

6-3 Reference Studies of impact on fauna during TBM operation at Thane Creek

Although the project on the alignment of the proposed Mumbai-Ahmedabad High Speed Railway Project passes underground approximately 30 m below the mudflats which are being used by the flamingos for feeding and roosting and also the Creek which harbours fish and shellfish diversity, the impact on the avian and coastal marine fauna cannot be evaluated, being the project is of first of its kind in India. However, since the corridor work is planned to be underground and will be performed through Tunnel Boring Machine (TBM), the physical disturbance due to civil work on elsewhere (Japan) can be taken up as case study, for evaluation of the impact during construction. Here some case studies are given below.

(i) Case Study in Japan –Impact of Noise and Vibration on Avifauna:

Sound impact to raptor by construction project: Through an experiment in Japan, auditory area of raptor was found between 1kHz- 4kHz, which is much narrower than human beings. Higher frequency (greater than 8kHz) and lower frequency less than 250Hz is not audible for raptors. However, sensitivity in the auditory area is much higher than human beings. (http://www.nilim.go.jp/lab/ddg/naiyo/shindou/shindou.html).

(ii) Case Study in Japan – Environmental mitigation to birds: National Institute for Land and Infrastructure Management

A study conducted by the National Institute for Land and Infrastructure Management recommended that to reduce construction load during breeding period if the location is close to the breeding area, conditioning (gradual adaptation to the construction environment) can be considered. Monitoring and counter measure if unusual behaviour is observed was also suggested along with generation of new habitat (creation of new mad flat). http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0906pdf/ks090614.pdf

(iii) Case Study in Japan - Monitoring study of behaviour of four pairs of raptor during construction of bridge in a canyon in Japan:

During the construction, the sound level generated from construction machineries and vehicles ranged between 40 and 60dB. The highest level was 74dB while steel pile driving and the background level was 35dB. The sound above did not affect the behaviour of the four pairs.

Monitoring during non-construction was also conducted and the behaviour of the four pairs were the same.

(iv) Case Study in Japan - Monitoring study of behaviour of one pair of raptor during construction of tunnel using torpedo in a canyon in Japan:
The sound level generated from torpedo ranged between 67dB and 88dB. However, the sound did not affect the behaviour of the pair. Other birds also did not fly on the blast, even it is in the night time.

(v) Case Study in Japan - Measures on geologic survey at the location close to raptor,
Ministry of Land, Infrastructure, Transport and Tourism:
No affect to raptors was observed during boring and seismic survey within their territories. While the surveys were undertaken, workers put on inconspicuous wear and acoustic insulation sheets were installed around the survey equipment.

Nevertheless, considering the above studies and as a precautionary measure, Environment Monitoring Plan for Thane Creek Flamingo Sanctuary at the beginning of construction and the stage of test operation of the High Speed Train and countermeasures when abnormal behaviour of flamingo was observed must be clearly stated along with the budget.

7.0 Monitoring Plan

Due to the uncertainty of the noise and vibration impacts and behavioural changes of bird species, two phase monitoring programmes are recommended namely. Monitoring Plan has been formulated in two Phase. Phase I as the conventional monitoring programme adapted for baseline survey and phase II as a comprehensive scientific monitoring programme shown in subsection 6-4. Phase I monitoring programme is summarised in this subsection.

7.1 Monitoring Plan (Phase I)

There is no substantial information in India available on the flamingos and other water birds, waders *etc*. from Thane creek and therefore, the habitat suitability and requirement for threatened birds of Thane creek along with other environmental parameters are needed for better conservation and management of the Thane creek biodiversity including flamingos and other birds. However, based on the case studies in Japan, it is also considered that the impact of construction by TBM might be minor / negligible.

To consolidate, a proposal for monitoring study, pertaining to impact of Noise and Vibration on the Flamingo and also the response and behaviour of flamingo towards noise and vibration from the tunnelling operation on birds and the benthic fauna as well as habitat is suggested. Although the observation on shore birds and flamingos especially along the Thane creek in relation to the frequent movement of sub-urban local trains indicates that the noise and vibration from the Vasi Bridge, which are highly localized (spatially and temporally), flamingos and other birds seldom respond to such disturbances, continuous monitoring might be necessary, from the viewpoint of precautionary principle, especially peak avian / faunal activities, November -December in Thane Creek.

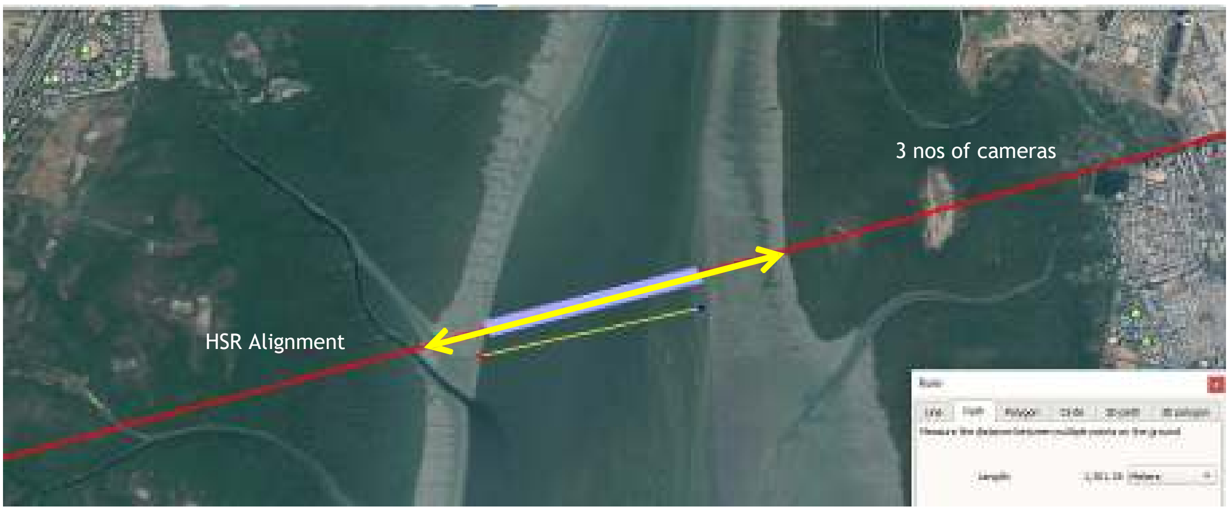
A seasonal bird surveys and counts on a regular basis should be conducted for Thane Creek Flamingo Sanctuary, especially targeting the area of alignment of MAHSR. This should be a major event every year in which, survey and count can be done using suitable vantage points in the periphery of the Mangroves. Bird species observed field can be identified using standard field guides (Kazmierczak 2000; Grimmet 2013). Photographs should be taken in the field with particular species/individual and flock/patch of congregation from a minimum distance possible so that actual count can be done from photos. The data of the bird species further can be grouped under various categories *viz*. frugivorous, insectivorous, carnivorous, and omnivorous depending on their feeding preferences.

- The following are the suggestive methods for Phase I bird and other faunal surveys around the construction area in Thane Creek. Presence/absence may be very helpful as a descriptive tool. That is, it may be informative to state that a species was present at 40% of location in habitat XX and 60% of location in habitat YY. Another advantage of presence/absence data is that some analytic methods can be used for such data but not for total detections.
- Fixed radius point counts are the basic method recommended for most monitoring studies, and are most widely used (Hutto et al. 1986, Ralph et al. 1993, Ralph et al. 1995). These can provide a cost-effective method for estimating the relative abundance of birds in Thane Creek.
- Spot-mapping - Can provide good density information and information on many aspects of avian life history. It is expensive per data point and may be better applied to research projects or to high priority areas or species.
- Suggestive datasheets are given in Appendix which may be used for the count.
- Permanent monitoring plots should be identified and monitoring to evaluate the status, distribution and abundance of avifauna, and other wildlife in the area, monitor pollution and review management interventions.
- Fixed monitoring locations are recommended.
- Three fixed automatic time delay cameras be placed along the alignment. Two of the three cameras shall be installed at the "Active construction area. One of the three camera shall be installed at "Non active construction area" as the control. The camera shall be calibrated for online monitoring and provision of data to the scientific community and monitoring the data and movement of various avian fauna data can be useful in mapping shift in habited, resting and roosting grounds. Mud flats are dominated by the flamingos hence this data will be extremely useful in monitoring the new development in the nesting, resting, roosting grounds of the flamingos, it can also be catalogued as well as evaluated by various different agencies using this online data stream.

Table: 8 Instrumentation proposed for the Environment Monitoring Plan for Thane Creek Flamingo Sanctuary, Phase – I

Sl. No	Description	Range	Location of Placement	Nos.
1.	Camera time delay capability and night vision.	20 Mega Pixel.	On Shore Installation of cameras on each shore looking towards the mudflats.	3
	Data Logger for (SA) & cloud support.		Data logging will be done on the shore in weather proof housing in controlled environment. Data transfer to the cloud shall be through	
	Housing and Power Supply		Power Supply shall be through the reinforced and shielded cables buried in HDPE pipes of 150mm diameter below the ground at depth pf 600mm. Secondary supply by	
	Construction: year 2019 - 2023 Expert: One Scientist to analyse the logged data. One Technician to	5 years	TCFS / Mumbai	1
	Operation year 2023 – 2028. Expert: One Scientist to analyse the logged data. One Technician to	5 years	TCFS / Mumbai	1

Sl. No. 1. Time delay cameras be placed close Grid all along the shore. On Shore Installation with a spacing of 100m, spread on 500m each side of the alignment. 10 cameras on each shore looking towards the mudflats in TCFS. The camera shall be calibrated for online monitoring and provision of data to the scientific community and monitoring the data and movement of various avian fauna data can be useful in mapping shift in habited, resting and roosting grounds. Mud flats are dominated by the flamingos hence this data will be extremely useful in monitoring the new development in the nesting, resting, roosting grounds of the flamingos, it can also be catalogued as well as evaluated by various different agencies using this online data stream. The alignment of the Tunnel and location of the proposed Cameras for Phase – I monitoring is shown in Map 1.



Source: google Maps

Map 1: Location Plan for the installation of camera on the alignment

Exhibit: 1 various types of wildlife shooting cameras with night vision

Table 9: Budget for Instrumentation proposed in the Environment Monitoring Plan for Thane Creek Flamingo Sanctuary, Phase – I

Sl No	Description	Range	Number	Budgeted Cost (Rs Lac.)
1.	Camera time delay capability and night vision.	20 Mega Pixel.	3	3
	Data Logger for (SA) & cloud support.		3	3
	Housing and Power Supply		1	4
	Total (instrumentation) –Phase - I			**10**
	Maintenance Budget	**No Of years**	**Per year Cost (Rs Lac)**	**TOTAL (Rs Lac)**
	2019 to 2023 during construction @ 25% per year for 5 years	5 years	2.5 each year	12.5
	Manpower for Data collection and upkeep of the systems @ One Scientist 30 lac per year & One Technicians 20 lac per year	5 years	50 each year	250

7.2 Phase II Comprehensive Environment Monitoring Plan for Thane Creek Flamingo Sanctuary, Mumbai with reference to Mumbai-Ahmedabad High Speed Railway Project

Due to the lack of scientific records and great uncertainties of the environmental impacts by the construction as well as the operation of the MAHSR, two phase monitoring approaches are recommended. As described above, Phase I monitoring will be recommended as the conventional monitoring as same as the baseline survey. Once any behaviour changes are recognized by the Phase I monitoring programme, Phase II monitoring programme shall be immediately formulated and implemented with the approvals of concerned authorities. Proposed comprehensive monitoring programmes are given as follow.

The Mumbai-Ahmedabad High Speed Railway Project is reported to be begin from 2019 to 2023 and there onwards up to 2028 during the 5 year maintenance period till 2028 has been formulated in two different phase.

- Phase-1 would be during the construction Start from 2019 to 2023.
- Phase-2 would be during the operations of high speed train for next 5 years i.e. from 2023 to 2028.

It is important to understand that during the construction a lot of pollution will be generated as a result of the movement and operations of the construction machinery and various site activities. It is paramount to evaluate the damage. This is done by making catalogue, listing and recording such activity which are considered hazardous to environment. This analysis may require technology which may not be available today however if the time series data is generated it will definitely assist in future to assess more vibrantly the potential impact from similar construction under the sea bed with this view we propose immediate deployment of Hydrophones arrays, Sonar sensors typically for recording movements of the marine species sonar to be deployed undersea above the alignment of the proposed tunnel.

Vibration Sensors to capture vibrational energy being transferred as a regular activity during the Tunnelling operations and during the regular operation of the HSR inside the tunnel, it is known scientific fact that Energy dissipation inside the water due to vibration can have potential of impact on the marine environment, hence it is advised that this should be recorded and kept for future analysis. So that the pre-construction baseline be captured before the start of undersea Tunnel Boring Machine activity.

Time delay cameras with night vision to relate the events of passing of HSR in the tunnel with the disturbance of the avian species.

Table: 10. Instrumentation proposed for the Environment Monitoring Plan for Thane Creek Flamingo Sanctuary, Phase – II

Sl. No	Description	Range	Location of Placement	Nos.
1.	Hydrophone array (HPA)	100m	On the seabed with the firm anchoring for recording the constant stream of data. With on-board data logging for facility of 7 days. On Board battery of 24 hrs.	23
	Data Logger for HAP & cloud support.		Data logging will be done on the shore in weather proof housing in controlled environment. Data transfer to the cloud shall be through the wireless connection.	
	Housing and Power Supply		Will be done on the shore in weather proof housing in controlled environment. Power Supply shall be through the reinforced and shielded cables buried in HDPE pipes of 150mm diameter below the sea floor at minimum 600mm depth anchored by 1.5m anchor bars at every 10m. Secondary Supply by Standby Invertors shall be secured for the facility.	
Sl. No	**Description**	**Range**	**Location of Placement**	**Nos.**
2.	Sonar array (SA) with L1.	100m	This will be secured 1m below the water-level in waterproof enclosure. It will be anchored on the floor with spring coil arrangement and floating buoy. Fish Finders 90, Garmin or similar equipment's. It will be placed between the LTL to LTL which is 1300m	11
	Data Logger for (SA) & cloud support.		Data logging will be done on the shore in weather proof housing in controlled environment. Data transfer to the cloud shall be through the wireless connection.	
	Housing and Power Supply		Will be done on the shore in weather proof housing in controlled environment. Power Supply to the sensors undersea shall be through the reinforced and shielded cables buried in HDPE pipes of 150mm diameter below the sea floor at minimum 600mm depth anchored by 1.5m anchor bars at every 10m. Secondary Supply by Standby Invertors shall be secured for the facility.	

Sl. No	Description	Range	Location of Placement	Nos.
3.	Vibration Sensors Array (VSA)	50	On the seabed with the firm anchoring for recording the constant stream of data. With On-board data logging for facility of 7 days. On Board battery of 24 hrs.	45
	Data Logger for HAP & cloud support.		Data logging will be done on the shore in weather proof housing in controlled environment. Data transfer to the cloud shall be through the wireless connection.	
	Housing and Power Supply.		Will be done on the shore in weather proof housing in controlled environment. Power Supply to the sensors undersea shall be through the reinforced and shielded cables buried in HDPE pipes of 150mm diameter below the sea floor at minimum 600mm depth anchored by 1.5m anchor bars at every 10m. Secondary Supply by Standby Invertors shall be secured for the facility.	

The details of instruments recommended for undertaking Phase - II study at Thane Creek are as below:

Sl. No. 1. Hydrophone array: If required multiple sensors maybe deployed to ensure each band and spectrum is catalogue and recorded for future analysis and interpretation. To be placed on the bed in such a manner to capture the railway born sound in the construction phase to capture the TBM related sound and during the operations phase rail born sounds from the HSR. Hydrophone sensors should be so placed as to have a reasonable overlap on the data collection influence zone. These shall be placed between HTL – HTL for a distance of 2200m spaced at the rate of 100m a total of 23 sensors shall be deployed as detailed in Map 2.

Source : Google Earth

Map 2: Location Plan for the Hydrophone array on the alignment between HTL – HTL for 2200m

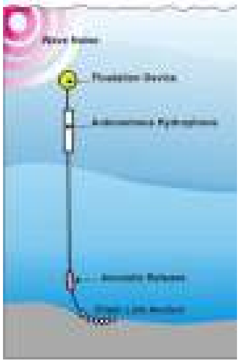
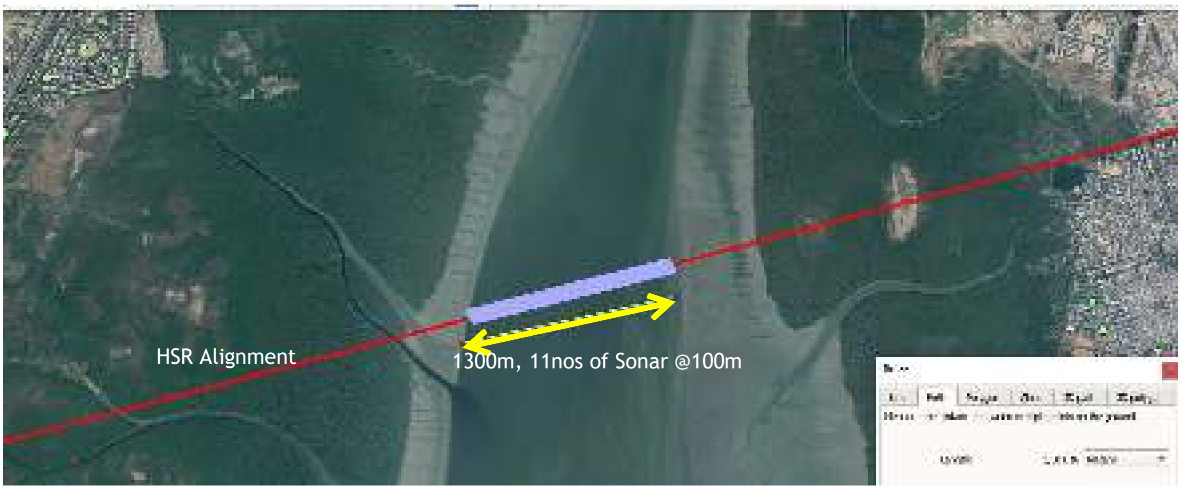


Exhibit 2: Various types of Hydrophone for HPA

Sl. No. 3. Sonar Array: Multiple sensors be deployed to ensure each band and spectrum is catalogue and recorded for future analysis and interpretation. Presently spacing can be assumed at hundred meters along the top of Tunnel securely with anchors and buoy. A constant data feed for data loggers can be developed. Map 3 shows the location plan for the sonar array a total of 11 sonars will be deployed leaving the end nodes as the water depth will be less near shoreline.



Map 3: Location Plan for the Sonar array on the alignment between LTL – LTL for 1300m

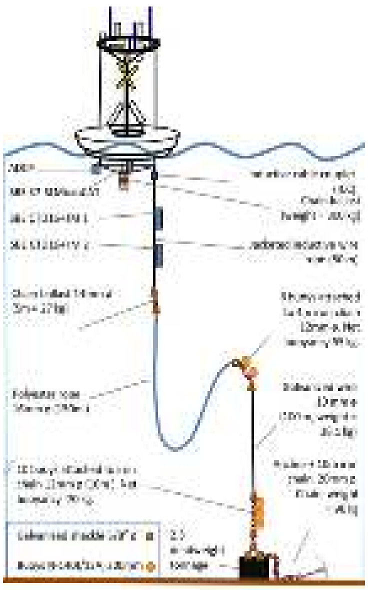
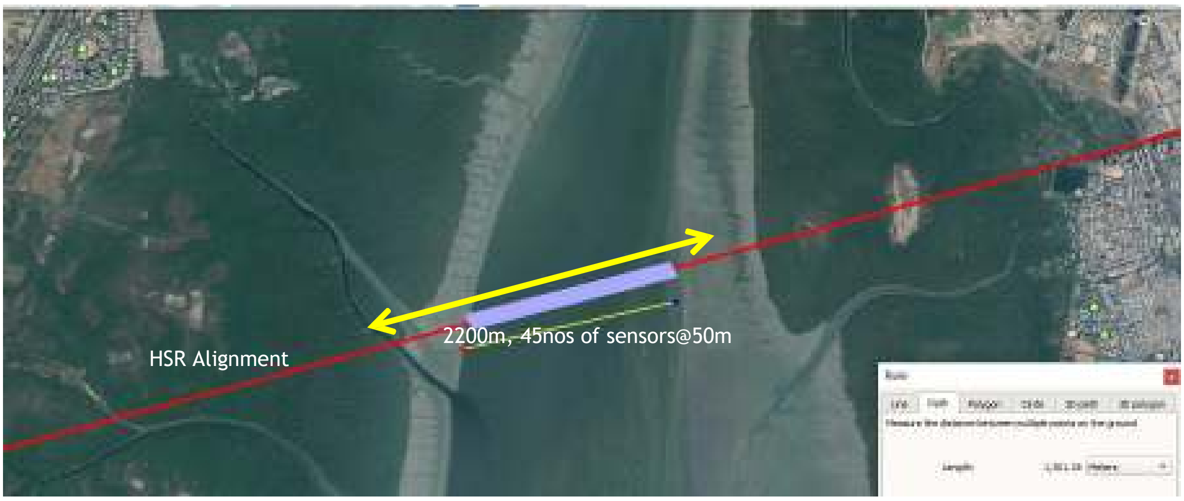


Exhibit 3: Various types of Sonar for SA

Sl. No. 3. Vibration sensors to be placed on the bed in such a manner to capture the railway born vibration from the HSR operations under the tunnel, to capture these vibration sensors should be so placed as to have a reasonable overlap for the data collection influence zone. They shall be placed from the start of the Mud Flats. A total of 45 nos of vibration sensor array with a spacing of 50m are proposed for placement on 2200m length on the alignment susceptible to vibrational impact due to movements in tunnel. For Best recording the sensors must be imbedded in the ground and anchored to insure the transfer of vibration. Map 4 shows the location of sensors. Budget for instrumentation of Phase – II is given in Table : 11.



Source : Google Earth

Map 4: Location Plan for the Vibration Sensor array on the alignment

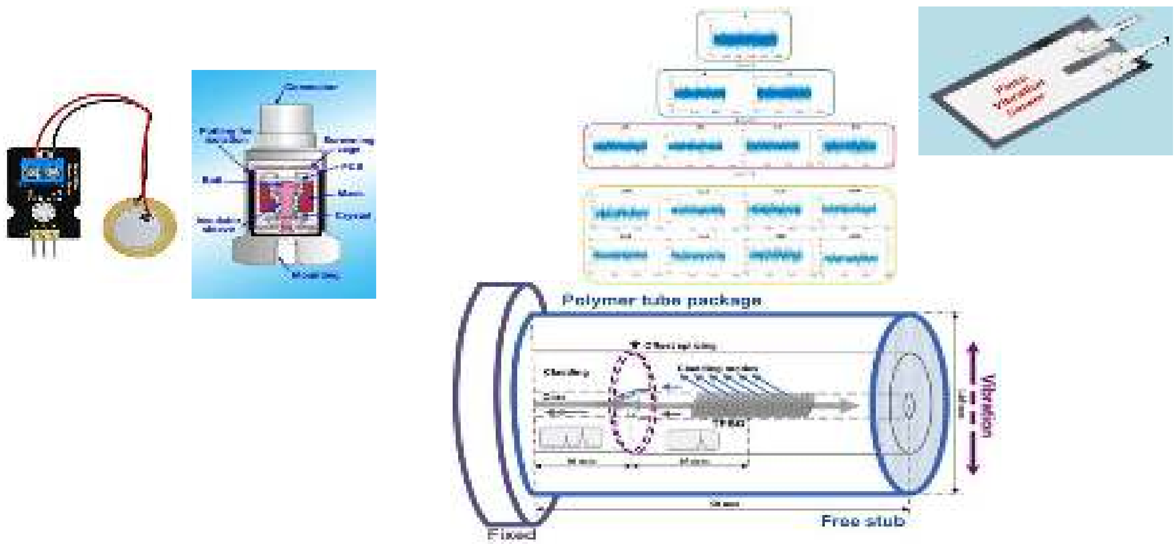


Exhibit 4: Various types of Vibration sensors for VSA

Table: 11. Budget for Instrumentation proposed in the Environment Monitoring Plan for Thane Creek Flamingo Sanctuary, Phase – II

Sl No	Description	Range	Number	Budgeted Cost (Rs Lac.)
1.	Hydrophone array (HPA)	100m	23	23
	Data Logger for HAP & cloud support.		23	10
	Housing and Power Supply		1	15
	Sub Total		**A**	**45**
2.	Sonar array (SA) with L1.	100m	11	11
	Data Logger for (SA) & cloud support.		11	4
	Housing and Power Supply		1	15
	Sub Total		**B**	**30**
3.	Vibration Sensors Array (VSA)	50	45	25
	Data Logger for HAP & cloud support.		45	20
	Housing and Power Supply.		1	15
	Sub Total		**C**	**60**
	Total (instrumentation) – Phase II		**A+B+C**	**135**
Sl No	**Description**	**No Of years**	**Per year Cost (Rs Lac)**	**Budgeted Cost (Rs Lac.)**
5.	Maintenance Budget 2023 to 2028 during Operations	**5 years**	**54 each year**	**270**
6.	Manpower for Data collection and upkeep of the systems @ Two Scientist 80 lac per year & 2 Technicians 50 lac per year,	**5 years**	**130 each year**	**650**
	TOTAL (O&M) - Phase II			**920**

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Annexure - 1

Bird Survey Datasheet

<u>Sampling Equipment/Material: ·</u>

- Topographic map of survey area
- Clipboard, pencil and eraser
- Small notebook for making notes of special events seen ·
- Bird field data sheets (one set for each survey site)
- Plastic sheets or large clear plastic bag to protect data sheets when raining
- Bird field guide
- Binoculars: 8 10X magnification and 40 50 millimetres field of view; 8x40; 10x42; 10x50
- Flagging tape or strips of coloured material
- Recorder to record unknown bird calls (optional)

Survey area ____________________ Date: ____________

Team Number ____________ **Team Leader** ____________________ Site number: ____________

Site location and description *(brief description using landmarks, photograph number, etc. so site can be located again)*

____

____

Map Name ____________________ **AMG Zone** _____ _____

Map scale ____________________
(topographic map gives AMG zone, easting and northing)

Easting __ __ __ __ __ __
(6 digits: should be recorded mid-point along transect)

Altitude ____________
(from topographic map, written in metres)

Northing __ __ __ __ __ __ __
(7 digits: should be recorded mid-point along transect)

Start time (24 hour)	**Finishtime** (24 hour)
Temperature at start (write in Celsius)	**Temperature at finish** (write in Celsius)

Wind (tick)
- ◯ 1. Calm
- ◯ 2. light, leaves rustle
- ◯ 3. Moderate, branches move
- ◯ 4. Strong, tops of trees move

Moon (tick)
- ◯ 1. No moon
- ◯ 2. less than or equal to 1-4 moon
- ◯ 3. less than or equal to 1/2 moon
- ◯ 4. less than or equal to 3/4 moon
- ◯ 5. between 3/4 and full moon
- ◯ 6. full moon

Rain (tick)
- ◯ 1. dry
- ◯ 2. light drizzle
- ◯ 3. constant drizzle
- ◯ 4. heavy rain
- ◯ 5. mist, fog or heavy haze

Cloud cover (in percentage of sky) ________

Opportunistic animal sightings field data sheet

Survey area ____________________

Team Number ____________ Team Leader ____________________

Species name	Species code	Date	Number observed	Observation type	Habitat type	Breeding code	Locality description	Zone	Easting	Northing

Bird field data sheet

Survey area ____________________

Team Number____________________ Team Leader ____________________

Sample area identification number	Start time (24 hrs)	Finish time (24 hrs)	Bird species code	Bird name	Observation type	Number of individuals		
						0 - 15 metres	15 - 30 metres	30 - 50 metres

Annexure 2

Population enumeration of Flamingoes in and around Thane creek of Mumbai from June 2017 to February 2018

Months	No. of Flocks	No. of Flocks/ Month	LF (Adult)	LF (Juv.)	GF (Adult)	GF (Juv.)	Total	Population/ Month
H5 Grid								
August 2017	0	0	**0**	**0**	**0**	**0**	**0**	**0**
September	0	0	**0**	**0**	**0**	**0**	**0**	**0**
October	2	2	**32**	**2**	**10**	**5**	**49**	**49**
November	2	2	**8**	**2**	**0**	**0**	**10**	**10**
December	1	3	80	22	13	5	**120**	**151.5**
	2		89	32	41	21	**183**	
		Sum >	**169**	**54**	**54**	**26**		
		Average >	**84.5**	**27**	**27**	**13**		
January 2018	3	6	210	124	82	34	**450**	**340**
	3		72	47	69	42	**230**	
		Sum >	**282**	**171**	**151**	**76**		
		Average >	**141**	**85.5**	**75.5**	**38**		
February	7	37	213	124	127	42	**506**	**1155**
	12		756	324	411	331	**1822**	
	4		526	124	345	130	**1125**	
	3		1257	164	379	120	**1920**	
	5		126	78	514	214	**932**	
	6		479	68	59	19	**625**	
		Sum >	**3357**	**882**	**1835**	**856**		
		Average >	**559.5**	**147**	**305.83**	**142.66**		
G5 Grid								
August	0	0	**0**	**0**	**0**	**0**	**0**	**0**
September	0	0	**0**	**0**	**0**	**0**	**0**	**0**
October	3	3	**4**	**0**	**9**	**0**	**13**	**13**
November	2	2	**54**	**21**	**3**	**0**	**78**	**78**
December	2	3	156	41	16	7	**220**	**132.5**
	1		21	4	12	8	**45**	
		Sum >	**177**	**45**	**28**	**15**		
		Average >	**88.5**	**22.5**	**14**	**7.5**		
January	2	9	324	156	70	54	**604**	**2728**
	7		1235	324	421	144	**2124**	
		Sum >	**1559**	**480**	**491**	**198**		
		Average >	**779.5**	**240**	**245.5**	**99**		
February	3	25	523	214	273	193	**1203**	**1165.16**
	8		621	259	302	221	**1403**	
	3		548	204	412	188	**1352**	

Months	No. of Flocks	No. of Flocks/ Month	LF (Adult)	LF (Juv.)	GF (Adult)	GF (Juv.)	Total	Population/ Month
	6		516	128	349	161	**1154**	
	3		265	103	641	136	**1145**	
	2		463	41	193	37	**734**	
		Sum >	**2936**	**949**	**2170**	**936**		
		Average >	**489.33**	**158.1**	**361.66**	**156**		
F5 Grid								
August	2	0	**380**	**0**	**60**	**0**	**440**	**440**
September	1	0	**0**	**0**	**5**	**0**	**5**	**5**
October	1	3	**21**	**16**	**20**	**5**	**62**	**62**
November	4	2	**32**	**5**	**8**	**4**	**49**	**49**
December	2	3	124	37	14	5	**180**	**135**
	1		46	12	23	9	**90**	
		Sum >	**170**	**49**	**37**	**14**		
		Average >	**85**	**24.5**	**18.5**	**7**		
January	2	4	1201	573	675	124	**2573**	**3726**
	2		546	127	334	146	**1153**	
		Sum >	**1747**	**700**	**1009**	**270**		
		Average >	**873.5**	**350**	**504.5**	**135**		
February	4	33	1468	492	424	129	**2513**	**1547.16**
	12		1489	376	527	275	**2667**	
	7		1076	345	217	66	**1704**	
	2		462	218	237	59	**976**	
	4		438	86	317	109	**950**	
	4		102	16	267	88	**473**	
		Sum >	**5035**	**1533**	**1989**	**726**		
		Average >	**839. 16**	**255.5**	**331.5**	**121**		
E5 Grid								
August	1	0	**6**	**0**	**0**	**0**	**6**	**6**
September	1	0	**0**	**0**	**11**	**0**	**11**	**11**
October	1	3	**7**	**0**	**9**	**0**	**16**	**16**
November	4	2	**110**	**23**	**125**	**23**	**281**	**281**
December	1	3	75	16	29	11	**131**	**120.5**
	2		52	23	26	9	**110**	
		Sum >	**127**	**39**	**55**	**20**		
		Average >	**63.5**	**19.5**	**27.5**	**10**		
January	5	4	142	26	265	75	**508**	**2035**
	2		723	154	426	224	**1527**	
		Sum >	**865**	**180**	**691**	**299**		
		Average >	**432.5**	**90**	**345.5**	**149.5**		
February	1	15	374	201	157	80	**812**	**942.16**
	3		326	157	102	15	**600**	

Months	No. of Flocks	No. of Flocks/ Month	LF (Adult)	LF (Juv.)	GF (Adult)	GF (Juv.)	Total	Population/ Month
	5		516	246	111	90	**963**	
	1		256	98	304	232	**890**	
	3		507	216	419	142	**1284**	
	2		649	107	272	76	**1104**	
		Sum >	**2628**	**1025**	**1365**	**635**		
		Average >	**438**	**170.8**	**227.5**	**105.83**		

Annexure-3

MAMMALIA: No. Orders :2, Family: 5, Genus: 5, Species:5

Sl.No.	Order	Family	Common name	Genus	Species
1	Carnivora	Canidae	Golden Jackal	*Canis*	*aureus*
2	Carnivora	Felidae	Jungle Cat	*Felis*	*chaus*
3	Herpestidae	Herpestidae	Indian Grey Mongoose	*Herpestes*	*edswardi*
4	Rodentia	Sciuridae	Indian Palm Squirrel	*Funambulus*	*palmarum*
5	Muridae	Muridae	Common Rat/Black Rat	*Rattus*	*rattus*

Annexure-4

REPTILES – LIZARDS & SNAKES: No. of Family:7, Genus:8, Species:8

Sl.No.	Family	Common name	Genus	Species
1	Agamidae	Oriental Garden Lizard	*Calotes*	*versicolor*
2	Scincidae	Common Garden Skink	*Lampropholis*	*guichenoti*
3	Varanidae	Asiatic Water Monitor Lizard	*Varanus*	*Salvator*
4	Colubridae	Indian Rat Snake	*Ptyas*	*Mucosa*
5	Colubridae	Checkered Keelback Snake	*Xenochropis*	*piscator*
6	Elapidae	Indian Spectacled Cobra	*Naja*	*naja*
7	Viperidae	Russell's Viper	*Daboia*	*russelli*
8	Homalopsidae	Dog Faced Water Snake	*Cerberus*	*rynchops*

Annexure-5

AMPHIBIA – FROGS, TOADS: No. of Family:1, Genus:1, Species: 1

Sl. No.	Order	Family	Common name	Genus	Species
1	Anura	Bufonidae	Common Indian Toad	*Duttaphrynus*	*Melanostictus*

Annexure-6

LEPIDOPTERA - BUTTERFLIES: No. of Family : 5, Genus : 19, Species : 29

Sl. No.	Order	Family	Common name	Genus	Species
1	Lepidoptera	Nymphalidae	Common Indian Crow	*Euploea*	*core*
2			Peacock Pansy	*Junoina*	*almanac*
3			Grey Pansy	*Junoina*	*atlites*
4			Chocolate pansy	*Junoina*	*iphita*
5			Plain Tiger	*Danaus*	*chrysippus*
6			Striped Tiger	*Danaus*	*genutia*
7			Glassy Tiger	*Parentica*	*aglea*
8			Common Bush Brown	*Mycalesis*	*perseus*
9			Common Castor	*Ariadne*	*merione*
10			Angled Castor	*Ariadne*	*ariadne*
11			Great Eggfly	*Hypolimnus*	*bolina*
12			Common Baron	*Euthalia*	*aconthea*
13			Common Leopard	*Phalanta*	*phalanta*
14			Common Sailer	*Neptis*	*hylas*
15		Pieridae	Common Grass Yellow	*Eurema*	*hecabe*
16			One-Spotted Grass Yellow	*Eurema*	*andersoni*
17			Three-Spotted Grass Yellow	*Eurema*	*blanda*
18			Common Gull	*Cepora*	*nerissa*
19			Common Wanderer	*Pareronia*	*valeria*
20			Common Wanderer	*Pareronia*	*valeria*
21			Salmon Arab	*Colotis*	*amata*
22			Common Jezebel	*Delius*	*eucharis*
23		Papilionidae	Common mormon	*Papilio*	*polytes*
24			Common Lime	*Papilio*	*demoleus*
25			Common Jay	*Graphium*	*doson*
26			Tailed Jay	*Graphium*	*agamemnon*
27		Hesperinidae	Oriental Straight Swift	*Pernera*	*guttata*
28			Indian Palm Bob	*Suastus*	*greminus*
29		Lycaenidae	Common pierrot	*Castalius*	*rosimon*

Annexure 7

COLEOPTERA – BEETLES &BUGS : No. of Family:4, Genus:6, Species:8

Sl.No.	Class	Family	Common name	Genus	Species
1	Insecta	Chrysomelidae	Pumpkin Beetles	*Aulacophora*	*fovoecollis*
2	Insecta	Chrysomelidae	Pumpkin Beetles	*Aulacophora*	*fovoecollis*
3	Insecta	Scarabaeidae	Mottled Flower Beetle	*Protaetia*	*aurichalcea*
4	Insecta	Chrysomelidae	Pumpkin Beetles	*Aulacophora*	*sp.*
5	Insecta	Chrysomelidae	Tortoise Beetle	*Cassida*	*sp.*
6	Insecta	Chrysomelidae	Golden Tortoise Beetle	*Aspidomorpha*	*sp.*
7	Insecta	Cerambycidae	Long Horn beetles	*Homocerus*	*sp.*
8	Insecta	Pentatomidae	Two-spotted Sesame Bug	*Eysarcoris*	*Sp.*

Annexure 8

ORTHOPTERA – GRASSHOPPERS: No. of Family:1, Genus:3, Species:3

Sl.No.	Family	Common name	Genus	Species
1	Acrididae	Grasshopper	*Aiolopus*	*thalassinus*
2	Acrididae	Citrus Locust	Chondracris	*rosea*
3	Acrididae	Rice Grasshopper	*Hieroglyphus*	*banian*

Annexure-9

MISC. INSECTS (FLIES, BEES, MOSQUITOES):

Sl. No.	Class	Family	Common Name	Genus	Species
1	Insecta	Muscidae	House fly	*Musca*	*domestica*
2	Insecta	Asilidae	Robber fly	*Efferia*	*sp.*
3	Insecta	Vespidae	Paper wasp	*Polistes*	*carolina*
4	Insecta	Vespidae	Hornet	*Vespa*	*sp.*
5	Insecta	Culicidae	Mosquitoes	*Culex*	*armigeres*

Annexure-10

ARACHNIDA : No. of Family:7, Genus:10, Species:15.

Sl. No.	Family	Common name	Genus	Species
1	Sparrasidae	Huntsman Spider	*Illyoplax*	*gangetica*
2	Pholcidae	Daddy's Long leg Spider	*Perisesarma*	*guttatum*
3	Araneidae	St. Andrew's Cross Orb Weaver Spider	*Argiope*	*aemula*
4	Oxyopidae	Lynx spider	*Oxyopes*	*shweta*
5			*Oxyopes*	*sp.*
6			*Oxyopes*	*sp.*
7			*Oxyopes*	*sp.*

Sl. No.	Family	Common name	Genus	Species
8			*Oxyopes*	*sp.*
9			*Oxyopes*	*sp.*
10	Salticidae	Two striped Spider	*Telamonia*	*dimidiata*
11			*Carrhotus*	*sp.*
12	Tetragnathidae	Worthy Orb-weaver	*Leucauge*	*decorata*
13			*Tetragntha*	*sp.*
14	Sparassidae		*Oilos*	*sp.*
15	?		*Cytophora*	*cicatorsa*

Annexure-11

FISH AND SHELLFISH: No. of Family:29, Genus:34, Species:39

Sl. No.	Family	Common name	Genus	Species
1	Gobiidae	Buddart's Google eyed Goby	*Boleopthalmus*	*boddaerti*
2		Mudskipper	*Boleopthalmus*	*dussumieri*
3		Burrowing Goby	*Trypauchen*	*vagina*
4	Terapontidae	Banded Grunter or Squeaking Perch	*Therapon*	*theraps*
5	Scathophagidae	Spotted Scat	*Scatophagus*	*argus*
6	Plotosidae	Striped Eel Cat Fish	*Plotosus*	*Arabica*
7	Bagruidae	Long-whiskered Cat Fish	*Mystus*	*gulio*
8	Triacanthidae	Short-nosed Tripod Fish	*Triacnthus*	*brevirostris*
9	Batrachoididae	Frog Fish	*Batrachus*	*grunniens*
10	Tetraodontidae	Lattice Blassop	*Tetradon*	*oblongus*
11	Stormateidae	Chinese Silver Pomfret (Chandi)	*Pampus*	*sinensis*
12		Silver Pomfret (Chandi)	*Pampus*	*argenteus*
13	Sciaenidae	Dhoma, Sin Croaker	*Sciaena*	*dussumieri*
14	Latidae	Coraker/ Drum ?	*Lates*	*calcarcifer*
15	Sciaenidae	Bronze Coraker	*Otholithoides*	*brunneus*
16	Mugilidae	Mullet	*Mugil*	*cephalus*
17		Mullet	*Mugil*	*macrolepis*
17	Muraenesocidae	Indian Conger	*Congresox*	*talabonoides*
19	Clupeidae	Chacunda gizzard shad	*Anodontostoma*	*chacunda*
20		Toli shad	*Tenualosa*	*toil*
21	Megalopidae	Indo pacific Tarpon	*Megalops*	*cyprinoides*
22	Belonidae	Spot tail needlefish	*Strongylura*	*strongylura*
23	Cichlidae	Pearl spot	*Etroplus*	*suratensis*
24	Gobiidae	Mud skipper	*Boleophthalmus*	*dussumieri*
25		Tank goby	*Glossogobius*	*giuris*
26	Latidae	Asian seabass	*Lates*	*calcarifer*
27	Scatophagidae	Spotted Scat	*Scatophagus*	*argus*
28	Serranidae	Orange spotted grouper	*Epinephelus*	*coioides*
29	Sillaginidae	Silver sillago	*Sillago*	*sihama*

30	Terapontidae	Target Fish	*Therapon*	*jarbua*
31	Bagridae	Long Whiskers Catfish	*Mystus*	*gulio*
32	Tetraodontidae	Smooth blaasop Puffer	*Lagocephalus*	*inermis*
33	Penaeidae	Jinga shrimp	*Metapenaeus*	*affinis*
34	Penaeidae	Indian white Shrimp	*Penaeus*	*indicus*
35		Tiger shrimp	*Penaeus*	*monodon*
36		Paste shrimp	*Acetes*	*indicus*
37	Portunidae	Flower crab	*Portunus*	(*Portunus) pelagicus*
38		Giant mud crab	*Scylla*	*serrata*
39		Purple mud crab	*Scylla*	*tranquebarica*

Annexure-12

A SYSTEMATIC LIST OF BIRDS WITH THEIR HABITAT TYPE, STATUS, ABUNDANCE AND FOOD/FORAGING IN THANE CREEK DURING THE STUDY PERIOD

Sl. No	Order	Family	Common name	*Genus*	Species	Habitat	Food/ Foraging	IUCN Status	R. Status	Abundance
1	Anseriformes	Anatidae	Indian spot-billed duck	*Anas*	*poecilorhyncha*	Waterbody, Wetland	Piscivore	LC	R	Common
2			Garganey	*Anas*	*quorquedela*	Waterbody, Wetland	Piscivore	LC	WM	Common
3			Gadwall	*Anas*	*strepera*	Waterbody, Wetland	Piscivore	LC	WM	Common
4			Northern pintail	*Anas*	*acuta*	Waterbody, Wetland	Piscivore	LC	WM	Common
5			Common teal	*Anas*	*creca*	Waterbody, Wetland	Piscivore	LC	WM	Common
6			Northern shoveler	*Spatula*	*clypeata*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	LC	WM	Common
7	Podicipediformes	Podicipitidae	Little grebe	*Tachybaptus*	*ruficolis*	Open Waterbody, Marsh	Piscivore	LC	R	Common
8	Ciconiformes	Ciconidae	Asian open-billed stork	*Anastomus*	*oscitans*	Crop, Human habitation, Marsh	Piscivore	LC	RM	Common
9			Painted stork	*Mycteria*	*leucocephala*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	NT	RM	Common
10	Phoenicopteriformes	Phoenicopteridae	Lesser flamingo	*Phoenicopterus*	*minor*	Saltpans, Mangroves, Creek	Piscivore	NT	WM	Common
11			Greater flamingo	*Phoenicopterus*	*roseus*	Saltpans, Mangroves, Creek	Piscivore	LC	WM	Common
12	Pelecaniformes	Threskiornidae	Black-headed ibis	*Threskiornis*	*melanocephalus*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	NT	WM	Common
13			Glossy ibis	*Plegadis*	*falcinellus*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	LC	WM	Uncommon
14			Eurasian spoonbill	*Platalea*	*leucorodia*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	LC	WM	Common
15		Ardeidae	Large egret	*Ardea*	*alba*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	LC	R	Common
16			Intermediate egret	*Mesophyoz*	*intermedia*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	NK	R	Common
17			Little egret	*Egretta*	*garzetta*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	LC	R	Common

Sl. No	Order	Family	Common name	*Genus*	Species	Habitat	Food/ Foraging	IUCN Status	R. Status	Abundance
18			Indian pond heron	*Ardeola*	*grayii*	Crops, OSW, Creek, Marsh, Mangroves, Wetland	Piscivore	LC	R	Common
19			Cattle egret	*Bubulcus*	*ibis*	Crops, OSW, Creek, Marsh, Mangroves, Wetland	Piscivore	LC	R	Common
20			Black crowned night heron	*Nycticorax*	*nycticorax*	Waterbody, Mangroves, Marsh, Wetland	Piscivore	LC	R	Uncommon
21			Wastern reef egret	*Egretta*	*gularis*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	LC	WM	Common
22			Grey heron	*Ardeola*	*cinerea*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	LC	RM	Common
23			Purple heron	*Ardeola*	*purpurea*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	LC	R	Common
24			Cinnamon bittern	*Ixobrychus*	*cinnamomeus*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	LC	SM	Rare
25		Phalacrocoracidae	Little cormorant	*Phalacrocor ax*	*niger*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	LC	RM	Common
26			Greater cormorant	*Phalacrocor ax*	*carbo*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	LC	RM	Common
27	Acciptriformes	Accipitridae	Black kite	*Milvus*	*migrans*	Waterbody,Grassland, Scrubland, Human Habitation	Omnivore	LC	R	Common
28			Black-eared kite	*Milvus*	*(migrans) lineatus*	Waterbody,Grassland, Scrubland, Human Habitation	Carnivore	LC	R	Common
29			Brahminy kite	*Halistur*	*indus*	Waterbody, Mangroves, Marsh, Wetland	Omnivore	LC	R	Common
30			Eurasian marsh herrier	*Circus*	*aeruginosus*	Waterbody, Mangroves, Creek, Marsh	Carnivore	LC	R	Uncommon
31			Shikra	*Accipiter*	*badius*	Forest, Waterbody,Wetland, Scrubland, Creek	Carnivore	LC	R	Common
32			Booted eagle	*Hieraaetus*	*pennatus*	Waterbody,Wetland, Creek, Human Habitation	Carnivore	LC	R	Common
33			Osprey	*Pandion*	*haliaetus*	Waterbody, Mangroves, Creek, Marsh, Wetland	Piscivore	LC	RM	Common
34	Gruiiformes	Rallidae	White-breasted waterhen	*Amaurornis*	*phoenicurus*	Waterbody, Mangroves, Creek, Marsh	Omnivore	LC	R	Common
35			Eurasian coot	*Fulica*	*atra*	Waterbody, Marsh, Wetland	Omnivore	LC	WM	Common
36			Common moorhen	*Gallinula*	*chloropus*	Open Waterbody, Mangroves	Omnivore	LC	RM	Common
37	Charadriformes	Charadridae	Red-wattled lapwing	*Vanelus*	*indicus*	OSW, Mangroves, Creek, Marsh, Wetland, Grassland	Insectivore	LC	R	Common

Sl. No	Order	Family	Common name	*Genus*	Species	Habitat	Food/ Foraging	IUCN Status	R. Status	Abundance
38			Kentish plover	*Charadrius*	*alexandrius*	OSW, Mangroves, Creek, Marsh, Wetland	Insectivore	LC	RM	Common
39			Little ringed plover	*Characrius*	*dubius*	OSW, Mangroves, Creek, Marsh, Wetland	Insectivore	LC	R	Uncommon
40			Lesser sand plover	*Charadrius*	*mongulus*	OSW, Mangroves, Creek, Marsh, Wetland	Insectivore	LC	R	Common
41			Greater sand plover	*Charadrius*	*leschenaultii*	OSW, Mangroves, Creek, Marsh, Wetland	Insectivore	LC	R	Common
42		Scolopacidae	Common sandpiper	*Actitis*	*hypoleucos*	OSW, Mangroves, Creek, Marsh, Wetland	Insectivore	LC	R	Common
43			Wood sandpiper	*Tringa*	*glareola*	OSW, Mangroves, Creek, Marsh, Wetland	Insectivore	LC	R	Common
44			Marsh sandpiper	*Tringa*	*stagnatitis*	OSW, Mangroves, Creek, Marsh, Wetland	Insectivore	LC	R	Common
45			Common greenshank	*Tringa*	*nebularia*	OSW, Mangroves, Creek, Marsh, Wetland	Insectivore	LC	R	Common
46			Common redshank	*Tringa*	*totanus*	OSW, Mangroves, Creek, Marsh, Wetland	Insectivore	LC	R	Common
47			Spotted redshank	*Tringa*	*erythropus*	OSW, Mangroves, Creek, Marsh, Wetland	Insectivore	LC	R	Uncommon
48			Eurasian curlew	*Numenius*	*arquata*	OSW, Mangroves, Creek, Marsh, Wetland	Piscivore	NT	WM	Common
49			Whimbrel	*Numenius*	*phaeopus*	Mangroves, Creek, Marsh, Wetland	Piscivore	LC	WM	Common
50			Little stint	*Collidris*	*minuta*	Mangroves, Creek, Marsh, Wetland	Insectivore	LC	R	Common
51			Black-tailed godwit	*Limosa*	*limosa*	Mangroves, Creek, Marsh, Wetland	Piscivore	NT	WM	Common
52		Rostratulidae	Common Snipe	*Gallinago*	*gallinago*	Waterbody, Mangroves, Creek, Marsh	Insectivore	LC	WM	Uncommon
53		Recurvirostridae	Pied avocet	*Recurvirostr a*	*avocetta*	Mangroves, Creek, Marsh	Piscivore	LC	RM	Common
54			Black-winged stilt	*Himantopus*	*himantopus*	Open Shallow Waterbody, Mangroves, Creek, Marsh	Piscivore	LC	R	Common
55		Laridae	Brown-headed gull	*Chroicoceph alus*	*brunicephalus*	Waterbody, Mangroves, Creek, Marsh	Piscivore	LC	R	Common
56			Black-headed gull	*Chroicoceph alus*	*rudibundus*	Waterbody, Mangroves, Creek, Marsh	Piscivore	LC	R	Common
57			River tern	*Sterna*	*aurantia*	Waterbody, Mangroves, Creek, Marsh	Piscivore	NT	WM	Uncommon

Sl. No	Order	Family	Common name	*Genus*	Species	Habitat	Food/ Foraging	IUCN Status	R. Status	Abundance
58			Whiskered tern	*Chlidonias*	*hybrida*	Waterbody, Mangroves, Creek, Marsh	Piscivore	LC	R	Common
59			Slender-billed gull	*Chroicocephalus*	*genei*	Waterbody, Mangroves, Creek, Marsh	Piscivore	LC	R	Common
60			Palls's gull	*Ichthyaetus*	*ichthyaetus*	Waterbody, Mangroves, Creek, Marsh	Piscivore	LC	R	Common
61			Common tern	*Sterna*	*hirundo*	Waterbody, Mangroves, Creek, Marsh	Piscivore	LC	R	Common
62	Columbiformes		Little tern	*Sternula*	*albifrons*	Waterbody, Mangroves, Creek, Marsh	Piscivore	LC	R	Common
63		Columbidae	Eurasian collared dove	*Streptopelia*	*orientalis*	Forest, Grassland, Scrubland, Human Habitation	F,G	LC	R	Common
64			Blue rock pigeon	*Columba*	*livia*	Forest, Grassland, Scrubland, Human Habitation	F,G	NK	R	Common
65			Spotted dove	*Stigmatopelia*	*chinensis*	Forest, Grassland, Scrubland, Human Habitation	F,G	NK	R	Common
66	Psittaciformes		Laughing dove	*Streptopelia*	*senegalensis*	Forest, Grassland, Scrubland	F,G	LC	R	Common
67		Psittacidae	Rose-ringed parakeet	*Psitaculla*	*eupatria*	Forest, Scrubland, Human habitation	Frugivore	LC	R	Common
68	Cuculiformes		Alexandrine parakeet	*Psitaculla*	*krameri*	Forest, Scrubland, Human habitation	Frugivore	LC	R	Common
69		Cuculidae	Common hawk-cuckoo	*Hierococcyx*	*varius*	Forest, Scrubland, Human habitation	Insectivore	LC	WM	Common
70			Asian koel	*Eudunamys*	*scolopaccus*	Forest, Scrubland, Human habitation	F,I	LC	R	Common
71	Stirgiformes		Southern Coucal	*Centropus*	*(sinensis) parroti*	Forest, Waterbody, Marsh, Mangroves	Omnivore	LC	R	Common
72		Stirgidae	Barn owl	*Tyto*	*alba*	Forest, Scrubland, Human habitation	Carnivore	LC	R	Uncommon
73	Apodiformes		Spotted owlet	*Athene*	*brama*	Forest, Scrubland, Human habitation	Carnivore	LC	R	Common
74		Hemiprocnidae/Apopidae	Asian palm swift	*Cypsiurus*	*balasiensis*	Forest, Grassland	Granivore	LC	R	Common
75	Upupiformes		House swift	*Apus*	*nipalensis*	Forest, Grassland	Granivore	LC	R	Uncommon
76	Coraciiformes	Upupidae	Common hoopoe	*Upupa*	*upops*	Forest, Grassland, Scrubland	Insectivore	LC	WM	Uncommon
77		Coracidae	Indian roller	*Coracias*	*bengalensis*	Forest, Grassland, Scrubland, Human Habitation	Carnivore	LC	R	Common
78		Meropidae	Blue-tailed bee-eater	*Merops*	*Philipinus*	Forest, Grassland, Scrubland	Insectivore	LC	RM	Common

Sl. No	Order	Family	Common name	*Genus*	Species	Habitat	Food/ Foraging	IUCN Status	R. Status	Abundance
79			Green bee-eater	*Merops*	*orientalis*	Forest, Grassland, Scrubland	Insectivore	LC	RM	Common
80		Alcedinidae	White-breasted kingfisher	*Halcyon*	*smyrensis*	Waterbody, Marsh, Mangroves	Piscivore	NK	R	Common
81	Piciformes		Pied kingfisher	*Caryle*	*rudis*	Waterbody, Marsh, Mangroves	Piscivore	LC	R	Common
82	Bucerotiformes	Picidae	Eurasian wryneck	*Jynx*	*torquilla*	Forest, Scrubland, Mangroves	Frugivore	LC	WM	Uncommon
83	Passeriformes	Bucerotidae	Indian grey hornbill	*Ocyceros*	*birostris*	Forest	Frugivore	LC	R	Uncommon
84		Aegithinidae	Common iora	*Aegithina*	*tiphia*	Forest, Scrubland	F,I	LC	R	Uncommon
85		Laniidae	Long-tailed shrike	*Lanius*	*schach*	Forest, Grassland, Scrubland, Mangroves	Insectivore	LC	R	Common
86			Brown shrike	*Lanius*	*striatus ?*	Forest, Grassland, Scrubland	Insectivore	LC	R	Common
87		Dicruridae	Black drongo	*Dicrurus*	*macrocerus*	Forest, Grassland, Scrubland, Human Habitation	Insectivore	LC	R	Common
88		Oriolidae	Indian golden oriole	*Oriolus*	*(oriolus) kundoo*	Forest, Scrubland	Omnivore	LC	R	Common
89			Black-hooded oriole	*Oriolus*	*xanthornus*	Forest, Scrubland	Omnivore	LC	R	Uncommon
90		Phiphiduridae	White-browed fantail	*Rhidipura*	*aureola*	Forest, Mangroves, Marsh	Frugivore	LC	R	Common
91			White-throated fantail	*Rhipidura*	*albicollis*	Forest, Mangroves, Marsh	Frugivore	LC	R	Common
92		Corvidae	Common house crow	*Corvus*	*splendens*	Forest, Mangroves, Human Habitation	Omnivore	LC	R	Common
93			Jungle crow	*Corvus*	*(macrochyncha) culminatus*	-DO-	Omnivore	LC	R	Common
94		Hirundinidae	Barn swallow	*Hirundo*	*rustica*	Grassland, Scrubland, Marsh, Wetland	Insectivore	LC	RM	Common
95			Wire-tailed swallow	*Hirundo*	*smithii*	-DO-	Insectivore	LC	LM	Common
96		Pycnonotidae	Red-vented bulbul	*Pycnonotus*	*cafer*	Forest, Scrubland, Mangroves	Frugivore	LC	R	Common
97			Red-whiskered bulbul	*Pycnonotus*	*jocosus*	Forest, Scrubland, Mangroves	Frugivore	LC	R	Common
98			White-eared bulbul	*Pycnonotus*	*leucotis*	Forest, Scrubland, Mangroves, Marsh	Frugivore	LC	R	Common

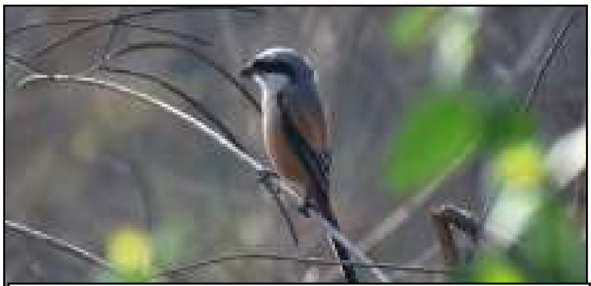
Sl. No	Order	Family	Common name	*Genus*	Species	Habitat	Food/ Foraging	IUCN Status	R. Status	Abundance
99		Cysticolidae	Ashy prinia	*Prinia*	*socialis*	Grassland, Scrubland, Marsh	Granivore	LC	R	Common
10			Plain prinia	*Prinia*	*inornata*	-DO-	Granivore	LC	R	Common
10			Common tailor bird	*Orthoto*	*musstorius*	-DO-	Insectivore	LC	R	Common
10		Sylviidae	Clamorous reed warbler	*Acrocephalu s*	*stentoreus*	-DO-	Insectivore	LC	WM	Uncommon
10			Blyth's reed warbler	*Acrocephalu s*	*dumetorum*	-DO-	Insectivore	LC	WM	Rare
10			Common chiffchaff	*Phylloscopus*	*collybita*	-DO-	Insectivore	LC	WM	Uncommon
10			Yellow-eyed warbler	*Setophaga*	*petechia*	-DO-	Insectivore	LC	WM	Common
10		Sturnidae	Rosy starling	*Pastor*	*roseus*	Forest	F,I	LC	WM	Uncommon
10			Asian pied starling	*Gracupica*	*contra*	Forest, Grassland	Omnivore	LC	R	Common
10			Common myna	*Acredotheres*	*tristis*	Forest, Grassland, Human Habitation, Marsh	Omnivore	LC	R	Common
10			Brahminy starling	*Sturnia*	*pagodorum*	Forest, Grassland	F,I	LC	SM	Rare
11		Muscicapidae	Oriental magpie robin	*Copyschus*	*sauloris*	Forest, Grassland, Human Habitation	Insectivore	LC	R	Common
11			Indian robin	*Saxicoloides*	*fulicatus*	Forest, Grassland, Scrubland	Insectivore	LC	R	Common
11			Desert wheatear	*Oenanthe*	*deserti*	Forest, Marsh	Insectivore	LC	WM	Uncommon , Rare
11			Common stonechat	*Saxicolator*	*quatus*	Forest, Grassland, Marsh	Insectivore	NK	WM	Uncommon , rare
11			Siberian stonechat	*Saxicola*	*maurus*	Forest, Grassland, Marsh	Insectivore	LC	WM	Uncommon
11		Nectarinidae	Purple sunbird	*Cinnyris*	*asiaticus*	Forest, Mangroves, Human Habitation	F,G,I	LC	R	Common
11			Purple-rumped sunbird	*Leptocoma*	*zeylottica*	-DO-	F,G,I	LC	R	Common
11		Passeridae	House sparrow	*Passer*	*domesticus*	Human Habitation	F,G	LC	R	Common
11		Placeidae	Baya weaver	*Ploceus*	*phillipinus*	Forest, Near Water Body, Grassland	F,G	LC	R	Common

Sl. No	Order	Family	Common name	*Genus*	Species	Habitat	Food/ Foraging	IUCN Status	R. Status	Abundance
11		Estrildidae	Sclay-breasted munia	*Lonchura*	*ponctulata*	Forest, Grassland	F,I	LC	R	Common
120		Motacilidae	Yellow wagtail	*Motacilla*	*flava*	Waterbody, Marsh, Mangroves, Wetland	Insectivore	LC	WM	Common
121			White wagtail	*Motacilla*	*alba*	-DO-	Insectivore	LC	WM	Common
122			Citrine wagtail	*Motacilla*	*citreola*	-DO-	Insectivore	LC	WM	Uncommon
123			White-browed wagtail	*Motacilla*	*maderaspatensis*	-DO-	Insectivore	LC	WM	Uncommon
124		Monarchidae	Asian paradise flycatcher	*Terpsiphone*	*paradisi*	Forest	Insectivore	LC	R	Uncommon, Rare
125		Leiothrichidae	Jungle Babbler	*Turboides*	*striata*	Forest, Scrubland, Human habitation	F, I	LC	R	Common

Field Photos of landscape, animals, birds, insecs etc. at Thane Creek

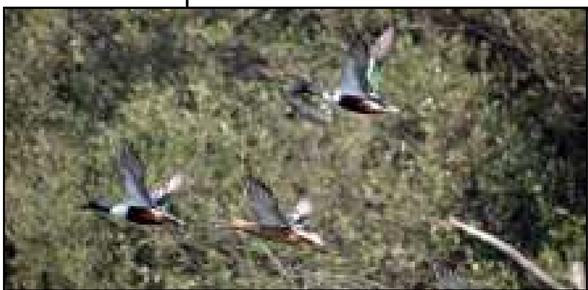
Field Photos of landscape, animals, birds, insecs etc. at Thane Creek

Black-headed ibis *Threskiornis melanocaphalus*

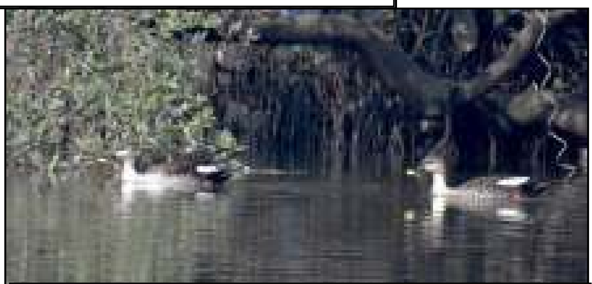


Long-tailed shrike *lanius schach*

Black-tailed godwit *Limosa limosa*



Northern shoveler *Spatula clypeata*



Indian Spot-billed duck *Anas poicilorhyncha*

Pallas's gull *Ichthyaetus ichthyaetus*

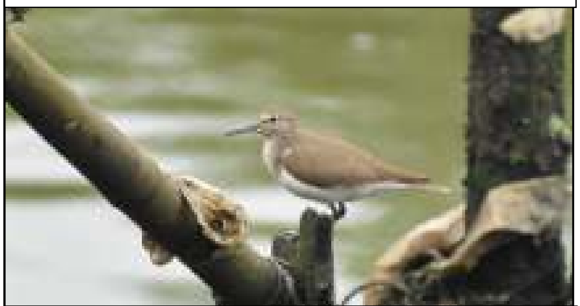
Greater cormorant *Phalacrocorax carbo*

Garganey *Anas quorquedela*

Common house crow *Corvus splendens*

Common kingfisher *Alcedo atthis*

Western marsh herrier *Circus aeruginosus*

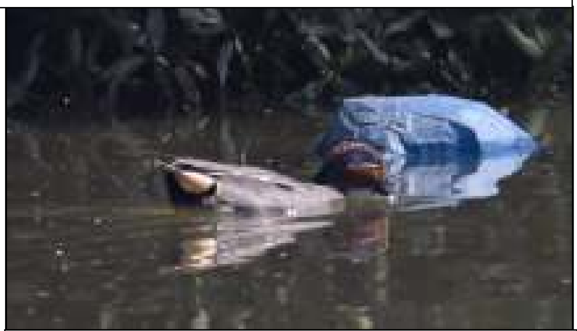


Common sandpiper *Actitis hypoleucos*

Common tailor bird *Orthoto mustorius*

White-eared bulbul *Pycnonotus leucotis*

White wagtail *Motacila alba*



Common teal *Anas creca*

Shikra *Accipiter badius*

Grey heron *Ardeola cineria*

House sparrow male *Passer domwsticus*

Greater sandplover *Charadrius leschenaultii*

Little ringed plover *Charadrius dubius*

Red-wattled lapwing *Vanellus indicus*

Red-whiskered bulbul *Pycnonotus jocosus*

River tern *Sterna aurantia*

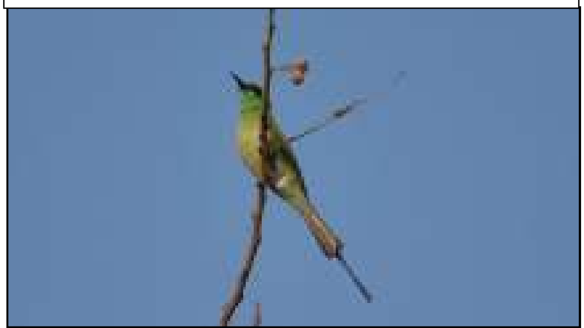
Intermediate egret *Mesophyox intermedia*

Purple-rumped sunbird male *Leptocoma ceylottica*

Scaly-breasted munia *Lonchura ponctulata*

Common myna *Acredotheres tristis*

Purple sunbird *Cinyrris asiaticua*



Green bee-eater *Merops orientalis*

Rose-ringed parakket *Psitaculla eupatria*

Striated heron *Butorides striata*

Southern coucal *Centropus (sinensis) parotti*

Little egret *Egretta garzetta*

Purple heron *Ardeola purpurea*

Little cormorant *Phalacrocorax niger*

Siberian stonechat *Saxicola maurus*

Common crow *Corvus splendes* with a kill

Brown-headed gull *Chroicocephalus brunicephalus*

Grey heron *Ardeola cineria* & Little egret *Egretta garzetta*

Black-tailed godwit *Limosa limosa* in flight

Booted eagle *Hieraaetus pennatus*

Intermediate egret *Mesophyox intrmedia* in breeding plumage

Osprey *Pandiaoon haliaetus*

Greater sand plover *Charadrius leschenaultia* in amazing circular congregation on top of a concrete pillar

Flocks of Northern shoveler *Spatula clypeata* flight across the creek

Brown-headed gull *Chroicocephalus brunicephalus*

Whiskered tern *Chlidonias hybrida*

Slender billed gull *Chroicocephalus genei*

Painted strok *Mycteria leucocephala* among juveniles of Greater flamingo *Phoenicopterus roseus*

River tern *Sterna aurantia*

Whimbrel *Numenius phaeopus*

Great egret *Ardea alba*

Pond heron *Ardeola grayii*

Little cormorant *Phalacrocorax niger*

Pied avocet *Recurvirostra avocetta*

Lesser flamigoes *Phoenicopterus minor* on mudflats for food

Lesser flamigoes *Phoenicopterus minor* on mudflats for food

Huge Flamingo (mixed) flock

Lesser flamingo *Phoenicopterus minor*

Greater flamingo *Phoenicopterus roseus*

Juveniles of Greater flamingo *Phoenicopterus roseus*

Flamingoes flying pattern

A huge Flamingo flock flying high up

Flamingoes against cityscape

Black headed gulls *Chroicocephalus rudibundus*

Greater flamingo *Phoenicopterus roseus*

Juveniles of Greater flamingo *Phoenicopterus roseus*

Huge Flamingo (mixed) flock

Flamingoes flying acroos mangrooves

Flamingo flight

Lesser flamingo *Phoenicopterus minor*

BUTTERFLIES

Orange tip *Anthocharis cardamines*

Common psyche *Leptosia nina*

Common sailor *Neptis hylas*

Common wanderer *Pareronia valeria*

Grey pansy *Junonia atlites*

Common pierrot *Castalius rosimon*

Common jezebel *Delias eucharis*

Angled caster *Ariadne ariadne*

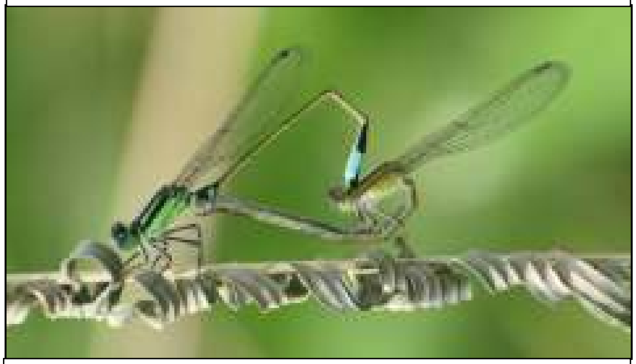
Peacock pansy *Junonia almana*

Great eggfly *Hypolimnas missipus*

ODONATA

Green marsh hawk *Orthretum sabina*

Brachythemis contaminata (Fabricius, 1793)



Senegal golden dartlet *Ischnura senegalensis*

Crocothemis servilia (Drury, 1770) (M)

Green marsh hawk *Orthretum Sabina* showing cannibalism (Eating a Common Picture-wing Female *Rhyothemis variegata)*

OTHER FAUNAL DIVERSITY OF THANE CREEK FLAMINGO SANCTUARY

Robber fly *Promachus maculatus* preying upon a *Camponotus sp.* ant

Mud dauber wasp *Sceliphron sp.*

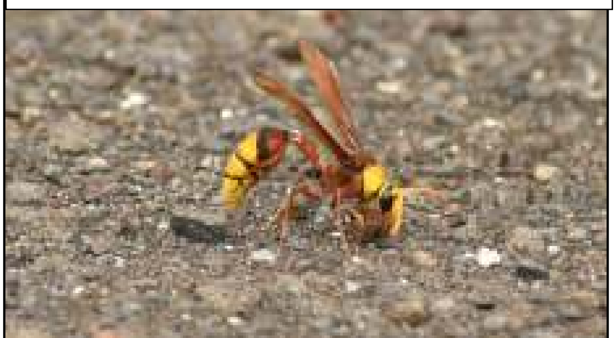
Red cotton bug *Dysdercus singulatus* mating

Red cotton bug *Dysdercus singulatus*

Sarcophaga albiceps

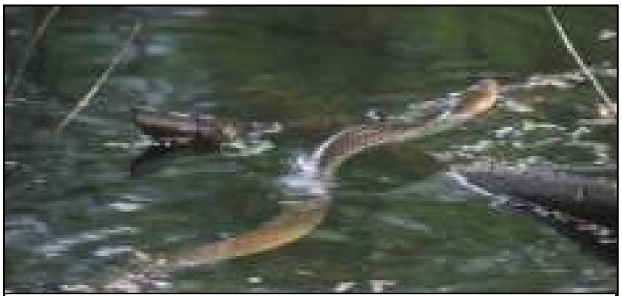
Mimegralla coeruleifrons

Carpenter bee *Xylocopa sp.*



Potter wasp *Delta pyriform*

REPTILES



Chekered keelback snake *Xenochropis piscator*

Common Indian skink *Lampropholis guichenoti*

SPIDERS

Leucauge dcorata

Oilos sp.

Oxyopes shweta

St. Andrew's Cross Orb Weaver Spider *Argiope aemula*

Oxyopes sp. Preying upon a huge *Camponotus sp.* ant

POLLUTION IN THANE CREEK

Annexure 4.16

4.16 PROTECTED AREAS

The entire stretch of the proposed MAHSR alignment can be divided into two segments in accordance with the ecological characteristics of the region.The first stretch falling in the state of Maharashtra region shows rich diversity comprising of Sanjay Gandhi National Park (SGNP), Dahanu Taluka-Ecologically Sensitive Area (DTESA), Tungareshwar Wildlife Sanctuary (TWLS), Thane Creek Flamingo Sanctuary, forests, creek, mangroves whereas, the stretch falling in Gujarat region comprises of mainly agricultural land with flat topography.

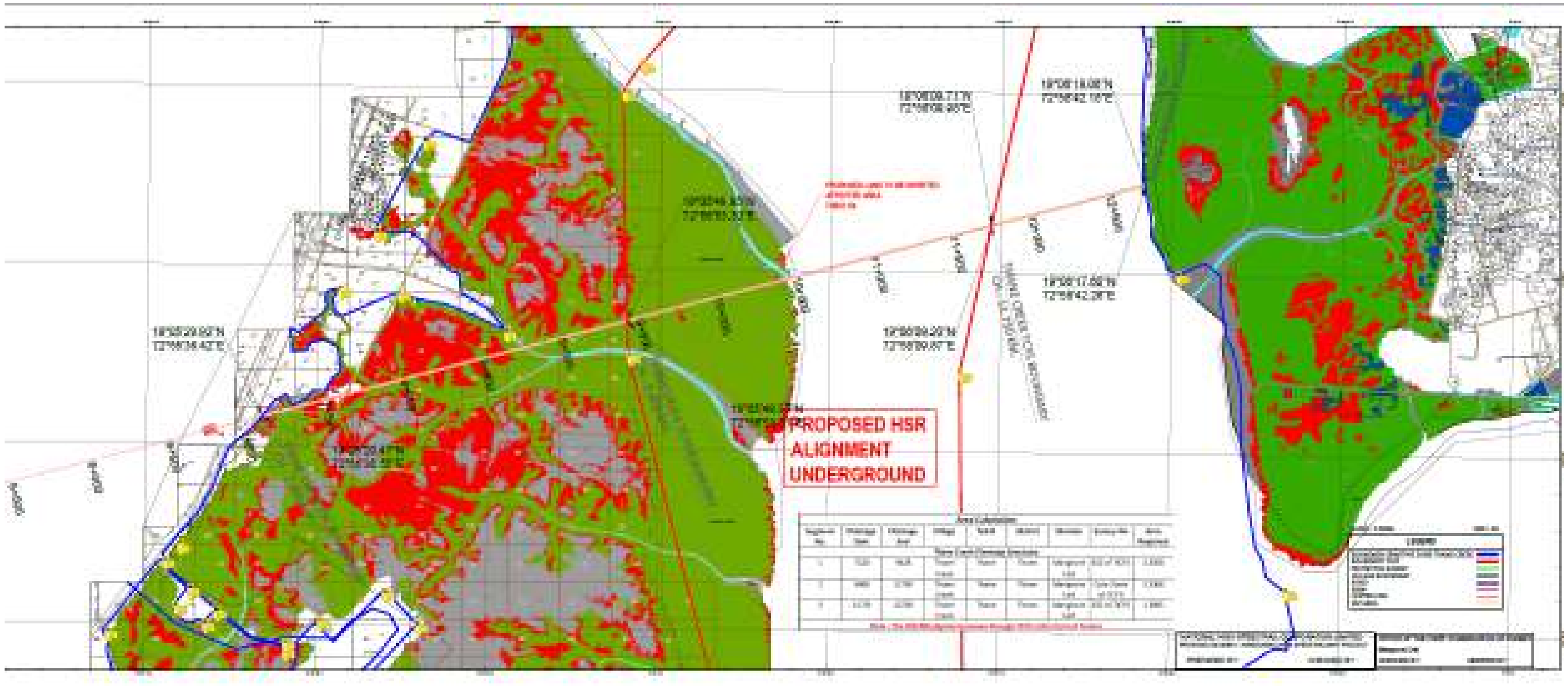
Most of the land in the study area (Zone of Influence) is used for agriculture and horticultural practices. The proposed MAHSR alignment in Maharashtra State passes through (i) SGNP, Borivalli, Mumbai, (ii) TWLS, Thane, and (iii) Thane Creek Flamingo Sanctuary. The map showing the proposed MAHSR alignment and the notified eco-sensitive area are shown in Exhibit 4.16.1 and the list along with chainage is presented in Table 4.16.1.

Table 4.16.1: Ecologically Sensitive Area falling under MAHSR Alignment

S.No	ESA	Chainage	Northing	Easting	Area (sq.m.)
Maharashtra					
Tungareshwar Wildlife Sanctuary					
1	10km zone	End from Ch.-74.891km	270796.8	2160055.9	549049
2	Proposed ESZ	Zone end from Ch.-56.580km	276094.3	2142734.2	15093
3	Proposed ESZ	Zone start from Ch.-56.099km	276450.8	2142384.1	
4	Proposed ESZ	Zone end from Ch.-53.614	278714.5	2141236.7	50981
5	Proposed ESZ	Zone start from Ch.-51.764km	280290.0	2140601.2	
6	Proposed ESZ	Zone end from Ch.-49.106km	282489.9	2139076.6	324008
7	Proposed ESZ	Zone start from Ch.-38.553km	290786.4	2132524.6	
8	Proposed ESZ	Start Ch.-31.781km.	293990.2	2126884.6	196399
Total Area of TWLS falling in 10km zone					**745448**
Total Area of TWLS falling in Proposed ESZ Area					**390082**
Thane Creek Flamingo Sanctuary					
1	ESZ Boundary	Ch.- 7.043 km.	281829	2112239.3	72000
2	TCFS Boundary	Ch.- 9.413 km.	284152.5	2112843.5	66003
3	TCFS Boundary	Ch.- 11.606 km.	286282.1	2113397.1	
4	ESZ Boundary	Ch.- 12.783 km.	287394.7	2113686.6	34491
Total Area falling under ESZ Boundary					**106491**
Total Area falling under TCFS					**66003**
Sanjay Gandhi National Park					
1	ESZ Area	zone start from ch.-51.764 km (location 1)	280380.5	2140562.0	**108066**
2	ESZ Area	zone start from ch.-49.106km	283105.6	2138289.9	

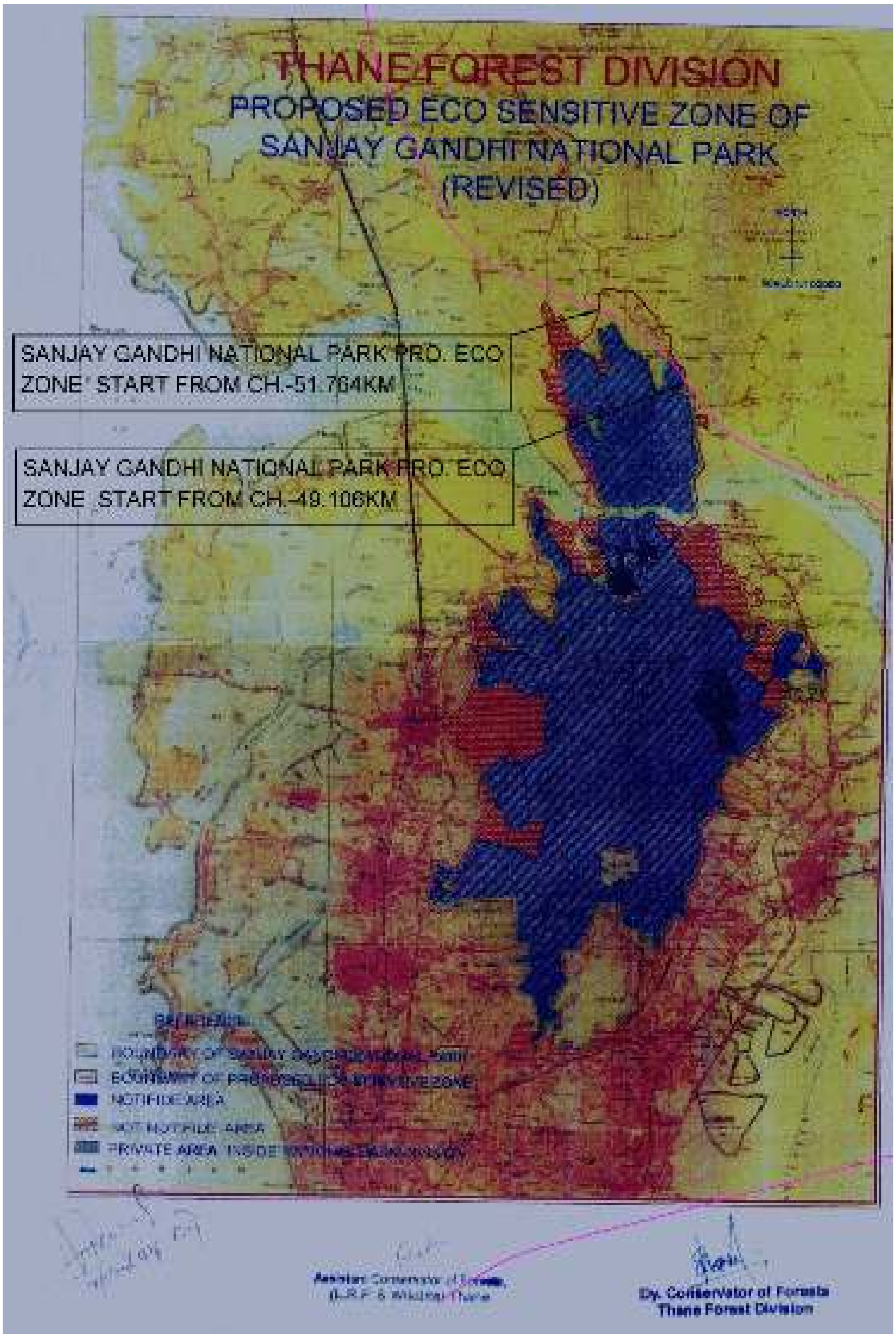
Source: Study Team

Exhibit 4.16.1(A): Thane Creek Flamingo Sanctuary and MAHSR Alignment



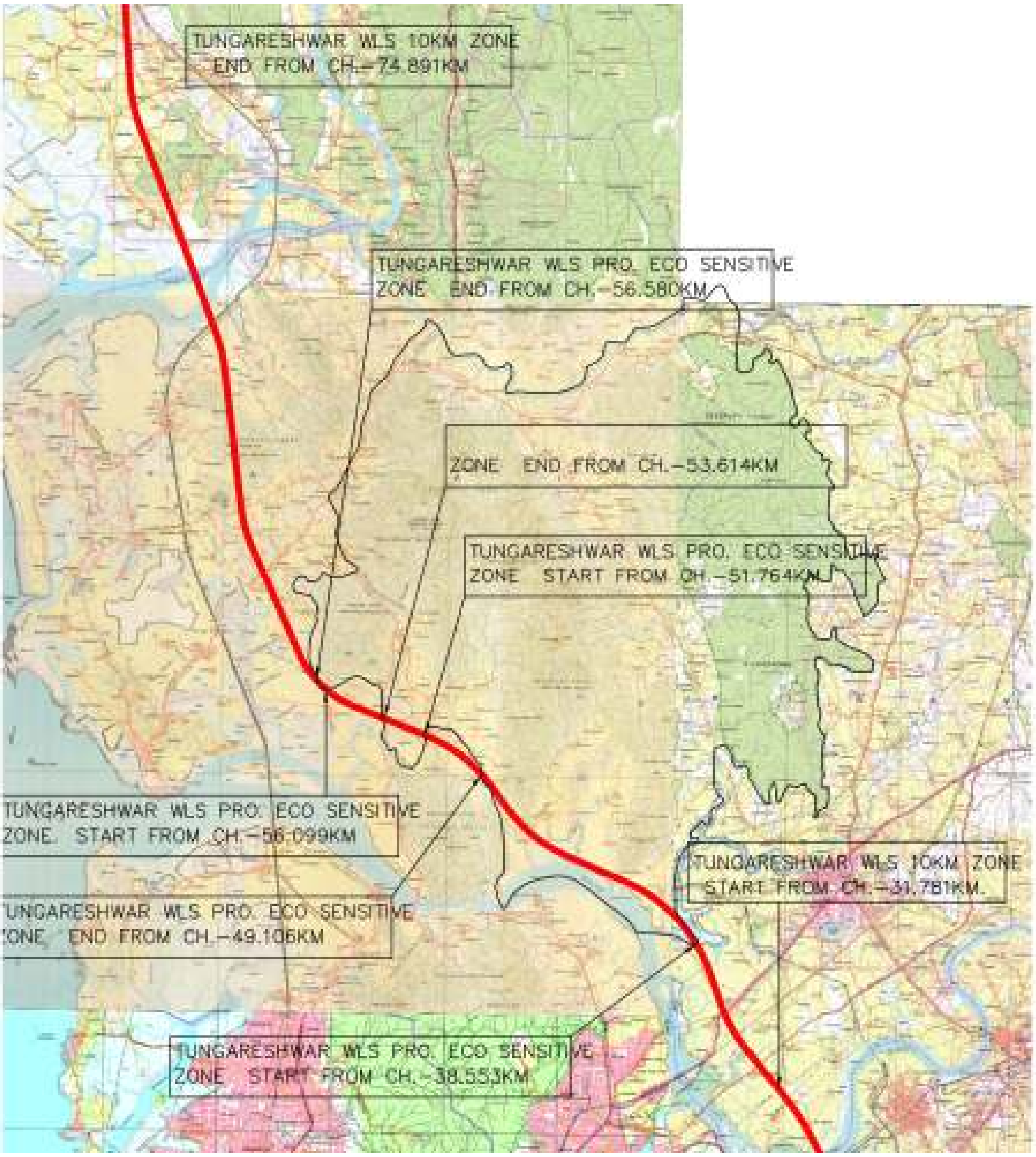
Source: CCF, Thane, Mangrove Cell

Exhibit 4.16.1(B): Sanjay Gandhi National Park and MAHSR Alignment



Source: CCF, SGNP

Exhibit 4.16.1(C): Tungareshwar Wildlife Sanctuary and MAHSR Alignment



Source: CCF, SGNP

Other ESAs area notified in both the provinces-Maharashtra and Gujarat is presented in Table 4.16.2.

Table 4.16.2: List of Protected Area in Maharashtra and Gujarat

S. No	Status	Name	ConcernedDistrict
MAHARASHTRA			
1.	**National Park**	Chandoli NP	Sangli
2.		Gugamal NP	Amravati
3.		Nawegaon NP	Bhandara, Gondia
4.		Pench NP	Nagpur
5.		Sanjay Gandhi National Park	Borivali, Thane, Mumbai
6.		Tadoba NP	Chandrapur
1	**Wildlife Sanctuary**	Amba Barwa WLS	Buldhana
2		Andhari WLS	Chandrapur
3		Aner Dam WLS	Dhule
4		Bhamragarh WLS	Gadchiroli
5		Bhimashankar WLS	Pune,Thane,Raigad
6		Bor WLS	Wardha,Nagpur
7		Chaprala WLS	Gadchiroli
8		Deolgaon Rehkuri WLS	Ahmednagar
9		Dhyanganga WLS	Buldhana
10		Gautala WLS	Aurangabad,Jalgaon
11		Great Indian Bustard WLS	Solapur, Ahmednagar
12		Jaikwadi WLS	Ahmednagar, Aurangabad
13		Kalsubai Harishchandragad WLS	Ahmednagar
14		Karnala WLS	Raigad
15		KaranjasoholWLS	Akola
16		KatepurnaWLS	Akola,Washim
17		KoyanaWLS	Satara
18		LonarWLS	Buldhana
19		MalvanMarineWLS	Sindhudurg
20		MayureswarSupeWLS	Pune
21		MelghatWLS	Amravati
22		NagziraWLS	Bhandara
23		NaigaonMayurWLS	Beed
24		NandurMadhameshwarWLS	Nashik
25		NarnalaWLS	Akola
26		PaingangaWLS	Yeotmal,Nanded
27		PhansadWLS	Raigad
28		RadhanagariWLS	Kolhapur
29		SagareshwarWLS	Sangli
30		TansaWLS	Thane
31		TipeshwarWLS	Yeotmal
32		TungareshwarWLS	Thane
33		YawalWLS	Jalgaon
34		YedsiRamlinGhatWLS	Osmanabad
35		WanWLS	Amravati
36	**Conservation Reserve**	Bhorkada	Nashik

S. No	Status	Name	ConcernedDistrict
37	**ESA**	Dahanu Taluka ESA	Palghar
		GUJARAT	
1	**NationalPark**	Vansda NP	Navasari、Valsad
2		Blackbuck NP	Bhavnagar
3		Gir NP	Junagadh
4		Marine(Gulf of Kachchh) NP	Jamnagar
1	**Wildlife Sanctuary**	Balaram Ambaji WLS	Banaskantha
2		Barda WLS	Rajkot, Jamnagar, Porbandar
3		Gaga Great Indian Bustard WLS	Jamnagar
4		Gir WLS	Junagadh、Amreli
5		Girnar WLS	Junagadh
6		Hingolgadh Nature Reserve WLS	Rajkot
7		Jambugodha WLS	Panchmahal
8		JessoreWLS	Banaskantha
9		Lala Great Indian Bustard WLS	Kachchh
10		KachchhDesertWLS	Kachchh
11		KhijadiyaWLS	Jamnagar
12		Marine(Gulf of Kachchh) WLS	Jamnagar
13		MitiyalaWLS	Amreli
14		NalSarovarBirdWLS	Ahmedabad,Surendranagar
15		Narayan Sarovar (Chinkara) WLS	Kachchh
16		Paniya WLS	Amreli
17		Porbandar Lake WLS	Porbandar
18		Purna WLS	Dangs
19		Rampara Vidi WLS	Rajkot
20		Ratanmahal WLS	Dahod
21		Shoolpaneswar (Dhumkhal) WLS	Narmada、Bharuch
22		Thol Lake WLS	Mahesana
23		Wild Ass WLS	Kachc,Rajkot,Mahesana, Patan, Banaskantha, Surendranagar
24	**Conservation Reserve**	Chharidhand	Kachchh

Source: Protected Area Network India, Maharashtra Environment Department home page, Maharashtra Forest Department homepage, Gujarat Forests & Environment Department homepage, Gujarat Forest Department homepage

Annexure 4.17

4.17 SENSITIVE LOCATIONS

Apart from the protected area, the proposed MAHSR alignment also intersects number of sensitive locations like temples, mosque, Eidgah, churches, educational institutions, hospitals *etc*. During the construction phase every care shall be taken to avoid any damage to these structures. The pier locations shall be judicially shifted to the extent possible to avoid the dismantling. A comprehensive list of the sensitive structures has prepared and presented in Table 4.17.1.

Table 4.17.1: Sensitive Locations along MAHSR Alignment

S.No.	Chainage	Geo-Coordinate		Name	Distance from C/L (m)	Category	Side
		Latitude	Longitude				
1	0+520	19° 4'7.63"N	72°52'12.98"E	Banudwara Kurla School	194	E	R.H.S
2	0+950	19° 4'25.31"N	72°52'17.29"E	Mohammedi Masjid	200	R	L.HS
3	0+950	19° 4'26.66"N	72°52'16.46"E	Mohammedi Sunni Jamma Masjid	240	R	L.HS
4	1+100	19° 4'21.84"N	72°52'24.51"E	Madarsa Masjid	20	R	R.H.S
5	1+100	19° 4'17.73"N	72°52'30.00"E	Madina Masjid	210	R	R.H.S
6	1+500	19° 4'34.15"N	72°52'31.61"E	Gurdwara	185	R	L.HS
7	1+750	19° 4'37.37"N	72°52'39.78"E	Masjid Ansari Kata	140	R	L.HS
8	1+750	19° 4'33.97"N	72°52'44.62"E	Guru Darashan Hospital	25	H	R.H.S
9	1+750	19° 4'32.01"N	72°52'45.36"E	Anjuman Khairul Islam School	88	E	R.H.S
10	1+825	19° 4'34.36"N	72°52'47.54"E	Mehboob E Subhani Masjid	60	R	R.H.S
11	2+000	19° 4'42.21"N	72°52'48.26"E	Hospital	135	H	L.HS
12	2+000	19° 4'42.21"N	72°52'48.26"E	Habib Hospital	135	H	L.HS
13	2+100	19° 4'39.36"N	72°52'54.85"E	Kurla Shia Isna Ashari Jama Masjid	50	R	R.H.S
14	2+900	19° 4'53.39"N	72°53'18.76"E	Don Bosco Institue of Management and Research	30	E	ROW
15	3+000	19° 4'59.33"N	72°53'19.08"E	Mosque	200	R	L.HS
16	3+800	19° 4'56.12"N	72°53'53.07"E	Church	200	R	R.H.S
17	4+500	19° 5'1.96"N	72°54'14.00"E	College	188	E	R.H.S
18	4+800	19° 5'7.01"N	72°54'22.37"E	Hindu Sabha Hospital	235	H	R.H.S
19	5+000	19° 5'13.35"N	72°54'26.02"E	MCGM School	60	E	L.HS
20	5+200	19° 5'14.83"N	72°54'33.43"E	Hindi High School	45	E	L.HS
21	5+200	19° 5'9.92"N	72°54'36.29"E	Temple	125	R	L.HS
22	5+300	19° 5'9.04"N	72°54'38.49"E	School	165	E	L.HS
23	5+500	19° 5'17.47"N	72°54'44.09"E	Temple	40	R	L.HS
24	5+800	19° 5'20.76"N	72°54'51.58"E	Temple	80	R	L.HS

S.No.	Chainage	Geo-Coordinate		Name	Distance from C/L (m)	Category	Side
		Latitude	Longitude				
25	5+900	19° 5'22.69"N	72°54'53.05"E	Church	120	R	L.HS
26	5+950	19° 5'15.79"N	72°55'0.56"E	Pant Nagar Municipal School No-3	140	E	R.H.S
27	15+500	19° 6'39.60"N	73° 0'13.58"E	Terana College	60	E	R.H.S
28	15+900	19° 6'50.53"N	73° 0'25.11"E	Ghansoli Dargah	180	R	L.HS
29	20+650	19° 8'20.93"N	73° 2'27.92"E	Temple	150	R	L.H.S
30	21+200	19° 8'27.18"N	73° 2'48.65"E	Omkareshwar Mandir	250	R	R.H.S
31	21+400	19° 8'36.82"N	73° 2'47.92"E	Datta Mandir	70	R	R.H.S
32	21+400	19° 8'39.25"N	73° 2'41.81"E	Gaondevi Mandir	125	R	L.H.S
33	21+400	19° 8'33.24"N	73° 2'51.60"E	Mosque	220	R	L.H.S
34	24+700	19°10'2.86"N	73° 3'53.94"E	Vitthal Rakhumai Temple	200	R	R.H.S
35	25+600	19°10'30.96"N	73° 4'7.26"E	Ganesh Temple	220	R	R.H.S
36	25+700	19°10'37.68"N	73° 3'51.74"E	Shankar Temple	270	R	
37	27+300	19°11'28.71"N	73° 3'55.10"E	Saibaba Temple	245	R	R.H.S
38	27+400	19°11'31.04"N	73° 3'48.61"E	Bhoir Khandoba Mandir	115	R	R.H.S
39	28+200	19°11'46.91"N	73° 3'25.74"E	Mhatardeshwar Shiv Mandir	225	R	L.H.S
40	31+100	19°13'12.19"N	73° 2'40.07"E	Madhyamik marathi school	15	E	L.H.S
41	31+900	19°13'34.81"N	73° 2'30.09"E	Sanskar English School	210	E	R.H.S
42	32+750	19°13'51.22"N	73° 1'59.38"E	Jivmata Mandir Maharastr	160	R	L.H.S
43	32+850	19°13'52.14"N	73° 1'54.35"E	Dattamandir	250	R	L.H.S
44	35+300	19°14'56.74"N	73° 1'5.65"E	School	250	E	L.H.S
45	35+350	19°15'0.90"N	73° 1'5.73"E	Jain Temple	210	R	L.H.S
46	35+400	19°15'5.32"N	73° 1'18.53"E	Parashuram Dhondu Taware Vidyalaya	180	E	R.H.S
47	35+550	19°15'4.65"N	73° 1'3.30"E	Hospital	230	H	L.H.S
48	35+800	19°15'17.74"N	73° 1'14.54"E	Shree Ganesh Hanuman Mandir	225	R	R.H.S
49	38+000	19°16'19.22"N	73° 0'30.70"E	Temple	250	R	L.H.S
50	50+150	19°20'21.15"N	72°55'20.20"E	Jain Temple	90	R	L.H.S
51	50+150	19°20'28.33"N	72°55'27.08"E	Temple	215	R	R.H.S
52	51+400	19°20'38.61"N	72°54'40.50"E	Temple	230	R	L.H.S
53	55+000	19°21'36.84"N	72°52'54.63"E	Temple	250	R	R.H.S
54	57+400	19°22'20.46"N	72°51'52.10"E	Temple	85	R	R.H.S
55	57+400	19°22'14.84"N	72°51'41.21"E	Temple	250	R	L.H.S
56	61+300	19°24'19.12"N	72°50'59.69"E	Hospital	230	H	R.H.S
57	61+800	19°24'30.16"N	72°50'52.50"E	Mosque	170	R	R.H.S
58	62+100	19°24'35.15"N	72°50'30.14"E	Vidya Vikasini School	300	E	L.H.S

S.No.	Chainage	Geo-Coordinate		Name	Distance from C/L (m)	Category	Side
		Latitude	Longitude				
59	63+150	19°25'10.34"N	72°50'35.08"E	Mosque	160	R	R.H.S
60	63+500	19°25'21.45"N	72°50'28.52"E	Mosque	60	R	R.H.S
61	63+550	19°25'22.32"N	72°50'25.70"E	Durga Temple	15	R	L.H.S
62	64+200	19°25'41.95"N	72°50'16.35"E	Vidya Vardhi Vidyalya	180	E	L.H.S
63	64+200	19°25'40.02"N	72°50'13.30"E	Ganesh Temple	250	R	L.H.S
64	67+500	19°27'30.38"N	72°50'10.87"E	Shiv Temple	100	R	R.H.S
65	69+000	19°28'18.81"N	72°49'55.30"E	Masjid Quraish	150	R	L.H.S
66	69+200	19°28'24.09"N	72°49'52.09"E	Kala Hanuman Temple	230	R	L.H.S
67	74+800	19°31'16.31"N	72°48'56.82"E	Shalimar Shiv Temple	40		L.H.S
68	83+850	19°35'58.77"N	72°47'41.97"E	Ekvira Temple	10	R	R.H.S
69	85+400	19°36'48.37"N	72°47'36.69"E	Shri Waghoba Mandir	30	R	L.H.S
70	85+500	19°36'51.05"N	72°47'34.32"E	Shree Swami Samarth Math	100	R	L.H.S
71	85+500	19°36'51.27"N	72°47'26.79"E	Swami Vivekananda Nursery & Primary School	250	E	L.H.S
72	92+100	19°40'26.69"N	72°47'25.25"E	Gaondevi Temple	140	R	R.H.S
73	100+000	19°44'41.54"N	72°47'35.48"E	Mahalakshmi Temple	240	R	R.H.S
74	103+700	19°46'42.66"N	72°47'26.17"E	Temple	200	R	L.H.S
75	103+900	19°46'49.04"N	72°47'37.01"E	Maan Church	100	R	L.H.S
76	103+950	19°46'50.98"N	72°47'39.15"E	Our Lady of Health Church	160	R	L.H.S
77	104+700	19°47'14.53"N	72°47'45.06"E	Durga Mata Temple	250	R	R.H.S
78	124+850	19°58'6.81"N	72°48'32.53"E	Shree Santoshi Mata Temple	340	R	L.H.S
79	132+500	20° 1'21.03"N	72°51'25.06"E	Jain Temple	250		R.H.S
80	151+700	20°11'28.07"N	72°53'27.20"E	Sudiksha Medical Aamgaon	120	E	L.H.S
81	169+050	20°20'11.68"N	72°57'15.69"E	Masjid Madarsa Faizane Alahazrat	130	R	R.H.S
82	171+300	20°21'19.89"N	72°57'37.18"E	Geeta Mandir Karvad Nijanand Nagar	60	R	R.H.S
83	173+800	20°22'44.24"N	72°57'49.14"E	Shiv Temple	340	R	R.H.S
84	173+800	20°22'42.04"N	72°57'23.73"E	Temple			L.H.S
85	174+100	20°22'53.29"N	72°57'26.04"E	Saraswat International Academy	300	R	L.H.S
86	188+700	20°30'45.98"N	72°58'7.37"E	Koteshwar Mahadev Mandir, Balda	250	R	L.H.S
87	192+400	20°32'42.47"N	72°58'41.33"E	Sankat Mochan Hanumanji Mandir, Binwada	400	R	R.H.S
88	195+600	20°34'29.49"N	72°58'33.94"E	Shri Dattaguru	110	R	L.H.S

S.No.	Chainage	Geo-Coordinate		Name	Distance from C/L (m)	Category	Side
		Latitude	Longitude				
				Temple			
89	196+000	20°34'41.35"N	72°58'34.75"E	Jalaram Temple	120	R	L.H.S
90	200+200	20°36'56.39"N	72°59'0.13"E	Maa Chandika Temple	240	R	R.H.S
91	200+600	20°37'10.85"N	72°58'47.96"E	Khodiyar Mata Temple	130		L.H.S
92	204+000	20°38'59.29"N	72°59'18.05"E	Bhawani Temple	300	R	R.H.S
93	204+700	20°39'21.01"N	72°59'18.94"E	Shree Swaminarayan Temple KHAJURDI	210	R	R.H.S
94	215+500	20°45'9.83"N	73° 0'11.99"E	Hazrat Peer Daegha	230	R	L.H.S
95	224+300	20°49'49.56"N	73° 0'57.16"E	Bhamtimata Mandir	200	R	R.H.S
96	236+950	20°56'29.22"N	72°59'7.58"E	Ganesh Temple	100	R	R.H.S
97	238+100	20°57'8.81"N	72°58'59.08"E	Mosque	390	R	R.H.S
98	239+300	20°57'38.51"N	72°58'34.13"E	Virvadi Hanuman Mandir	100	R	R.H.S
99	244+500	21° 0'14.13"N	72°57'29.69"E	Jangli Hanuman Temple	400	R	R.H.S
100	248+650	21° 2'16.60"N	72°56'25.40"E	Mosque	270	R	R.H.S
101	259+900	21° 8'12.18"N	72°55'41.83"E	Genius Educational Academy	90	E	L.H.S
102	260+100	21° 8'17.08"N	72°55'51.97"E	Hospital	180	H	R.H.S
103	267+750	21°12'26.82"N	72°55'52.61"E	Vihatmata Temple Near Sanya Gaam Gate	300	R	L.H.S
104	269+700	21°13'28.96"N	72°55'56.24"E	Khadsad primary school	320	E	L.H.S
105	271+000	21°14'11.92"N	72°56'15.96"E	Shree Gyanjyot vidhyalay	125	E	R.H.S
106	275+600	21°16'39.32"N	72°56'21.27"E	Hanumandada Mandir	40	R	
107	275+800	21°16'46.41"N	72°56'19.84"E	Jay Meldi Maa Mandir	60	R	R.H.S
108	275+950	21°16'49.86"N	72°56'19.10"E	Kholvad EidGaah	60	R	R.H.S
109	276+550	21°17'9.22"N	72°56'9.10"E	Limdeshwar Temple	60	R	L.H.S
110	276+600	21°17'8.41"N	72°56'4.71"E	Limdeshwar Mahadev Temple	180	R	L.H.S
111	276+650	21°17'13.52"N	72°56'14.81"E	Tai Wad Masjid	280	R	R.H.S
112	276+650	21°17'13.36"N	72°56'20.19"E	Badat Faliya Masjid	130	R	R.H.S
113	276+850	21°17'18.65"N	72°56'17.25"E	Mosque	240	R	R.H.S
114	276+900	21°17'19.70"N	72°56'13.89"E	Markaz Musjid Kathor	160	R	R.H.S
115	276+950	21°17'21.02"N	72°56'3.64"E	Galiyara Hostel	100	E	R.H.S
116	277+050	21°17'23.15"N	72°56'0.64"E	V.D.Galiyara High School	170	E	L.H.S
117	277+100	21°17'24.85"N	72°56'14.38"E	Nyay Mandir	160	R	R.H.S

S.No.	Chainage	Geo-Coordinate		Name	Distance from C/L (m)	Category	Side
		Latitude	Longitude				
118	281+450	21°19'43.24"N	72°55'37.54"E	Muni International School	325	R	R.H.S
119	282+500	21°20'16.12"N	72°55'29.51"E	Shree Panchadev Swaminarayan Mandir	350	R	R.H.S
120	289+700	21°24'3.62"N	72°54'17.86"E	Ramapir Temple	280	R	L.H.S
121	289+900	21°24'10.34"N	72°54'14.32"E	Shiv Temple Mulad	400	R	L.H.S
122	292+450	21°25'26.82"N	72°55'1.01"E	Mahadev Temple	25	R	R.H.S
123	292+550	21°25'29.27"N	72°55'5.76"E	Kimamli Temple	120	R	R.H.S
124	299+950	21°29'12.33"N	72°56'39.84"E	Gokul Dham	230	R	R.H.S
125	316+300	21°38'3.09"N	72°57'31.79"E	Kadakia Institute of Management and Studies	273	E	R.H.S
126	323+300	21°41'48.48"N	72°57'20.21"E	School	400	E	R.H.S
127	324+100	21°42'14.89"N	72°57'15.50"E	VCT Girls School	321	E	R.H.S
128	325+800	21°43'8.32"N	72°57'10.86"E	Mosque	294	R	R.H.S
129	346+400	21°53'56.64"N	72°59'6.86"E	Masjid	72	R	R.H.S
130	348+500	21°55'3.94"N	72°59'19.59"E	Hajarat Isapir Dargah & Kabristan	230	R	L.H.S
131	348+500	21°55'2.27"N	72°59'24.81"E	Kothy Vantersa Masjid	70	R	L.H.S
132	380+600	22°10'27.59"N	73° 7'43.87"E	Ganpatibapa Temple	120	R	L.H.S
133	390+100	22°14'54.59"N	73°10'21.49"E	Kotnath Mahadev Temple	342	R	L.H.S
134	390+950	22°15'21.19"N	73°10'30.49"E	Swaminarayan Temple	179	R	L.H.S
135	391+000	22°15'22.17"N	73°10'28.58"E	Bethel Mar Thoma Church Makarpura		R	L.H.S
136	392+750	22°16'19.10"N	73°10'47.41"E	E .N .T Hospital	200	H	R.H.S
137	392+900	22°16'24.22"N	73°10'42.06"E	Ramdevpir Temple	40	R	R.H.S
138	393+450	22°16'40.83"N	73°10'40.72"E	Sureshwar Mahadev Temple	30	R	L.H.S
139	393+900	22°16'56.07"N	73°10'51.54"E	Ruthubhara Arogya Mandir	262	R	R.H.S
140	394+300	22°17'10.35"N	73°10'38.37"E	Hospital and Girls College	140	E	L.H.S
141	395+050	22°17'33.79"N	73°10'52.54"E	Neelnath Mahadev Temple	208	R	R.H.S
142	395+150	22°17'36.87"N	73°10'49.01"E	Jay Mahakali Mandir	100	R	R.H.S
143	395+350	22°17'44.10"N	73°10'48.82"E	Sidhdheshwar Mahadev	76	R	R.H.S
144	395+400	22°17'44.99"N	73°10'42.09"E	Akota Moti Masjid	108	R	L.H.S
145	395+400	22°17'45.25"N	73°10'40.60"E	Akota Gam Moti Masjid	160	R	L.H.S
146	395+450	22°17'47.34"N	73°10'47.99"E	Om Sainath Mandir	50	R	R.H.S

S.No.	Chainage	Geo-Coordinate		Name	Distance from C/L (m)	Category	Side
		Latitude	Longitude				
147	395+500	22°17'48.43"N	73°10'51.66"E	Mahadev Temple	152	R	R.H.S
148	395+550	22°17'49.35"N	73°10'47.81"E	Sai Baba Mandir	40	R	R.H.S
149	395+600	22°17'51.14"N	73°10'48.90"E	Hanuman Mandir	68	R	R.H.S
150	395+700	22°17'54.03"N	73°10'41.92"E	Masjid	140	R	L.H.S
151	395+800	22°17'57.15"N	73°10'38.67"E	Shree Ganesh Mandir	242	R	L.H.S
152	395+850	22°17'58.79"N	73°10'53.51"E	Shiv Mandir	175	R	R.H.S
153	396+200	22°18'10.42"N	73°10'36.98"E	Verai mata Temple	317	R	L.H.S
154	396+250	22°18'12.17"N	73°10'46.66"E	Sai Temple	45	R	L.H.S
155	396+510	22°18'21.82"N	73°10'46.79"E	Madhurai Kamaraj University	61	E	L.H.S
156	396+600	22°18'23.14"N	73°10'57.96"E	Bhimnath Mahadev Mandir - Navnath	255	R	L.H.S
157	396+600	22°18'23.73"N	73°10'50.34"E	Muraad Shaheed Masjid	40	R	L.H.S
158	396+650	22°18'26.25"N	73°10'52.00"E	Dhiraj Hospital	88	H	R.H.S
159	396+650	22°18'26.06"N	73°10'52.59"E	Navjeevan High School	102	E	R.H.S
160	396+800	22°18'30.50"N	73°10'54.96"E	Kadak Bazaar Masjid	180	R	R.H.S
161	396+700	22°18'27.31"N	73°10'39.62"E	Shree Chimanbhai Patel Orthopaedic Hospital - Dr.K.C. Patel	260	H	L.H.S
162	396+750	22°18'28.10"N	73°10'41.62"E	Maitri Hospital	200	H	L.H.S
163	397+100	22°18'40.72"N	73°10'59.53"E	University Experimental School	340	E	R.H.S
164	397+250	22°18'45.41"N	73°10'53.20"E	Sanjiv Hospital	167	H	R.H.S
165	397+800	22°19'5.06"N	73°10'58.14"E	Rosary High School	388	E	R.H.S
166	397+900	22°19'5.51"N	73°10'39.85"E	Ranmukteshwar Mahadev Temple	94	R	L.H.S
167	398+000	22°19'9.62"N	73°10'46.88"E	The Maharaja Sayajirao University of Baroda Halls of Residence	144	E	R.H.S
168	298+200	22°19'10.88"N	73°10'31.51"E	Jesus Temple Bible Church	212	R	L.H.S
169	398+400	22°19'25.21"N	73°10'41.15"E	Polytechnic MS University	249	E	R.H.S
170	98+550	22°19'25.87"N	73°10'35.66"E	Umapati Mahadev Temple	120	R	R.H.S
171	399+000	22°19'42.71"N	73°10'32.88"E	St Joseph High School	357	E	R.H.S
172	399+100	22°19'44.39"N	73°10'29.37"E	Shree kashi vishwnath Temple	290	R	R.H.S
173	400+400	22°20'17.25"N	73°10'4.80"E	Mosque	285	R	R.H.S
174	400+700	22°20'25.69"N	73° 9'58.62"E	W Railway Model Training Centre	277	E	R.H.S

S.No.	Chainage	Geo-Coordinate		Name	Distance from C/L (m)	Category	Side
		Latitude	Longitude				
175	400+800	22°20'28.91"N	73° 9'53.04"E	Rameshwar Mahadev Mandir	201	R	L.H.S
176	401+350	22°20'36.03"N	73° 9'31.59"E	Infant Jesus Church, Near Chhani Bridgr	181	R	L.H.S
177	401+450	22°20'37.54"N	73° 9'28.48"E	Gaushiya Masjid	227	R	L.H.S
178	412+650	22°25'37.31"N	73° 7'18.61"E	Khodal Dham Temple	100	R	L.H.S
179	412+750	22°25'50.79"N	73° 7'27.30"E	Limboj Mataji Mandir	370	R	R.H.S
180	412+800	22°25'48.33"N	73° 7'23.24"E	Shree Swaminarayan Temple(Vadtal Tabu)	235	R	R.H.S
181	412+900	22°25'52.37"N	73° 7'20.43"E	Param Aruvedic Hospital	273	H	R.H.S
182	418+100	22°27'40.35"N	73° 4'58.75"E	Ambe ma temple	343	R	L.H.S
183	425+600	22°30'39.92"N	73° 2'7.63"E	Ramnagar Gurukul	291	E	L.H.S
184	429+150	22°32'16.15"N	73° 1'0.44"E	Shree Krishna Pranami Temple Shree Indravatipuri Dham,Mogar	6	R	R.H.S
185	430+800	22°32'56.12"N	73° 0'21.06"E	Bhutnath Mahadev, Vaghasi	78	R	L.H.S
186	445+600	22°38'36.28"N	72°54'24.27"E	SNV International School	160	E	R.H.S
187	448+300	22°39'17.48"N	72°52'59.20"E	Baba Ramdev Temple	290	R	R.H.S
188	450+950	22°39'44.70"N	72°51'30.97"E	Euro_School_Nadiad	3	E	R.H.S
189	451+300	22°39'56.94"N	72°51'22.68"E	Pramukh Swami Wadi	240	R	R.H.S
190	471+000	22°47'43.28"N	72°43'55.60"E	Chhapra Primary School	242	E	L.H.S
191	488+780	22°55'50.59"N	72°38'20.77"E	Ropes, Meldi Mata Temple	35	R	R.H.S
192	491+500	22°57'14.43"N	72°37'47.58"E	Vagheswari Temple	130	R	L.H.S
193	493+250	22°58'5.15"N	72°37'20.81"E	Ramapir Mandir	245	R	L.H.S
194	494+000	22°58'28.12"N	72°37'13.60"E	Kashi Vishwanath Mandir	166	R	L.H.S
195	494+400	22°58'42.44"N	72°37'12.87"E	Sai_Temple	15	R	L.H.S
196	494+500	22°58'48.27"N	72°37'20.99"E	The Church Of North India Grace Church	275	R	R.H.S
197	494+800	22°58'57.64"N	72°37'14.52"E	The Rock of Ages Church	210	R	R.H.S
198	495+150	22°59'3.98"N	72°37'0.79"E	Gurunanak Hospital	80	H	L.H.S
199	495+400	22°59'14.42"N	72°37'7.17"E	Shree Gayatri Mandir	208	R	R.H.S
200	495+500	22°59'16.23"N	72°37'3.08"E	Sharda Ben Ni Vadi	195	R	R.H.S
201	495+500	22°59'13.43"N	72°36'50.90"E	Muktjivan English Medium School	227	E	L.H.S
202	495+500	22°59'18.49"N	72°37'5.85"E	Raja Bhagat School	222	E	R.H.S

S.No.	Chainage	Geo-Coordinate		Name	Distance from C/L (m)	Category	Side
		Latitude	Longitude				
203	495+950	22°59'28.62"N	72°36'52.04"E	Meghdoot Vidya Vihar School	31	E	L.H.S
204	496+000	22°59'28.90"N	72°36'50.23"E	Shree Simandhar swami Diagamber Jain Mandir	76	R	L.H.S
205	496+100	22°59'33.05"N	72°36'49.96"E	Sai Baba Mandir	51	R	L.H.S
206	496+250	22°59'37.74"N	72°36'48.58"E	Kodiyar Mata Mandir	39	R	L.H.S
207	496+300	22°59'40.69"N	72°36'55.56"E	Vani Hospital	178	H	R.H.S
208	496+305	22°59'40.82"N	72°36'54.64"E	Shri Kashi Vishwanath Mahadev Temple - Panchratan Dev Mandir	146	R	R.H.S
209	496+350	22°59'41.07"N	72°36'50.62"E	Pallav - J. M. Desai Memorial Hospital	46	H	R.H.S
210	496+350	22°59'41.20"N	72°36'49.52"E	Shaishav Children Hospital	20	H	R.H.S
211	496+450	22°59'42.49"N	72°36'41.00"E	Shree Swaminarayan High School	191	E	L.H.S
212	496+500	22°59'43.93"N	72°36'38.50"E	Swaminarayan Mandir	243	R	L.H.S
213	496+550	22°59'47.69"N	72°36'49.95"E	Het Medical Agency	102	H	R.H.S
214	496+600	22°59'50.82"N	72°36'51.78"E	Matrudham Charitable Ankhni Hospital	185	H	R.H.S
215	496+800	22°59'55.08"N	72°36'44.32"E	Helyen_Higher_Secondary_School	35	E	R.H.S
216	496+850	22°59'52.62"N	72°36'35.18"E	Ravi Surgical Hospital(Centre of Excellence for Hernia & Piles Surgery)	233	H	L.H.S
217	496+950	22°59'57.70"N	72°36'38.22"E	New People Motor Driving School	93	E	L.H.S
218	497+390	23° 0'8.12"N	72°36'27.11"E	Nelson's English School	267	E	L.H.S
219	497+400	23° 0'8.68"N	72°36'27.44"E	Ramji Mandir	252	R	L.H.S
220	497+600	23° 0'21.69"N	72°36'40.34"E	Pragathi High School	237	E	R.H.S
221	498+050	23° 0'33.45"N	72°36'29.48"E	Usmaniya Masjid	86	R	R.H.S
222	498+150	23° 0'36.41"N	72°36'30.30"E	Jagnath Mahadev Mandir	144	R	R.H.S
223	498+200	23° 0'37.45"N	72°36'25.38"E	Hazrat Masoom Pir's Drgah	28	R	R.H.S
224	498+400	23° 0'46.67"N	72°36'29.43"E	Masjid-E-Bilal	240	R	R.H.S
225	498+550	23° 0'49.70"N	72°36'27.16"E	Saint Joseph School	220	E	R.H.S
226	498+600	23° 0'50.56"N	72°36'25.92"E	Holy Family Church	200	R	R.H.S
227	499+100	23° 1'0.58"N	72°36'3.70"E	Jogni Maa Temple	264	R	L.H.S

S.No.	Chainage	Geo-Coordinate		Name	Distance from C/L (m)	Category	Side
		Latitude	Longitude				
228	499+200	23° 1'6.17"N	72°36'8.24"E	Baba RamdevJi Temple	77	R	L.H.S
229	499+400	23° 1'12.12"N	72°36'3.86"E	Mukta Mandir	160	R	L.H.S
230	499+450	23° 1'14.77"N	72°36'3.85"E	Mata Mandir	150	R	L.H.S
231	499+460	23° 1'15.80"N	72°36'3.13"E	Shri Tin Devi Mandir	170	R	L.H.S
232	499+500	23° 1'17.47"N	72°36'2.35"E	Tin Ghumti Masjid	186	R	L.H.S
233	499+600	23° 1'19.67"N	72°36'14.81"E	Gomtipur Muncipal School	168	E	R.H.S
234	499+680	23° 1'22.59"N	72°36'13.48"E	Patrewali Masjid	130	R	R.H.S
235	499+850	23° 1'28.21"N	72°36'1.68"E	Hanumaan Mandir	203	R	L.H.S
236	500+050	23° 1'35.42"N	72°36'17.75"E	Peer Shah Hammad Masjid	250	R	R.H.S
237	500+250	23° 1'40.59"N	72°36'3.76"E	Jhulta Minara (Archiological)	142	A	L.H.S
238	500+300	23° 1'42.48"N	72°36'2.54"E	Kalu Shaheed Dargah	173	R	L.H.S
239	501+200	23° 2'13.95"N	72°36'11.19"E	Damujavar Dargah	192	R	R.H.S
240	501+450	23° 2'16.33"N	72°35'55.57"E	Dashma Temple	168	R	L.H.S
241	501+800	23° 2'24.13"N	72°35'47.21"E	Juni Eidgah Masjid Mosque	252	R	L.H.S
242	502+050	23° 2'34.36"N	72°35'48.63"E	Alla Malin Masjid	60	R	L.H.S
243	502+100	23° 2'39.83"N	72°35'57.26"E	Vir Hanumanji Mandir	238	R	R.H.S
244	502+130	23° 2'39.57"N	72°35'54.35"E	Shree Sahjanand Gurukul	162	R	R.H.S
245	502+200	23° 2'41.39"N	72°35'54.51"E	Sahajanand gurukul school	193	E	R.H.S
246	502+400	23° 2'47.81"N	72°35'47.73"E	Samarpan Medical Hospital	130	H	R.H.S
247	502+500	23° 2'50.98"N	72°35'51.14"E	Girdharnagar Shahibaug High School	260	E	R.H.S
248	502+500	23° 2'50.77"N	72°35'47.26"E	Hanuman Temple	160	R	R.H.S
249	502+720	23° 2'56.41"N	72°35'41.66"E	Chandramani Hospital	104	H	R.H.S
250	502+750	23° 2'51.37"N	72°35'32.41"E	Dayar-E-Ahmadi Mosque	180	R	L.H.S
251	502+880	23° 2'58.17"N	72°35'34.72"E	Bharti Vallabh Hospital	32	H	L.H.S
252	502+950	23° 3'1.84"N	72°35'36.56"E	Shani Dev Temple, Shahibaug	67	R	R.H.S
253	503+350	23° 3'12.04"N	72°35'23.25"E	ESIC Hospital	138	H	L.H.S
254	503+410	23° 3'15.97"N	72°35'31.65"E	Calico Museum of Textiles	125		R.H.S
255	503+500	23° 3'17.06"N	72°35'30.04"E	Rani Sati Mandir	93	R	R.H.S

S.No.	Chainage	Geo-Coordinate		Name	Distance from C/L (m)	Category	Side
		Latitude	Longitude				
256	503+550	23° 3'18.78"N	72°35'26.70"E	The Rosery School	17	E	R.H.S
257	503+580	23° 3'19.20"N	72°35'24.81"E	State Police Welfare Hospital	37	H	L.H.S
258	503+590	23° 3'19.98"N	72°35'26.58"E	Retina Foundation Eye Research Center	18	H	R.H.S
259	503+750	23° 3'26.39"N	72°35'32.82"E	Reshambai Fertility Hospital	223	H	R.H.S
260	503+800	23° 3'26.43"N	72°35'17.03"E	Ambaji Mata Temple	224	R	L.H.S
261	504+100	23° 3'33.99"N	72°35'13.90"E	Swaminarayan Temple Narayanghat	282	R	L.H.S
262	504+150	23° 3'36.77"N	72°35'17.97"E	Moinuddin Chisti's Dargah	160	R	L.H.S
263	504+190	23° 3'38.81"N	72°35'20.51"E	Nilkanth Mahadev Mandir	81	R	L.H.S
264	504+200	23° 3'40.58"N	72°35'27.48"E	Sardar Vallabhbhai Patel National Memorial	119		R.H.S
265	504+280	23° 3'41.53"N	72°35'31.38"E	Bhimnath Temple	232	R	R.H.S
266	504+300	23° 3'42.69"N	72°35'29.14"E	Jayatri Temple	175	R	R.H.S
267	504+610	23° 3'52.45"N	72°35'17.36"E	Temple_Dashama	124	R	L.H.S
268	504+800	23° 3'58.15"N	72°35'12.21"E	Jogni Mata Mandir	251	R	L.H.S
269	504+970	23° 4'4.23"N	72°35'20.72"E	Vision School of Science	10	E	R.H.S
270	505+050	23° 4'7.07"N	72°35'24.28"E	Shree Baleshwar Mahadev	122	R	R.H.S
271	505+200	23° 4'11.64"N	72°35'14.91"E	Shree Kesari Nandan Hanuman Mandir	128	R	L.H.S
272	505+780	23° 4'30.40"N	72°35'19.32"E	Hanuman Mandir Sabarmati	62	R	R.H.S
273	506+450	23° 4'52.55"N	72°35'16.04"E	Shree LVU College	218	E	R.H.S
274	506+592	23° 4'51.84"N	72°34'59.57"E	Ranip School	203	E	R.H.S
275	506+800	23° 5'4.54"N	72°35'9.82"E	St Ann's High School	260	E	R.H.S
276	506+840	23° 5'0.42"N	72°34'59.24"E	Mataji Mandir	64	R	L.H.S
277	507+000	23° 5'7.63"N	72°35'2.42"E	Sumrit Mandir	139	R	R.H.S
278	507+.050	23° 5'10.36"N	72°35'1.62"E	Mosque	160	R	R.H.S

Source: Study Team

A: Archaeological, E: Educational Institutions, H: Hospital, R: Religious

Annexure 4.20

4.20.1 INDIGENOUS/ETHNIC MINORITY

(1) Maharashtra

According to the Census 2011, Maharashtra is the second most populous state in India with a population of 112,374,333 (9.28% of India's population) of which male and female are 58,243,056 and 54,131,277 respectively. The total population growth during 2001-2011 was 15.99 percent while in the previous decade 1991-2001, it was 22.57 percent. Since independence, the decadal growth rate of population has remained higher (except in the year 1971) than the national average. The Census 2011 for the state recorded 55% of the population to be rural with 45% being urban based. As per Census 2011 record scheduled castes and scheduled tribes accounts for 11.8 and 8.9% of the population respectively. The scheduled tribes include *adivasis* such as Thakar, Warli, Konkana and Halba. According to Census 2011, Hinduism is the principal religion at 79.83% of the total population, while Muslims accounted for 11.54% of the total population, being the second-largest community and the largest minority group. Buddhism accounts 5.81% in Maharashtra's total population. 6,531,200 people are followers of Buddhism in Maharashtra as per Census 2011. Sikhism, Christianity and Jainism constituted 0.20%, 0.96%, 1.25% respectively. Maharashtra had the largest concentration of Buddhists at 58.3% – 73.4% of the total Buddhists in India reside in Maharashtra. The state contributed 9.28% to India's population.

Table 4.20.1 (A): List of Other Backward Class in Maharashtra

No. & Name of the Caste	No. & Name of the Caste	No. & Name of the Caste
1. Alitkar	130. Bandi	234. Chintala
2. Bagdi	131. Rachbandhiya	235. Dakaleru
3. Deleted	132. Rangari	236. Darji
4. Badia	133. Ragrez	237. Deleted
5. Bajania	134. Raot, Ravat, Rautiya	238. Kurba, Kurubar
6. Bajigar	135. Rangrez (Bhavsar, Rangari)	239. Harkantra,Mangeli, Mangele, Page, Sanduri
7. Buttal	136. Deleted	240. Wats, Bhadwal, Rajak
8. Bhand, Chappar Bhand	137. Deleted	241. Dommara
9. Bavaiya or Targal	138. Deleted	242. Gaadaaba or Godaba
10. Bhavin	139. Deleted	243. Gangani
11. Bhisti or Pakhali, Sakka	140. Sanjogi	244. Garodi
12. Deleted	141. Saraaniya	245. Goller
13. Bari or Barai	142. Deleted	246. Godala
14. Beriya	143. Deleted	247. Habura
15. Besdeva	144. Deleted	248. Harani
16. Bhadbhunja, Bhujaya, Bhunjva, Bhurji, Bharadbhunja, Bhuranji,	145. Suppaling	249. Hil- Redidas

No. & Name of the Caste	No. & Name of the Caste	No. & Name of the Caste
Bhunj		
17. Bhanta	146. Sutharia (In Sindh)	250. Deveri
18. Bhat Bhaat	147. Sahis,Saes,Shis	251. Winkar, Wanya, Bankar
19. Chamatha	148. Sapera	252. Kachiya
20. Chandalgada	149. Shilavat	253. Korach, Padlor
21. Charan or Gadhavi	150. Singiwala	254. Kalal, Kalar, Lad, Ladwak, Goud Kalal, Shivhare - excluding Lad Barahman * (comment added in June 2008)
22. Charodi	151. Deleted	255. Kandel
23. Chippa, Chhipa	152. Deleted	256. Kasera
24.Das or Dangadidas	153. Shimpi, Idrisi/Darji,Sai Sutar, Jain Shimpi, Shravak Shimpi, Shetwal, Shetval, Saitwal, Saitval, Meru Shimpi / Meru Kshatriya Shimpi *	257. Kasai, Kasab, Kureshi
25. Davgar	154. Sonar	258. Katipamula
26. Depala	155. Tandel	259. Kirar
27. Devali	156. Deleted	260. Christian Koli
28. Devdig, Devadiga *	157. Targala	261. Korachar or Korave
29. Deleted	158. Thetwar	262. Kodaku with Korava
30. Dholi, Hashmi/ Dafali	159. Thoria	263. Komakapu
31. Deleted	160. Tambat,Twashta Kasar, Kasar	264. Kondu
32. Deleted	161. Thogati	265. Lakhari
33. Deleted	162. Wadi	266. Lohar-Gada, Dodi, Panchal, Khatawali
34. Deleted	163. Deleted	267. Chunari
35. Gandharap	164. Wansphod, Hindu Dharkar	268. Deleted
36. Gujrath Bori	165. Wadhai (Sutar) (deleted * in June 2008)	269. Mahil
37. Deleted	166. Warthi	270. Maidasi
38. Deleted	167. Deleted	271. Mazwar
39. Gadhavi	168. Yerkula	272. Matiyara, Matihara
40. Deleted	169. Agari, Agale or Kalan	273. Mankar khalu
41. Deleted	170. Bhavsar	274. Mondiwar, Mondiwara
42. Gochaki	171. Kurhin,Shetti	275. Munda
43. Gurav	172. Nilgar, Nili, Nirali	276. Hajam, Kalseru, Navliga, Kanshi, Nabhik, Nai, Waland
44. Deleted, Gavlan (Gawalvansh) (deleted * in June 2008)	173. Koskanti Devang (No.CBC-1468/ 83475/j, dt.19.01.1968)	277. Pachbhotala, Pachbotala

No. & Name of the Caste	No. & Name of the Caste	No. & Name of the Caste
45. Gavandi, Gurjar - Kadia	174. Sutar, Sudhar, Vaadhhai *, Baadhhi *, Badhhai *, Baadhhai *, Wadhhi *, Wadi *, Wadhai * and Sub-Castes- Jhade Sutar *, Panchal Sutar *	278. Padampari
46. Halepaik	175. Phutgudi	279. Bhisti
47. Deleted	176. Deleted	280. Pamula
48. Deleted	177. Pinjara, Pinjari, Mansuri	281. Panchama
49. Jagiyasi	178. Deleted	282. Panda
50. Jajak	179. Bhilala	283. Phar
51. Jatiya	180. Deleted	284. Pinjari
52. Jatigar	181. Teli, Tilwan-teli, Maratha-teli, Tarane-teli, Deshkar-teli, Erandel -teli, Lingayat-teli,Ekbail-teli, Donbail-teli, Ekbahiya-teli, Savteli	285. Purwali
53. Javheri, Parjiya Soni	182. Mali (Sub castes- Phulmali, Phule, Halade, Kacha, Kadu, Bawane Adhprabhu, Adhsheti, Jire,Unde, Lingayat Mali, etc), Bagwan (Muslim), Bharat Bagwan, Marar, Maral, Kosare, Gase Wanmali, Savatamali, Pachkalasi,Waadwal, Chowkalashi, Raen (Bagwan), Pachkalsi similar sub castes- Somvanshiya Pathare Kshatriya *, Pathare Kshatriya Pachkalsi * Pathare Kshatriya *, Sutar *, Sartikar *, Ghodekhau *, S.K.P. *	286. Rachbhoya
54. Deleted	183. Lonari	287. Rautiya
55. Jogin	184. Deleted	288. Sangari
56. Johari	185. Talwar-Kanade/Kanadi *(rectified in 2008)	289. Santal
57. Julaha - Ansari	186. Raghvi (Dist-Vidarbh)	290. Saunta or Sonta
58. Jangam	187. Bhandari,Bawarchi/ Bhatiyara (Muslim)	291. Savteli
59. Deleted	188. Ganali or Gandali	292. Sare
60. Jadi	189. Powar or Pawar, (Powar or Pawar surnames), Bhoyar, Bhoir, Bhovir	293. Bhavgar, Shiv shimpi, Namdev
61. Deleted	190. Kathar, Kathar-wani, Kanthhar wani, Vaishya wani, Kulwant wani, Nevi (excluding Lingayat wani or Ladwani) - added: Dhakad *, Mitkari Wani *, Wani *, Boral *, Borul *, Boraal *, Borad *, Tamboli *	294. Shingdav or Shingadya
62. Kammi	191. Momin, Ansari	295. Sindhur
63. Kapadi	192. Fakir Bandarwala	296. Sore
64. Deleted	193. Deleted	297. Sunna
65. Khati	194. Ghadashi	298. Sunnai
66. Deleted	195. Tamboli, Muslim religious Pan pharosh * (rectified in June 2008)	299. Bhadai
67. Deleted	196. Christians - Converted from Schedule caste.	300. Ganninga, ganchi

No. & Name of the Caste	No. & Name of the Caste	No. & Name of the Caste
68. Deleted	197. Lanzad, Lazad *	301. Thotewadu
69. Kongadi	198. Yadav	302. Timali
70. Korchar	199. Ladsi	303. Walwai
71. Deleted	200. Deleted	304. Wadder (Kalawader or Pathroad)
72. Kachora	201. Gabit	305. Wanadi
73. Kadaira	202. Atar	306. Yenadiwadas
74. Kamati	203. Aundhiya	307. Yergolawad or Thella Pamalwadas
75. Kasabi	204. Baadak, Baarav	308. Odewar
76. Deleted	205. Bagaloo	309. Manyar (Bangalwala), Maniyar, Maneri
77. Deleted	206. Marwar Bawori, Marbar Waghri	310. Jaatgaar
78. Deleted	207. Udasi, Deleted	311. Karadi
79. Deleted	208. Balsanthanam	312. Kunkuwale
80. Kuchbandh	209. Mathura Banjara	313. Wadhai (deleted * in June 2008), Deleted, Khat-wadhai
81. Kuchharia	210. Shingade Banjara	314. Deleted
82. Kumbhar or Kumhar	211. Lambade	315. Kohali
83. Kunbi (Leva, Kunbi, Leva Patidar), Maratha Kunbi, Kunbi Maratha	212. Phanade Banjara	316. Khatik, Kureshi Khatik, Kasai
84. Deleted	213. Sunar Banjara	317. Daangari
85. Kachi	214. Ghaliya Banjara	318. Wedu (Waghari)
86. Kathi	215. Shigadya Banjara	319. Dhawad
87. Kasar (sub-castes - Kachar, Kachari)	216. Baoriya	320. Nirhali (Nirali)
88. Labha	217. Koli Bariya	321. Chitrakathi - Hardas
89. Ladiya, Ladhiya, Lariya	218. Bathini	322.Besta, Besti. Bestallu
90. Ladhaf or Lai-daf (Naddaf), Mansuri	219. Begari	323. Parivar
91. Lakheria	220. Bhampta / Ghantichore / Pardeshi	324. Sawakalar
92. Deleted, Hadad/ Mistri, (Luhar, Luwar)	221. Pong	325. Hanbar
93. Machhi	222. Daasar	326. Dode Gujar, Gujar, Leve Gujar, Reve Gujar, Reva Gujar, Suryavanshi Gujar, Badgujar similar castes- Londhari */Pendhari *

No. & Name of the Caste	No. & Name of the Caste	No. & Name of the Caste
94. Manbhav	223. Uchila	327. Pahad / Pahadi
95. Deleted	224. Bhandura,Billawar, Thiya *, Belchheda *	328. Gadriya
96. Marwar bori	225. Kharavi, Dhivar Bhoi	329. Machhimar (Daldi)
97. May	226. Bhoyar	330. Bhaldar
98. Mina	227. Bindali	331. Alkari
99. Mahali	228. Burbuk	332. Pendhari
100. Mehadar	229. Chadar	333. Yalam / Yelam / Yallam
101. Mhali	230. Chakravaday -Daasar	334. Mahat / Mahut, Mahawat
102. Mitha	231. Chandal	335. Fakir
103. Deleted	232. Chenwu or Chenwwar	336. Loth, Lotha, Lothi
104. Mathura	233. Chimur	337. Nalband
105. Namdhari	130. Bandi	338. Kulekadgi, Kullekadgi, Kulakadgi, Kullakadgi
106. Namdharipek	131. Rachbandhiya	339. Mujavar
107. Nirshikari	132. Rangari	340. Mulana, Mulani, Mulane
108. Naavi-Nhavi, (Salmani, Hajam), Warik, Nabhik, Napit, Mhali, Waland, Hadpad, Hajjam, Naavisen, Salmaniya	133. Ragrez	341. East Indian, East Indian Christian, East Indian Katholic
109. Nethura	134. Raot, Ravat, Rautiya	342.
110. Noniya, Loniya, Luniya, Nuniya	135. Rangrez (Bhavsar, Rangari)	343. Lad Shakhiya Wani *
111. Nakkashi	136. Deleted	344. Muslim - Kakar *
112. Nili	137. Deleted	345. Dorik *
113. Nilkanti	138. Deleted	346. Patwa *
114. Nekarjada	139. Deleted	
115. Padharia	140. Sanjogi	
116.Padiyar	141. Saraaniya	
117. Paatradavru	142. Deleted	
118. Phasechari	143. Deleted	
119. Phudagi	144. Deleted	
120. Pakhali, Sakka	145. Suppaling	
121. Panchal	146. Sutharia (In Sindh)	
122. Paanka	147. Sahis,Saes,Shis	
123. Peraki, Perakewad, Perike, Peraka	148. Sapera	
124. Putligar	149. Shilavat	

No. & Name of the Caste	No. & Name of the Caste	No. & Name of the Caste
125. Parit or Dhobi,Telgu Madelwar (Parit)	150. Singiwala	
126. Patkar, Patavekari, Patavegar, Pategar, Pattegar, Patvi, Kshatriya Patkar, Somvanshiya Sahastrarjun Kshatriya, Khatri *,Kshatriya *	151. Deleted	
127. Phulari	152. Deleted	
128. Rachevar	153. Shimpi, Idrisi/Darji,Sai Sutar, Jain Shimpi, Shravak Shimpi, Shetwal, Shetval, Saitwal, Saitval, Meru Shimpi / Meru Kshatriya Shimpi *	
129. Raikari, Rayikar	154. Sonar	

Source: Dept of Social Justice, Cultural Affairs & Special Assistance, Government of Maharashtra

Table 4.20.1 (B): List of Special Backward Class in Maharashtra

SN.	Name of Caste - SBC	Remarks
1	Gowaari, Gawaari	
2	Deleted	(Maana)
3	(1)Koshti (2) Halaba Koshti (3) deleted (4) Sali, Swakul Sali (5) Lad Koshti (6) Gadhhewal Koshti (7) Deshkar (8) Salewar (deleted *) (9) Padma Shali, Chenewar, Channewar, Salewar * (10) Dewang (11) Kachi Bandhhe (12) Patvis (13) Satasaale (14) Saade (15) Jainkoshti	* Deleted Salewar at Sr No.3/8 & added Salewar at Sr No. 3/9 in 2008 June
4	(1)Koli and similar castes (2) Machhimar Koli (3) Ahir Koli (4) Khandeshi Koli (5) Paankoli (6) Christian Koli (7) Chumbale Koli (8) Paanbhare Koli (9) Koli Suryavanshi (10) Mangela (11) Sonkoli (12) Vaiti (13) Khaarava or Khaaravi (14) Those Kolis who are not included in SC	
5	(1) Munnerwar (2) Munnurwar (3) Munnur (4) Telagu Munnur (5) Munnurwar Telagu (6) Munnurkapu (deleted*) (7) Kaapewar (deleted *) (8) Telagu Kaapewar (9) Munnurwaad (10) Telagu Phulmaali.	*Deleted in 2008 June
6	Muslim Religious Bhangi */Mehetar */ Lalbeg */ Halalkhor */Khakrob *	* Included at Sr No.7 in 2008 June
N.B.	SBC Caste Status Updated till March 31, 2006. This refers to Maharashtra Govt Letter No.CBC-10/2006/P.No.94/MVC-5 of Dept of Social Justice, Cultural Affairs & Special Assistance, Mantralaya Extension Building, Mumbai-32 dated 25.5.2006 addressed to various Ministerial Depts, Divisional Commissioners, DMs, ZP CEOs, Tahsildars etc	
	* **In June 2008, some New Castes were added, some Castes were deleted or rectified in OBC, NT and SBC categories** on the basis of 3 reports No.18 to 21 of the State Backward Class Commission submitted to the Govt during 2006 and 2007 and published vide **Maharashtra Govt Letter No.CBC-10/2006/P.No.94/MVC-5** of Dept of Social Justice, Cultural Affairs & Special Assistance, Mantralaya Extension Building, Mumbai-32 **dated 25.6.2008**	

Source: Dept of Social Justice, Cultural Affairs & Special Assistance, Government of Maharashtra

Table 4.20.1 (C): List of Scheduled Caste in Maharashtra

S.No.	Name of Caste - SC	Remarks
1	Ager	
2	Anamook	
3	Aaremala	
4	Aarwa Mala	
5	Bahna, Bahana	
6	Bakad, Bant	
7	Balahi, Balaai	
8	Basor, Burud, Baansor, Baansodi	
9	Bedajangam, Budagaa Jangam	
10	Bedar	
11	Bhaambi, Bhaambhi, Asodi, Chamdiya, Chamaar, Chamaari, Chambhar, Chamgaar, Haralayya, Harali, Khalpa, Machigaar, Mochigaar, Maadar, Maadig, Mochi, Telagu Mochi, Kamati Mochi,Ranigaar, Rohidas, Nona, Ramnami, Rohit, Samgaar, Surajyabanshi, Surajyaramnami	
12	Bhangi, Mehatar, Olagaana, Rukhi, Malkana, Halalkhor, Lalbegi, Balmiki, Karor, Zadgalli	
13	Bindala	
14	Byagara	
15	Chalwaadi, Channaya	
16	Chennadaasar, Holaya Daasar, Holeya Dasaari	
17	Dakkal, Dokkalwar	
18	**Dhor, Kakkayya,** Kankayya, Dohor	
19	Dom, Dumar	
20	Yallamwar, Yellamalvandalu	
21	Ganda, Gandi	
22	Garoda, Gaaro	
23	Ghassi, Ghassiya	
24	Hallir	
25	Halsaar, Hasalaar, Hulsawar	
26	Holar, Vhalar	
27	Holaya, Holer, Holeyaa, Holiyaa	
28	Kaikadi	Akola, Amaravati, Bhandara, Buldhana, Nagpur, Vardha and Yavatmal Districts. And Chadrapur dist except Rajura Taluka.
29	Katiya, Pathariya	
30	Khangar, Kanera, Mirdha	
31	**Khatik,** Chikwa, Chikvi	

S.No.	Name of Caste - SC	Remarks
32	Kolupool-Wandalu	
33	Kori	
34	Lingader	
35	Maadagi	
36	Maadiga	
37	**Mahar,** Meharaa,Taral, Dhegu-Megu	
38	Maahayaavanshi, Dhed, Vankar, Maru-Vankar	
39	Mala	
40	Mala Daasari	
41	Mala Hannai	
42	Mala Jangam	
43	Mala Masti	
44	Mala Saale, Netkanee	
45	Mala Sanyasi	
46	**Mang, Matang,** Minimaadig, Dakhani-Mang, Mang-Mhashi, Madaari, Gaarudi,Radhemang	
47	Mang-Garodi, Mang-Garudi	
48	Manne	
49	Masti	
50	Menghwal, Menghwar	
51	Mitha, Ayalwar	
52	Mukri	
53	Nadiya, Haadi	
54	Paasi	
55	Saansi	
56	Shenwa, Chenwa, Sedamaa, Ravat	
57	Sindhollu, Chindollu	
58	Tirgaar, Tirbanda	
59	Toori	
N.B.	SC Caste Status Updated till March 31, 2006. This refers to Maharashtra Govt Letter No.CBC-10/2006/P.No.94/MVC-5 of Dept of Social Justice, Cultural Affairs & Special Assistance, Mantralaya Extension Building, Mumbai-32 dated 25.5.2006 addressed to various Ministerial Depts, Divisional Commissioners, DMs, ZP CEOs, Tahsildars *etc.*	

Source: Dept of Social Justice, Cultural Affairs & Special Assistance, Government of Maharashtra

Table 4.20.1 (D): List of Scheduled Tribe in Maharashtra

S.No.	Name of Caste-Schedule Tribe
1.	Andh
2.	Baiga
3.	Barda

S.No.	Name of Caste-Schedule Tribe
4.	Bavacha, Bamcha
5.	Bhaina
6.	Bharia Bhumia, Bhuinhar Bhumia, Pando
7.	Bhattra
8.	Bhil, Bhil garasia, Dholi, Bhil, Dangri Bhil, Dungri, Garasia, Mewsi Bhil, Rawal Bhil, Tadvi Bhil, Bhagalia, Bhilala Pawra, Vasava, Vasave
9.	Bhunjia
10.	Binjhwar
11.	Birhul, Birhor
12.	Chodhara (excluding Akola, Amravati, Bhandara, Buldana, Chandrapur, Nagpur, Wardha, Yavatmal, Aurangabad, Bhir, Nanded, Osmanabad and Parbhani districts)
13.	Dhanka, Tadvi, Tetaria, Valvi
14.	Dhanwar
15.	Dhodia
16.	Dubla Talavia, Halpati
17.	Gamit, Gamta, Gavit, Mavchi, Padvi
18.	Gond, Rajgond, Arakh, Arrakh, Agaria, Asur, Bedi Maria, Bada Maria, Bhatola, Bhimma, Bhuta, Koilabhuta, Koilabhuti, Bhar, Bisonhorn Maria, Chota Maria, Dandami Maria, Dhuru, Dhurwa, Dhoba, Dhulia, Dorla, Kaiki, Gatta, Gatti, Gaita, Gond Gowari, Hill Maria, Kandara Kalanga, Khatola, Koitar, Koya, Khirwar, Khirwara, Kucha Maria, Kuchaki Maria, Media, Maria, Mana, Meannewar, Moghya, Mogia Moghya, Mudia, Muria, Nagarchi, Naikpod, Nagwanshi, Ojha, Raj Sonjhari Jhareka, Thatia, Thotya, Wade Maria, Vade Maria.
19.	Halba, Balbi
20.	Kamar
21.	Kathodi, Katkari, Dhor Kathodi, Dhor Kathkari, Son Kathodi, Son Katkari
22.	Kawar, Kanwar, Kaur, Cherwa, Rathia, Tanwar, Chattri
23.	Khairwar
24.	Kharia
25.	Kokna, Kokni, Kukna
26.	Kol
27.	Kolam, Mannervarlu
28.	Koli dhor, Tokre Koli, Kolcha, Kolgha
29.	Koli Mahadev, Dongar Koli
30.	Koli Malhar
31.	Kondh, Khond, Kandh
32.	Korku, Bopchi, Mouasi, Nihal, Nahul, Bondhi, Bondeya
33.	Koya, Bhine Koya, Rajkoya
34.	Nagesia, Nagasia
35.	Naikda, Nayaka, Cholivala Nayaka, Kapadia Nayaka, Mota Nayaka, Nana Nayaka
36.	Oraon, Dhangad
37.	Pardhan, Pathari, Saroti
38.	Pardhi, Advichincher, Phans Pardhi, Phanse Pardhi, Langoli Pardhi, Behelia, Behellia, Chita

S.No.	Name of Caste-Schedule Tribe
	Pardhi, Shikari, Takankar, Takia
39.	Parja
40.	Patelia
41.	Pomla
42.	Rathwa
43.	Sawar, Sawara
44.	Thakur, Thakar, Ka Thakar, Ma Thakur, Ma Thakar
45.	Thoti (in Aurangabad, Bhir Nanded, Osmanabed and Parbhani districts and Rajura tahsil of Chandrapur district)
46.	Varli
47.	Vitolia, Kotwalia, Barodia

Source: Dept of Social Justice, Cultural Affairs & Special Assistance, Government of Maharashtra

Table 4.20.1 (A): List of Vimukta Jati (Vj) -Denotified Tribes (DTS) in Maharashtra

S.No.	Name of VJ Tribe	SN	Akin Tribe	Remarks
1	Berad	1.A	-	
		1.B	Naikwadi	
		1.C	Talwar	
		1.D	Walmiki	
2	Bestar	2	Sanchalu Vaddar	
3	Bhamata	3.A	Bhamati	
		3.B	Girni Vaddar	
		3.C	Kamati	
		3.D	Patharut	
		3.E	Takari (incl Muslims)	
		3.F	Uchale	
		3.G	Ghantichor	
4	Kaikadi	4.A	Dhontale	
		4.B	Korva	
		4.C	Makadwale or Kunchi Korva	
		4.D	Pamlor	
		4.E	Korvi	
5	Kanjarbhat	5.A	Chhara	
		5.B	Kanjar	
		5.C	Nat	
6	Katabu	-	-	
7	Banjara	7.A	Gor Banjara	
		7.B	Lambada / Lambara	
		7.C	Lambhani	
		7.D	Charan Banjara	
		7.E	Labhan	
		7.F	Madhura Labhan	
		7.G	Kachakiwale Banjara	
		7.H	Laman Banjara	
		7.I	Laman/Lamani	
		7.J	Laban	

S.No.	Name of VJ Tribe	SN	Akin Tribe	Remarks
		7.K	-	
		7.L	Dhali /Dhalia	
		7.M	Dhadi /Dhari	
		7.N	Singari	
		7.O	Navi Banjara	
		7.P	Jogi Banjara	
		7.Q	-	
		7.R	-	
		7.S	Banjari	
8	***	-	Pal Pardhi	
9	Raj Pardhi	9.A	****	
		9.B	Gaon Pardhi	
		9.C	Haran Shikari	
		9.D	****	
10	Rajput Bhamta	10.A	Pardeshi Bhaamta	
		10.B	Pardeshi Bhamti	
11	Ramoshi	-	-	
12	Vadar	12.A	Gadi Vaddar	
		12.B	Jaati Vaddar	
		12.C	Mati Vaddar	
		12.D	Patharwat	
		12.E	Sangtarash/ Dagadfodu	
		12.F	Vaddar	
13	Waghari	13.A	Salaat	
		13.	Salaat Waghari	
14	Chhapparband (incl Muslims)	-	-	

VJ Status Updated till March 31, 2006.
This refers to **Maharashtra Govt Letter No.CBC-10/2006/P.No.94/MVC-5** of Dept of Social Justice, Cultural Affairs & Special Assistance, Mantralaya Extension Building, Mumbai-32 dated 25.5.2006 addressed to various Ministerial Deptt., Divisional Commissioners, DMs, ZP CEOs, Tahsildars *etc.*

Source: Dept of Social Justice, Cultural Affairs & Special Assistance, Government of Maharashtra

(2) Gujarat

Gujarat is one of the most diverse states in India. Its history stretches over a long period from the age old Harappan Civilization to the Mughal period. Gujarat's endless journey from roots to wings is timeless.

Gujarat is also one of the most progressive states in India with state of an art government infrastructure. Gujarat has state wide area Network having connectivity up to taluka level offices. Almost all government departments are networked under GSWAN. Village panchayats are also given VSAT connectivity under the e-Gram project.

This is the land of Gujarat where a very small community "Parsis" in the world came in the middle of 7th century and landed at Sanjan in Gujarat and adopted Gujarati language. In the middle of the 17th century, the Africans called Siddis migrated to Gujarat and carved out a small State of Jafrabad in the State. In addition, there are number of dominant castes in the State.

The people of Gujarat comprises several different ethnic groups and tribes, including the nomadic Ahirs, shepherd community of the Garasia Jats, the craftsmen of the Meghwal tribe and the vibrant colorful Rabadis who trace their roots to Afghanistan and Sind.

There are 290 distinct communities in Gujarat. And interestingly, as many as 206 of these are immigrants from neighboring Rajasthan, Madhya Pradesh and Maharashtra - and even overseas! The Siddis who live in coastal Saurashtra have Negroid features typical of the people of Africa. They are descendants of the African sailors and traders who found their way to Indian shores in the early centuries of the millennium.

The majority of the population lives in small, rustic villages, although about one-third lives in urban areas. The peace-loving Jains form a sizable and influential part in the population of the state (12%). Their foremost religious vow is 'ahimsa' (non-violence) - the simple, but unique weapon that Mahatma Gandhi used against the British! The people of Gujarat are so courteous that in conversation they add the suffix 'Bhai' (brother) or 'Ben' (sister) to the name of the person addressed hence 'Vallabh-bhai' or 'Meera-ben'.

The words for castes in Gujarat are two-Jati and Gnati, which have special significance. Jati emphasizes birth, while Gnati emphasizes connections, relationship and community. The caste is an intuition, an ordering of life and a special system in this land. The Hindus are divided into a number of castes. The four main castes in the past in order were: Brahman, Kshatriya, Vaishya and Shudra.

According to the Census 2011, the population of Scheduled Castes in Gujarat is 30,60,000 which 7.4 per cent of the total population. Most of the Scheduled Castes are local, but some of them like Maru, Vankar have migrated from south India *e.g.* Mahar. They generally follow their hereditary professions but some of them serve in different cadres.The total population of Scheduled Tribes is 14.9 per cent of the total population of the State. In the country as a whole, the population of the tribal is about 8.1 per cent. Gujarat thus has a larger concentration of the tribal population than the national average. The seven districts in which most of the tribal people live are - Valsad, Dangs, Surat, Bharuch, Vadodara, Panchmahals and Sabarkantha. Bhils are the largest tribal group.

Siddis are notified as a Scheduled Tribe under the Constitution. The Africans in Gujarat are called Siddis who are supposed to have migrated to Gujarat in the middle of the 17th century. They had carved out a small State of Jafrabad in Gujarat. They are the descendants of African Negrows, chiefly from Somalia coast and brought to India as slaves. It was customary with the rulers to employ Arabs, Makranis and Sidis as guards and watchmen at their palaces. They are Muslim by religion.

The Parsis are a very small community in the world. They are mainly concentrated in India, but some have settled in U.K., U.S.A., Australia, Japan *etc.* They are the descendants of the ancient Iranian people who belonged to the Zorostrian religion and flourished in Iran. After the downfall of the last empire of the Sasanians on account of religious persecution, about the middle of the7th century, some of the Parsis left Iran for ever. They came to India and landed at Sanjan in Gujarat and have adopted Gujarati language. The Parsis are scattered over in several towns in Gujarat.

The Gujarati Muslims may be divided into two main sections, those who have a foreign origin and those who are almost entirely of local Hindu descent. From the middle of the 7th to the end of the 18thcentury, foreign Muslims continued to find their way into Gujarat. Of the local converts, some were persuaded while others were forced to adopt Islam. Among the Muslims of foreign origin, there are Saiyads, Shaikhs, Pathans and Mughals. The Vohras, Siphais, Ghanchis, Pinjaras, Momnas, Khojas, Molesalams, Memons and Chhipas are Muslims converted from Hindu.

(3) Scheduled Caste and Scheduled Tribes-Zone of Influence (Study Area)

Table 4.20.1 illustrates the status of Scheduled Caste and Scheduled Tribes in the Study Area as per the Census 2011. The total Schedule Cast (SC) population in the study area stood at 3129030 (5.98 per cent of the total population of the study area) comprising 1620602 males and 1508428 females. The highest SC population was recorded as 645107 in Thane urban area followed by 640981 in Ahmedabad urban area as per the Census Records of 2011. The Schedule Tribe (ST) contributes to 12.58 per cent (6585506) of the total population of the study area comprising 3326853 males and 3258653 females.

The highest ST population was reported as 1265162 in Thane rural area followed by 1040599 in Vadodara rural area. It can be concluded that the ST population are on higher side in the rural area as compared to urban conglomerate. The lowest SC population was reported as 17348 in Navsari rural area whereas the ST population was lowest in Anand urban area as 9884.

Table 4.20.1: Population of Schedule Cast & Schedule Tribe in the Zone of Influence

District	No. of Households	Total Population	Male	Female	Schedule Cast Population	Male Schedule Cast	Female Schedule Cast	Schedule Tribe Population	Male Schedule Tribe	Female Schedule Tribe
GUJARAT										
Ahmedabad-Rural	228482	1151178	595583	555595	118502	61988	56514	16749	8656	8093
Ahmedabad-Urban	1281652	6063047	3192468	2870579	640981	337087	303894	72389	38450	33939
Anand-Rural	297658	1457758	758499	699259	74755	39026	35729	9884	5129	4755
Anand-Urban	129947	634987	328725	306262	29710	15450	14260	14940	7632	7308
Kheda-Rural	359691	1776276	915197	861079	86794	44935	41859	27275	14255	13020
Kheda-Urban	107165	523609	270530	253079	28837	14799	14038	13061	6802	6259
Panch Mahals-R	378648	2055949	1053376	1002573	83082	42398	40684	697576	356032	341544
Panch Mahals-U	67963	334827	173585	161242	17364	8880	8484	24028	12316	11712
Vadodara-Rural	417600	2099855	1077943	1021912	83102	42935	40167	1040599	529305	511294
Vadodara-Urban	459506	2065771	1075793	989978	138527	71667	66860	109302	57360	51942
Bharuch-Rural	217298	1026060	529393	496667	35364	18086	17278	431980	221464	210516
Bharuch-Urban	116185	524959	276314	248645	26871	13893	12978	56214	28934	27280
Navsari-Rural	203297	920535	464749	455786	17348	8712	8636	571812	285999	285813
Navsari-Urban	91834	409137	213416	195721	18116	9247	8869	67847	33741	34106
Valsad-Rural	216948	1070177	542644	527533	20777	10537	10240	785002	392473	392529
Valsad-Urban	147455	635501	344578	290923	17460	9020	8440	117792	58503	59289
Surat-Rural	269680	1232109	640060	592049	38640	19559	19081	683413	342580	340833
Surat-Urban	1063520	4849213	2762164	2087049	119475	62643	56832	173539	89509	84030
MAHARASHTRA										
Mumbai Suburban	2105604	9356962	5031323	4325639	583302	300291	283011	104560	55033	49527
umbai-Urban	674339	3085411	1684608	1400803	219934	111564	108370	25093	13488	11605
Thane-Rural	541599	2545470	1300136	1245334	84982	43891	41091	1265162	627288	637874
Thane-Urban	1987566	8514678	4564942	3949736	645107	333994	311113	277289	141904	135385
Total	**11363637**	**52333469**	**27796026**	**24537443**	**3129030**	**1620602**	**1508428**	**6585506**	**3326853**	**3258653**

Source: Directorate General Office, Census of India, 2011

Annexure 4.21

4.21 SOCIO-ECONOMIC PROFILE OF THE STUDY AREA-ZONE OF INFLUENCE

This section presents the socio-economic profile of the study area (Zone of Influence) with respect to the following indicators-population trends, sex ratio, occupational pattern *etc.*, The socio-economic data used in the section are derived from various sources, including the published data of Census of India, District Census Handbook, electronic media and published reports/journals. The analysis included a review of the Feasibility Report for the proposed MAHSR, which included early community involvement in the project (including outreach to minority and low-income populations, in compliance with the prevailing law of the land), station design workshops, and the maintained connectivity of pedestrian, bicycle, and vehicle crossings of the rail corridor to maintain neighborhood and community integrity.

A detailed socio-economic survey and analysis of the project affected persons has been carried out and addressed in the RAP document prepared by NHSRCL

(1) Study Area

For population and household characteristics, including minority populations, census data was analysed for the study area. Because of the sparse population in rural portions of the study area, especially in the State of Gujarat region, some villages encompass very large areas of land that often extend for miles beyond the study area. This was done by reviewing Google Earth imageryand respective Toposheet of Survey of India to determine the presence of habitations within the study area and by site visits to the study areas during September 2014-November 2014 at the F/S Stage and again from May 2017 onwards during the Detailed Design Stage of the project. There are twelve proposed stations in the entire alignment of HSR. All the stations are located in the urban conglomerate. The list of the villages and cities falling in the Zone of Influence is enumerated in Table 4.21.1.

Table 4.21.1: Villages and Cities in the Zone of Influence

S. No	District	Sub-district	Villages
STATE: GUJARAT			
1	Ahmadabad	Ahmadabad City	Urban Area of Ahemdabad and Sabarmati
2	Ahmadabad	Daskroi	Vinzol, Ropda, Geratpur, Gamdi, Barejdi
3	Anand	Anand	Bhumel, Chaklasi, Boriavi, Kanjari, Rajnagar, Ajarpur, Lambhvel, Samarkha, Ajupura, Mangal Nagar, Prasanna Nagar, Nav Bhavan Colony, Ganesh Colony, Anand, Mahaveer Nagar,
4	Kheda	Mehmedabad	Raska, Rohlsa, Amsaran, Nenpur
5	Kheda	Kheda	Devdi
6	Kheda	Nadiad	Khambhali,Degam,Zarol,Andhai,Arera,Hathnoli, Alijada, Manjipura,Dabhan,Davda,Bamroli, Tundel, Dumral, Pipalag, Gutal, Narsanda
7	Vadodara	Vadodara	Rajupura,Vasad,Dodka,Fajalpur,Sankarda,Nandesari,Lalpura ,Vasana, Kotariya,Padmala,Ranoli,Dhanora, Ajod, Sisva, Omkarpura, Jawahar Nagar, Kayali Village, Karadiya, Chhani, Laxmi Nagar, Phulwadi, Fatehganj, Saraswati Nagar, Alembic Nagar, Gorwa, Swami Narayan Nagar, Badi, Murji

S. No	District	Sub-district	Villages
			Nagar, Nizampura,Sri Krishna Nagar, Gaon,Balaji Nagar, Lajpat Nagar, Vadiwadi, Anand Nagar, Anandpura, Fatehpura, Babajipura, Navapura, Manjalpur, Manjeet Nagar, Bhagat Colony, Kololi
8	Vadodara	Padra	Chapad,Gavkhana,Shihor,Virpur,Madapur,Sareja Colony
9	Vadodara	Karjan	Pingalwada,Harsunda,Sarar,Bamangam,Kherda,Anastu,Khandha, Kanabha,Chorbhuj,Karjan,Karanmadi Bodka, Khambola, Manqrol, Sanpa
10	Bharuch	Amod	Sunthodra,Telod,Ochhan,Matar,Ajamnagar,Vasna, Vantarsa, Keshlu
11	Bharuch	Bharuch	Padariya, Kurchan, Karela,Tankariya,Kahan,Seqva, Pipalia, Parkhet,Sitpon,Hingalla,Jhanghar,Pariej,Tralsa Kothi,Mahudhala, Aldar, Luwara, Vagusana, Derol, Samar, Vahalu, Vansi, Vilayat, Tham,Kanthariya,Manubar
12	Bharuch	Anklesvar	Dehegam,Park Safari,Hinqlot,Shishu Vihar Dham, Borbhatha, Modi Nagar, Haripura, Pungam, Diva, Surwadi, Andada,Boldara,Nangal, Kosamadi, Kathodara, Ghodadara, Panoli, Utiyadara, Dhamdod, Hath, Amod, Dungra, Pandavai, Kosamba, Kharach, Kumvarda
13	Navsari	Navsari	Padgha,Vejalpor,Kasbapar,Sarai,Ahmadpur,Telada, Amadpor, Pinsad, Navsari, Nasilpur, Dharagin, Siaodra Adada, Khadsupa, Kachhol,Vegam
14	Navsari	Jalalpore	Kapletha,Dabhel,Asana,Asunder,Kolasana,DhamanSadodra
15	Navsari	Gandevi	Pinjra, Pathari, Pardi, Manekpor, Dhanori, Pipaldhara, Surat, Khergam, Ankleshwar, Vadsangal, Kesali, Deshad, Nandarkha, Pati,Antaliya,Bilimora
16	Navsari	Chikhli	Ghekti
17	Valsad	Valsad	Gorgam,Panchlai,Dungari,Sonwada,Tighara,Saron, Endergota, Khajurdi, Palan, Gundlav, Kewada, Muli, Abrama, Jujwa, Pathri, Chanvai, Binwada, Balda
18	Valsad	Pardi	Sukhlav, Jiyu Colony,Kumbhariya,Kutchihie Society, Pardi, Palsana,Borlai,Udwada,Amli,Khadki,Dungri,Velparva,Motiwada, Kikarla, Sarodhi, TidharaParia, Khuntej, Bagwada, Tarmaliya, Dumalav, Tukwada, Ambach, Pandor, Balitha, Kocharva, Vankachh, Karvad, Aarti Colony, Dungra, Borigam, Valwada
19	Valsad	Umbergaon	Achchhari, Boralai, Bhilad, Anklas,Achad,Nandigam
20	Surat	Olpad	Kudsad, Bharundi,Kareli,Madhar,Khalipor
21	Surat	Kamrej	Shekhpur, Ghaludi, Antroli,Tharoli, Velanja, Umra, Choryasi, Amboli, Abrama, Kathor, Bhairav, Kholvad, Diomand Nagar, Navagam,Laskana,Pasodara,Kathodara,Kosmada,Oviyan, Antroli, Umbhel
22	Surat	Surat City	Khambhsla, Saniya Kanade, Eklera, Bonand,Ravla Allas Vaktana,Kapletha,Lajpor
23	Surat	Palsana	Haripura,Kadodara,Tantlthalya,Kharbhasi,ChalthanSanki,Talodara,Timbarva,Erthan,Vadadala,Baleshvar,Lingad,Taraj,Intalva,Makhinga
DADRA & NAGAR HAVELI			

S. No	District	Sub-district	Villages
24	Silvasa	Dadra & Nagar Haveli	Dadra, Demani, Nani Tambadi, Dhapsa, Kachigam, Athal, Kharadpada, Kanadi, Naroli
STATE: MAHARSHTRA			
25	Palghar	Talasari	Achchhad,Kajali, Bormal, Kochai,Sawroli,Amagaon, Donqari, Girgaon, Vasa, Kawada,Sawane,Vadavali, Dhamanagaon, Karajgaon, Vankas
26	Palghar	Dahanu	Dahanu,Gangangaon, Ghadane, Bramhanwadl, Pardi Bahare,Talothe,Punjave, Sasvand, Nagzari, Ambesari Patilpada, Sogwe, Junnarpada, Ashagad, Jamshet, Saravali, Gaurwadi, Agwan, Motapada, Pale, Sakhare, Motgaon, Gowane, Vadade, Palghar, Ambiste
27	Palghar	Palghar	Ranishigaon, Shigaon, Police Colony, Pamali, Swarup Nagar, Ashutosh Nagar, Boisar, Mahagaon, Friends Colony, Warangade, Betegaon, Kambalgaon, Umroli, Birwadi, Panchali, Agawan, Morekuran, Kolgaon, Devkhope, Shelwadi, Palghar, Varkhunti, Wasare, Kamare, Mykhop, Umbar Pada, Nandade, Nagave, Agarwadi, Vatthalwadi, Saravali, Manjurli,Mande, Shilte,Saratodi,Virathan, Khardi, Bandar, Dongare, Mithagar,Jalsar,Kandre Bhure,Wadhiv, Saravali, Navghar, Vadhi, Datiware
28	Palghar	Vasai	Kasarali,Palghar,Dahisar,Koshimbe,Gadakari Nagar,Baba Nagar,Tokare,Khairpada,Prem Nagar,Virar,Kargil Nagar, Nalaso East,Benjil,Nagrik Colony,Ostwal Nagari,Umvaola,Pelhar,Dube State, Bilalpada, Vasai, Agarwa, Gokhivare, Waliv, Gokul Nagar, Rajavali, Kolhi, Chinchoti, Juchar, Sarjmori,Kaman,Navghar Mori, Poman, Dongar, Nagal
29	Thane	Bhiwandi	Nagli, Bhiwandi, Paye Gaon, Firangpada, Kharbav, Tembhavali, Junandurkhi, Vadghar, Dunge, Vadunavaghar, Kewani, Heera Nagar, Kopar Khairane, Kalher Village, Pume, Val Village, Kasheli Village, Thane, Mankoli Village,Dapode, Dive Anjur, Gundavali, Surai, Anjur, Bharodi, Alimghar
30	Thane	Navi Mumbai	Adabali Village,Mhape Village,Sector-2,Sector-3,Sector-4, Kopar, Sector-20,Sector-9,Sector-19,Sector-22, Khairane
31	Thane	Thane	Diva, Mumbara,
32	Mumbai (Suburban)		Vikhroli, Ghatkopar-West, Amrut Nagar, Vidya Vihar, Sanjay Nagar, Rajawadi, Wadia Colony, Kranti Nagar, Jari Mari Govind Nagar, Premier Colony, Kole, Kalyan, Sundar Nagar, Kallna, Nagpada

Source: Study Team

Note: Palghar was declared district under directive No.Pra.Phe.B.1108/C.R.167/Thane/M-10 on 1st August 2014, hence the villages now part of Palghar are included in Thane District.

(2) Demography and Socio-Economic Features

Demography and socio-economic features include population, number of houses and households, literacy, population density *etc.*In order to assess the demographic and socio-economic features of the study area, census records of Maharashtra and Gujarat State for the year 2001 and 2011 have been compiled and analyzed. The list of the villages and cities falling within the ZOI of the proposed alignment has been illustrated in Table 4.21.1 above. In this section district level data of Census 2011 has been compiled, analyzed and discussed in the subsequent sections.

(3) Population, Gender and Population Density

Table 4.21.2 illustrates the status of population and its growth, sex ratio and population density.

Population

As per the Census 2011, the total population of the ZOI stood at 45,131,455. The population growth shows downward trend during the last decade of 2001-2011 as compared to 1991-2001. The Mumbai District shows negative trend which is good for the development. The population growth in the Mumbai district stood at 5.14 per cent during 1991-2001 and the same has been recorded as 5.75 per cent during 2001-2011 decade. Similarly, the Mumbai city has shown remarkable control over population outburst, having 27.9872 per cent during 1991-2001 drastically came down to 8.01 per cent during 2001-2011.

Gender

The sex ratio in general shows positive trend except Surat which shows declining trend in sex ratio. As per the Census 2001, it stood at 810 females per 1000 males which came down to 788 females per 1000 males as per Census 2011. Mumbai has recorded phenomenal growth in sex ratio having 857 females per 1000 males as per Census 2011 as compared to 822 females per 1000 males as per Census 2001which shows 4.26 percentage increase in the sex ratio.

Population Density

It is evident from the Table 4.21.1, that there has been phenomenal growth in the population and its density. The highest population density is recorded in Mumbai suburban area which stands at 20925 per sq. km. (Census 2011) showing upward trend as compared to that of 2001 (19373.1 per sq. km.). However, the rural area of Mumbai district shows downward trend with 20038 per sq. km. in Census 2011, compared to that of Census 2001 (21261.3 per sq. km.).This is because of the migration of the rural population towards suburban area in search of livelihood. The lowest population density was recorded in Bharuch district of Gujarat with figure at 238 per sq. km (Census 2011) as compared to 210 per sq. km. (Census 2001).

Table 4.21.2: Population, Sex Ratio and Population Density in the Zone of Influence

District	Population 2011			% age Decadal Variation population		Sex- Ratio		Population Density per sq. km.	
	Persons	Males	Females	1991-01	2001-11	2001	2011	2001	2011
GUJARAT									
Ahmedabad	7,208,200	3,787,050	3,421,150	27.25	22.31	892	903	727	890
Anand	2,090,276	1,088,253	1,002,023	13.04	12.57	910	921	631	711
Kheda	2,298,934	1,187,098	1,111,836	13.32	12.81	923	937	479	541
Panch Mahals	2,388,267	1,227,805	1,160,462	20.39	17.92	938	945	389	458

District	Population 2011			% age Decadal Variation population		Sex- Ratio		Population Density per sq. km.	
	Persons	Males	Females	1991-01	2001-11	2001	2011	2001	2011
Vadodara	4,157,568	2,150,229	2,007,339	19.87	14.16	919	934	482	551
Bharuch	1,550,822	805,945	744,877	19.37	13.14	921	924	210	238
Navsari	1,330,711	678,423	652,288	13.24	8.24	955	961	557	602
Valsad	1,703,068	884,064	819,004	29.65	20.74	920	926	465	561
Surat	6,079,231	3,399,742	2,679,489	54.30	42.19	810	788	968	1376
MAHARSHTRA									
Thane*	11,054,131	5,879,387	5,174,744	54.92	35.94	858	880	851	1157
Mumbai (Suburban)	9,332,481	5,025,165	4,307,316	27.99	8.01	822	857	19373	20925
Mumbai	3,145,966	1,711,650	1,434,316	5.14	-5.75	777	838	21261	20038
Total	45,131,455	27,824,811	24,514844						

Source: Directorate General Office, Census of India, 2011

*Note: * Palghar was declared district under directive No.Pra.Phe.B.1108/C.R.167/Thane/M-10 on the 1st August 2014, hence the Census Data of Palghar is included in Thane district Census Data.*

(4) Occupational Pattern of the Study Area

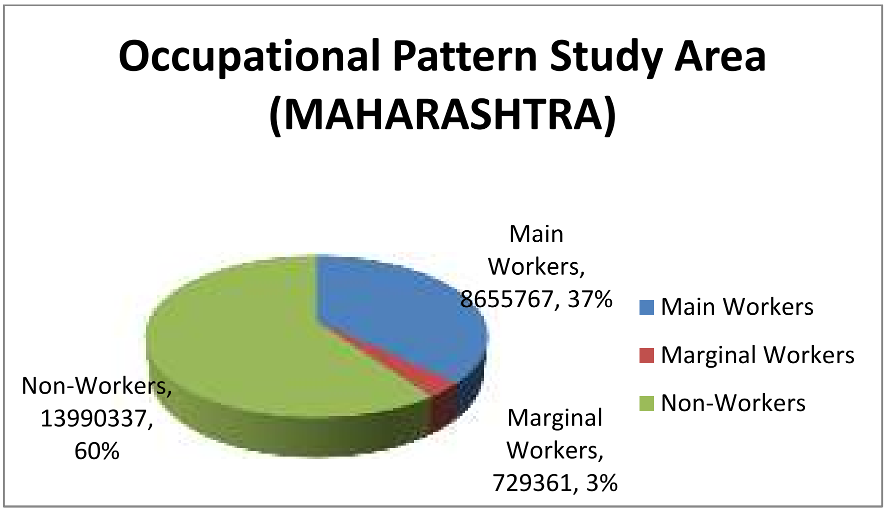
Table 4.21.3 shows the status of occupational pattern of the ZOI based on the Census 2011. The population of main workers in the ZOI stands at 18465302 (35.29 per cent of the total population) comprising of male – 15024665 and female – 3440637 respectively. On perusal of the Table 4.21.3, it is evident that the population of the main workers is the highest in Mumbai suburban which stands at 93515922 followed by Thane urban-3045058 whereas, the lowest population of main workers recorded in Navsari-144902. The population of the marginal workers (which work for 3 to 6 months in a year) stood at 2412238 (4.61 per cent of the total population). The population of the marginal workers recorded highest in Panch Mahals which stands at 379808 (0.73 per cent of the total population). This is because of the rural character of the district. The population of non-workers in the study area stands at 31140831(59.50 per cent of the total population) comprising male – 11595194and female – 19545637. The number of female non-workers are on higher side, which indicate that even now most of the female are house wives. They prefer to be at home to take care of the children and old aged family members. It is surprising to note that the population of non-workers in Mumbai suburban is the highest in the study area which stands at 5621941 (10.74 per cent of the total population of the ZOI) comprising male – 2087001 and female-3534940 followed by Thane where it stands at 5191640 (9.92 per cent of the total population of the ZOI) comprising male – 1931237 and female – 3260403. During the construction of the MAHSR the non-workers can be engaged suitably.

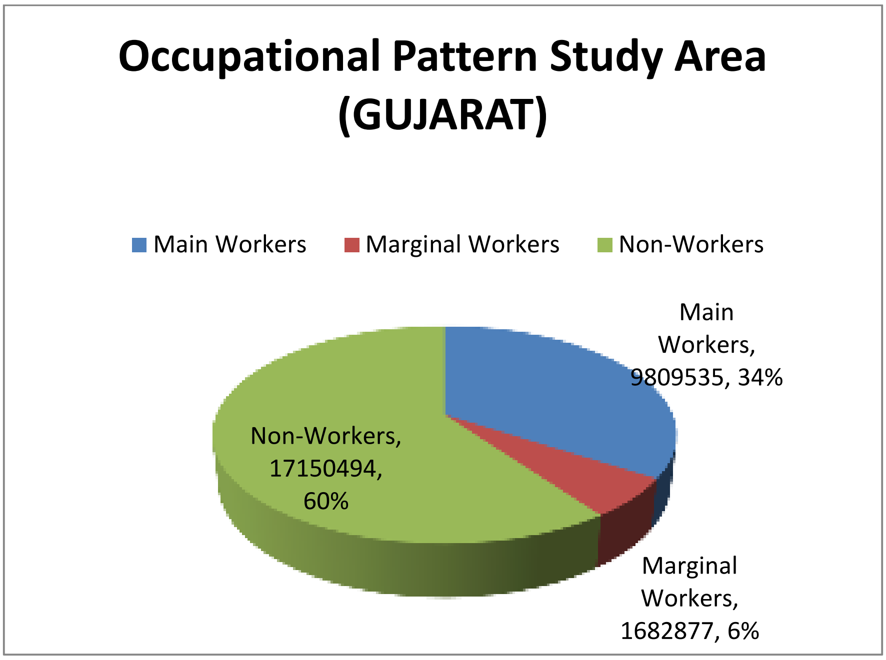
Table 4.21.3: Occupational Pattern of the Study Area

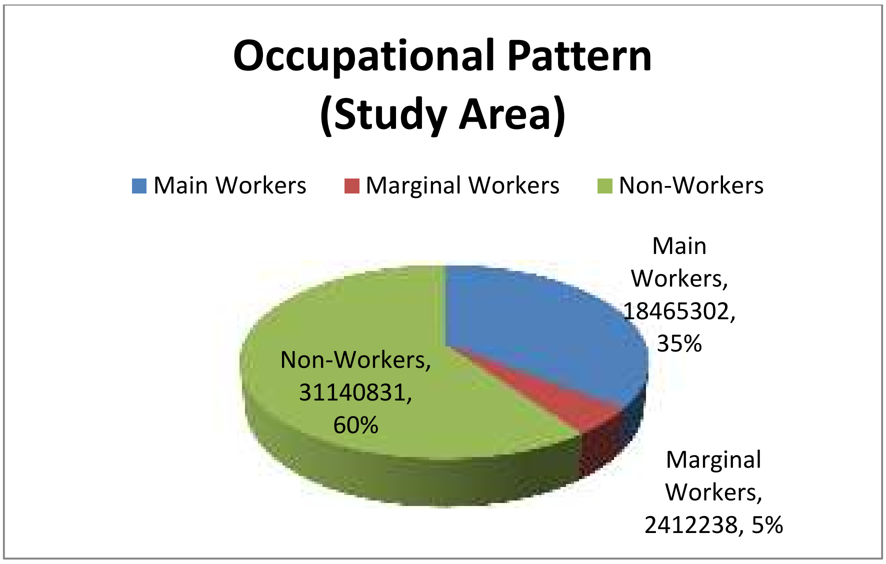
District	Population			Main Workers			Marginal Workers			Non-Workers		
MAHARASHTRA												
	Persons	Males	Females	Persons	Males	Females	Persons	Males	Females	Persons	Males	Females
Thane –Rural*	2545470	1300136	1245334	885453	595115	290338	237976	113980	123996	1375741	570718	805023
Thane –Urban*	8514678	4564942	3949736	3045058	2464388	580670	244438	149082	95356	5191640	1931237	3260403
Mumbai Suburban	9356962	5031323	4325639	3515922	2811481	704441	183283	109677	73606	5621941	2087001	3534940
Mumbai	3085411	1684608	1400803	1209334	975508	233826	63664	38123	25541	1801015	663599	1137416
GUJARAT												
Ahmedabad – Rural	1151178	595583	555595	374763	311753	63010	87848	26721	61127	677954	254049	423905
Ahmedabad – Urban	6063047	3192468	2870579	1957646	1693961	263685	145434	80976	64458	3941319	1406455	2534864
Anand – Rural	1457758	758499	699259	495207	403545	91662	113832	37047	76785	836746	313254	523492
Anand – Urban	634987	328725	306262	194824	166681	28143	26122	14191	11931	411205	146409	264796
Kheda – Rural	1776276	915197	861079	568726	461277	107449	174935	60833	114102	1018196	386662	631534
Kheda – Urban	523609	270530	253079	153408	132291	21117	19814	12130	7684	347706	124479	223227
Panch Mahals	2390776	1226961	1163815	685141	561301	123840	379808	98657	281151	1293269	553396	739873
Vadodara – Rural	2099855	1077943	1021912	712860	567617	145243	253760	68557	185203	1107415	433027	674388
Vadodara – Urban	2065771	1075793	989978	647800	554174	93626	46534	29580	16954	1364738	487397	877341
Bharuch – Rural	1026060	529393	496667	363649	281479	82170	73534	29063	44471	578875	214202	364673
Bharuch – Urban	524959	276314	248645	162892	142405	20487	14469	9577	4892	345020	122586	222434
Navsari – Rural	920535	464749	455786	365102	256694	108408	64473	23882	40591	483631	181124	302507
Navsari – Urban	409137	213416	195721	144902	118681	26221	8515	4793	3722	254207	89160	165047
Valsad – Rural	1070177	542644	527533	350874	259041	91833	121648	44417	77231	576743	230795	345948
Valsad – Urban	635501	344578	290923	226453	191353	35100	20394	11294	9100	385690	140239	245451
Surat – Rural	1232109	640060	592049	522191	375267	146924	66490	22311	44179	636710	239610	397100
Surat – Urban	4849213	2762164	2087049	1883097	1700653	182444	65267	36395	28872	2891070	1019795	1871275
TOTAL	**52333469**	**27796026**	**24537443**	**18465302**	**15024665**	**3440637**	**2412238**	**1021286**	**1390952**	**31140831**	**11595194**	**19545637**

Source: Directorate General Office, Census of India, 2011

Note: Palghar was declared district under directive No.Pra.Phe.B.1108/C.R.167/Thane/M-10 on 1st August 2014, hence the Census Data of Palghar District is included in Thane district Census Data.


Occupational Pattern Study Area (MAHARASHTRA)
Main Workers, 8655767, 37%
Marginal Workers, 729361, 3%
Non-Workers, 13990337, 60%
Main Workers
Marginal Workers
Non-Workers


Occupational Pattern Study Area (GUJARAT)
Main Workers
Marginal Workers
Non-Workers
Main Workers, 9809535, 34%
Non-Workers, 17150494, 60%
Marginal Workers, 1682877, 6%


Occupational Pattern (Study Area)
Main Workers
Marginal Workers
Non-Workers
Main Workers, 18465302, 35%
Non-Workers, 31140831, 60%
Marginal Workers, 2412238, 5%

Annexure 4.23

4.23 EDUCATIONAND LIERACY

Education is pivotal to Human Resource Development. Education is the most significant and vital factor not only for economic growth of a society but also for elimination of socio-economic inequalities prevalent in any society. Education not only provides a society with highly skilled and trained work force but also creates informed and aware citizenry and is directly instrumental in uplifting the standards of living. It is thus imperative that every progressive society creates a robust education system catering to the aspirations of its people.

Constitutional and Legislative Provisions relating to Education

Education (including technical education, medical education and universities, subject to the provisions of Entries 63, 64, 65 and 66 of List I (Union List); vocational and technical training of labor) falls in List III (Concurrent List) of Seventh (7^{th}) Schedule of the Indian Constitution and is, therefore, a concurrent legislative subject matter in India, meaning, that the Parliament as well as the State Governments are empowered to legislate. By convention, the States are given the primacy but in case of a conflict with any Parliamentary Law, the Parliamentary law shall prevail over the State law.

The Article 45 of the Constitution of India in Part IV *i.e.* Directive Principles of State Policy provided that the State shall endeavor to provide within 10 years from the commencement of the Constitution, free and compulsory education for all children till the age of 14 years. The Directive principles of State policy are not enforceable in any Court (Article 37) and do not vest any rights in the citizens. They are merely principles of governance that the State must strive to achieve while enacting laws. Thus, no necessary Constitutional obligation was cast upon the State to provide education. The Supreme Court of India however, interpreted Article 21 in Part III (Fundamental Rights) of the Constitution to be wide enough to encompass education as a fundamental right.

The Parliament of India vide the Constitution (86th Amendment) Act, 2002 that came into effect from 01.04.2010, substituted the Article 45 and also inserted Article 21A in Part III of the Constitution. Article 45 now provides that, the State shall endeavor to provide early childhood care and education for all children till the age of 6 years. Article 21A makes education a Fundamental Right and provides that the State shall provide free and compulsory education to all children of age 6-14 years in such manner as the State may determine by law.

To give effect to Article 21A, the Parliament of India enacted "The Right of Children to Free and Compulsory Education Act" 2009, (Act 35 of 2009) and came into effect from 01.04.2010. The Act was amended through The Right of Children to Free and Compulsory Education (Amendment) Act, 2011 (Act 30 of 2012) and further though The Right of Children to Free and Compulsory Education (Amendment) Act, 2017 (Act 24 of 2017).

The Constitution also guarantees self determined rights to religious and linguistic minorities to establish and administer educational institutes (Article 30) and provides for affirmative action for advancement of socially and educationally backward classes of citizens and Scheduled Castes and Tribes.

Across India, Schools, Colleges, Universities, Institutions of higher learning, Research organizations *etc.* are administered either by the State Governments, Central Government, private organizations (including corporate's, religious and charitable institutions *etc.*), Minorities *etc*. Based upon financial sources, they are classified into Public, Government aided or Private. The role and share of the private sector in education has been steadily increasing over the last couple of decades, mainly on account of higher earnings of the parents, scarcity of vacancies in higher education especially professional, scarcity of employment opportunities and lack of quality public education system *etc*.

Initiative Taken by the Government

The Central and State governments have launched multiple programs to achieve universalization of primary education. ***Sarva Shiksha Abhiyan*** (SSA), among others aim to universalize primary education (up to class 4) by 2007 and elementary education (up to class 7) by 2010 by focusing on the disadvantaged sections–girls and those belonging to Scheduled Castes and Tribes among whom the school dropout rate quite high.

New Central Sector Scheme of Interest Subsidy on Educational Loans taken by Students From Economically Backward Sections to Pursue Technical/Professional Education in India Under the Educational Loan Scheme of the Indian Banks' Association

The Government has approved a new Central Sector Scheme to provide full interest subsidy during the period of moratorium on loans taken by students belonging to economically weaker sections from scheduled banks under the Educational Loan Scheme of the Indian Banks Association for pursuing any of the approved courses of studies in technical and professional streams from recognized institutions in India.

Rashtriya Uchchatar Shiksha Abhiyan (RUSA)

Rashtriya Uchchatar Shiksha Abhiyan (RUSA) is a Centrally Sponsored Scheme (CSS), launched in 2013 aims at providing strategic funding to eligible state higher educational institutions. The central funding (in the ratio of 60:40 for general category States, 90:10 for special category states and 100% for union territories) would be norm based and outcome dependent. The funding would flow from the central ministry through the state governments/union territories to the State Higher Education Councils before reaching the identified institutions. The funding to states would be made on the basis of critical appraisal of State Higher Education Plans, which would describe each state’s strategy to address issues of equity, access and excellence in higher education.

RUSA would create new universities through up gradation of existing autonomous colleges and conversion of colleges in a cluster. It would create new model degree colleges, new professional colleges and provide infrastructural support to universities and colleges. Faculty recruitment support, faculty improvements programmers and leadership development of educational administrators are also an important part of the scheme.

Recent Steps

UDAAN is dedicated to the development of girl child education, so as to promote the admission of girl students. USTTAD has been approved to upgrade the Skills and Training in Traditional Arts/ crafts. The scheme aims to build capacity of traditional artisans/craftsmen, standardization of the traditional arts/crafts, their documentation and establishing market linkages.

The Government created a dedicated ministry of Skill Development immediately to empower our youth. Dedicated Ministry created for skill development. 76 lakh youth have been provided skill training so far under various programs. Skill certifications have been given academic equivalence under ‘School to Skill’ programme. Pradhan Mantri Kaushal

Vikas Yojana with anoutlay of Rs. 1,500 crores have been approved. Pandit Deen Dayal Upadhyaya Grameen Kaushal Yojana will train 10 lakh rural youth in 3 years

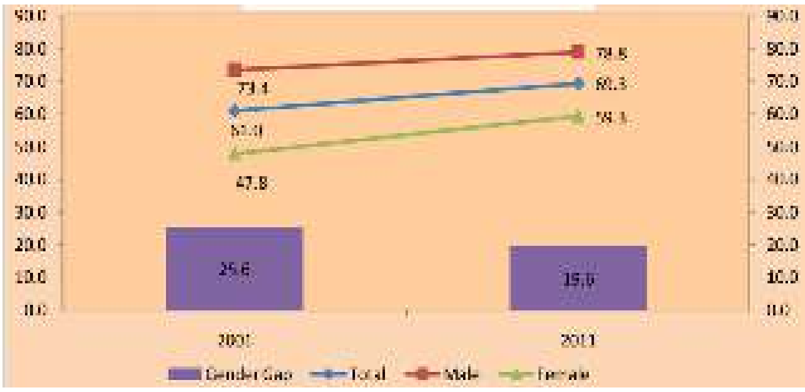
Amendments to Apprenticeship Act are paving way for more opportunities for on-the-job training. Government will support one lakh apprentices in next two and a half years by sharing the 50 % of the stipend. Govt plans to have more than 20 lakh apprentices in next few years against present number of 2.9 lakh.

National Education Statistics

1) Literacy Rate

The two main sources of educational statistics are the educational institutions and the household surveys. The educational institutions provide the data on enrolment and number of teachers whereas information on aspects like literacy rate, educational level of population, private expenditure on education etc., is available only through household surveys. In India, a person aged 7 years and above who can both read and write with understanding in any language has been taken as literate. The Adult Literacy rate (15+ Age Group) is the percentage of population 15-24 years old who can both read and write with understanding a short simple statement on everyday life. The adult literacy rate has shown an upward trend for females as well as males. It has increased from 61% to 69.3% during the period 2001-2011. This indicator, being a statement about the stock of human capital, is slow to change. As per National Sample Survey's 71st round findings, Adult Literacy rate stands 70.5% for year 2014. The decadal variation in the literacy rate in India is shown in Exhibit 4.23.1.

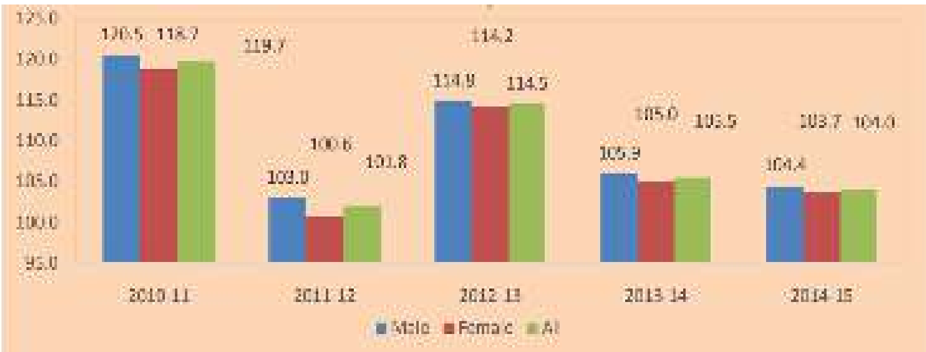
Exhibit 4.23.1: Decadal variation in Literacy Rate (%)



Source: Educational Statistics - At a Glance (2016)-HRD Ministry

The bright line is that from 2001 to 2011, the increase in adult literacy rate was higher among females than males and the gender gap was also narrowing down. The Gross Enrolment Ratio (GER) for a class-group is the ratio of the number of persons in the class-group to the number of persons in the corresponding official age-group. Thrust on providing primary education has yielded results with the GER presently exceeding hundred. The progress is visible across the social categories and gender with GER for SC, ST and girls shooting above hundred (Refer Exhibit 4.23.2).

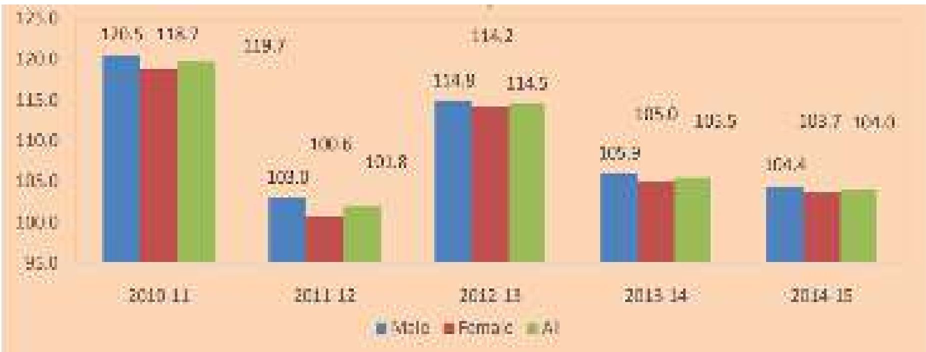
Exhibit 4.23.2: Trend in GER amongst ST students at Elementary level



Source: Educational Statistics - At a Glance (2016)-HRD Ministry

The GER for all persons in elementary education has increased from 81.6% in 2000-01 to 96.9% (provisional figure) in 2014-15. At this level, the GER for boys and girls increased by 4.5 (from 90.3% to 94.8%) and 26.4 (from 72.4% to 99.2%) percentage point respectively during the stipulated period. Education is the single most important factor to ensure gender equality and empowerment. The Gender Parity Index (GPI) is the ratio of the number of female students enrolled at primary, secondary and tertiary levels of education to the corresponding number of male student in each level. Thus GPI (based on GER) which is free from the effects of the population structure of the appropriate age group, provides picture of gender equality in education. During 2005-06 to 2014-15, substantial progress has been achieved towards gender parity in education as revealed by GPI as shown in Exhibit 4.23.3.

Exhibit 4.23.3: Trend in Gender Parity Index



Source: Educational Statistics - At a Glance (2016)-HRD Ministry

<u>State Education Statistics</u>

a) <u>Maharashtra</u>

The districts through which the MAHSR alignment passes in Maharashtra have four thousand and twenty-four primary schools, zero middle schools, one thousand two hundred seventy-six secondary schools and thirteen hundred and eight senior secondary schools.

In graduation level education there are three hundred and fifty-six Arts/ Science/ Commerce college, five thousand two thundered and twenty-sevenmedical colleges and over three thousand six hundred engineeringcolleges in the districts along this alignment (refer Table 4.23.1).

Maharashtra ranks one of the better states in education infrastructure however its Human Development Index (primary level) is 0.677. Smaller states and states from the north-eastern region higher EDI values at Upper Primary than at Primary level of education. For example, EDIs in case of Kerala are 0.756 at Primary and 0.788 at Upper Primary levels compared to 0.767 and 0.747 respectively in case of Delhi. Almost similar EDI values are obtained in case of the remaining three states. Gujarat (0.677), Maharashtra (0.677), Andhra Pradesh (0.670) and Punjab (0.654).

The districts of Maharashtra through which MAHRS alignment passes (Mumbai, Thane & Palghar) have well developed educational infrastructure (Ref. Table 4.6.1).

Maharashtra has 24 universities with a turnout of 1,60,000 Graduates every year. The University of Mumbai is the largest university in the world in terms of the number of graduates and has 141 affiliated colleges.

Table 4.23.1 Educational, Recreational and Cultural Facilities (Maharashtra)

Sr. No.	District	Name of Town	Primary school	Middle school	Secondary school	Senior Secondary school	U/G Level Colleges	Medical colleges	Engineering colleges
1	Thane	Dahanu (M Cl)	23	16	5	2	1	64	64
2		Chinchani (CT)	13	6	1	1	1	39	60
3		Vikramgad (CT)	7	7	4	1	1	110	82
4		Jawhar (M Cl)	8	7	5	2	0	110	110
5		Kudus (CT)	7	3	1	1	15	42	45
6		Vada (CT)	13	5	4	2	1	2	45
7		Palghar (M Cl)	15	8	7	4	1	45	3
8		Katkar (CT)	6	4	2	2	16	59	15
9		Boisar (CT)	14	14	10	4	14	58	14
10		Salwad (CT)	5	4	1	5	20	20	12
11		Dandi (CT)	4	3	1	1	15	59	13
12		Khaira (CT)	4	2	1	1	11	57	11
13		Saravali (CT)	3	2	1	1	15	60	15
14		Manor (CT)	10	4	4	2	19	85	85
15		Shirgaon (CT)	5	3	3	6	6	51	6
16		Umbar Pada Nandade (CT)	2	1	1	1	19	30	19
17		Tarapur (CT)	8	4	2	2	16	34	16
18		Pasthal (CT)	11	10	6	2	1	130	17
19		Vasai-Virar City (M Corp)	195	185	142	28	5	2	2
20		Chandrapada (CT)	4	1	1	1	1	15	10
21		Mira-Bhayandar (M Corp.)	182	171	102	11	7	5	5
22		Thane (M Corp.)	427	423	261	66	7	1	4
23		Navi Mumbai (M Corp.)	243	232	159	36	37	4	10
24		Bhiwandi Nizampur (M Corp.)	170	160	80	16	1	1	17
25		Padagha (CT)	5	3	2	1	15	15	32
26		Shelar (CT)	3	3	2	2	2	2	18
27		Khoni (CT)	6	4	3	1	1	1	20

Sr. No.	District	Name of Town	Primary school	Middle school	Secondary school	Senior Secondary school	U/G Level Colleges	Medical colleges	Engineering colleges
28		Mahapoli (CT)	3	3	1	1	11	11	41
29		Borivali Tarf Rahur (CT)	2	2	2	1	1	15	35
30		Kambe (CT)	2	1	1	5	5	25	25
31		Katai (CT)	4	1	2	2	2	2	20
32		Karivali (CT)	3	3	1	4	4	4	15
33		Kharbav (CT)	1	1	1	1	5	17	17
34		Rahanal (CT)	5	5	3	2	4	4	13
35		Purne (CT)	1	1	2	2)	4	4	13
36		Kalher (CT)	5	5	2	6	6	6	6
37		Kon (CT)	10	7	5	1	3	20	20
38		Kasara Bk. (CT)	16	5	3	34	16	80	35
39		Shahapur (CT)	8	7	4	2	1	60	3
40		Vashind (CT)	10	7	4	3	9	45	12
41		Khardi (CT)	4	4	1	1	15	67	18
42		Gotheghar (CT)	2	1	1	1	1	56	1
43		Asangaon (CT)	8	6	5	1	1	60	1
44		Kalyan-Dombivli (M Corp.)	311	287	201	44	17	20	1
45		Kambe (CT)	3	3	2	7	7	28	27
46		Mharal Bk (CT)	9	6	5	2	8	25	25
47		Ulhasnagar (M Corp.)	132	129	70	21	8	30	30
48		Badlapur (M Cl)	53	53	30	3	1	35	1
49		Ambarnath(M Cl)	159	135	82	18	1	25	1
50		Vangani (CT)	6	6	3	1	26	60	60
51		Murbad (CT)	10	8	4	1	10	70	70
52	Mumbai	Greater Mumbai (M Corp.) (Part)	642	541	413	126	21	5	13
		TOTAL	**2802**	**2511**	**1655**	**454**	**356**	**1873**	**1081**

Source: censusindia.gov.in

b) Gujarat

The State of Gujarat has achieved impressive improvement in education indicators in the last 15 years. The achievement is both because the demand for education has increased and the supply has also improved in most parts of the State.

Gujarat had an estimated 8.2 million children enrolled in the primary classes with the Gross Enrolment Ration (GER) touching almost 100%. There were about 2.77 million children enrolled in institutions imparting secondary and higher secondary education.

Gujarat ranks 9th on the Education Development Index (EDI); Planning and prepared by the National University of Educational Administration (NUEPA), this index measures the performance of states on the Universalization of Elementary Education programme. Though it is a significant leap from its 14th position not very long ago, it still points to a compelling need for making intensive efforts to bring about a change in the status of education in the state.

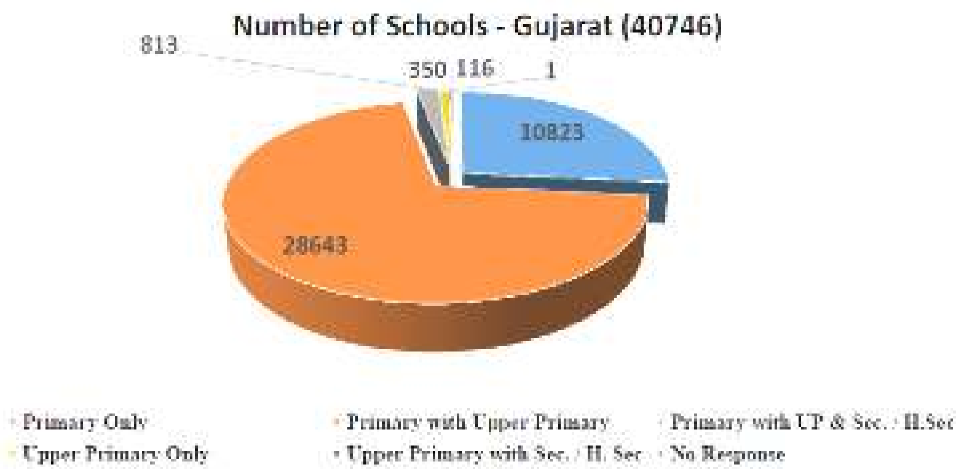
Both the government and the private sector are increasingly playing a larger role in ensuring that children are not left out of the education system for want of infrastructure. Gujarat Knowledge Society (GKS) is a society formed by the Govt. of Gujarat to prepare the youth for the knowledge-based economy and society so as to stimulate creation of world class knowledge resources by developing new competencies in skills. It uses PPP model in which demand- driven skill training programmes are delivered by private training agencies in the classrooms & computer labs of existing Government schools and colleges.

Gujarat Technical University (GTU) was established in the year 2007 with a view to cover Technical Education of the State under one umbrella so as to have a common academic setup all over the Gujarat.

There are total 30 universities in Gujarat as of 4th February 2012. In Gujarat, there is one central university, eighteen state universities, two deemed universities and nine private universities as on date. Fresh data released by the Ministry of Human Resources Development (MHRD), Government of India, suggest that Gujarat is one of the poorest performers in ensuring the enrollment of children in secondary and higher secondary schools. Found reflected in the report, "Secondary Education in India, Thematic Maps: 2012-13", published by the National University of Educational Planning and Administration (NUEPA), which operates under the MHRD, the data suggest that out of 20 major states, as many as 13 of them enrolled a higher proportion of students than Gujarat at the higher secondary level. At the secondary level, things are not very different – here, too, as many as 13 major states enrolled higher proportion of students than Gujarat.

Gujarat education system follows a uniform pattern of elementary education *i.e.* the Std 1 – IV (Primary) and Std. V – VII (Upper Primary). According to DISE Date 2011 – 2012, there are 40746 schools including Primary, Upper Primary, Secondary and Higher Secondary Schools. Government is the major provider of elementary education. In Gujarat 33,496 Elementary Schools run and managed by the Government and 7444 school run by the private managements. The status of educational facilities in Gujarat is shown in Exhibit 4.23.4.

Exhibit 4.23.4: Status of No. of Schools



Source: www.educationinnovations.org/.../Status%20of%20Elementary%20Education%20in%.

Table 4.23.2 Educational, Recreational and Cultural Facilities (Gujarat)

Sr. No.	District	Name of Town	Primary school	Middle school	Sec. school	Senior Secondary school	UG Level College	Medical colleges	Engineering colleges
1	Ahmadabad	Viramgam (M)	22	0	4	3	62	62	62
2		Sanand (M + OG)	25	0	9	4	25	25	25
3		Ahmadabad Cantonment (CB)	6	0	4	3	7	7	7
4		Ahmadabad (M Corp.)	1337	0	255	255	1	4	6
5		Bareja (M)	13	0	2	2	20	20	20
6		Bopal (CT)	12	0	3	3	13	13	13
7		Singarva (CT)	2	0	1	14	14	14	14
8		Nandej (CT)	2	0	2	4	18	18	18
9		Dholka (M + OG)	34	0	16	6	42	42	42
10		Bavla (M + OG)	7	0	4	9	32	32	32
11		Ranpur (CT)	9	0	30	3	130	120	120
12		Barwala (M)	10	0	2	2	132	67	67
13		Dhandhuka (M)	16	0	6	2	105	95	95
14	Anand	Sojitra (M)	9	0	3	2	22	20	22
15		Umreth (M)	13	0	7	5	30	30	39
16		Boriavi (M)	16	0	3	2	7	7	7
17		Ode (M)	9	0	2	2	30	40	25
18		Anand (M + OG)	72	0	23	28	2	8	5
19		Vallabh Vidyanagar (M)	9	0	8	3	1	3	3
20		Karamsad (M)	15	0	2	3	3	3	1
21		Vithal Udyognagar (INA)	2	0	2	2	2	2	2
22		Gamdi (CT)	3	0	2	2	5	4	5
23		Hadgood (CT)	3	0	5	5	5	7	6
24		Petlad (M)	21	0	7	4	21	29	1
25		Khambhat (M + OG)	30	0	6	7	1	72	55
26		Borsad (M)	15	0	9	7	1	18	21
27		Vasna	2	0	3	3	3	23	20

Sr. No.	District	Name of Town	Primary school	Middle school	Sec. school	Senior Secondary school	UG Level College	Medical colleges	Engineering colleges
		Borsad (INA)							
28		Anklav (M)	11	0	2	1	28	30	28
29	Kheda	Kapadvanj (M)	20	0	6	3	35	44	64
30		Virpur (CT)	7	0	3	1	75	110	104
31		Balasinor (M)	19	0	8	8	30	65	72
32		Kathlal (M)	8	0	4	2	18	27	52
33		Mehmedabad (M)	10	0	7	4	29	28	43
34		Kheda (M)	8	0	4	1	54	20	41
35		Nadiad (M + OG)	93	0	9	18	34	2	22
36		Chaklasi (M)	28	0	5	2	30	12	32
37		Kanjari (M)	10	0	1	1	34	12	10
38		Mahudha (M)	5	0	6	1	27	18	42
39		Thasra (M)	8	0	2	1	12	50	45
40		Dakor (M + OG)	14	0	3	3	1	35	35
41	Vadodara	Savli (M)	4	0	1	1	1	1	1
42		Nandesari (INA)	4	0	1	6	23	23	23
43		Petro-Chemical Complex (INA)	3	0	3	3	12	12	12
44		GSFC Complex (INA)	4	0	3	4	5	5	5
45		Vadodara (M Corp. + OG)	469	0	336	221	4	6	4
46		Por-Ramangamdi (INA)	1	0	25	25	25	25	25
47		Nandesari (CT)	4	0	2	23	23	23	23
48		Ranoli (CT)	3	0	2	1	14	14	14
49		Karachiya (CT)	1	0	3	3	10	10	10
50		Bajwa (CT)	3	0	4	4	9	9	9
51		Jawaharnagar (Gujarat Refinery)	10	0	4	3	6	6	6

Sr. No.	District	Name of Town (CT)	Primary school	Middle school	Sec. school	Senior Secondary school	UG Level College	Medical colleges	Engineering colleges
52		Undera (CT)	2	0	2	4	5	5	5
53		Tarsali (CT)	5	0	5	5	5	5	5
54		Vaghodia (INA)	1	0	2	2	7	7	3
55		Jarod (CT)	3	0	1	1	20	20	20
56		Vaghodia (CT)	6	0	1	1	9	9	4
57		Jetpur (CT)	10	0	4	2	85	85	85
58		Chhota Udaipur (M)	20	0	8	3	1	100	100
59		Kavant (CT)	4	0	2	1	25	115	115
60		Nasvadi (CT)	5	0	3	2	80	80	80
61		Alikherva (CT)	5	0	1	1	70	70	70
62		Bodeli (CT)	3	0	3	1	70	70	70
63		Dabhoi (M)	17	0	6	8	29	29	29
64		Padra (M + OG)	37	0	3	1	15	15	15
65		Karjan (M)	11	0	5	2	32	20	32
66	Bharuch	Jambusar (M)	18	0	8	5	52	52	47
67		Amod (M)	7	0	4	1	65	65	40
68		Bharuch (INA)	2	0	1	1	10	73.5	3
69		Bharuch (M)	70	0	25	13	10	32	2
70		Palej (CT)	5	0	1	1	50	50	26
71		Sherpura (CT)	2	0	4	4	3	70	4
72		Nandelav (CT)	3	0	1	1	2	70	2
73		Bholav (CT)	4	0	1	1	70	70	1
74		Jhadeshwar (CT)	6	0	4	3	1	70	2
75		Maktampur (CT)	3	0	1	1	2	70	1
76		Anklesvar (M + OG)	33	0	9	7	16	60	11
77		Anklesvar (INA)	10	0	9	9	17	64	13
78		Panoli (INA)	2	0	2	7	23	50	20
79		Andada (CT)	6	0	2	1	19	60	9
80		Gadkhol	6	0	3	1	20	60	9

Sr. No.	District	Name of Town	Primary school	Middle school	Sec. school	Senior Secondary school	UG Level College	Medical colleges	Engineering colleges
		(CT)							
81		Sarangpore (CT)	4	0	2	2	20	71	9
82		Bhadkodara (CT)	2	0	1	4	20	64	15
83		Sanjali (CT)	3	0	1	9	21	71	24
84		Kharach (CT)	3	0	1	20	36	35	35
85		Valia - Jhagadia (GNFC Scooter Project Area) (INA)	2	0	1	1	80	80	7
86		Valia (Naldhari) (INA)	3	0	3	3	70	70	3
87	Navsari	Navsari (M + OG)	50	0	20	17	29	29	5
88		Kabilpor (CT)	7	0	3	2	31	31	7
89		Kaliawadi (CT)	2	0	2	2	30	30	7
90		Chhapra (CT)	4	0	1	1	30	30	9
91		Vijalpor (M)	9	0	2	2	33	33	1.2
92		Mahuvar (CT)	4	0	2	1	36	36	18
93		Gandevi (M)	6	0	2	2	56	56	22
94		Bilimora (M)	16	0	8	8	44	44	23
95		Devsar (CT)	2	0	3	3	46	46	24
96		Bilimora (Talodh) (CT)	2	0	1	1	55	55	28
97		Antaliya (CT)	2	0	2	2	65	65	26
98		Chikhli (CT)	5	0	2	0.2	62	62	30
99		Bansda (CT)	11	0	2	1	95	95	65
100	Valsad	Valsad (M + OG)	27	0	17	17	95	2	1
101		Valsad (INA)	1	0	2	2	75	8	2
102		Pardi Sondhpur	3	0	1	1	80	3	2

Sr. No.	District	Name of Town	Primary school	Middle school	Sec. school	Senior Secondary school	UG Level College	Medical colleges	Engineering colleges
		(CT)							
103		Bhagdawada (CT)	1	0	1	1	95	2	2
104		Nanakwada (CT)	2	0	2	2	77	1	2
105		Pardi Parnera (CT)	3	0	3	3	95	9	5
106		Parnera (CT)	4	0	2	1	90	10	7
107		Atul (CT)	1	0	2	7	84	10	7
108		Dharampur (M)	11	0	4	2	106	31	29
109		Pardi (M)	10	0	1	1	92	15	15
110		Vapi (M)	40	0	3	1	101	34	30
111		Vapi (INA)	4	0	3	5	105	33	28
112		Orvad (CT)	1	0	1	1	92	31	25
113		Balitha (CT)	3	0	2	2	105	32	30
114		Salvav (CT)	3	0	1	1	150	29	20
115		Chhiri (CT)	3	0	2	2	150	35	24
116		Chanod (CT)	3	0	2	2	104	37	27
117		Karvad (CT)	2	0	1	4	120	38	22
118		Lavachha (CT)	2	0	5	12	135	46	37
119		Sarigam (INA)	3	0	3	3	10	48	45
120		Umbergaon (M)	11	0	2	1	32	63	70
121		Umbergaon (INA)	2	0	2	3	33	63	65
122		Sarigam (CT)	7	0	2	2	25	48	1
123		Bhilad (CT)	4	0	1	1	153	45	1
124		Daheli (CT)	4	0	7	7	156	47	7

Sr. No.	District	Name of Town	Primary school	Middle school	Sec. school	Senior Secondary school	UG Level College	Medical colleges	Engineering colleges
125		Sanjan (CT)	7	0	1	1	160	57	11
126		Dehari (CT)	2	0	5	5	50	68	75
127		Solsumba (CT)	3	0	1	1	35	63	75
128	Surat	Kim (CT)	6	0	1	1	1	30	30
129		Sayan (CT)	3	0	2	1	24	24	24
130		Tarsadi (M)	6	0	4	2	45	45	45
131		Kosamba (CT)	2	0	3	1	45	30	1
132		Mandvi (M)	6	0	2	2	30	65	40
133		Amboli (CT)	1	0	1	1	3	20	20
134		Surat (M Corp.)	844	0	149	317	1	4	5
135		Hajira (INA)	17	0	6	4	17	17	17
136		Magdalla (INA)	20	0	20	20	20	20	20
137		Sachin (INA)	1	0	1	1	24	24	24
138		Kansad (M)	9	0	3	2	18	18	18
139		Bharthana Kosad (CT)	1	0	5	7	12	12	12
140		Ichchhapor (CT)	5	0	3	3	14	14	14
141		Limla (CT)	1	0	1	1	10	10	10
142		Mora (CT)	1	0	1	3	15	15	15
143		Pardi Kanade (CT)	2	0	1	1	20	20	20
144		Sachin (CT)	3	0	3	2	20	20	20
145		Vareli (CT)	7	0	3	12	18	18	18
146		Kadodara (CT)	5	0	4	4	15	15	15
147		Chalthan (CT)	5	0	3	1	18	20	20

Sr. No.	District	Name of Town	Primary school	Middle school	Sec. school	Senior Secondary school	UG Level College	Medical colleges	Engineering colleges
148		Bardoli (M)	16	0	12	10	1	31	31
149		Baben (CT)	2	0	1	1	2	37	37
	TOTAL		**4024**	**0**	**1276**	**1308**	**5779**	**5100**	**3667**

Source: censusindia.gov.in

Education Statistics in the Zone of Influence (ZOI)

Table 4.23.3 shows the status of literacy rate in the ZOI. It is evident from the Table 4.23.3, there has been phenomenal growth in the literacy rate both in urban and rural areas of the study area during the last decade 2001-2011. In Gujarat region, the highest literacy rate was recorded in Ahmedabad and Surat (86.65 %) in all followed by Anand (85.79 %). The male literacy rate was the highest in Kheda (93.40 %) followed by Anand (93.23 %), where as the literacy rate amongst female was highest in Surat (81.02 %) followed by Ahmedabad (80.29 %).

In the Maharashtra region, the highest literacy rate was recorded in Mumbai suburban areas as 90.9 % as per the Census 2011 compared to 86.89 % as per the Census 2001. The male literacy rate was highest in Mumbai, where it stood at 94.28 per cent as per Census 2011 against 91.56 per cent as per Census 2001. Amongst the female, the highest literacy rate was recorded in Mumbai suburban as 86.93 per cent as per Census 2011 against 81.12 per cent as per Census 2001. It can be concluded that the literacy rate in the study area is excellent in the urban areas whereas same in rural area is moderate. However, trend in literacy rate shows upward surge over the decade.

Table 4.23.3: Literacy Rates in the Zone of Influence

District	Literacy Rate*					
	Persons		Males		Females	
	2001	2011	2001	2011	2001	2011
GUJARAT						
Ahmadabad	79.62	86.65	87.4	92.44	70.98	80.29
Anand	74.51	85.79	86.09	93.23	61.94	77.76
Kheda	71.9	84.31	85.97	93.40	56.8	74.67
Panch Mahals	60.92	72.32	75.91	84.07	44.94	59.95
Vadodara	70.76	81.21	80.04	87.59	60.73	74.40
Bharuch	74.41	83.03	82.98	88.80	65.11	76.79
Navsari	75.83	84.78	82.77	90.06	68.61	79.30
Valsad	69.15	80.94	77.9	86.48	59.62	74.96
Surat	77.62	86.65	83.83	91.05	69.87	81.02
MAHARASHTRA						
Thane	80.66	86.18	87.06	90.9	73.10	80.78
Mumbai (Suburban)	86.89	90.9	91.56	94.28	81.12	86.93
Mumbai	86.40	88.48	90.23	90.54	81.38	86.03

Note- Literacy rate is the percentage of literates to population aged 7 years and above*

Source: Directorate General Office, Census of India, 2011

The Government of India has taken various steps to enhance the literacy level and imparting the quality education to the citizen of the country:

MAHRS Project Contribution

During the construction phase, a large workforce will be deployed throughout the alignment. The construction period being assumed to be of 4-5 years, it is reasonably expected the workers to bring along their family. A construction camp/housing camp for the workers is proposed at every 25 km along the alignment. There will be necessity of establishing schools for children in the vicinity of the camp. It is not necessary that all the construction camp shall be in the urban/sub-urban area. Hence it will be the responsibility of NHSRCL through its contractor to provide arrangements at such off sites for education to the children of workers, especially in the Right to Education age group of 6-14 years.

Annexure 4.25

4.25 WASTE GENERATION AND MANAGEMENT

Thousands of small scale and bigger industrial units simply dump their waste, more often toxic and hazardous, in open spaces and nearby water sources. Over the last three decades, many cases of serious and permanent damage to environment by these industries have come to the fore. Rapid industrialization has resulted in the generation of huge quantity of wastes, both solid and liquid, in industrial sectors such as sugar, pulp and paper, fruit and food processing, sago/starch, distilleries, dairies, tanneries, slaughter houses, poultries, *etc*. Despite requirements for pollution control measures, these wastes are generally dumped on land or discharged into water bodies, without adequate treatment, and thus become a large source of environmental pollution and health hazard.

Classification of Industrial Waste

In a broad sense, industrial wastes could be classified into two types:
1. Hazardous Industrial Waste
2. Non-hazardous Industrial Waste

Hazardous Industrial Waste

Hazardous wastes, which may be in solid, liquid or gaseous form, may cause danger to health or environment, either alone or when in contact with other wastes. Various agencies have defined hazardous wastes in different ways and as such, there is no uniformly accepted international definition so far. It is presumed that about 10 to 15 percent of wastes produced by industries are hazardous and the generation of hazardous wastes is increasing at the rate of 2 to 5 percent per year.

Hazardous industrial wastes in India can be categorized broadly into two categories.
i) Hazardous wastes generated from various industries in India
ii) Hazardous industrial wastes imported into India from Western Countries for re-processing and recycling.

Inventorisation of hazardous wastes generating units and quantification of wastes generated in India are being done by the respective State Pollution Control Boards (SPCBs). Hazardous waste in particular includes products that are explosive, flammable, irritant, harmful, toxic, carcinogenic, corrosive, infectious, or toxic to reproduction. Table 4.25.1 shows the source of various Hazardous Wastes.

Table 4.25.1: Potential for Recovery of Energy from Industrial Wastes

Hazardous Waste Component	Source
Heavy Metal	
Arsenic	Mining, non-anthropogenic geo-chemical formation
Cadmium	Mining, fertilizer industry, battery waste
Chromium	Mining areas, Tanneries
Lead	Lead acid battery smelters
Manganese	Mining areas
Mercury	Chlor-alkali industries, healthcare institutes
Nickel	Mining, metal refining
Hydrocarbons	
Benzene	Petrochemical industries, solvents

Hazardous Waste Component	Source
Heavy Metal	
Vinyl chloride	Plastics
Pesticides	Insecticides
Organic Chemicals	
Dioxins	Waste incineration, herbicides
PCBs	Fluorescent lights, e-waste, Hydraulic fluid

Use of Hazardous Wastes as Alternate Fuels

In the European Union, about 3 million tons of hazardous waste from cement works has been used as an alternate fuel. There are a large number of hazardous wastes generating units located in India. 11,138 units have been given authorization by SPCBs under Hazardous Waste (Management and Handling) Rules, 2003, mostly for temporary storage of hazardous wastes within the plant premises. In India, about 4.43 million tons of hazardous wastes are generated annually, out of which 71,833 tons are incinerable (as per the reports of SPCBs submitted to the Supreme Court of India). There is a need to explore the possibility of using such wastes by other industries.

Incineration

Incineration serves the dual purpose of reduction of both the toxicity and the volume of the waste, which is an important consideration when the disposal of wastes is finally destined for landfills. Most of the process wastes from chemical unit operations can very well be treated in properly designed incinerators.

Hazardous Wastes (Secured) Landfill

Hazardous waste landfill site is designed scientifically to have an impervious stratum at bottom to stop leachates percolation, and thus to avoid soil and water pollution/contamination in the vicinity of the landfill site. HDPE lining is used in making the landfill impervious. There are arrangements made for collection and treatment of leachates from the hazardous wastes. Various reports indicate that more than 19 Treatment, Storage & Disposal Facilities (TSDF) have been created in Gujarat alone. Many other states are following the similar action to establish such facilities. However, some kind of risk will always be there for the people and ecosystem by these operating and closed TSDFs.

Non-Hazardous Industrial Waste

Non-hazardous or ordinary industrial waste is generated by industrial or commercial activities but is similar to household waste by its nature and composition. It is not toxic, presents no hazard and thus requires no special treatment.

In particular, it includes ordinary waste produced by companies, shopkeepers and trades people (paper, cardboard, wood, textiles, packaging, *etc.*). Due to its non-hazardous nature, this waste is often sorted and treated in the same facilities as household waste.

TREATMENT OPTIONS FOR NON-HAZARDOUS INDUSTRIAL WASTE

Non-hazardous industrial wastes being diversified in their chemical nature, physical texture and moisture content and calorific values *etc.* demand distinct treatment options which are broadly classified in the Table 4.25.2.

Table 4.25.2: Waste Generation and Treatment Methods

Industries	Prominent Waste Generated	Treatment Option	Application
Sugar	Sugar bagasses	Combustion and Gasification	Heat and power
	Pressmud	Composting	Fertilizer
	Sugar molasses	Fermentation	Ethanol synthesis
	Fermentative Yeast biomass	Biomenthanation	Biogas production and digestate
Slaughter Houses	Organs, Tissues, Blood, Hides, Animal excreta and Carcass etc	Biomenthanation	Biogas production and digestate
Paper Mills	Pulp	Biomenthanation	Biogas production and digestate
	Paper shaving	Combustion	Heat and power
	Wood waste and paper boards	Combustion and Gasification	Heat and power
Dairy Plants	Whey and Milk cream	Biomenthanation	Biogas production and digestate
Sago Factories	Starch materials and peels	Biomenthanation	Biogas production and digestate
Tanneries	Hides and skins	Acid treatment and Biome	Biogas production and digestate
Animal Husbandries	Animal excreta and body fluids	Biomethanation	Biogas production & digestate
Fruits and Vegetables Processing Units	Pulp wastes	Biomethanation	Biogas production & digestate

Source: Source: Energy Alternatives India

Table 4.25.3: List of Waste Treatment Plant Installed enroute proposed MAHSR

Location	Capacity	Type of Plant
Vadodara Municipal Corporation, Vadodara, Gujarat	52,000 m^3/day	Sewage Treatment Plant at Tarsali for combined domestic sewage and industrial waste water.
Baroda Municipal Corporation, Baroda, Gujarat.	28,000 m^3/day	Sewage Treatment Plant at Wadi for combined domestic sewage and industrial waste water
Baroda Municipal Corporation, Baroda, Gujarat.	9,000 m^3/day	Sewage Treatment Plant at Tarsali for combined domestic sewage and industrial waste water.
City and Industrial Development Corporation, Vashi - New Bombay, Maharashtra.	4,500 m^3/day	Sewage Treatment plant.
Krishak Bharati Co-operative Limited (KRIBHCO), Hazira, Surat	3,000 m^3/day	Sewage Treatment plant.
Gujarat Narmada Valley Fertilizers Co. Ltd., Bharuch, Gujarat.	1,200 m^3/day	Sewage Treatment Plant for GNFC Township.
Gujarat Narmada Auto Limited. Chanderia, Bharuch, Gujarat.	350 m^3/day	Sewage Treatment plant.
M/s. IOT Infrastructure & Energy Services Limited	72 m^3/day	Sewage Treatment plant.
Kvearner, Bharuch	2.5 m^3/day	Sewage Treatment plant.
Bajuwa Gram Panchayat, Baroda, Gujarat.	1000 m^3/day	Sewage Treatment plant.
Pirana, Ahmedabad	106 MLD	Sewage Treatment plant.

Location	Capacity	Type of Plant
Vasna, Ahmedabad	126 MLD	Sewage Treatment plant.
Atladara, Vadodara	86 MLD	Sewage Treatment plant.
Tarsali, Vadodara	52 MLD	Sewage Treatment plant.
Gajarwadi, Vadodara	66 MLD	Sewage Treatment plant.
Anjana, Surat	82.5 MLD	Sewage Treatment plant.
Bhatar, Surat	120 MLD	Sewage Treatment plant.
Singanapore, Surat	100 MLD	Sewage Treatment plant.
Adharwadi, Kalyan	16 MLD	Sewage Treatment plant.
Triambak, Nashik	22 MLD	Sewage Treatment plant.
Nashik	78 MLD	Sewage Treatment plant.
Kopri Thane	54 MLD	Sewage Treatment plant.
Surat Municipal Corporation	200 TPD	Solid Waste
Gujarat Urban Development Corporation (GUDC), Ahmedabad	200 TPD	Solid Waste
Surat Municipal Corporation	600 TPD	Solid Waste
Aurangabad Municipal Corporation(AMC)	360 MT/ day.	Solid Waste
Nanded Waghala City Municipal Corporation	250 TDP	Solid Waste
Municipal Corporation of Greater Mumbai (MCGM)	600 TPD	Solid Waste
Ahmedabad	1.11 miliion Tonne per annum	Solid Waste
Vadodara	1.11 miliion Tonne per annum	Solid Waste
Surat	1.11 miliion Tonne per annum	Solid Waste
Vapi	1.11 miliion Tonne per annum	Solid Waste
Mulund	650 MT/Month	Solid Waste
Deonar	650 MT/Month	Solid Waste
Kanjur	650 MT/Month	Solid Waste
Navi Mumbai-Turbine Municipal Solid Waste Processing Waste Disposal Facility	650 MT/Month	Solid Waste
Thane-Diaghar	650 MT/Month	Solid Waste
Mira-Bhayander (Thane)	315 MT/Month	Solid Waste
Vasai-Virar	Gokhiware village-550 MT/Month	Solid Waste
Kalyan-Dombivali	Village-Umbarde- 550 MT/Month	Solid Waste
Ulhasnagar	500 MT/Month	Solid Waste
Bhiwandi Nizampur City	Dapode village-300 MT/Month	Solid Waste

Source: Mumbai Metropolitan Regional Development Authority (MMRDA), Maharashtra cpcb.nic.in/Data base on Hazardous Waste Management in India

(1) Solid Waste Disposal

This section describes the regulatory setting and affected environment associated with hazardous materials and wastes, the potential project impacts related to hazardous materials and wastes, and the mitigation measures that would reduce these impacts. Construction and operation of the MAHSR could cause ground disturbance (including disturbance of groundwater or surface water) near a known contaminated site or sites or where contamination could exist in the study area. Construction and operation of the project could also involve the use, storage, and disposal of hazardous materials and wastes in the study area. Under the existing planning phase, type of construction waste which is expected to generate are asphalt or concrete chunks, surplus soil, construction scrap materials and others. Although the quantity and percentage composition of construction waste is not clear at this stage, surplus soil is planned to be reused as much as possible in construction of the MAHSR embankment. In addition, all other construction waste is also planned to comply with relevant Center or State laws pertaining to the waste management. According to JICA's Guideline and MOR's Environmental Policy, concept of waste utilization will be promoted by encouraging recycling and reuse. The project, therefore, will inbuilt such measures to reduce overall volume of waste generated from different construction sites linearly along the proposed alignment. In principle, most of metal scrap and other saleable wastes are received by authorized dealers. However, concrete and masonry wastes which constitute a major part of construction wastes are currently not recycled. At present, private contractors remove this waste to privately own low-lying land for a price or more commonly, dump it in an unauthorized manner along roads or other public land. Small quantities of construction waste usually get mixed with domestic waste due to lack of segregated storage and collection facilities. These improper practices shall be improved in the Project by promoting separate collection, site storage and disposal of debris and bulk wastes. Some part of these wastes can be used in embankment and in road making along the embankment. Other non-usable part of such concrete and masonry waste shall be disposed of in only designated low-lying sites which have been already identified by the local municipal council or committee of falling along the alignment. Burning of debris, vegetation, rubber or any other form of construction waste is prohibited as per the existing legislation and no such practice shall be allowed in the project. Other form of waste such as non-recyclable waste, packaging waste, e-waste (used cartridges, toners, wires, computers, printers *etc.*) generated from the site offices and labour camps shall be disposed of as per the existing laws. The tunnel sectional area shall be minimized as far as possible to cut the construction cost. Thus, MAHSR Study team recommended a tunnel inner void space of 80 m^2 including a margin. The longest tunnel in the proposed MAHSR has been envisaged from proposed Bandra Kurla Complex Railway Station to Shilphata with a length of 20.375 km 30 m below the bed of Thane Creek. Based on the geological formation of the region, the area is underlain by Basaltic rocks. Therefore, during the construction of the tunnel, the waste shall be generated in the form of rocks only. These rocks shall be used in the construction after crushing to the desired size. There is no tunnel in Gujarat region on the proposed alignment. The rocks of the tunnel shall be stored at designated location with easy access along the proposed HSR alignment.

(2) Municipal Waste

The proposed Railway Stations and Maintenance Depots on the MAHSR shall be located in the city limit and in some cases out skirt of the cities. The municipal waste generated at these stations and maintenance depots shall be handled as per the prevailing statutory rules and regulations. Solid Wastes Management Rules, 2016 are applicable to every municipal authority responsible for collection, segregation, storage, transportation, processing and disposal of municipal solid.

Management of Municipal Solid Wastes

Any municipal solid waste generated in a city or a town, shall be managed and handled in accordance with the compliance criteria and the procedure laid down in Schedule-II shown in Table 4.25.4.

Table 4.25.4: Schedule II (Specifications Relating to Collection, Segregation, Storage, Transportation, Processing and Disposal of Municipal Solid Waste)

No.	Parameters	Compliance criteria
1	Collection of municipal solid wastes	1. Littering of municipal solid waste shall be prohibited in cities, towns and in urban areas notified by the State Governments. To prohibit littering and facilitate compliance, the following steps shall be taken by the municipal

No.	Parameters	Compliance criteria
		authority, namely: - i. Organising house-to-house collection of municipal solid wastes through any of the methods, like community bin collection (central bin), house-to-house collection, collection on regular pre-informed timings and scheduling by using bell ringing of musical vehicle (without exceeding permissible noise levels); ii. Devising collection of waste from slums and squatter areas or localities including hotels, restaurants, office complexes and commercial areas; iii. Wastes from slaughter houses, meat and fish markets, fruits and vegetable markets, which are biodegradable in nature, shall be managed to make use of such wastes; iv. Bio-medical wastes and industrial wastes shall not be mixed with municipal solid wastes and such wastes shall follow the rules separately specified for the purpose; v. Collected waste from residential and other areas shall be transferred to community bin by hand-driven containerized carts or other small vehicles; vi. Horticultural and construction or demolition wastes or debris shall be separately collected and disposed off following proper norms. Similarly, wastes generated at dairies shall be regulated in accordance with the State laws; vii.Waste (garbage, dry leaves) shall not be burnt; viii. Stray animals shall not be allowed to move around waste storage facilities or at any other place in the city or town and shall be managed in accordance with the State laws. 2. The municipal authority shall notify waste collection schedule and the likely method to be adopted for public benefit in a city or town. 3. It shall be the responsibility of generator of wastes to avoid littering and ensure delivery of wastes in accordance with the collection and segregation system to be notified by the municipal authority as per para 1(2) of this Schedule.
2	Segregation of municipal solid wastes	In order to encourage the citizens, municipal authority shall organise awareness programmes for segregation of wastes and shall promote recycling or reuse of segregated materials. The municipal authority shall undertake phased programme to ensure community participation in waste segregation. For this purpose, the municipal authorities shall arrange regular meetings at quarterly intervals with representatives of local resident welfare associations and non-governmental organizations.
3	Storage of municipal solid wastes	Municipal authorities shall establish and maintain storage facilities in such a manner as they do not create unhygienic and in sanitary conditions around it. Following criteria shall be taken into account while establishing and maintaining storage facilities, namely: - i. Storage facilities shall be created and established by taking into account quantities of waste generation in a given area and the population densities. A storage facility shall be so placed that it is accessible to users;
		ii. Storage facilities to be set up by municipal authorities or any other agency shall be so designed that wastes stored are not exposed to open atmosphere and shall be aesthetically acceptable and user-friendly; iii. Storage facilities or 'bins' shall have 'easy to operate' design for handling, transfer and transportation of waste. Bins for storage of bio-degradable wastes shall be painted green, those for storage of recyclable wastes shall be printed white and those for storage of other wastes shall be printed black; iv. Manual handling of waste shall be prohibited. If unavoidable due to constraints, manual handling shall be carried out under proper precaution with due care for safety of workers.

No.	Parameters	Compliance criteria
4	Transportation of municipal solid wastes	Vehicles used for transportation of wastes shall be covered. Waste should not be visible to public, nor exposed to open environment preventing their scattering. The following criteria shall be met, namely: i. The storage facilities set up by municipal authorities shall be daily attended for clearing of wastes. The bins or containers wherever placed shall be cleaned before they start overflowing; ii. Transportation vehicles shall be so designed that multiple handling of wastes, prior to final disposal, is avoided.
5	Processing of municipal solid wastes	Municipal authorities shall adopt suitable technology or combination of such technologies to make use of wastes so as to minimize burden on landfill. Following criteria shall be adopted, namely: (i) The biodegradable wastes shall be processed by composting, vermicomposting, anaerobic digestion or any other appropriate biological processing for stabilization of wastes. It shall be ensured that compost or any other end product shall comply with standards as specified in Schedule-IV; (ii) Mixed waste containing recoverable resources shall follow the route of recycling. Incineration with or without energy recovery including pelletisation can also be used for processing wastes in specific cases. Municipal authority or the operator of a facility wishing to use other state-of-the-art technologies shall approach the Central Pollution Control Board to get the standards laid down before applying for grant of authorisation.
6	Disposal of municipal solid wastes	Land filling shall be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Land filling shall also be carried out for residues of waste processing facilities as well as pre-processing rejects from waste processing facilities. Land filling of mixed waste shall be avoided unless the same is found unsuitable for waste processing. Under unavoidable circumstances or till installation of alternate facilities, land-filling shall be done following proper norms. Landfill sites shall meet the specifications as given in Schedule –III.

Source: Solid Wastes Management Rules, 2016

Existing Land Fill Site

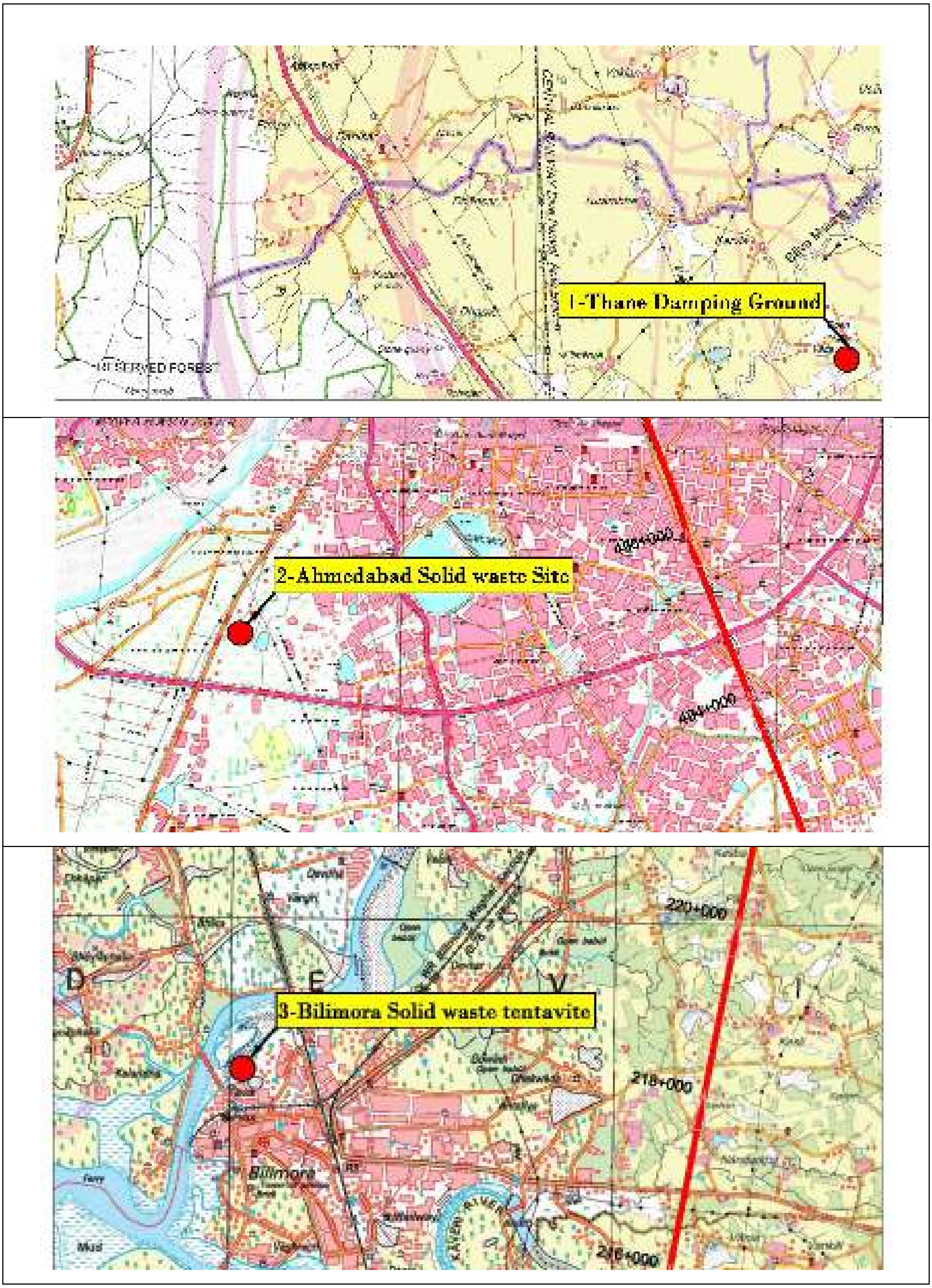
During the field survey the details pertaining to existing land fill site have been collected from the concerned municipal corporations and district authorities. The list of land fill site located along the proposed corridor or in the project district/towns are presented in Table 4.25.5 and shown in Exhibit 4.25.1.

Table 4.25.5: Existing /Expected Land Fill /Solid Waste Disposal Sites

S. No	Location of Dumping Site	Survey No	Distance from the Proposed Alignment (Crow fly)	Geo-Coordinates	Area of Dump Site	Engineered Landfill	Segregation Method	Design Year	Capacity of Dumping Site	Maintained By	Weight Station	No. of truck Per day
1	**Thane Taloja**	--	9.200 km	19°5'30.96"N 73°6'57.12"E	-	Yes		25	22,812,500 tons	MMRDA on PPP model	-	-
2	**Ahmedabad** / Narol	159 and 169	5.60 Km	22°58'49.28"N 72°33'51.84"E	35000 sqm	No	Automatic	2025	4000 tons /months	pvt	Yes	375
3	**Bilmora**	33	5.5km	20°46'35.90"N 72°57'32.49"E	7000 sqm	NO	Manual	2035	13-14M.T	own	No	8
4	**Vapi/** Namdha Chandor	925/ 993/ 995/ 994	7.95 km	20°21'58.71"N 72°53'2.82"E	22000 sqm	NO	Manual	2050	50-55 Tons/ day	own	No	27
5	**Valasd/** Pardi sandhapor	156/134/138	4.28 km	20°37'40.27"N 72°56'23.25"E	16795 sqm	NO	Automatic	2040	34- 40 tons/day	pvt	No	19
6	**Navsari/** Bandar Road	699	7.35 km	20°57'23.79"N 72°54'14.20"E	16705 sqm	NO	Automatic	2045	65-70 tons/day	pvt	Yes	85
7	**Surat/** Bhimrad Village	177	9.82 km	21° 6'38.53"N 72°50'0.25"E	1880000 Sqm	NO	Manual	2050	2200 MT /month	pvt	Yes	200
8	**Baruch** / Mandwar Bujar	417/ 418	11.1 km	21°42'37.03"N 73° 3'20.24"E	16187.4 Sqm	NO	Manual	2045	100 Tons/day	own	No	45
9	**Ankleshwar/** Sukavali Aaboli road	157	1.7 km	21°37'27.00"N 72°58'28.03"E	22720 sqm	Yes	Automatic	2030	25-30 Tons/day	pvt	Yes	21

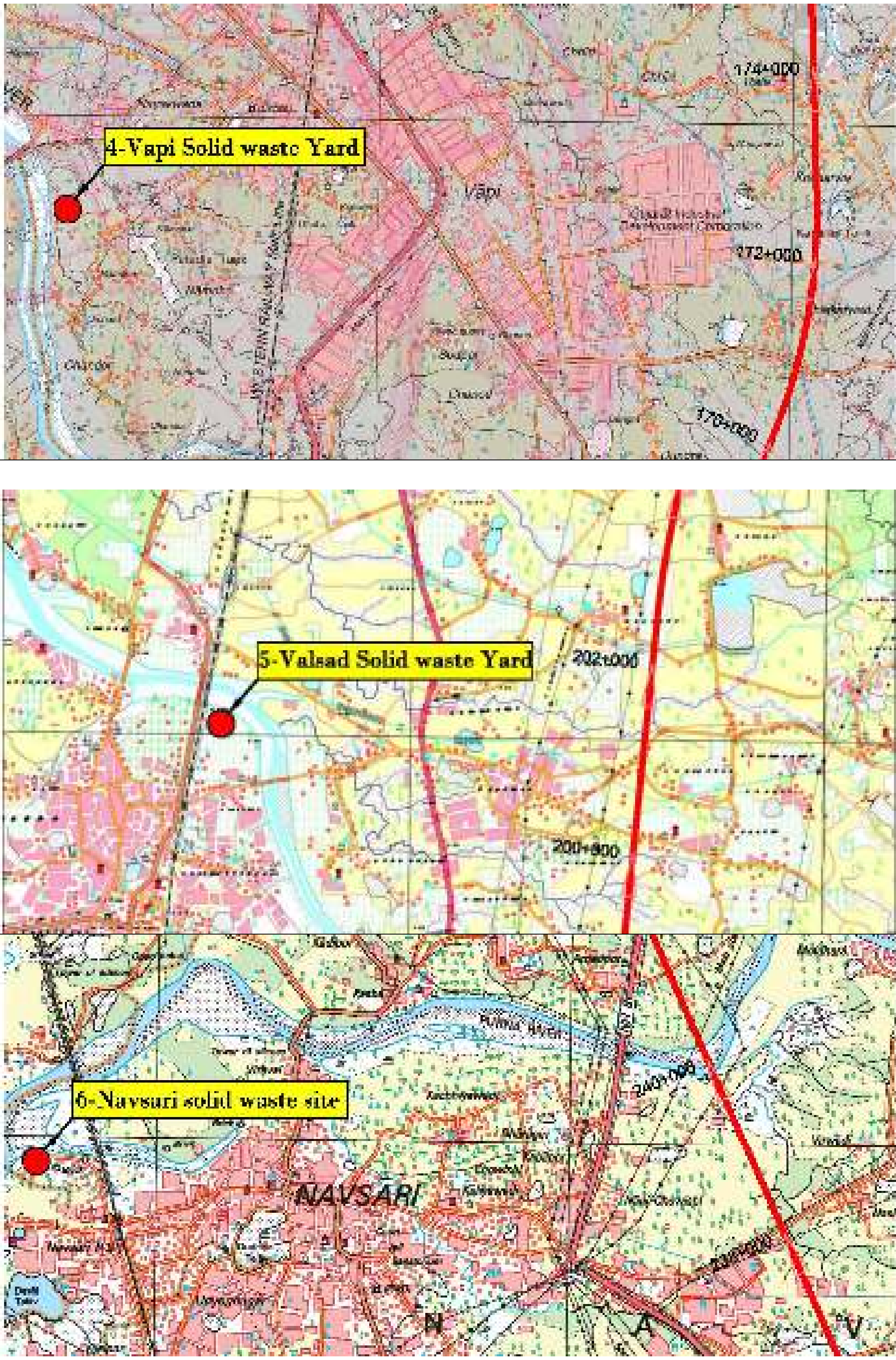
S. No	Location of Dumping Site	Survey No	Distance from the Proposed Alignment (Crow fly)	Geo-Coordinates	Area of Dump Site	Engineered Landfill	Segregation Method	Design Year	Capacity of Dumping Site	Maintained By	Weight Station	No. of truck Per day
10	**Anand**/ Lambhevel village	---	3.51 km	22°34'46.21"N 72°56'44.96"E	22000 Sqm	No	Manual	2035	60-70 Tons/day	pvt	No	24
11	**Vadodara/** Makarpura	-	3.66 km	22°13'58.93"N 73°12'22.12"E	45000 sqm	NO	Automatic	2045	4.5 MLT/ Year	pvt	Yes	350
12	**Gandhinagar / Sec 30 Near Mukti Dham**		22.4 km	23°14'53.08"N 72°40'48.29"E	not defind	NO	Mannual	---	60-70 tons/day	own	Yes	40-50

Exhibit 4.25.1 (A): Existing Land Fill /Solid Waste Disposal Sites



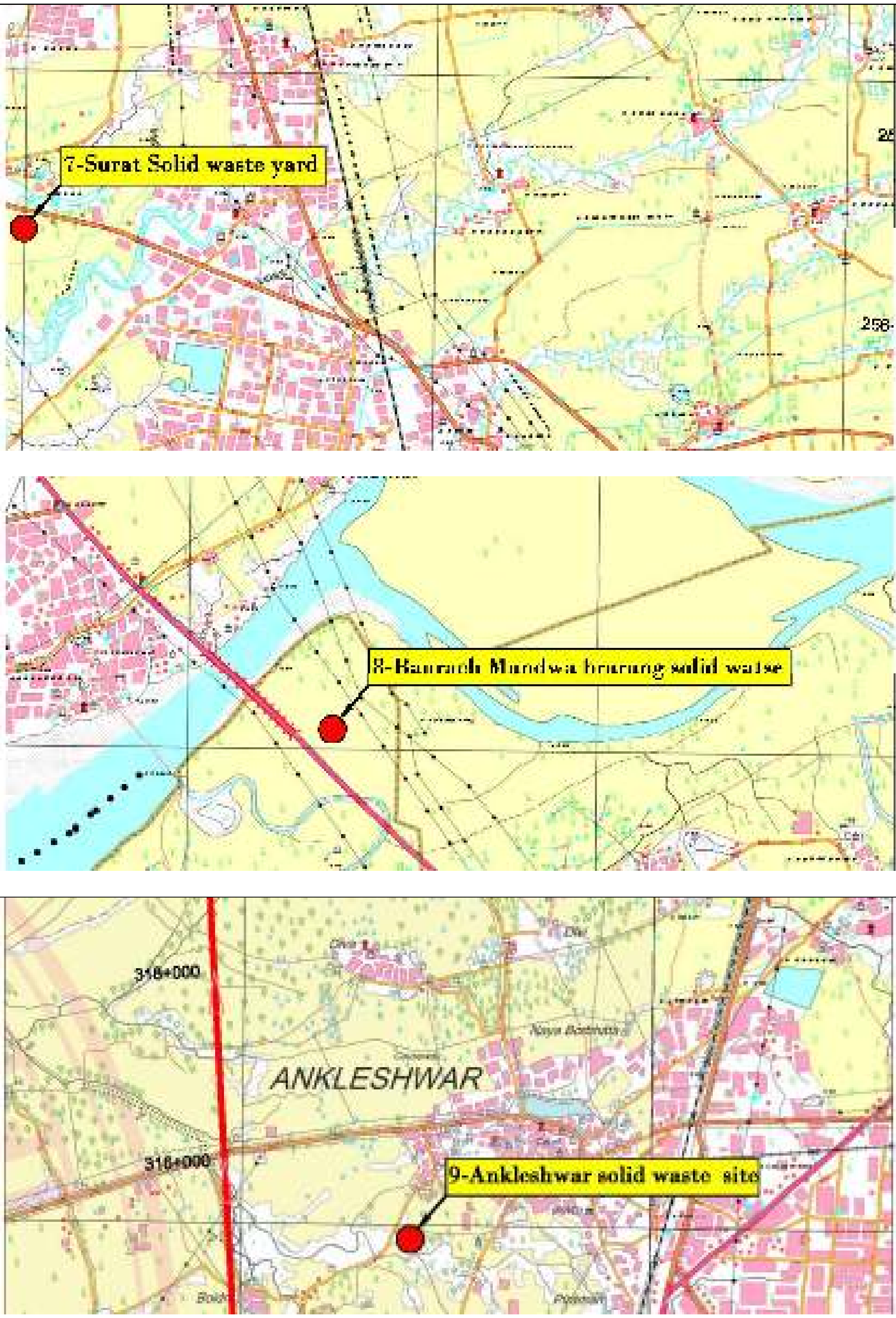
Source : SOI Topohseet

Exhibit 4.25.1 (B): Existing Land Fill /Solid Waste Disposal Sites



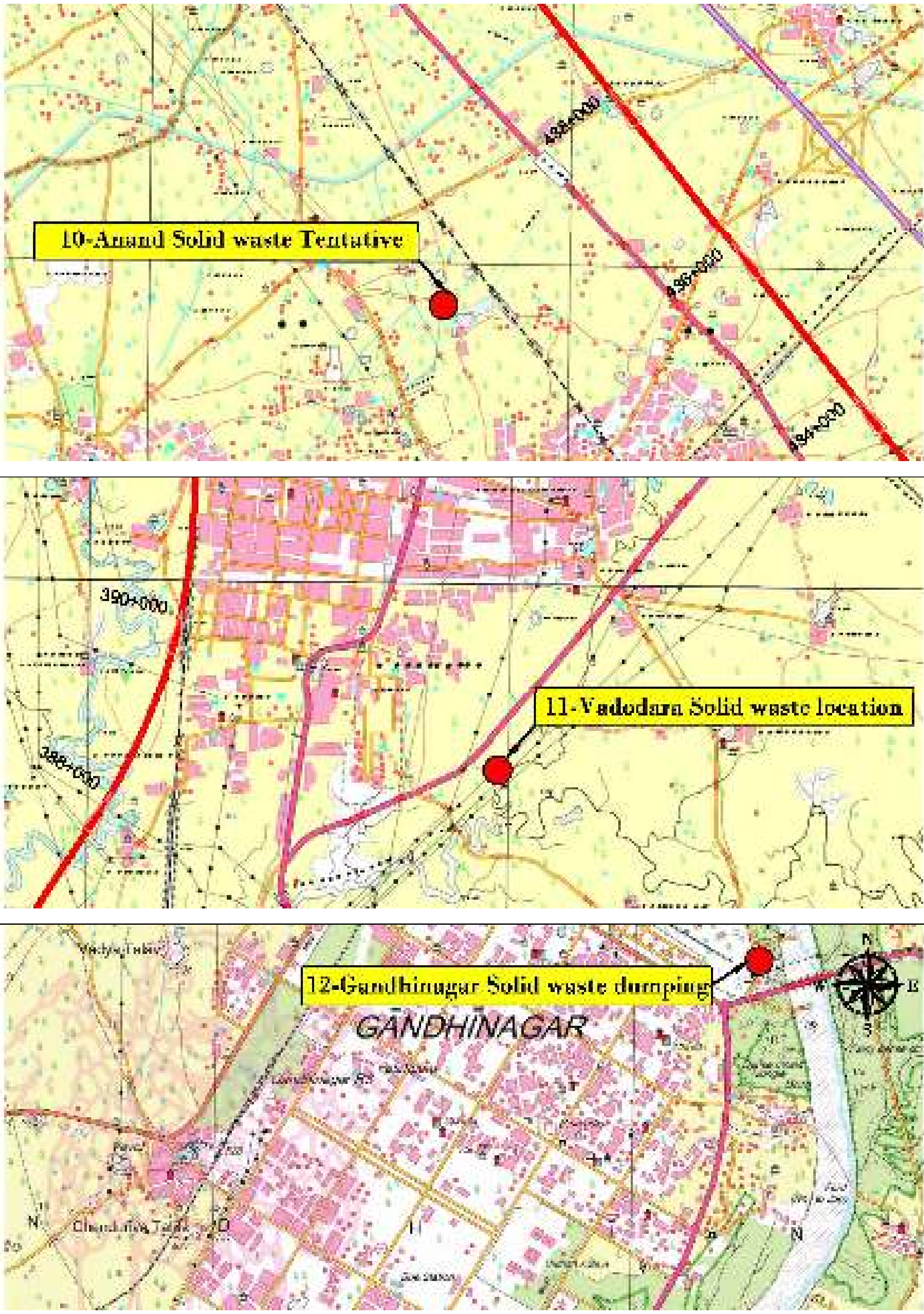
Source: SOI Topohseet

Exhibit 4.25.1 (C): Existing Land Fill /Solid Waste Disposal Sites



Source: SOI Topohseet

Exhibit 4.25.1 (D): Existing Land Fill /Solid Waste Disposal Sites



Source: SOI Topohseet

Annexure 4.26

4.26 OFFENSIVE ODOUR

4.26.1 Introduction

An odour is perceived when chemicals in gaseous form stimulate the human olfactory system present in the nose. The human nose has hundreds of receptors, each coded by for by unique DNA to detect different odours, and therefore, accounting for why different people have different sensitivity and reactions to smell. Reactions to odours can be very subjective thus making objective assessment of odour difficult.

In other words, it can further be defined as the “perception of smell” or in scientific terms as “a sensation resulting from the reception of stimulus by the olfactory sensory system”. Whether pleasant or unpleasant, odour is induced by inhaling air – borne volatile organic or inorganic chemicals.

With growing population, industrialization and urbanization, the odour problem has been assuming objectionable proportion. Urbanization without proper sanitation facilities is a major cause of odour problem. Rapidly growing industrialization has aggravated the problem through odorous industrial operations. Odour contributes to air quality concerns and affects human lifestyle. Odour is undoubtedly the most complex of all the air pollution problems. Unlike conventional air pollutants, odour has distinctly different characteristics, which, to an extent, can be comparable with noise pollution. Similar to noise, nuisance is the primary effect of odour on people. Some such characteristics are:

- Substances of similar or dissimilar chemical constitution may have similar odour. Nature and strength of odour may change on dilution.
- Weak odour is not perceived in presence of strong odour.
- Odour of same strength blends to produce a combination in which one or both may be unrecognizable.
- Constant intensity of odour causes an individual to quickly loose awareness of the sensation and only noticed when it varies in intensity.
- Fatigueforoneodourmaynotaffecttheperceptionofdissimilarodourbutwillinterferewitht heperceptionofsimilarodour.
- An unfamiliar odour is more likely to cause complaint than a familiar one.
- Two or more odorous substances may cancel the smell of each other.
- Odour travels down wind.
- Person can smell at a distance.
- Many animals have keener sense of olfaction than man.
- Likes and dislikes often depend on association of the scent with pleasant or unpleasant experiences.

4.26.2 Field Observation

During field survey of environmental attributes, offensive odour problem was not encountered at any location along the proposed MAHSR alignment. The existing dumping sites/land fill sites located in the nearby urban areas are far off from the proposed alignment. The solid waste disposal sites which are the source of offensive odour, are not located in the ZOI of the proposed MAHSR alignment. Cleanliness shall be maintained at construction sites during the construction phase and at the proposed stations, maintenance depots during the operation phase to avoid any foul odour.

4.26.3 Effects of Odour

Odour affects human beings in a number of ways. Strong, unpleasant or offensive smell scan interfere with a person's enjoyment of life especially if they are frequent and/or persistent. Major factors relevant to perceived odour nuisance are:

- Offensiveness;
- Duration of exposure to odour;
- Frequency of odour occurrence;
- Tolerance and expectation of the receptor.

Though foul odour may not cause direct damage to health, toxic stimulants of odour may cause ill health or respiratory symptoms. Secondary effects, in some, may be nausea, insomnia and discomfort. Very strong odour can result in nasal irritation; trigger symptoms in individuals with breathing problems or asthma. On the economic front, loss of property value near odour causing operations/industries and odorous environment is partly a consequence of offensive odour.

4.26.3 Odorous Compounds

Odorous substances emitted from industrial sources include both inorganic and organic gases and particulate. Many odorous compounds result from biological activity or are present in emissions from chemical processes. Most of the odorous substances derived from anaerobic decomposition of organic matter contain sulfur and nitrogen. Some of the odorous compounds emitted from industrial sources and their volatility & detection thresholds are given in Table 4.26.1. Most of the odorous substances are gaseous under normal atmospheric conditions or atleast have a significant volatility. Usually, lower the molecular weight of a compound, the higher is its vapor pressure & potential fore mission to the atmosphere. Substances of high molecular weight are normally less volatile and thus normally have fewer odours. The reduced sulfur compounds, such as the mercaptans and organic sulfides, tend to be the most odorous, based on the irrelatively low odour threshold concentrations.

Table 4.26.1: Details of Offensive Odorous Compounds Emitted from Industries

Sl. No.	Compound/Odorant	Formula	Molecular Weight	Volatilityat25°Cinppm	OdourDetectionThresholdinppm(v/v)	Offensive Odour Description
1.	**InorganicCompounds**					
	• Ammonia	NH_3	17	Gas	17	Pungent,Irritating
	• Chlorine	Cl_2	71	Gas	0.080	Pungent, Suffocation
	• HydrogenSulp	H_2S	34	Gas	0.00047	Rotteneggs
	• Ozone	O_3	48	Gas	0.5	Pungent, irritating
	• Sulphurdioxid	SO_2	64	Gas	2.7	Pungent, irritating
2.	**Acids**					
	• AceticAcid	CH3COOH	60	Gas	1.0	Vinegar
	• ButyricAcid	CH3CH2CH	88	Gas	0.12	Rancidbutter
	• PropionicAcid	CH3CH2C	74	Gas	0.028	
3.	**Alcohols**					
	• Amylalcohol	C5H11OH	88	Gas	---	---
	• Butylalcohol	$CH3(CH2)_3OH$	74	Gas	0.10	--

Sl. No.	Compound/Odorant	Formula	Molecular Weight	Volatilityat25°Cinppm	OdourDetectionThresholdinppm(v/v)	Offensive Odour Description
4.	**Aldehydes&Ketones**					
	• Formaldehyde	HCHO	30			Acrid
	• Acetaldehyde	CH_3CHO	44	Gas	0.067	Fruit
	• Butylaldehyde	C_3H_7CHO	72			Rancid
	• Acetone	CH_3COCH_3	58			Fruit
5.	**Amines**					
	• Methylamine	CH_3NH_2	31	Gas	4.7	Putrid,Fishy
	• Dimethylami	$(CH_3)_2NH$	45	Gas	0.34	Putrid,Fishy
	• Trimethylamine	$(CH_3)_3N$	59	Gas	0.0004	Putrid,Fishy
	• Ethylamine	$C_2H_5NH_2$	45		0.27	Ammoniacal
	• Diethylamine	$(C_4H_9)_2NH$	129		0.020	
	• Di-isopropylamine	$(C_3H7)_2NH_2$	101		0.13	Fishy
	• Dibutylamine	$(C_4H_9)_2NH$	129	8,000	0.016	Fishy
	• nbutylamine	$CH_3(CH_2)_3NH_2$	73	93,000	0.080	Sour,ammonia
6.	**Mercaptans**					
	• Allylmercaptan	CH_2CHCH_2SH	74	---	0.0015	Disagreeable,garlic
	• Amylmercaptan	$CH_3(CH2)_4SH$	104	---	0.0003	Unpleasant,Putrid
	• Benzylmercaptan	C6H5CH2SH	124	---	0.0002	Unpleasant,strong
	• Ethylmercaptan	C2H5SH	62	710,000	0.0003	DecayedCabbage
	• Methylmercaptan	CH3SH	48	Gas	0.0005	RottenCabbage
	• Phenylmercaptan	C6H5SH	110	2,000	0.0003	Putrid,garlic
	• Propylmercaptan	C3H7SH	76	2,20,000	0.0005	Unpleasant
7.	**Sulphides**					
	• Diethyl sulphide	(C2H5)2S	106		0.02	Ether
	• Dimethy lsulphide	(CH3)2S	62	830,000	0.001	DecayedCabbage
	• Dimethyl disulphide	(CH3)2S2	94		0.0076	Putrid
	• Diphenyl sulphide	(C6H5)2S	186	100	0.0001	Unpleasant
8.	**OrganicHeterocycles**					
	• Indole	C6H4(CH)2NH	117	360	0.0001	Faecal,nauseating

Sl. No.	Compound/Odorant	Formula	Molecular Weight	Volatilityat25°Cinppm	OdourDetectionThresholdinppm(v/v)	Offensive Odour Description
	• Pyridine	C5H5N	79	27,000	0.0001	Pungent,irritating
	• Skatole	C9H9N	131	200	0.001	Fecal,nauseating
	• Thiocresol	CH3C6H4S	124	---	0.0001	Rancid

Source: Journal of Indian Association for EnvironmentalManagement,Vol.29,Feb,2002

4.26.4 Sources of Odour

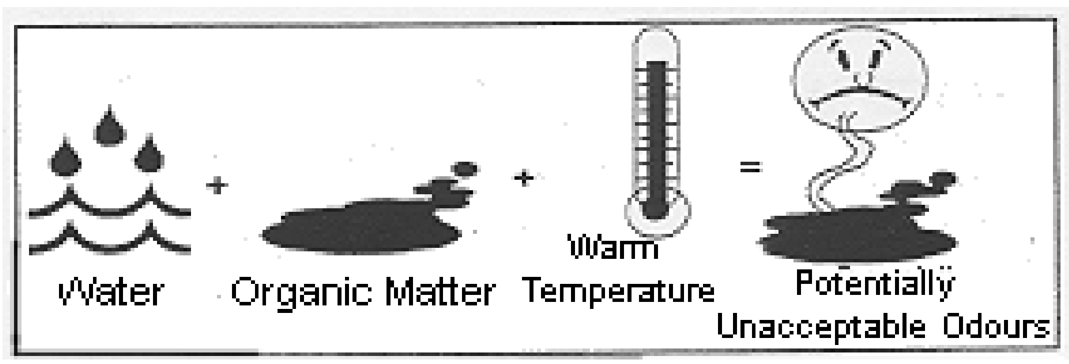
Most commonly reported odour-producing compounds are hydrogen sulfide (rotten egg odour) and ammonia (sharp pungent odour). Carbon disulfide, mercaptans, product of decomposition of proteins (especially of animal origin) phenols and some petroleum hydrocarbons are other common odorants. Most offensive odour is created by the anaerobic decay of wet organic matter such as flesh, manure *etc*. For example, odour originating from livestock manureisa result of a broad range of over 168 odour-producing compounds. Warm temperature enhances anaerobic decay and foul odour production, as represented in Exhibit 4.26.1.

Odour sources can be classified as:

- **Point Sources:** Point sources are confined emissions from vents, stacks and exhausts.
- **Area Sources:** Area sources may be unconfined like sewage treatment plant, waste water treatment plant, solid waste landfill, composting, house hold manure spreading, settling lagoons etc.
- **Building Sources:** Building sources of odour like pigs heds and hog confinement chicken.
- **Fugitive Sources:** In this source of odour, emissions are of fugitive nature like odour emissions from soil bed orbio-filter surface.

Odour can arise from many sources. Most of the sources are man- made. Garbage/ improper dumping on vacant land is a common phenomenon. It leads to foul smell due to putrefaction of dumped garbage, which lies uncollected for days together.

Exhibit 4.26.1: Conditions for Potential Foul Odour



Industries such as Pulp & Paper, Fertilizer, Pesticides, Tanneries, Sugar & Distillery, Chemical, Dye & Dye Intermediates, Bulk Drugs & Pharmaceuticals etc, Large Live stock operations, Poultry Farms, Slaughter Houses, Food and Meat processing industries and Bone Mills are among major contributors to odour pollution. Agricultural activities like decaying of vegetation, production and application of compost etc. also contribute too dour pollution.

In urban areas, improper handling of public amenities like toilets of 0cinemahall, bus, railway stations, hospitals, shopping complex *etc*. generate pungent odour, which affects the users as well as neighbor hood residents. Vehicular sector also has its share in odour pollution. Rapidly growing vehicular population as well as pollutants emitted by them generate harmful and pungent odour that have marked effects on pedestrians as well as near- by residents. Some of the important sources of odour pollution, the specific section and sources in the process and odorous compounds emitted are listed in Table 4.26.2.

Table 4.26.2 Important Sources of Odour Pollution and Odorous Compounds Emitted

Sources	**Sections**	**Odorous Compounds**
Pulp& Paper	Digester Black Liquor Storage Tank Evaporator Recovery Boiler Smelt Dissolving Tank Limekiln	CH_3SH $CH_3SH,CH_3'_2S$ $H_2S,CH_3'_2S_2,CH_3'_2S$ $CH_3SH,CH_3'_2S$ H_2S, CH_3SH CH_3SH,SO_2
Fertilizers	Nitrogenous Phosphatic	NH_3,SO_2 F_2
Pesticides		CH_3CHO,NH_3,H_2S
Tanneries	Raw hide sand skins storage /waste fleshing	purification of Hides & Skins
	Beam house operation Finishing operation	NH_3,H_2S Volatile organic compounds
	ETP: Collection Tanks ETP: Primary Treatment Units ETP: Sludge Dewatering System ETP: Anaerobic Lagoons	H_2S H_2S H_2S H_2S,CH_4
Sugar& Distillery	Bio-methanation Aeration Tank	H_2S NH_3
Chemical	-	NH_3H_2S, Cl_2, Mercaptans & Phenols
Dye& Dye Intermediates	-	NH_3,H_2S,SO_2,Mercaptans,
Bulk Drugs &Pharmaceuticals	Biological extracts and wastes spent termination liquors	H_2S,SO_2,Mercaptans,
Waste Water Treatment Plant	Anaerobic decomposition	H_2S& Mercaptans
Municipal Solid Waste	Anaerobic decomposition	H_2S, Mercaptans
Slaughter Houses	By-product /Waste Storage Effluent Treatment Plant	CH_4,H_2S, Mercaptans

Source: CPCB

4.26.5 Odour Index

The odour index is defined as the dimensionless ratio of the vapour pressure and the 100% odour recognition threshold (the concentration at which 100% of the odour panel detect/ recognised the odour as being representative of the odorant being studied). The odour index provides information on the potential of a particular compound to cause odour problems under evaporative conditions. The odour indices of the common odorous compounds are given in Table 4.26.3.

Table 4.26.2 Important Sources of Odour Pollution and Odorous Compounds Emitted

Sources	Sections	OdorousCompounds
Pulp& Paper	Digester Black LiquorStorageTank Evaporator RecoveryBoiler SmeltDissolvingTank Limekiln	CH_3SH CH_3SH,$CH_3{}'_2S$ H_2S,$CH_3{}'_2S_2$,$CH_3{}'_2S$ CH_3SH,$CH_3{}'_2S$ H_2S, CH_3SH CH_3SH,SO_2
Fertilizers	NitrogenousPh osphatic	NH_3,SO 2 F_2
Pesticides		CH_3CHO,NH_3,H_2S
Tanneries	Raw hidesand skins storage /wastefleshing	purification of Hides& Skins
	Beamhouse operation Finishingoperation	NH_3,H_2S Volatileorganiccompounds
	ETP: CollectionTanks ETP:PrimaryTreatment Units ETP: SludgeDewatering System ETP: Anaerobic Lagoons	H_2S H_2S H_2S H_2S,CH_4
Sugar& Distillery	Bio-methanation AerationTank	H_2S NH_3
Chemical	-	NH_3H_2S,Cl_2,Mercaptans&P henols
Dye& DyeIntermediat	-	NH_3,H_2S,SO_2,Mercaptans,
Bulk Drugs &Pharmaceuticals	Biologicalextracts and wastesspentterminationliquors	H_2S,SO_2,Mercaptans,
WasteWaterTreat ment Plant	Anaerobic decomposition	H_2S& Mercaptans
Municipal SolidWaste	Anaerobic decomposition	H_2S, Mercaptans
SlaughterHouses	By-product /WasteStorageEffluent	CH_4,H_2S, Mercaptans

Source: CPCB

Table 4.26.3: Odour Indices of the Common Odorous Compounds

Compound	Odour Index	Compound	Odour Index
Acetaldehyde	4,300,000	Benzaldehyde	22,000
Acetic acid	15,000	Benzene	300
Acetic andydride	12,800	Benzylchloride	28,000
Acetone	720	1,3 butadiene	2,530
Acrylic acid	4,210	n-butane	480
Allylalcohol	13,800	n-butanol	120
Allylchloride	17,900	Sec. butanol	400
Ammonia	167,300	Tert. Butanol	55,900
n-butylacetate	1,200	Ethylene	57,100
n-butylamine	395,000	Ethylether	1,939,000
n-butylchloride	6,300	Formaldehyde	5,000,000

Compound	Odour Index	Compound	Odour Index
n-butylether	13,400	Hydrogen sulfide	17,000,000
n-butylmercaptan	49,340,000	Isobutane	3,000,000
n-butylsulfide	658,000	Isobutanol	320
n-butyric acid	50,000	Isobutene	4,640,000
Carbon disulfide	44,430	Isobutylacetate	3,300
Carbon tetrachloride	540	Methanol	22
Chlorobenzene	52,600	Methylacetate	1,100
Chlorobromomethane	350	Methylamine	940,000
Chloroform	70	Methylamylalcohol	12,650
Diethylamine	880,000	Methylchloride	200,000
Diethylsulfide	14,400,000	phenol	16
Diethylketone	1,900	Propane	425
Dimethylamine	280,000	Propionic acid	112,300
Dimethylsulfide	2,760,000	Skatole	30,000
Ethane	25,300	Toluene	720
Ethanol	11	Valeric acid	256,300
Ethylacetate	1,900		

Source: NEERI Nagpur

Annexure 5 (a)

Country	Title	Space of Assessment	Time	Index	Noise Level Limits	Notes
Austria	Railway Noise Immission Ordinance 1993	Free field	Day-night	$L_{Aeq,T}$	65 dB (06-22), 55 dB (22-06)	Limits for the level of railway noise are adjusted by - 5dB to allow for lower perceived annoyance from trains at the same average sound level as other sources.
Belgium	Environmental convention concerning noise and vibration from railways (2001)	Outdoor	Daytime and nighttime	$L_{Aeq,sp,rail-ways}$	70 dB (07-22), 65 dB (22-07) 65 dB (07-22), 60 dB (22-07) [1)]	$L_{Aeq,sp,rail-ways}$: time averaged, A-weighted sound level calculated for a specified location for the sound from all railway operations within a specified period. [1)] Limits for new railway infrastructures or for expanded operations on existing infrastructures In addition, the Guidelines provide goals for limits lower than the specified limits. The Guidelines also describe situations where urgent intervention may be needed to reduce the existing time-averaged sound level so as to not exceed the limits.
Denmark	Guidelines from the Environmental Protection Agency, 1/1997 and Annex to Guideline 1/1997: Noise and vibrations from railways (2007 July)	Free field	Day-evening-night	L_{den}	59 dB	- Summer Residential, Camping
					64 dB	- Hospital, School, Residential
					69 dB	- Hotel, Office
France	Basic law about the fight against noise n°92-1444 (31/12/92) Decree n°95 22(9/01/95) about land-transport noise limits /Order of 8/11/99 concerning railway noise	Outdoor 2 m in front of windows	Day-night	$L_{Aeq,T}$		New or modified land uses:
					60 dB (06-22), 55 dB (22-06)	- Residential areas, and schools
					57 dB (06-22), 55 dB (22-06)	- Hospitals
					65 dB (06-22), 60 dB (22-06)	- Other areas
Germany	Traffic Noise Ordinance, 1990 June 12	Outdoor, 1 m from façade	Day-night	$L_{Aeq,T}$		Limits for new & significantly modified roads*)
					57 dB (06-22) , 47 dB (22-06)	- Hospitals and schools
					59 dB (06-22) , 49 dB (22-06)	- Residential areas
					64 dB (06-22) , 54 dB (22-06)	- Mixed business & residential areas

					69 dB (06-22) , 59 dB (22-06)	- Areas with light industry
						*) The sound from railway operations on new lines or existing lines is subject to the noise immission limits as for road traffic except that 5 dB is subtracted from the measured or calculated time-averaged A-weighted sound level of a railway before comparison with these limits to allow for the lower perceived annoyance from the sound of trains having the same timeaveraged sound level as other sources.
Germany	Remedial Program for existing federal roads (since 1978) and railways (since 1999)	Outdoor, Free field	Day-night	$L_{\mathrm{Aeq},T}$	70 dB (06-22) , 60 dB (22-06)	- Hospitals, schools, & residential areas
					72 dB (06-22) , 62 dB (22-06)	- Mixed business & residential areas
					75 dB (06-22) , 65 dB (22-06)	- Areas with light industry (with 5 dB adjustment for the sound of railway operations, see above)
Germany	Annex 1 to DIN 18005 Noise Protection in Urban Planning (1987)	Outdoor, Free field	Day-night	$L_{\mathrm{Aeq},T}$		Noise level limits apply for planning of new residential and other areas
					50 dB (06-22) , 40 dB (22-06)	- Purely residential areas, spa areas, vacation areas
					55 dB (06-22) , 45 dB (22-06)	- Mainly residential areas, campgrounds
					55 dB (06-22) , 45 dB (22-06)	- Cemeteries, parks
					60 dB (06-22) , 45 dB (22-06)	- Special residential areas
					60 dB (06-22) , 50 dB (22-06)	- Rural areas, mixed residential and commercial areas
					65 dB (06-22) , 55 dB (22-06)	- Town centers, commercial areas (with 5 dB adjustment for the sound of railway operations, see above)
Italy	Decree of the President of the Republic 18 November 1998, n. 459	Outdoor, 1 m from façade	Day-night	$L_{\mathrm{Aeq},T}$	70 dB (06-22), 60 dB (22-06)	Railway-receiver distance not greater than 100 m.
					50 dB (06-22), 40 dB (22-06)	Sensitive receivers: schools, hospitals
Japan	Environmental Quality Standards for Noise of Shinkansen Trains (1975)	Outdoor: free field	Any time (06-24)	L_{ASmax} 1)	70 dB	- Area I (mainly for residential use)
					75 dB	- Area II (where normal living conditions should be preserved, including commercial and industrial areas)
						1) The maximum S-time-weighted and A-frequencyweighted sound level is measured at a prescribed position during the passage of 20 consecutive trains. For assessing compliance with the noise-

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>level limits, the level of the average of the squared sound pressure signals is calculated from the ten highest of the 20 measured maximum sound levels.</td></tr>
<tr><td rowspan="6">Korea</td><td rowspan="6">Environmental Quality Standards (1991, revised 2000)</td><td rowspan="6">Outdoors (affected areas)</td><td rowspan="6">Day-night</td><td rowspan="6">$L_{Aeq,24h}$</td><td></td><td>Existing train lines</td></tr>
<tr><td>63 dB</td><td>- Area I: Areas for mainly residential use.</td></tr>
<tr><td>68 dB</td><td>- Area II: Areas for commercial and industrial use with no significant residential use.</td></tr>
<tr><td></td><td>For new train lines after 2015</td></tr>
<tr><td>60 dB</td><td>- Area I</td></tr>
<tr><td>65 dB</td><td>- Area II</td></tr>
<tr><td rowspan="4">Norway</td><td rowspan="4">Guideline on noise in planning (T-1442, 2012)</td><td rowspan="4">Outdoor, most exposed facade, free field, relevant height for dwelling</td><td rowspan="4">Day-evening-night</td><td>L_{den}</td><td>58 dB</td><td rowspan="2">Red zone, nearest the noise source, enter an area that is not suited to noise-sensitive uses and the establishment of new buildings with noise sensitive uses should be avoided</td></tr>
<tr><td>L_{5AF}</td><td>75 dB</td></tr>
<tr><td>L_{den}</td><td>68 dB</td><td rowspan="2">Yellow zone is an assessment zone where buildings with noise sensitive uses can be listed if mitigation measures provide a satisfactory noise ratio.</td></tr>
<tr><td>L_{5AF}</td><td>90 dB</td></tr>
<tr><td rowspan="5">Slovenia</td><td rowspan="5">Decree relating to assessment and management of environmental noise (O. J. RS, 121/2004)</td><td rowspan="5">Outdoor per ISO 1996-2</td><td rowspan="5">Day-evening-night

Day: 06-18
Evening: 18-22
Night: 22-24 &00-06</td><td rowspan="5">L_n
L_{den}</td><td rowspan="5"><table><tr><td>Area</td><td>L_n</td><td>L_{den}</td></tr><tr><td>A</td><td>65 dB</td><td>75 dB</td></tr><tr><td>B</td><td>50 dB</td><td>60 dB</td></tr><tr><td>C</td><td>45 dB</td><td>55 dB</td></tr><tr><td>D</td><td>40 dB</td><td>50 dB</td></tr></table></td><td>Noise level limits applicable to individual areas depend on the corresponding land use and the applicable time-average sound level. Four types of areas are specified as follows:</td></tr>
<tr><td>- A: Areas where high sound levels are permitted, for example, non-residential areas used for industry and manufacturing</td></tr>
<tr><td>- B: Areas where lower levels of intruding noise are permitted, for example, residential areas with some retail and light-manufacturing businesses</td></tr>
<tr><td>- C: Areas where disturbing sounds are not permitted, for example, primarily residential areas</td></tr>
<tr><td>- D: Areas that require the lowest level of prevailing sound, for example, quiet regions in open country</td></tr>
</table>

Slovenia	Decree relating to limits on time average sound level indicators of environmental noise (O. J. RS, 105/2005)	Outdoor per ISO 1996-3	Day-evening-night Day: 06-18 Evening: 18-22 Night: 22-24 & 00-06	L_d L_e L_n L_{den}	Area / L_d / L_e / L_n / L_{den} A / 70 dB / 65 dB / 60 dB / 70 dB B / 65 dB / 60 dB / 55 dB / 65 dB C / 60 dB / 55 dB / 50 dB / 60 dB D / 55 dB / 50 dB / 45 dB / 55 dB	These noise level limits apply to individual areas as described above and for the sound from road traffic, railways, and operations of civil aircraft from major airports
Spain	Royal legislative decree 1302/1986	Outdoor	All day or day-night	$L_{Aeq,T}$	$L_{Aeq,24h}$: 65 dB or $L_{Aeq,d}$: 65 dB and $L_{Aeq,n}$: 55 dB	For residential areas and areas where wildlife are to be protected
Sweden	Guidelines adopted by Parliament and implemented by government authorities	Free field	All day	$L_{Aeq,24h}$	55 dB outdoors 30 dB indoors	
				L_{AFmax}	70 dB outdoors 45 dB indoors	
Switzerland	Noise Abatement Ordinance, issued 1986 (latest rev: 2006 September)	Middle of open window	Day: 06-22 Night: 22-06	$L_{Aeq,T}$ 1)	same noise-level limits as for road-traffic noise	1) Rating level $L_r = 10 \lg (10^{0.1 \cdot L_{r1}} + 10^{0.1 \cdot L_{r2}})$ with $L_{r1} = L_{Aeq,T}$ + K1 for regular train traffic $L_{r2} = L_{Aeq,T}$ + K2 for train-shunting noise Adjustment K1 for regular train traffic: K1= -5 dB for N > 79 K1= 10 lg(N/250) dB for 7.9 < N < 79 K1= -15 dB for N < 7.9 (N = trains/day or night) Adjustment K2 for shunting noise: 0 to +8 dB
Turkey	Evaluation and Management of Environmental Noise, 01 July 2005 No. : 25862	Outdoor	Day: 07-19 Evening: 19-23 Night: 23-07	$L_{Aeq,T}$	65 dB(Day), 55 dB(Night) 1)	1) Residential areas and the natural environment
UK	Land Compensation Act (1973): a) Noise Insulation Regulations 1975 as amended – new roads b) Noise Insulation (Railways and other Guided transport systems) 1996,	1 m from the façade of eligible premises	18 hours Day-night	$L_{A10,18h}$	68 dB (06-24)	Grants given for sound insulation to dwellings affected by newly upgraded roads where limits are exceeded. Similar scheme for railways.
				$L_{Aeq,T}$	68 dB (06-24) 63 dB (00-06)	

	1998 - new railways					
UK	Town and Country Planning Acts, (1990): a) Planning Policy Guidance Note 24 (PPG24) (PAN 56, Scotland) b) Planning Directive 85/337 (Environmental Impact assessments)	Free Field	Day: 06-24 Night: 00-06	$L_{\text{Aeq},T}$	For railways: | A | B | C | D 1) D: | <55 | 55-66 | 66-74 | >74 N: | <45 | 45-59 | 59-66 | >66	1) A: Noise not a factor
						B and C: Noise mitigation measures need to be included in the planning proposal before permission to build is granted.
						D: Planning permission should normally be refused, because of noise.
						PPG24 applies to situations where residential development is planned close to an existing noise source. D = daytime N = nighttime Where a new noise source is planned close to existing residential development a noise impact assessment is required.
USA	High-Speed Ground Transportation Noise and Vibration Impact Assessment [Federal Railway Administration (FRA), 1998]	Outdoor, free field	Day-night	L_{dn}	65 dB	A day-night averaged sound level of 65 dB is considered “severe impact”.
					50 dB to 55 dB	A day-night averaged sound level between 50 dB and 55 dB is considered to be an “impact”. The “impact” boundary varies with the type of the land use and with the existing level of ambient sound.
USA	Surface Transportation Board (STB, 1998)	Outdoor, free field	Day-night	L_{dn}	65 dB	A day-night averaged sound level of 65 dB is considered “severe impact”.
					50 dB to 55 dB	A day-night averaged sound level between 50 dB and 55 dB is considered to be an “impact”. The “impact” boundary varies with the type of the land use and with the existing level of ambient sound.

Annexure 5 (b)

Prediction of Operational Noise and Vibration in Japan

5.0 BACKGROUND

Since the impact of noise and vibration, generated by operation of high speed train, is considered significant to the environment alongside the railway arraignment, a study of prediction of noise was conducted. And a study on vibration was qualitatively conducted.

5.1 NOISE

5.1.1 Methodology

Desktop study, using available reports regarding Shinkansen, was carried out to understand the actual noise levels on operation of high speed railway.

Based on the desktop study, noise level alongside the highspeed rail arraignment was predicted, using the method on prediction of noise levels along the Shinkansen railway line in Japan[1] (hereinafter referred to as "the Method").

5.1.2 Desktop Study

(1) Items of Desktop Study

Following items were studied, reviewing available reports in Japan regarding Shinkansen.

- Actual level of noise on operation of E5 type Shinkansen
- Measures to noise in Japan
- Advantage of measures

(2) Results of The Desktop Study

In total 6 reports, prepared by 6 prefectures where Shinkansen passes, were reviewed to understand the actual noise levels.

The measurement point of noise in the reports is uniformly set as 25m horizontally from the center of rail way and 1.2m vertically above ground.

Since planed operation speed in India is 320km/h, the results of noise measurement at passing speed over 300km/h were chosen. And the results of E5 type or E5+E6 type were selected, as same type (E5) in India. The number of data is 203.

Clear relationship between maximum noise level, passing speed and track type was not seen, while negative relationship between maximum noise level and distance from receiving point to the tip of sound barrier was seen with slab track, although data variation is great. It is considered that those are because some kind of mitigation to reduce the noise level have been undertaken in some monitoring points.

[1] K. Nagakura and Y. Yoshida, Method on prediction of noise levels along the Shinkansen railway line, 2000

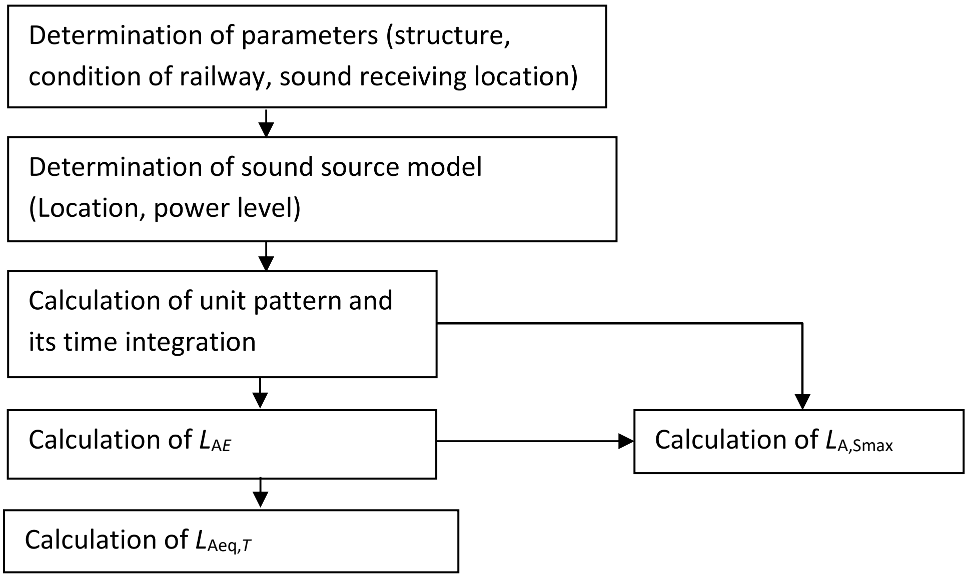
Therefore, it was concluded that the results of actual measurement are only used to understand the present situation of the operation of Shinkansen, and another approach to assess the impact of highspeed railway would be necessary. Thus, the study of prediction was carried out.

5.1.3 Noise Prediction

(1) Prediction Procedure

The prediction procedure is shown in Exhibit 5.1.1.

Exhibit 5.1.1: Prediction Procedure



L_{AE}: Weighted equivalent continuous perceived noise level

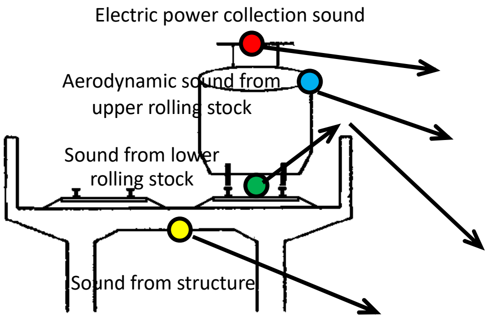
$L_{Aeq,T}$: Equivalent continuous A-weighted sound pressure level

$L_{A,Smax}$: Maximum A-weighted sound pressure level with time-weight feature S

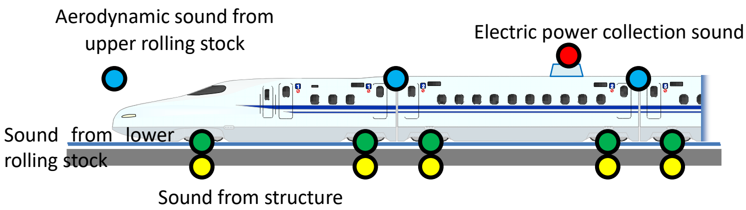
(2) Determination of Soubd Source Model

Distribution of sound source is shown in Exhibit 5.1.2.

Exhibit 5.1.2: Distribution of Sound Source



(a). Cross section



(b). Longitudinal section

Note: Each colored dot shows the sound source. Same color means same sound source.

In this study, following four (4) kinds of sound were considered as omnidirectional point-sound source:

- Sound from lower rolling stock: rolling motion, gear sound, aero dynamics;
- Aerodynamic sound from upper rolling stock: Leading head, joining section;
- Electric power collection sound: Spark sound, aerodynamic sound;
- Sound from structure: Structure.

The position of these sound sources and generated sound levels vary depending on the kind of rolling stock and its speed. The effectiveness of sound mitigation is expressed by the correction values of power level.

(3) Power Level of Soubd Source

A study on power level of high speed railway, including mitigation measures to minimize the level of for sound source, has ever conducted[2]. Based on the report of the study, the power level reduction of E5 class train, which is not targeted in the Method, comparing to the E2 Class train is shown in Table 5.1.1.

Table 5.1.1: Determination of Power Level Reduction for E5 Class Train

Sound source		Noise Reduction	Comparison Target	Reference
Sound from lower rolling stock		About 1 dB	E2 class (No. 1000)	JR East Technical Review No.31-Spring 2010
Sound from structure		About 2 dB	ditto	ditto
Aerodynamic sound at upper rolling stock	Joining section	About 7 dB	ditto	ditto
	Leading head	About 2 dB	ditto	ditto
Electric power collection sound		About 6 dB	ditto	ditto

Note: Since data power level for E5 class train is not available at moment, the power level of FASTTECH 360 (a test train) was used in this study.

[2]A study on mitigation measures for Shinkansen noise, 2016

The equationsto calculate each power level, which is specified in the Method, are listed in Table 5.1.2.

Table 5.1.2: Equations to Calculate Power Level

Power level	Equation	Correction value
$L_{W1}(V)$	$L_{W1}(V) = L_{W1}(200) + 30\log_{10}(V/200)$	Ballasted track : -5 dB
$L_{W2}(V)$	$L_{W2}(V) = L_{W2}(200) + 30\log_{10}(V/200)$	Elastic skid direct coupling track : -10 dB Low spring coefficient rail fastening device : -5 dB Ballast mat : -8 dB
$L_{W3}(V)$	$L_{W3}(V) = L_{W3}(200) + 60\log_{10}(V/200)$	
$L_{W4}(V)$	$L_{W4}(V) = L_{W4}(200) + 60\log_{10}(V/200)$	

$L_{W1}(V)$: Power level of sound from lower rolling stock、

$L_{W2}(V)$: Power level of sound from structure

$L_{W3}(V)$: Power level of aerodynamic sound at upper rolling stock

$L_{W4}(V)$: Power level of electric power collection sound

Where:

$L_{Wn}(200)$: Power level of each sound source at the reference speed (V= 200km/h). Each power level for E5 class train at the reference speed was set as sown in Table 5.1.3, based on the results from Table 5.1.1.

Table 5.1.3: Power Level (L_{Wn}(200)) at the Reference Speed

Unit: dB

Train type	L_{W1}(200)	L_{W2}(200)	L_{W3}(200)		L_{W4}(200)
			Joining section	Leading Head	
E2	113.5	89.0	88.0	97.0	100.0
E5	112.5	87.0	81.0	95.0	94.0

(4) Calculation of Power Level

a) Calculation of Unit Pattern

Temporal variation ($L_{pA,p}(t)$: unit pattern) of sound level at receiving point generated by a moving point sound source was calculated by the equations (1) and (2).

$$L_{pA,pn}(t) = L_W - \alpha - 20\log R_n(t) - \Delta L_{pn}(t) \quad \cdots\cdots (1)$$

$$L_{pA,p}(t) = 10\log(10^{L_{pA,p1}(t)/10} + 10^{L_{pA,p2}(t)/10}) \quad \cdots\cdots (2)$$

Where:

$L_{pA,pn}(t)$: (n=1) Unit pattern of direct sound
(n=2) Unit pattern of the sound reflected from the ground surface

L_W : Unit pattern of point sound source

α : α =8, when the sound is emitted to half space from a point sound source, such as sound from lower rolling stock, sound from structure and aerodynamic sound at upper rolling stock

α =11, when the sound is emitted to whole space from a point sound source, such as electric power collection sound

$R_n(t)$: Distance from sound source to receiving point at a time (t)

$\Delta L_{pn}(t)$: Diffraction collection value for a sound barrier to a point sound source at a time (t)

Weighted equivalent continuous perceived noise level ($L_{AE,p}$) generated by a moving point sound source was calculated by the equation (3).

$$L_{AE,p} = 10 \log \int_{-\infty}^{\infty} 10^{L_{pA,p}(t)/10} dt \quad \text{(3)}$$

b) CALCULATION OF WEIGHTED EQUIVALENT CONTINUOUS PERCEIVED NOISE LEVEL

Weighted equivalent continuous perceived noise level (L_{AE}), when one (1) train cars passes, was calculated by the equation (4), by summation energy of the weighted equivalent continuous perceived noise level of each point sound source.

$$L_{AE} = 10 \log \sum_n 10^{L_{AE,p,n}/10} \quad \text{(4)}$$

Where:

$L_{AE,p,n}$: Weighted equivalent continuous perceived noise levelof each point sound source (from 1 to n)

c) Calculation of Equivalent Continuous A-Weighted Sound Pressure Level

Equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$) during the measuring time (T: (second)) was calculated by the equation (5).

$$L_{Aeq,T} = 10 \log \left[(T_0 / T) \sum_n 10^{L_{AE,n}/10} \right] \quad \text{(5)}$$

Where:

T_0 : 1 second

$L_{AE,n}$: Weighted equivalent continuous perceived noise level of each passing train during atime (T)

d) Calculation of Maximum A-Weighted Sound Pressure Level

Maximum A-weighted sound pressure level with time-weight feature Swas calculated by the equation (6).

$$L_{pA,S}(t) = 10 \log \int_{-\infty}^{t} \left(\sum_n 10^{L_{pA,p,n}(\tau)} \right) e^{-(t-\tau)/Tc} d\tau \quad \text{(6)}$$

Where:

$L_{A,Smax}$: Maximum value of $L_{pA,S}(t)$

$L_{pA,p,n}(t)$: Unit pattern of point sound source (from 1-n)

T_c : Time constant (= 1 second)

Since the equation (6) is complicated, a simplified equation can be used when the longitudinal section of structure and geography is uniform, using the equation (7) with some conditions.

$$L_{A,Smax} = L_{AE} - 10\log(l/v) - \Delta L \quad \cdots\cdots (7)$$

Condition:

$w/v \ll T_c(=1\sec)$ and $l/v \gg T_c(=1\sec)$ and $l/r \gg 1$ must be satisfied.

Where:

w : Spacing of sound source (m)
l : Length of series of sound source (m)
v : Speed of sound source (m/s)
r : Distance between sound source and receiving point (m)
ΔL : Collection value (see Table 5.1.4)

Table 5.1.4: Collection Value (ΔL)

Unit: dB

		l/v(s)							
		∞	9.6	7.2	4.8	3.6	2.4	1.8	1.2
l/r	∞	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	32	0.00	0.08	0.14	0.25	0.39	0.73	1.11	1.85
	24	0.00	0.15	0.21	0.33	0.47	0.82	1.20	1.95
	18	0.00	0.24	0.32	0.46	0.61	0.97	1.36	2.12
	12	0.00	0.32	0.41	0.58	0.75	1.12	1.51	2.27
	8	0.00	0.48	0.61	0.81	1.00	1.39	1.79	2.54
	6	0.00	0.64	0.81	1.04	1.25	1.65	2.05	2.78
	4	0.00	0.96	1.20	1.48	1.71	2.13	2.52	3.23
	3	0.00	1.26	1.57	1.90	2.15	2.57	2.95	3.63
	2	0.00	1.80	2.22	2.65	2.93	3.35	3.71	4.33
	1.5	0.00	2.24	2.76	3.28	3.59	4.02	4.36	4.94
	1	0.00	2.85	3.54	4.24	4.62	5.09	5.41	5.93

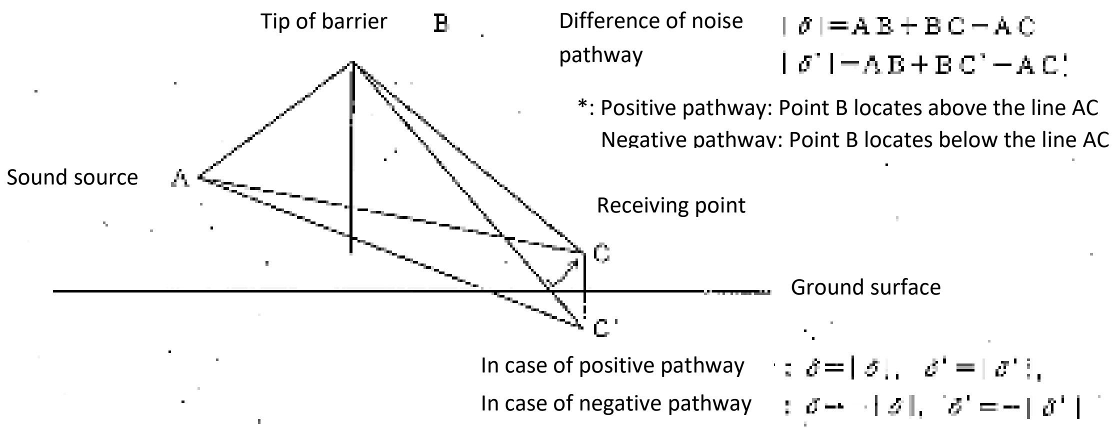
e) Collection Value of Diffraction

Collection value of diffraction (ΔL_p) of sound caused by sound barrier was calculated by following procedure.

i. Difference of noise pathway [δ (m)] was calculated, based on each location of sound source, tip of barrier, receiving point or mirrored receiving point (see Figure 5.1.3).

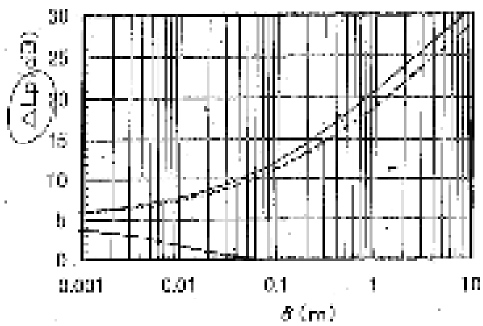
ii. Collection value of diffraction (ΔL_p) based on the Difference of noise pathway (δ) was determined by Figure 5.1.4 for the sound from lower rolling stock and by Exhibit 5.1.5 for the aerodynamic sound at upper rolling stock and for the electric power collection sound.

Exhibit 5.1.3: Determination of Difference of Noise Pathway



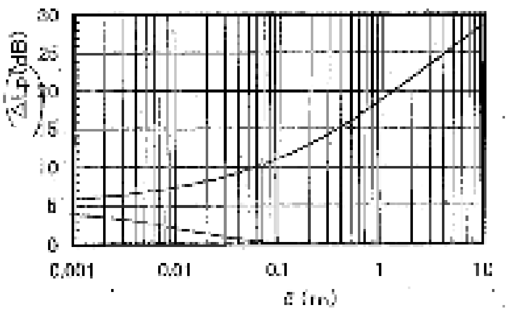
Source: Nagakura et al.[3]

Exhibit 5.1.4: Collection Value of Diffraction forthe Sound from Lower Rolling Stock



Source: Nagakura et al.

Exhibit 5.1.5: Collection Value of Diffraction for the Aerodynamic Sound at Upper Rolling Stock and for the Electric Power Collection Sound



Source: Nagakura et al.

[3] Nagakura et al., "The Method of Predicting the Way-side Noise Level of Shinkansen", Tech. Rep. Noise and Vib. Acoust. Soc. Jpn., N-2000-01,(2000)

(5) Noise Prediction Scenario and Condition

a) Prediction Scenario

Noise levels from high speed railway were predicted with the 48 scenarios as shown in Table 5.1.5. The target year of the prediction is 2023 (start of operation) and 2053 (operation peak). And the train speed is 320km/h and 350km/h respectively. The latest type of viaduct without any anti-noise measures, such as vibration absorption slab, was selected as an elevated structure. As for the sound barrier, general linear wall type with four (4) different heights were used for the prediction.

Table 5.1.5: Prediction Scenarios

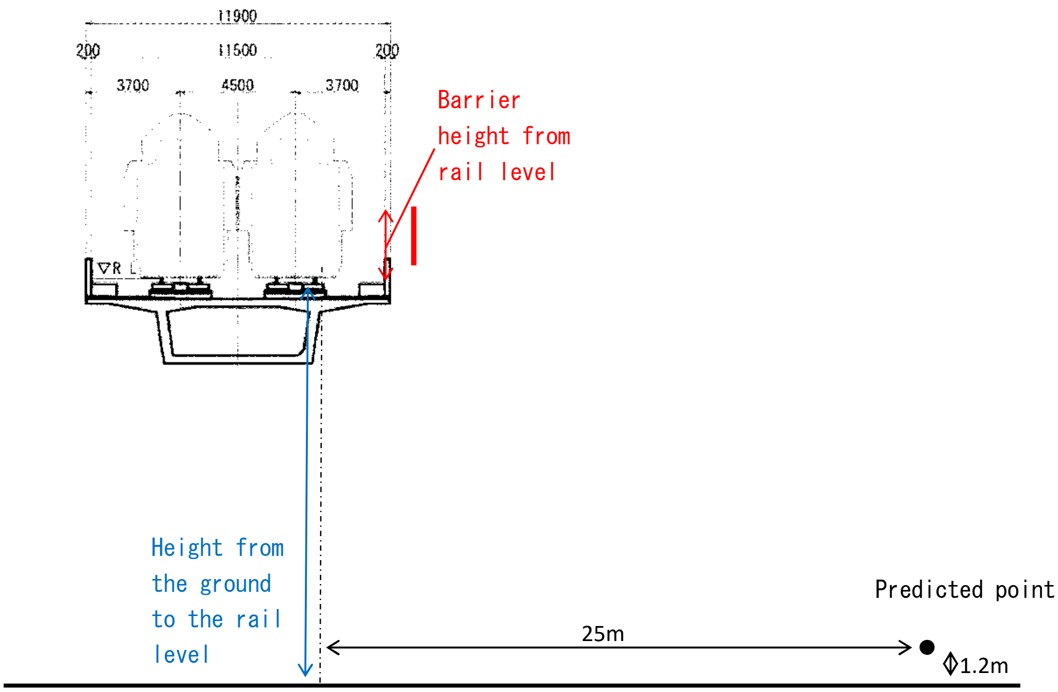
Category	Target year	No. of cars	Train Speed	Viaduct structure	Height to the railway level above ground	Sound barrier height from railway level [m]			
						2.0	2.5	3.0	3.5
A-1	Initial phase in 2023 62 trains at day time 8 trains at night time	10cars 253m Length	320km/h	Concrete	10m	○	○	○	○
A-2					15m	○	○	○	○
A-3					20m	○	○	○	○
B-1			350km/h		10m	○	○	○	○
B-2					15m	○	○	○	○
B-3					20m	○	○	○	○
C-1	Peak number train period in 2053 192 trains at day time 18 trains at night time	16cars 403m Length	320km/h	Concrete	10m	○	○	○	○
C-2					15m	○	○	○	○
C-3					20m	○	○	○	○
D-1			350km/h		10m	○	○	○	○
D-2					15m	○	○	○	○
D-3					20m	○	○	○	○

b) CROSS SECTION OF THE PREDICTION

Cross section of the prediction is shown as Exhibit 5.1.6.

The predicted point was set at 25m horizontally from the nearest railway with 1.2m vertical height m above ground.

Exhibit 5.1.6: Cross Section of the Prediction



c) Threshold Value for The Judgement of Impact

i) Noise Control in India

The regulation for the noise control in India (The Noise Pollution (Regulation and Control) Rules, 2000) specifies the standard values of noise as shown in Table 5.1.6. The target noise, however, is from cars, speakers and instruments, and the noise from railway is not covered.

Table 5.1.6: Ambient Air Quality Standards in respect of Noise in India

Area Code	Category of Area / Zone	Limits in dB(A) LAeq	
		Day time	Night time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Note: day time is 0600 - 2200, night time is 2200 - 0600 the following day

ii) Threshold Value for Judgement of Impact

In this study, threshold values to judge the impact cause by noise generation from railway were set as 65dB for day time and 55dB for night time respectively, based on the ambient noise standard in India. These values are 10dB higher than the values of “Residential area” of the ambient noise standard in India. According to the regulation in India, the authority who manage the sound source must receive complaint and take counter measure, in case the sound level exceeds 10dB higher than the standard value. Therefore, a value (standard vale + 10bB) can be considered that it shows a maximum permissible limit and, thus, it is used as a threshold value in this study.

7. Complaints to be made to the authority.

(1) A person may, if the noise level exceeds the ambient noise standards by 10dB(A) or more given in the corresponding columns against any area / zone or, if there is a violation of any provision of these rules regarding restrictions imposed during night time, make a complaint to the authority.

(2) The authority shall act on the complaint and take action against the violator in accordance with the provisions of these rules and any other law in force.

Source : The Noise Pollution (Regulation And Control) Rules, 2000

(6) Result of the Prediction

a) MAXIMUM NOISE LEVEL

Prediction result of Maximum A-weighted sound pressure level with time-weight feature S ($L_{A,Smax}$) on train passing is shown in Table 5.1.7. The predicted values vary between 70dB and 77dB, showing the same level of actual measurement in Japan.

Table 5.1.7: Prediction Results of $L_{A,Smax}$ from High Speed Railway [dB]

Category	Target year	No. of cars	Train Speed	Viaduct structure	Height to the railway level above ground	Barrier height from railway level [m]			
						2.0	2.5	3.0	3.5
A-1	Initial phase in 2023 62 trains at day time 8 trains at night time	10cars 253m Length	320km/h	Concrete	10m	75	74	73	72
A-2					15m	73	72	72	71
A-3					20m	72	71	70	70
B-1			350km/h		10m	77	75	74	73
B-2					15m	75	74	73	72
B-3					20m	73	72	72	71
C-1	Peak number train period in 2053 192 trains at day time 18 trains at night time	16cars 403m Length	320km/h	Concrete	10m	76	75	74	73
C-2					15m	74	73	72	72
C-3					20m	73	72	71	71
D-1			350km/h		10m	77	76	75	74
D-2					15m	75	74	74	73
D-3					20m	74	73	73	72

Note: Day time is 0600 - 2200, Night time is 2200 - 0600 the following day

b) Equivalent Sound Level

Results of prediction of equivalent continuous A-weighted sound pressure level (L_{Aeq}) during day time is shown in Table 5.1.8 and the one during night time is shown in Table 5.1.9, respectively. The sound levels during day time in year 2023 (start of operation) varies between 48dB and 54dB, and these levels do not exceed the threshold value. The sound level in the operation peak (year 2053) varies between 56dB and 64dB. The result of a scenario with 10m viaduct and 2.0m sound barrier height exceeds the threshold value, 60dB.

The sound levels during day time and night time both in year 2023 (start of operation) and in year 2053 (operation peak) varies between 42dB and 62dB, which do not exceed the threshold value.

Table 5.1.8 Prediction Results of L_{Aeq} from High Speed Railway during Day Time [dB]

Category	Target year	No. of cars	Train Speed	Viaduct structure	Height to the railway level above ground	Sound barrier height from railway level [m]			
						2.0	2.5	3.0	3.5
A-1	Initial phase in 2023 62 trains at day time 8 trains at night time	10cars 253m Length	320km/h	Concrete	10m	53	52	51	50
A-2					15m	51	50	49	49
A-3					20m	50	49	48	48
B-1			350km/h		10m	54	53	52	51
B-2					15m	52	51	50	49
B-3					20m	50	50	49	48
C-1	Peak number train period in 2053 192 trains at day time 18 trains at night time	16cars 403m Length	320km/h	Concrete	10m	61	60	59	58
C-2					15m	59	58	57	57
C-3					20m	57	57	56	56
D-1			350km/h		10m	62	60	59	59
D-2					15m	60	59	58	57
D-3					20m	58	58	57	56

Note: Day time is 0600 - 2200, Night time is 2200 - 0600 the following day

Indicate the value exceeds 60dB (Threshold value for noise impact in the Silence Zone during day time).

Table 5.1.9: Prediction Results of L_{Aeq} from High Speed Railway during Night Time [dB]

Category	Target year	No. of cars	Train Speed	Viaduct structure	Height to the railway level above ground	Sound barrier height from railway level [m]			
						2.0	2.5	3.0	3.5
A-1	Initial phase in 2023 62 trains at day time 8 trains at night time	10cars 253m Length	320km/h	Concrete	10m	47	46	45	44
A-2					15m	45	44	43	43
A-3					20m	44	43	42	42
B-1			350km/h		10m	48	47	46	45
B-2					15m	46	45	44	44
B-3					20m	45	44	43	43
C-1	Peak number train period in 2053 192 trains at day time 18 trains at night time	16cars 403m Length	320km/h	Concrete	10m	53	52	51	50
C-2					15m	52	51	50	49
C-3					20m	50	49	49	48
D-1			350km/h		10m	54	53	52	51
D-2					15m	52	51	51	50
D-3					20m	51	50	50	49

Note: day time is 0600 - 2200, night time is 2200 - 0600 the following day

Indicate the value exceeds 50dB (Threshold value for noise impact in the Silence Zone during night time).

c) Sound Level Contour

Sound level contour of L_{Aeq}during day time is shown in Exhibit 5.1.7 and night time in Exhibit 5.1.8, respectively.

Exhibit 5.1.7 (1): Sound Level Contour of L_{Aeq} during Day Time

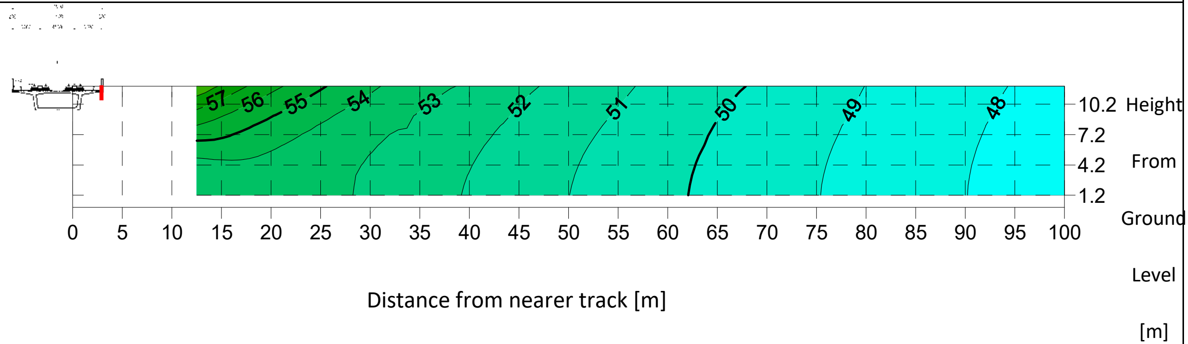
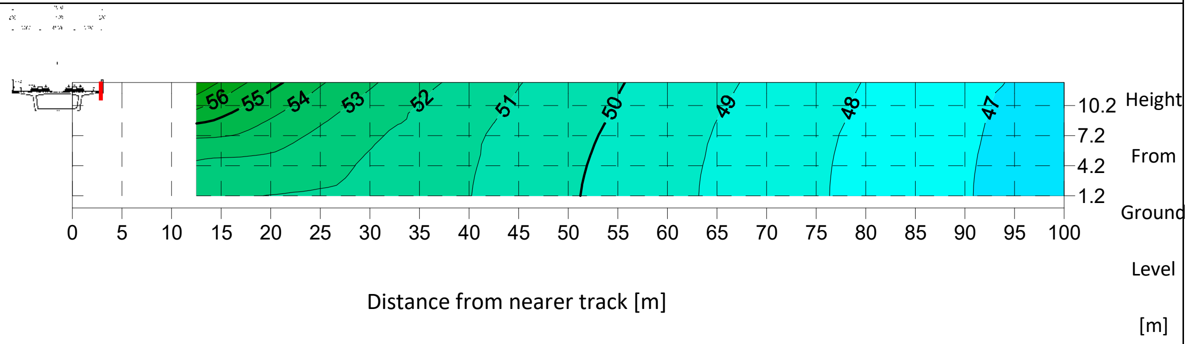
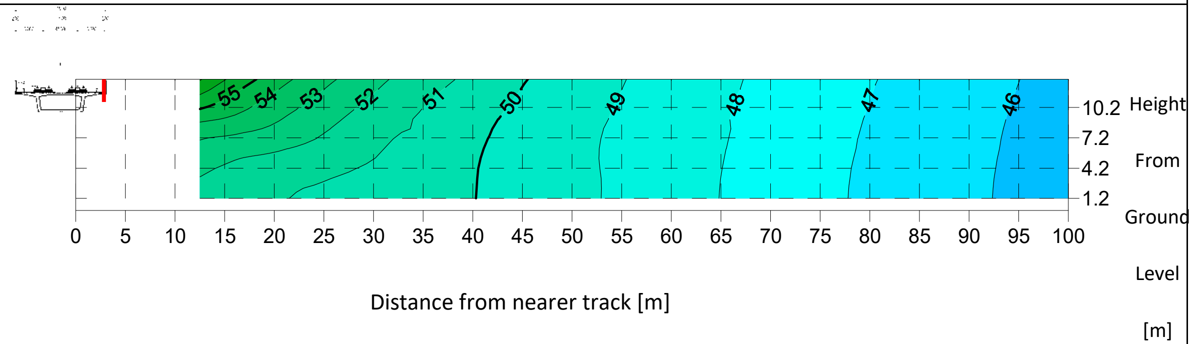
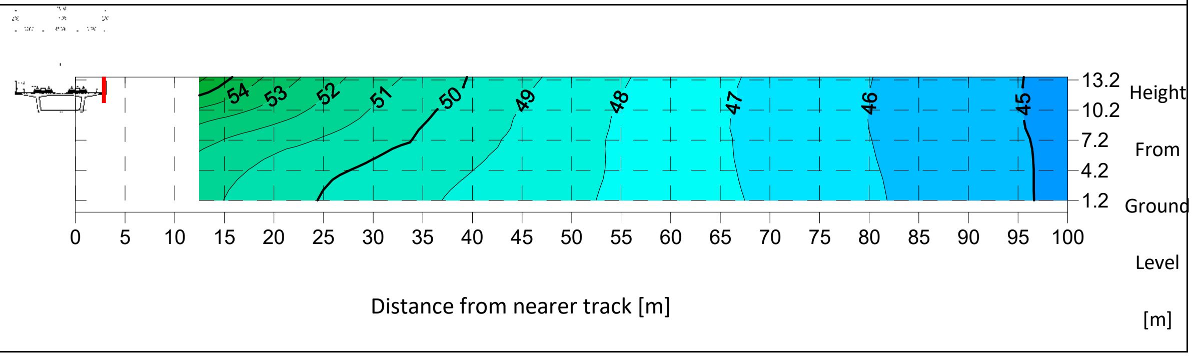
Height of sound barrier	[Other conditions] Category: A-1, Target year: 2023(Initial phase), No. of cars: 10, TrainSpeed:320 km/h Height of the railway level from ground: 10 m
2.0 m	
2.5 m	
3.0 m	
3.5 m	

Exhibit 5.1.7 (2): Sound Level Contour of L_{Aeq} during Day Time

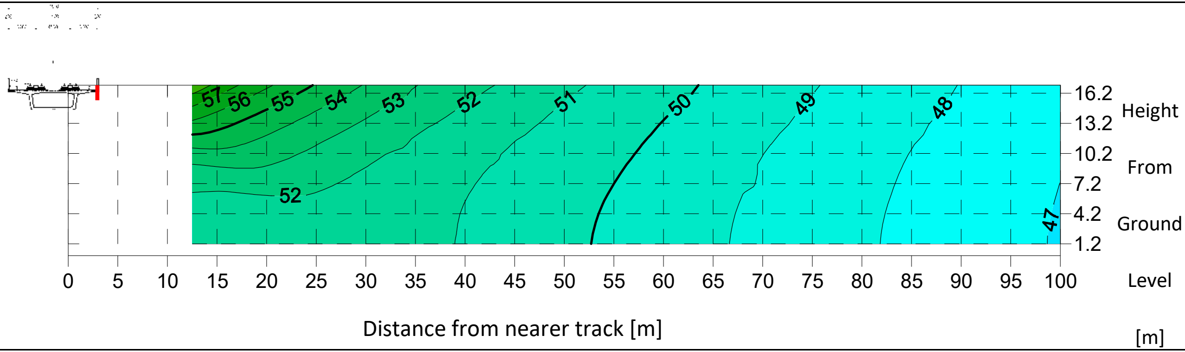
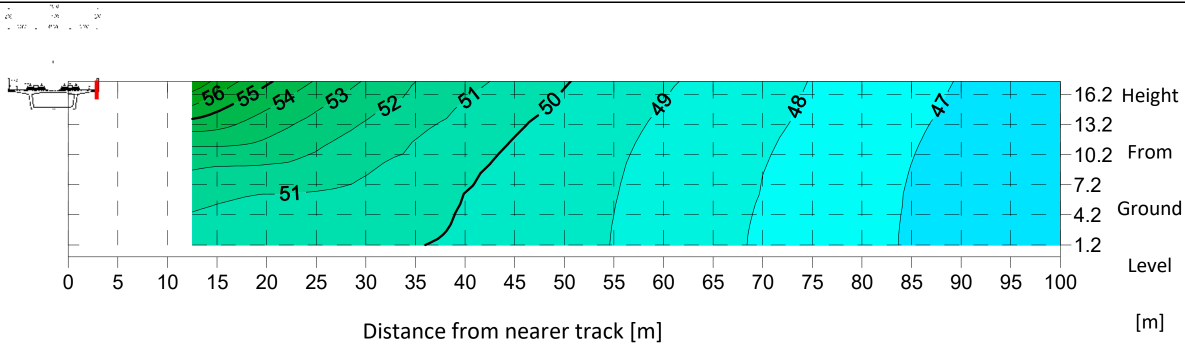
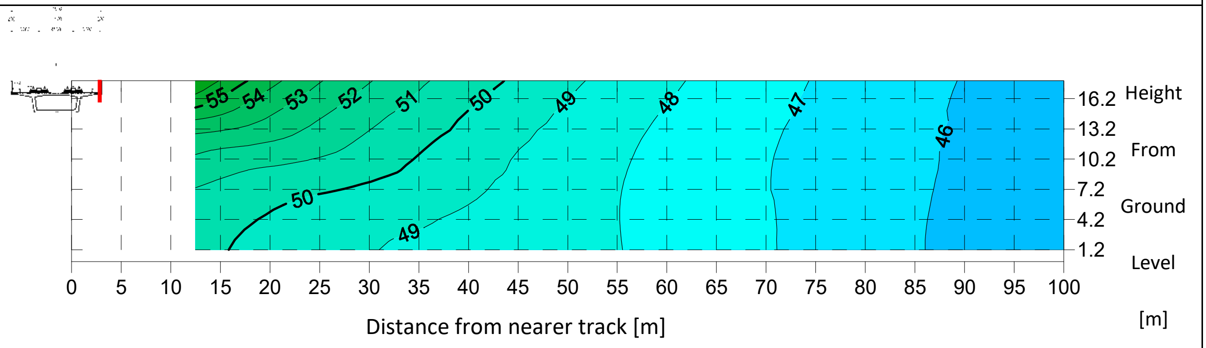
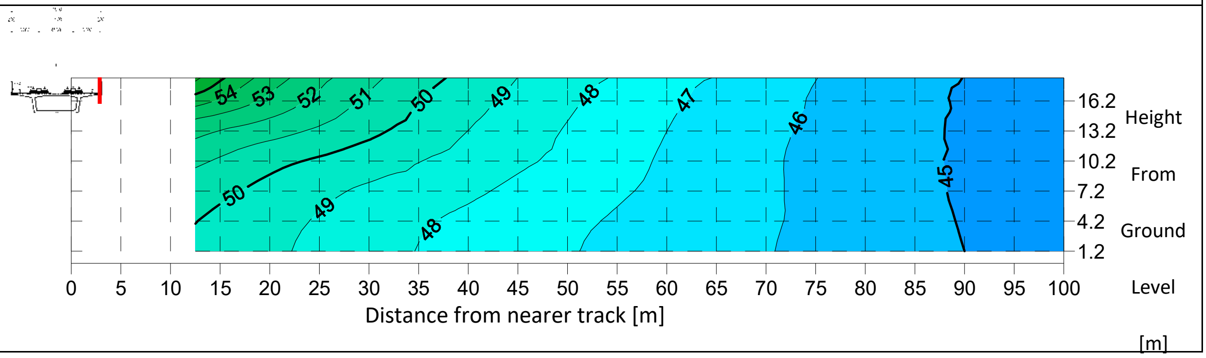
<table>
<tr><td>Height of sound barrier</td><td>[Other conditions]
Category: A-2, Target year: 2023(Initial phase), No. of cars: 10, TrainSpeed:320 km/h
Height of the railway level from ground: 15m</td></tr>
<tr><td>2.0 m</td><td>
</td></tr>
<tr><td>2.5 m</td><td>
</td></tr>
<tr><td>3.0 m</td><td>
</td></tr>
<tr><td>3.5 m</td><td>
</td></tr>
</table>

Exhibit 5.1.7 (3): Sound Level Contour of L_{Aeq} during Day Time

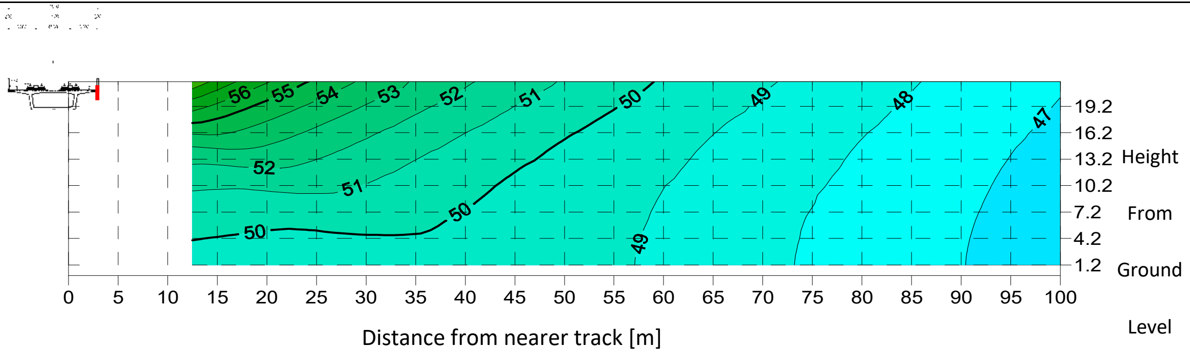
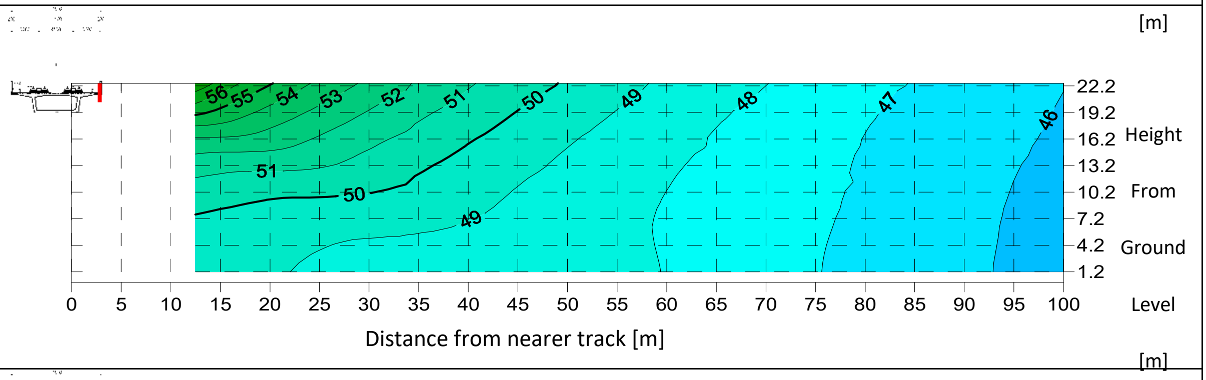
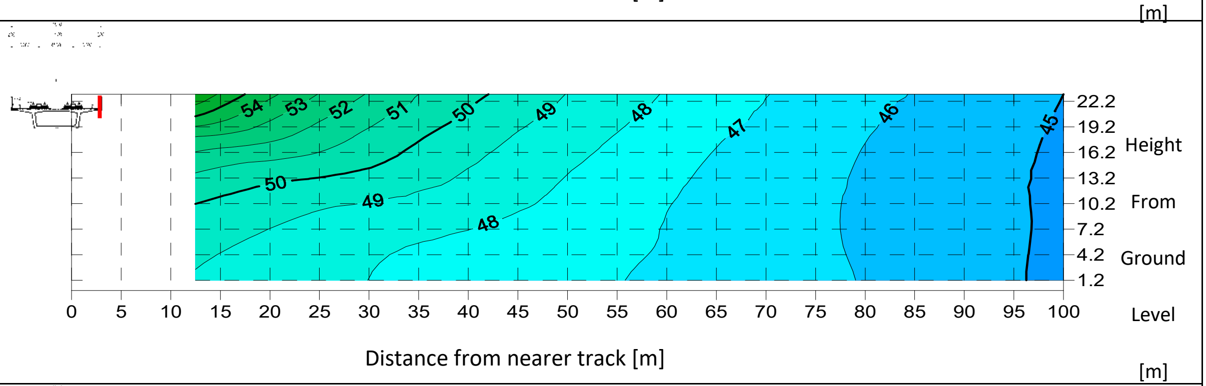
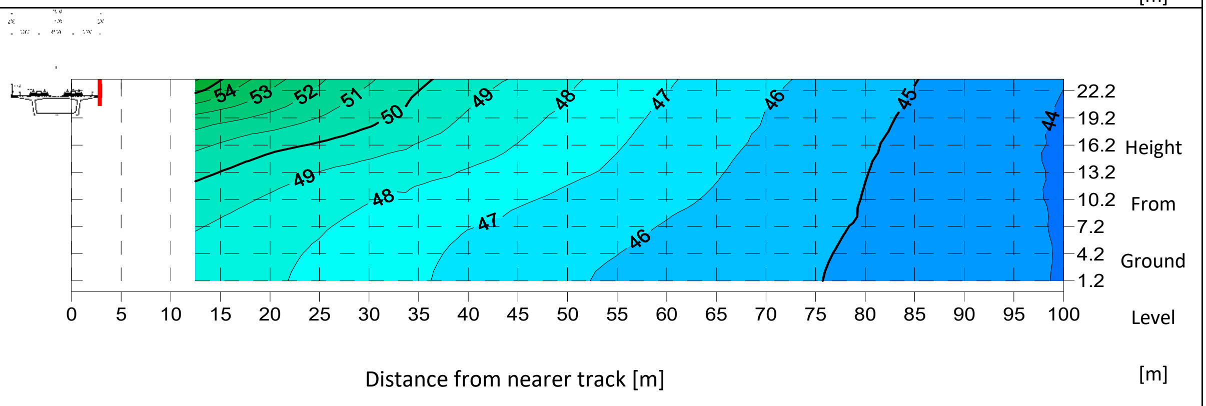
Height of sound barrier	[Other conditions] Category: A-3, Target year: 2023(Initial phase), No. of cars: 10, TrainSpeed:320 km/h Height of the railway level from ground: 20 m
2.0 m	
2.5 m	
3.0 m	
3.5 m	

Exhibit 5.1.7 (4): Sound Level Contour of L_{Aeq} during Day Time

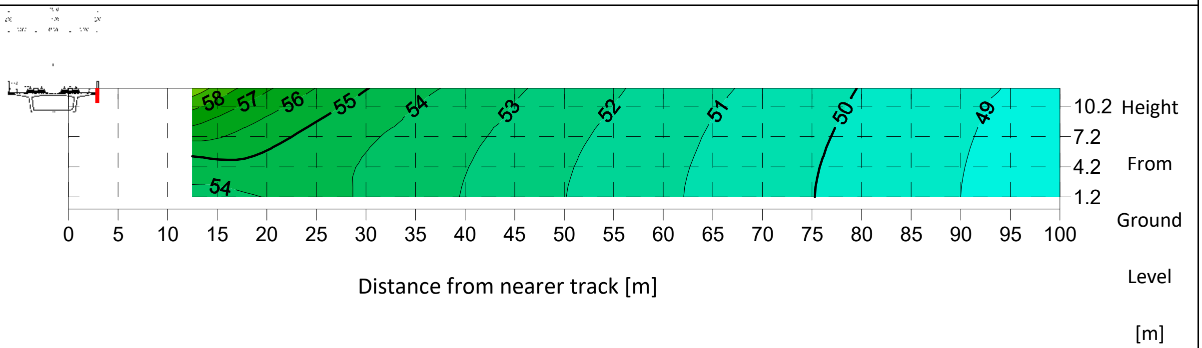
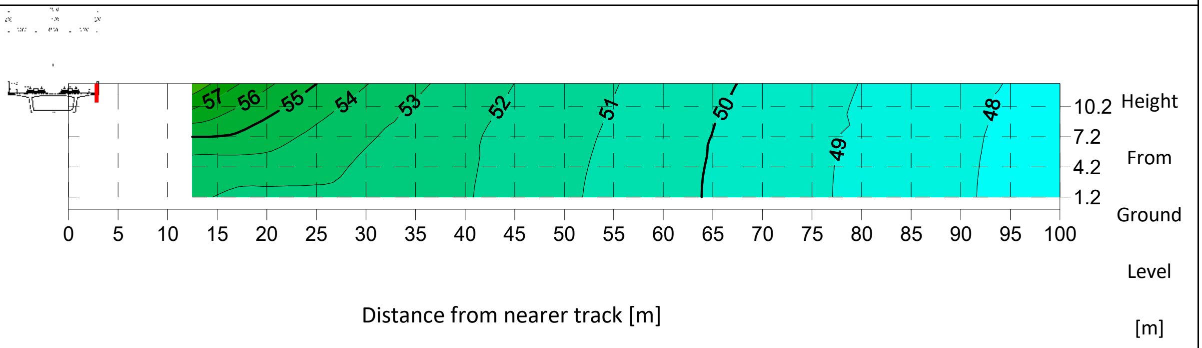
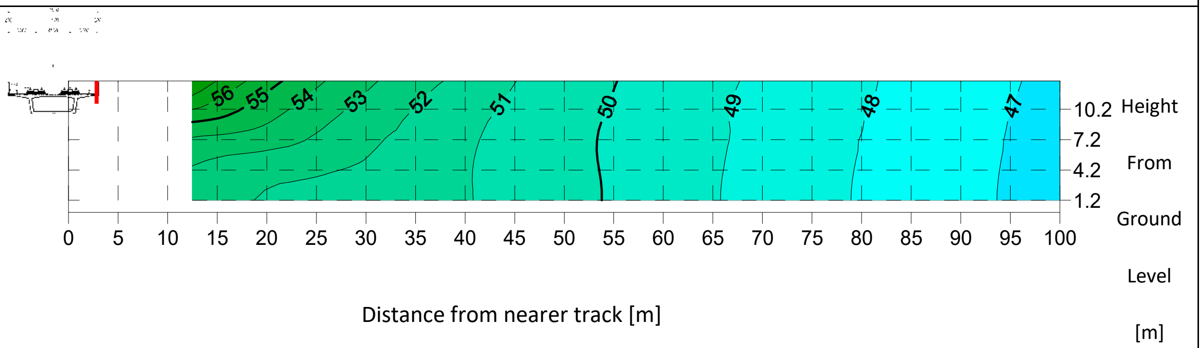
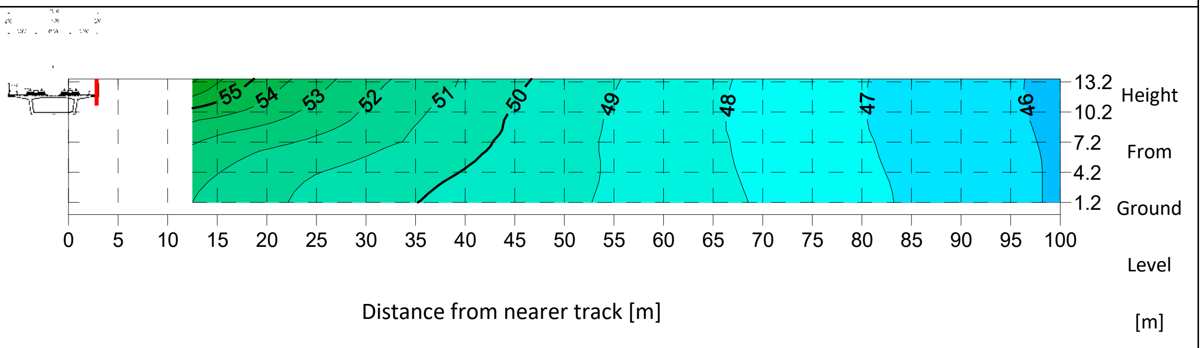
<table>
<tr><td>Height of sound barrier</td><td>[Other conditions]
Category: B-1, Target year: 2023(Initial phase), No. of cars: 10, TrainSpeed:350 km/h
Height of the railway level from ground: 10 m</td></tr>
<tr><td>2.0 m</td><td>
</td></tr>
<tr><td>2.5 m</td><td>
</td></tr>
<tr><td>3.0 m</td><td>
</td></tr>
<tr><td>3.5 m</td><td>
</td></tr>
</table>

Exhibit 5.1.7 (5): Sound Level Contour of L_{Aeq} during Day Time

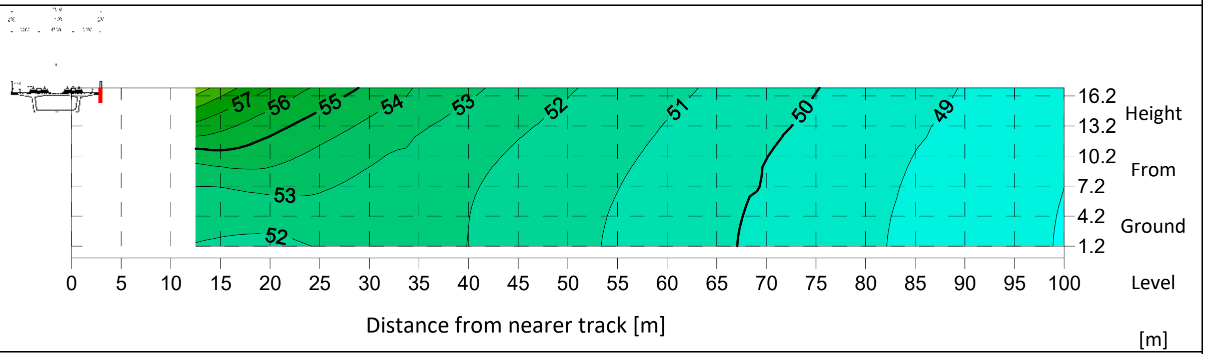
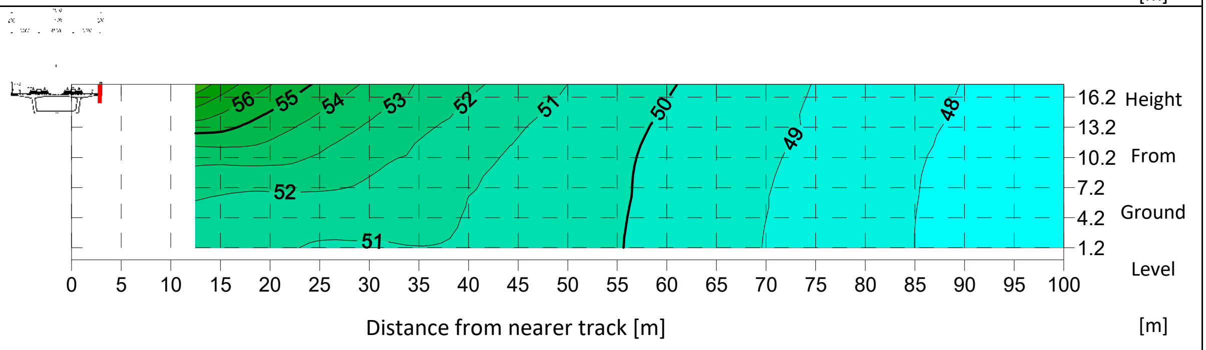
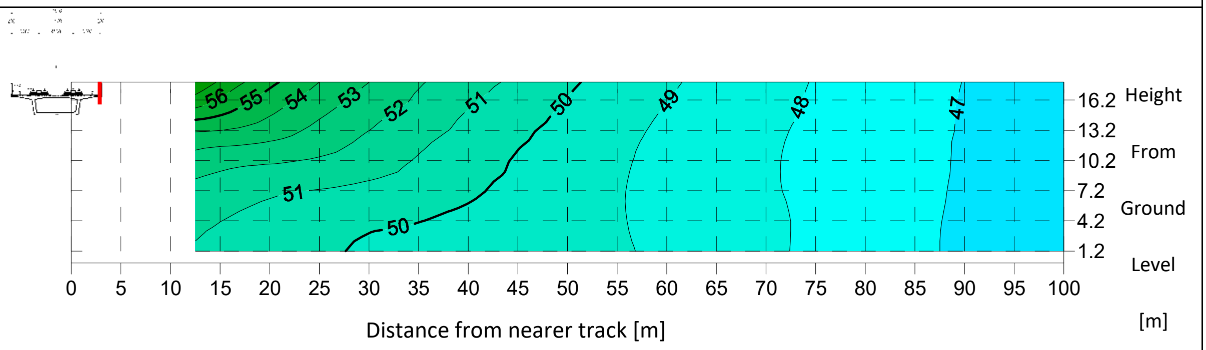
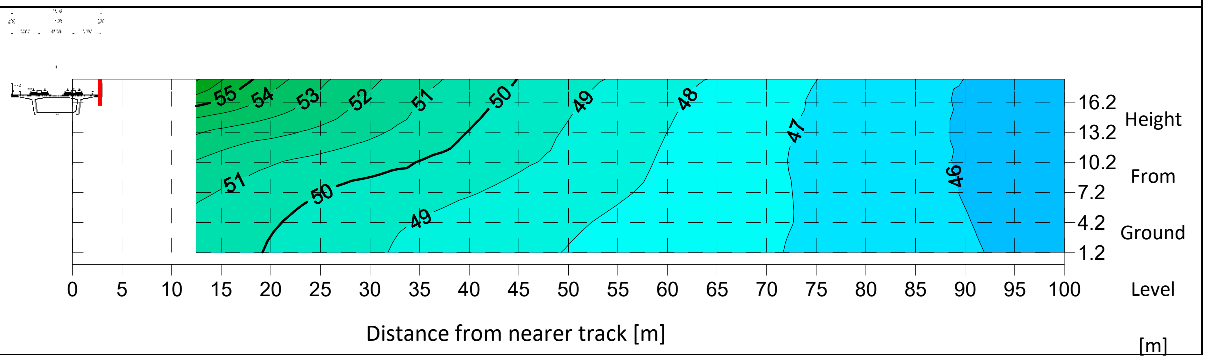
<table>
<tr><td>Height of sound barrier</td><td>[Other conditions]
Category: B-2, Target year: 2023(Initial phase), No. of cars: 10, TrainSpeed:350 km/h
Height of the railway level from ground: 15 m</td></tr>
<tr><td>2.0 m</td><td>
</td></tr>
<tr><td>2.5 m</td><td>
</td></tr>
<tr><td>3.0 m</td><td>
</td></tr>
<tr><td>3.5 m</td><td>
</td></tr>
</table>

Exhibit 5.1.7 (6): Sound Level Contour of L_{Aeq} during Day Time

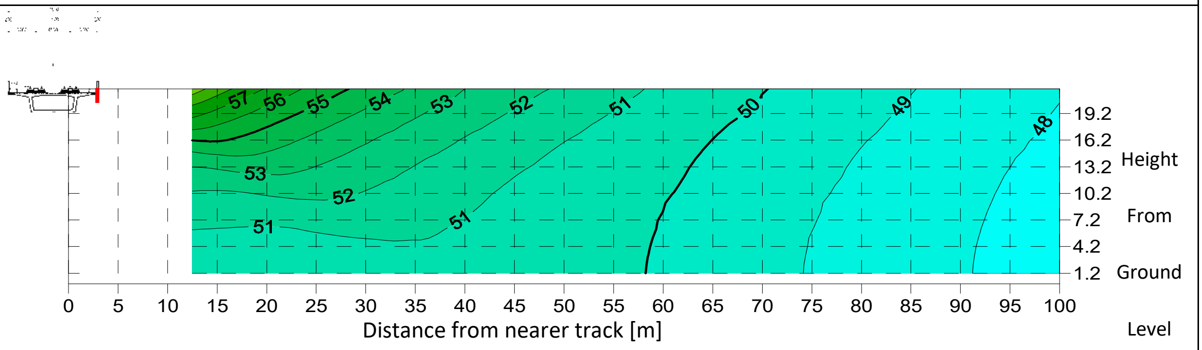
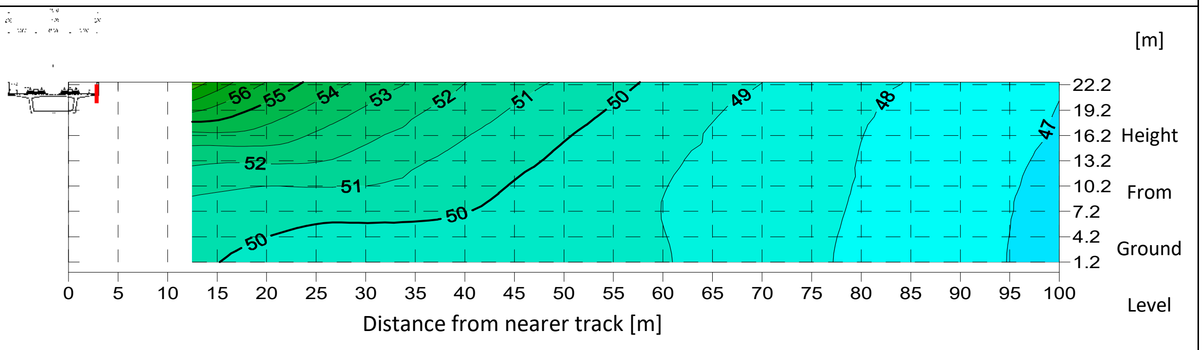
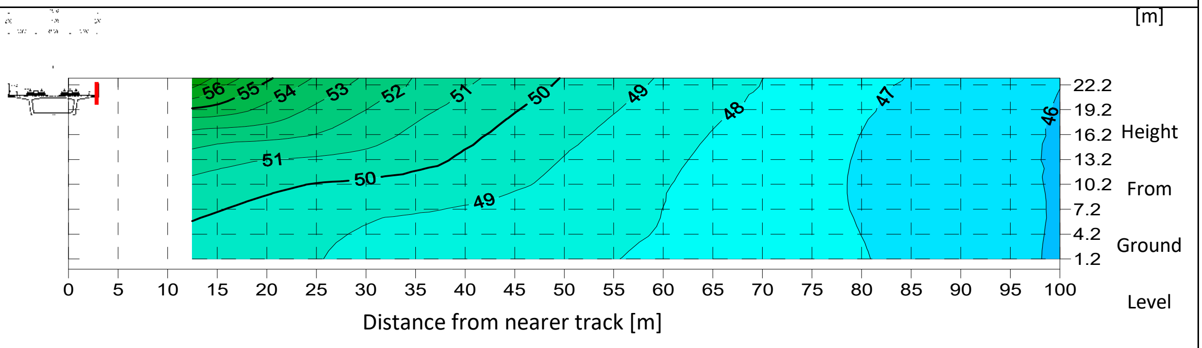
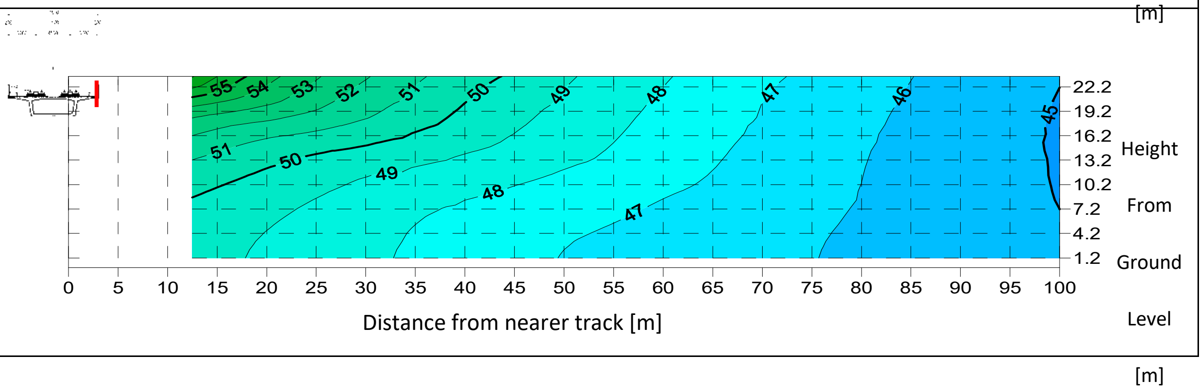
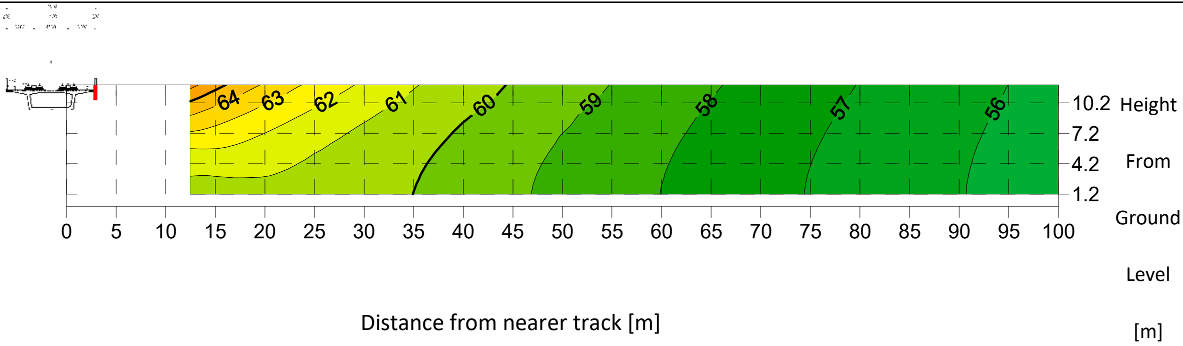
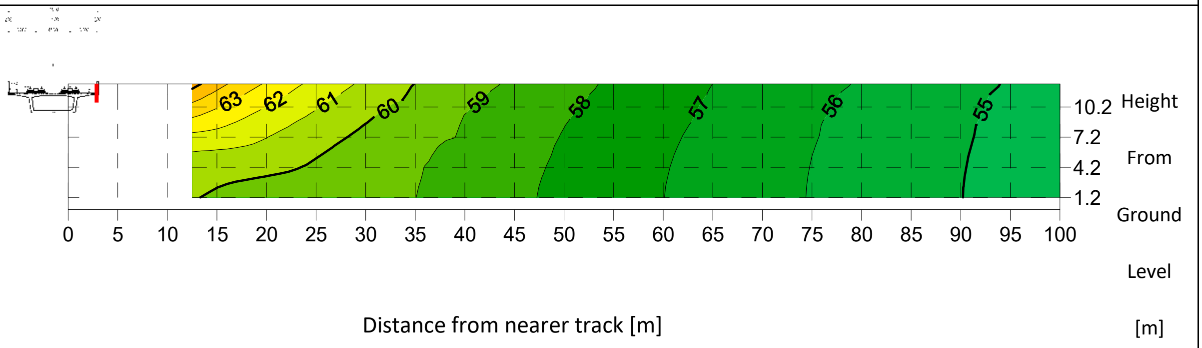
Height of sound barrier	[Other conditions] Category: B-3, Target year: 2023(Initial phase), No. of cars: 10, TrainSpeed:350 km/h Height of the railway level from ground: 20 m
2.0 m	
2.5 m	
3.0 m	
3.5 m	

Exhibit 5.1.7 (7): Sound Level Contour of L_{Aeq} during Day Time

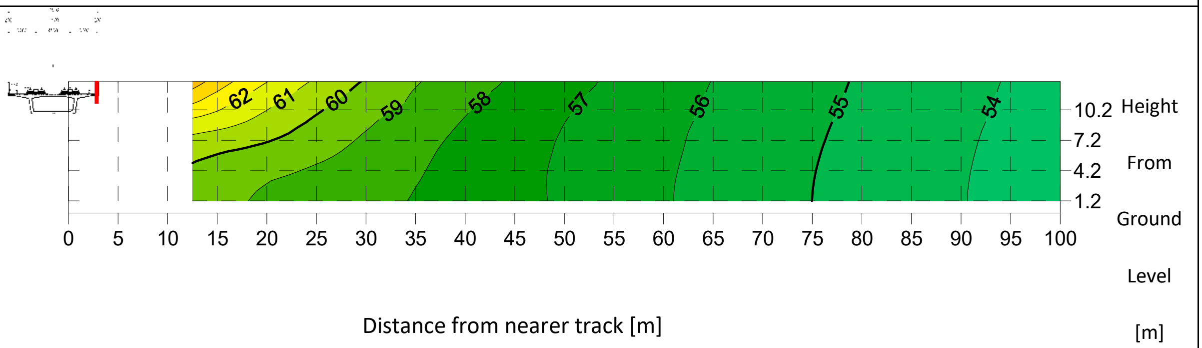
<table>
<tr><td>Height of sound barrier</td><td>[Other conditions]
Category: C-1, Target year: 2053(Operation peak), No. of cars: 16, TrainSpeed:320 km/h
Height of the railway level from ground: 10 m</td></tr>
<tr><td>2.0 m</td><td>



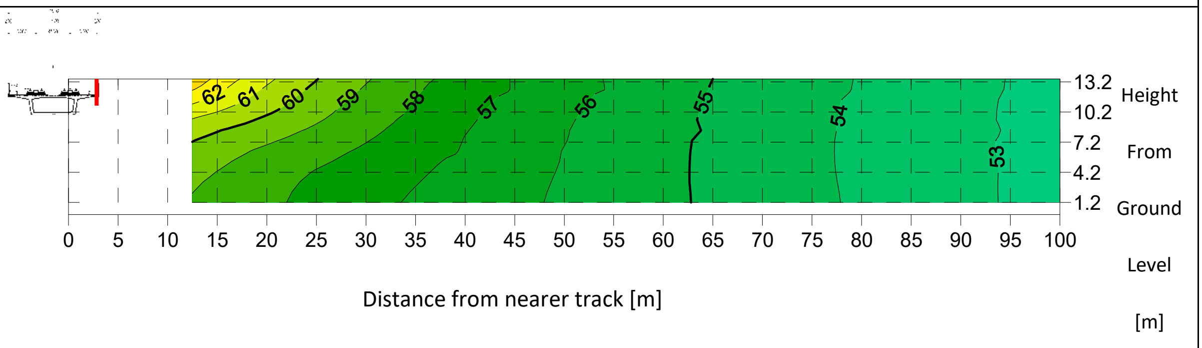
</td></tr>
<tr><td>2.5 m</td><td>



</td></tr>
<tr><td>3.0 m</td><td>



</td></tr>
<tr><td>3.5 m</td><td>



</td></tr>
</table>

Figure 5.1.7 (8): Sound Level Contour of L_{Aeq} during Day Time

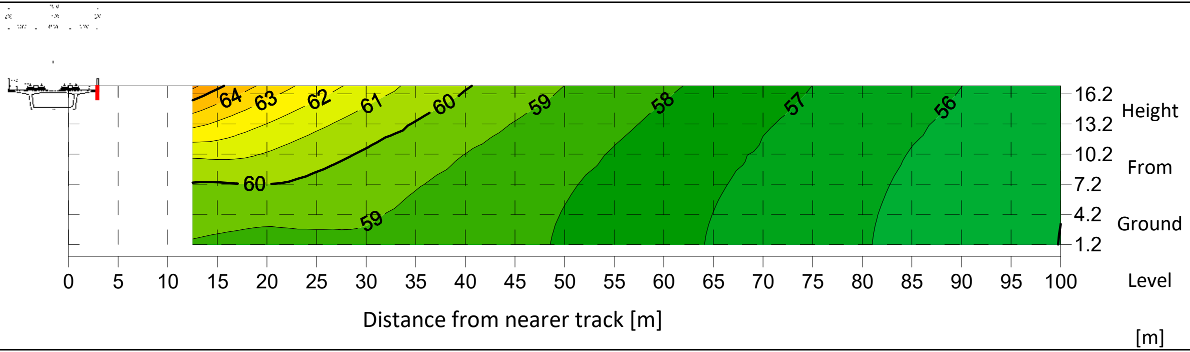
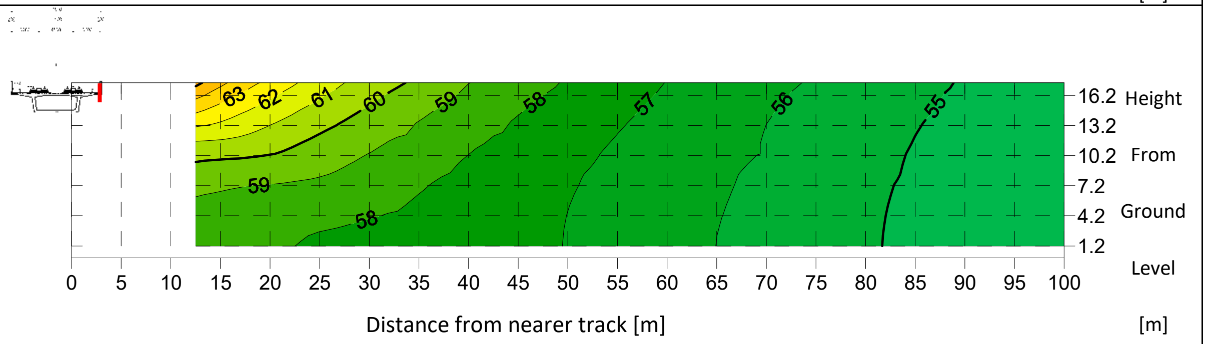
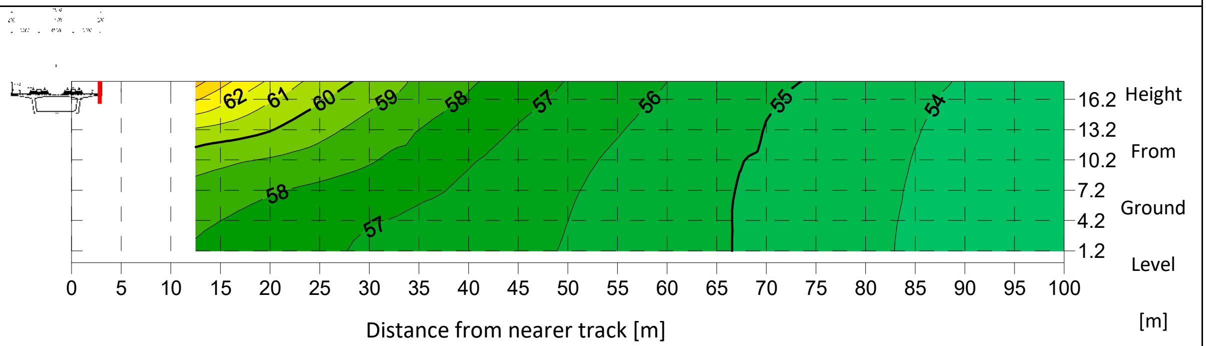
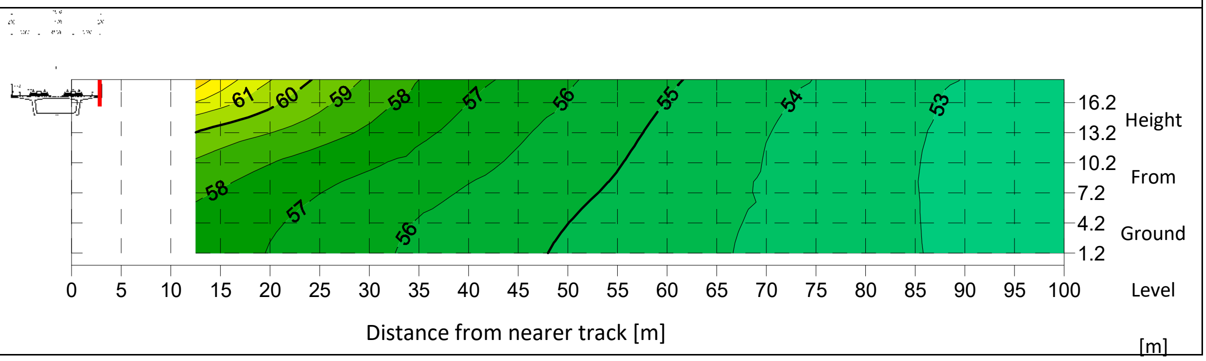
<table>
<tr><td>Height of sound barrier</td><td>[Other conditions]
Category: C-2, Target year: 2053(Operation peak), No. of cars: 16, TrainSpeed:320 km/h
Height of the railway level from ground: 15 m</td></tr>
<tr><td>2.0 m</td><td>
</td></tr>
<tr><td>2.5 m</td><td>
</td></tr>
<tr><td>3.0 m</td><td>
</td></tr>
<tr><td>3.5 m</td><td>
</td></tr>
</table>

Exhibit 5.1.7 (9): Sound Level Contour of L_{Aeq} during Day Time

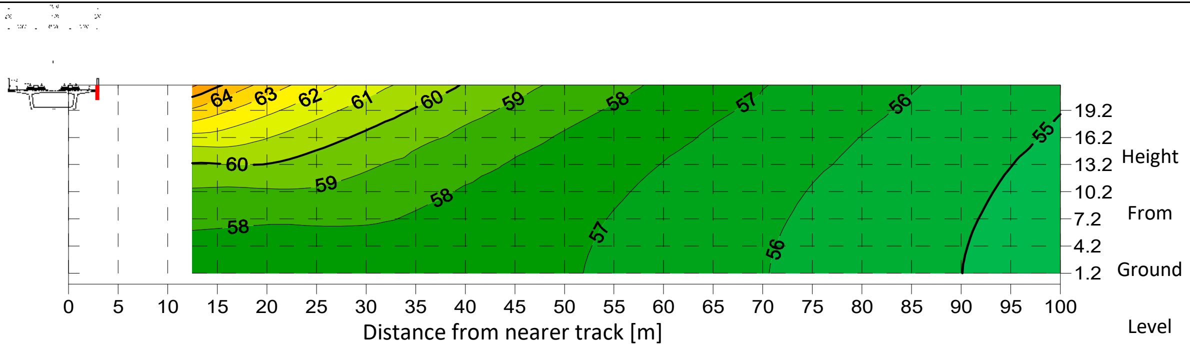
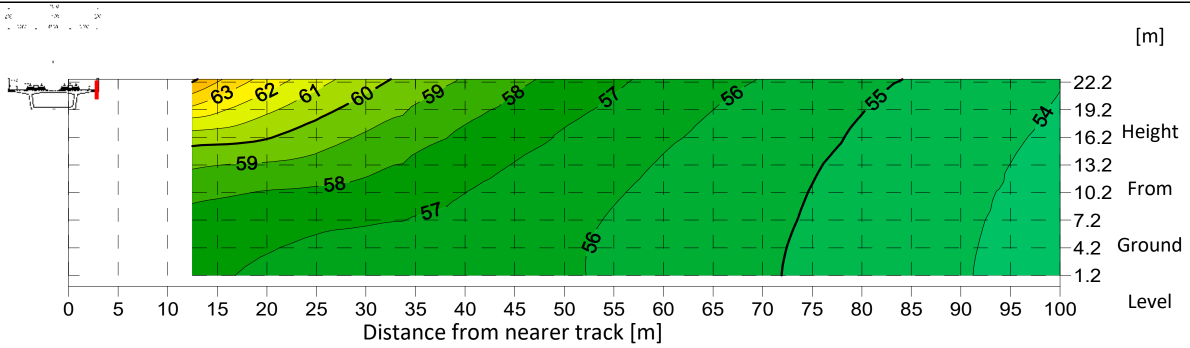
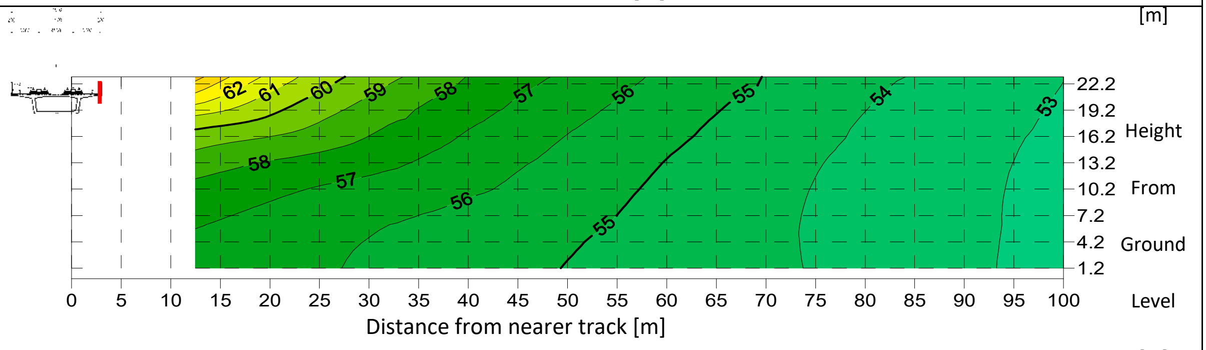
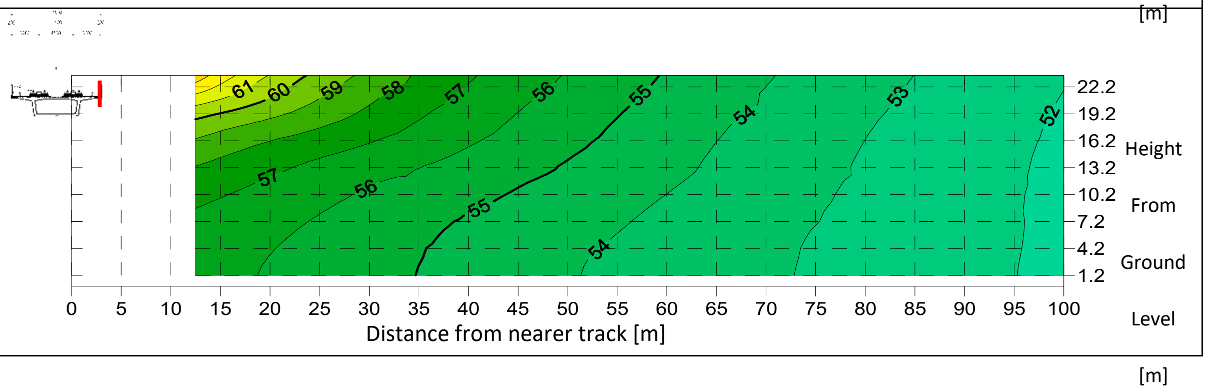
Height of sound barrier	[Other conditions] Category: C-3, Target year: 2053(Operation peak), No. of cars: 16, TrainSpeed:320 km/h Height of the railway level from ground: 20 m
2.0 m	
2.5 m	
3.0 m	
3.5 m	

Exhibit 5.1.7 (10): Sound Level Contour of L_{Aeq} during Day Time

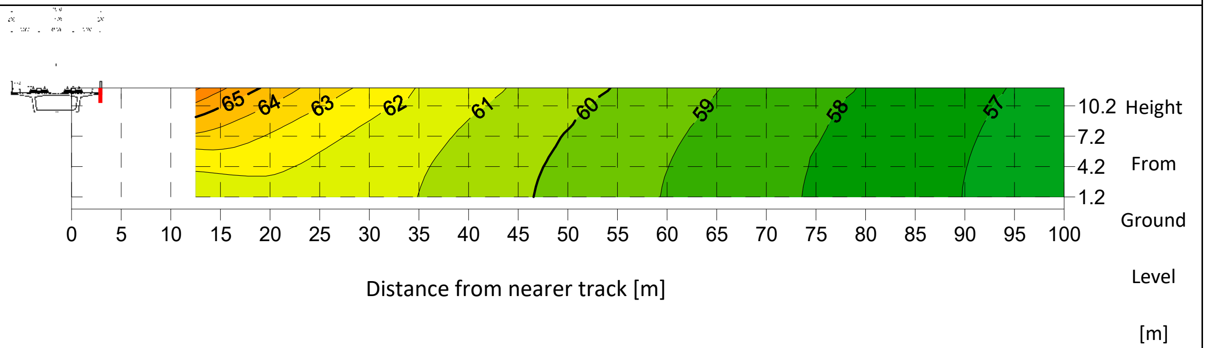
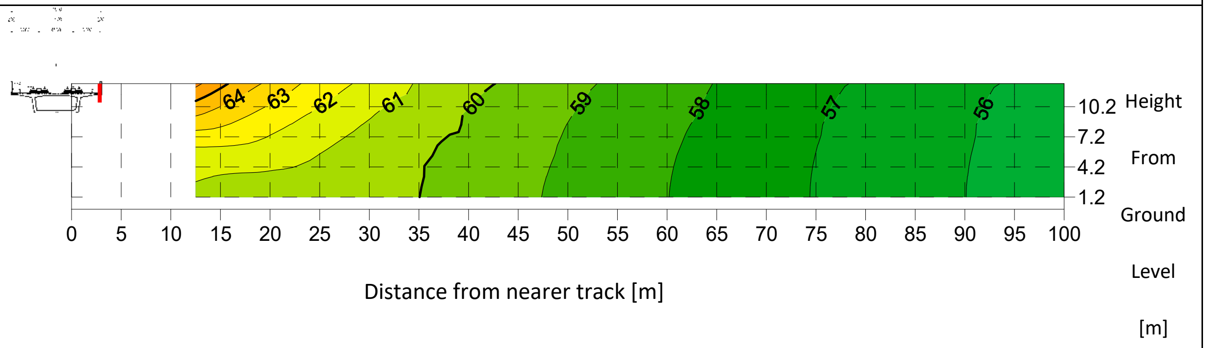
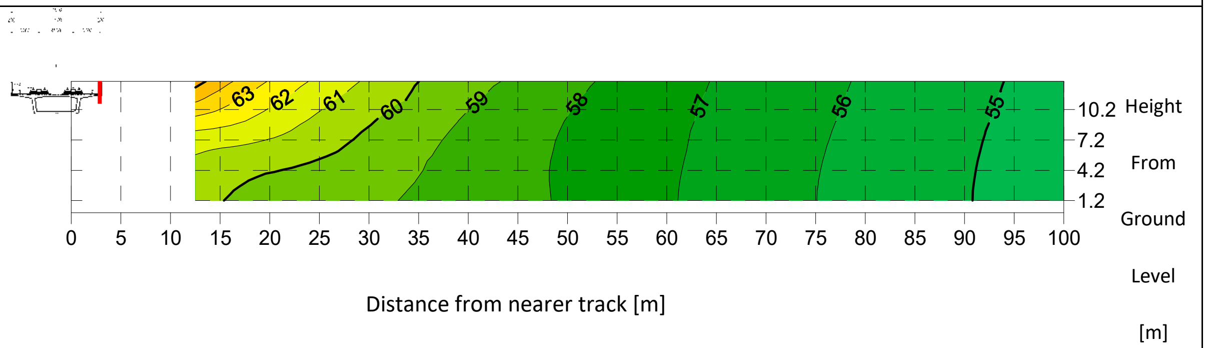
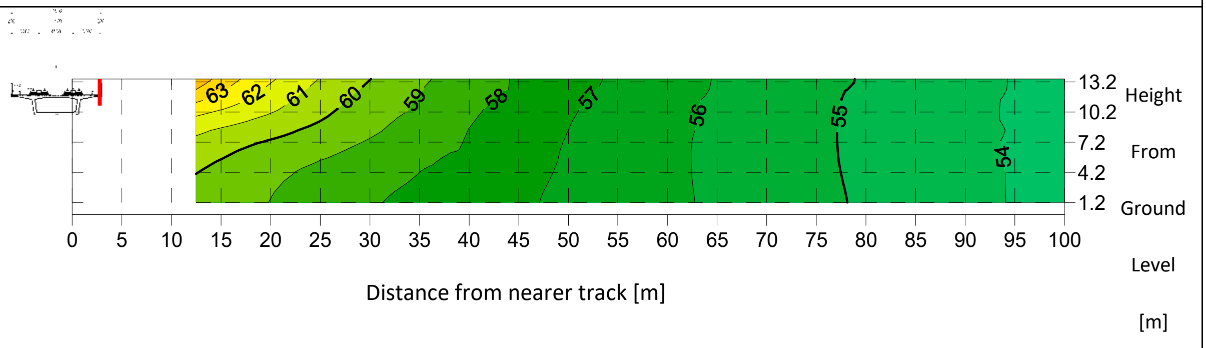
Height of sound barrier	[Other conditions] Category: D-1, Target year: 2053(Operation peak), No. of cars: 16, TrainSpeed:350 km/h Height of the railway level from ground: 10 m
2.0 m	
2.5 m	
3.0 m	
3.5 m	

Exhibit 5.1.7 (11): Sound Level Contour of L_{Aeq} during Day Time

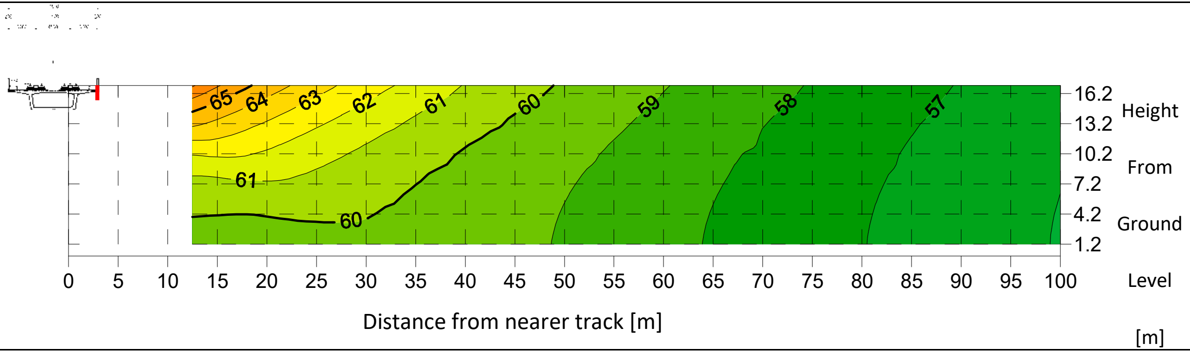
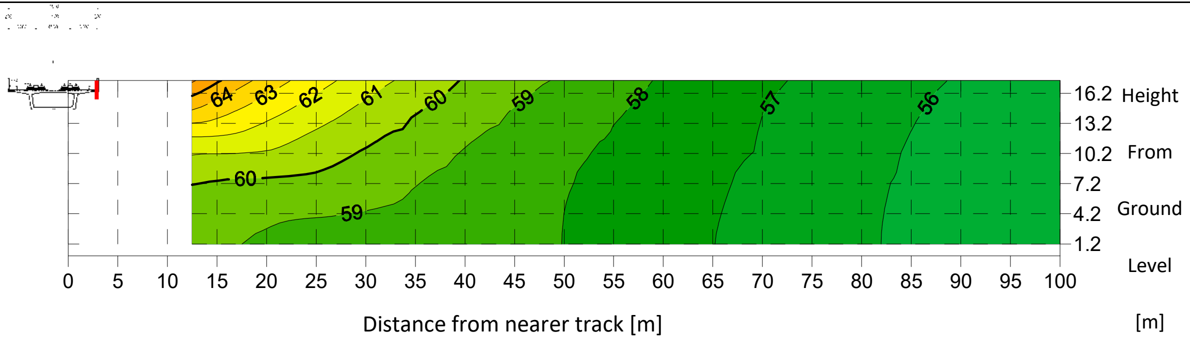
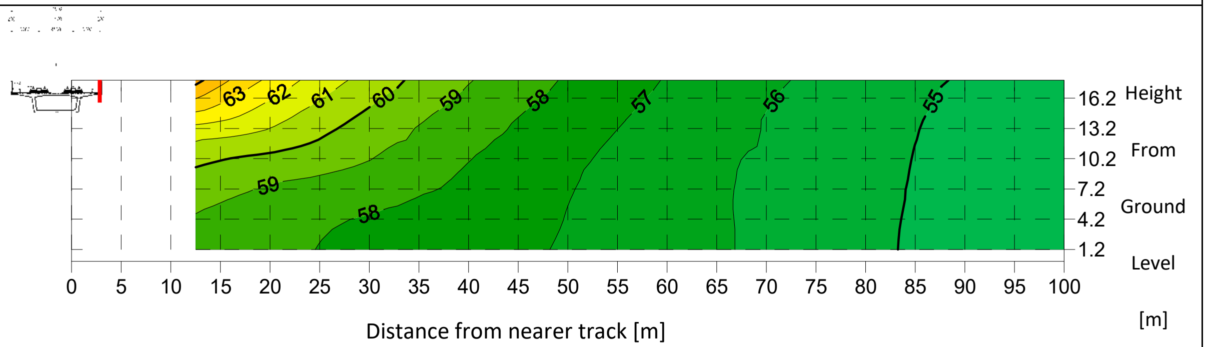
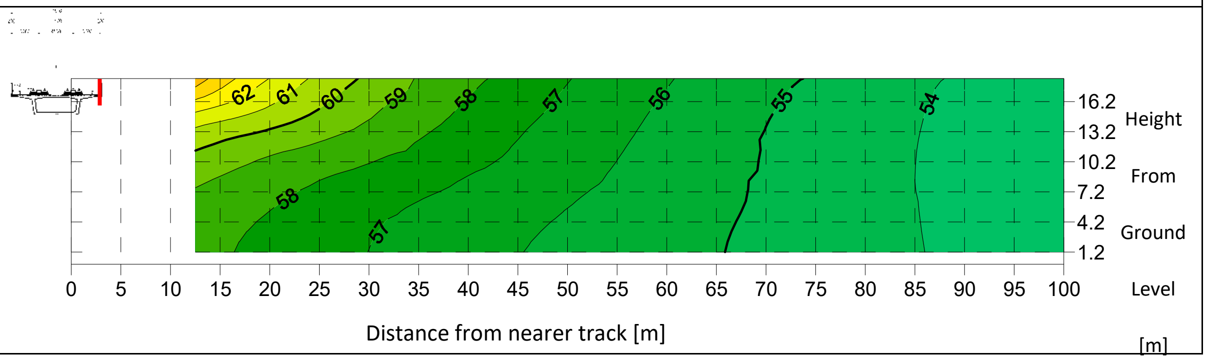
<table>
<tr><td>Height of sound barrier</td><td>[Other conditions]
Category: D-2, Target year: 2053(Operation peak), No. of cars: 16, TrainSpeed:350 km/h
Height of the railway level from ground: 15 m</td></tr>
<tr><td>2.0 m</td><td>
</td></tr>
<tr><td>2.5 m</td><td>
</td></tr>
<tr><td>3.0 m</td><td>
</td></tr>
<tr><td>3.5 m</td><td>
</td></tr>
</table>

Exhibit 5.1.7 (12): Sound Level Contour of L_{Aeq} during Day Time

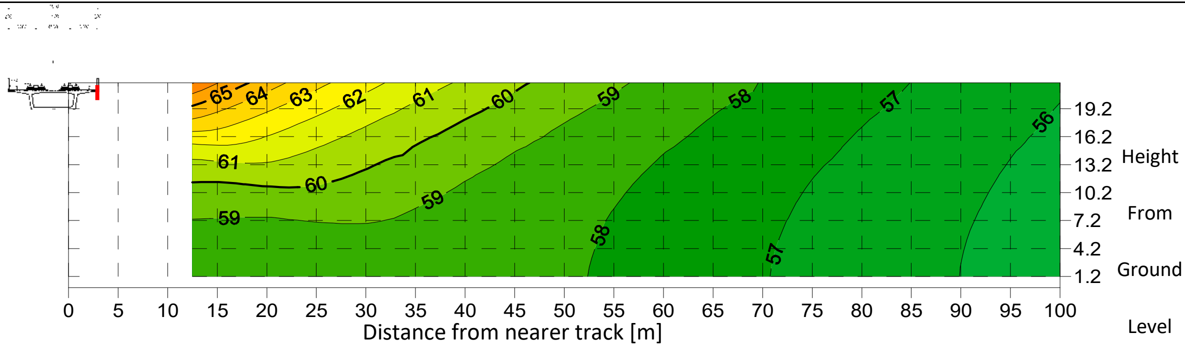
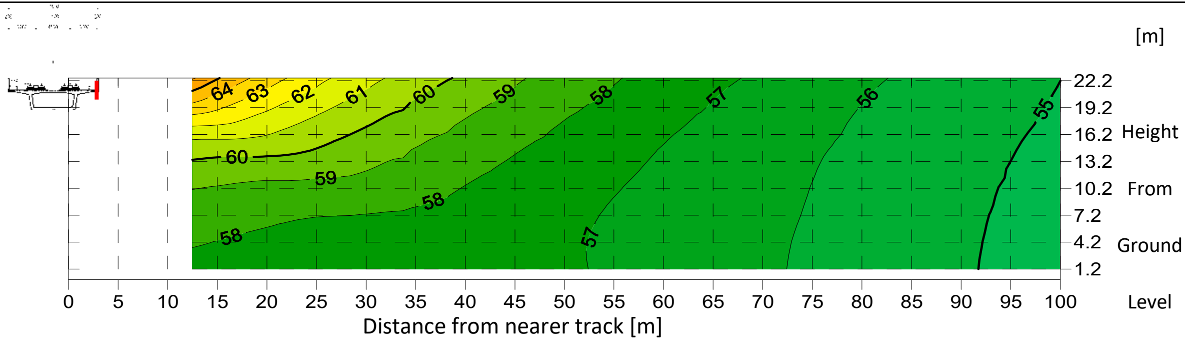
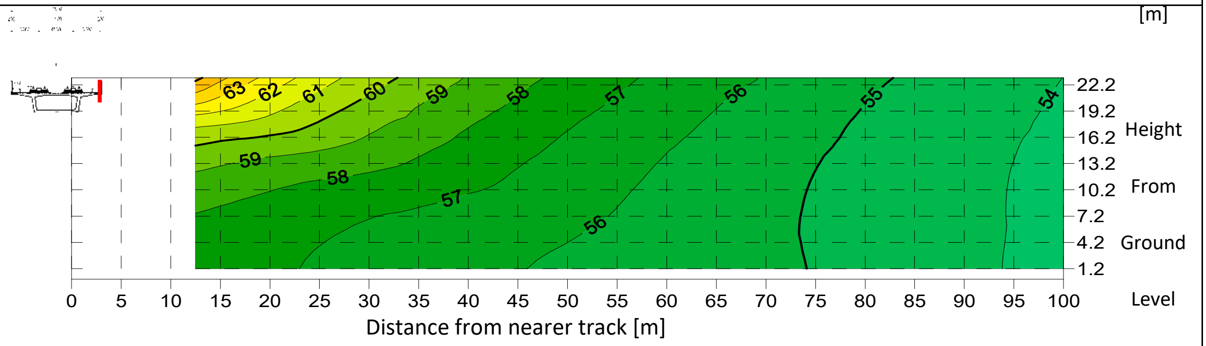
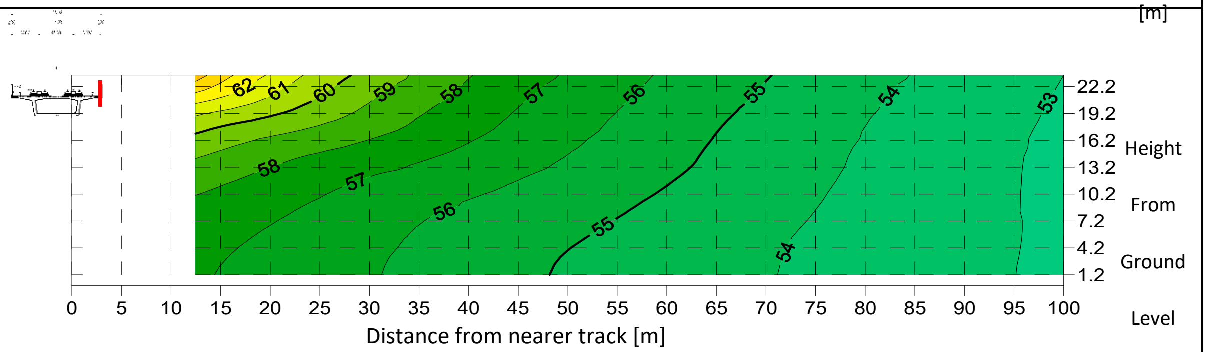
Height of sound barrier	[Other conditions] Category: D-3, Target year: 2053(Operation peak), No. of cars: 16, TrainSpeed:350 km/h Height of the railway level from ground: 20 m
2.0 m	
2.5 m	
3.0 m	
3.5 m	

Exhibit 5.1.8 (1): Sound Level Contour of L_{Aeq} during Night Time

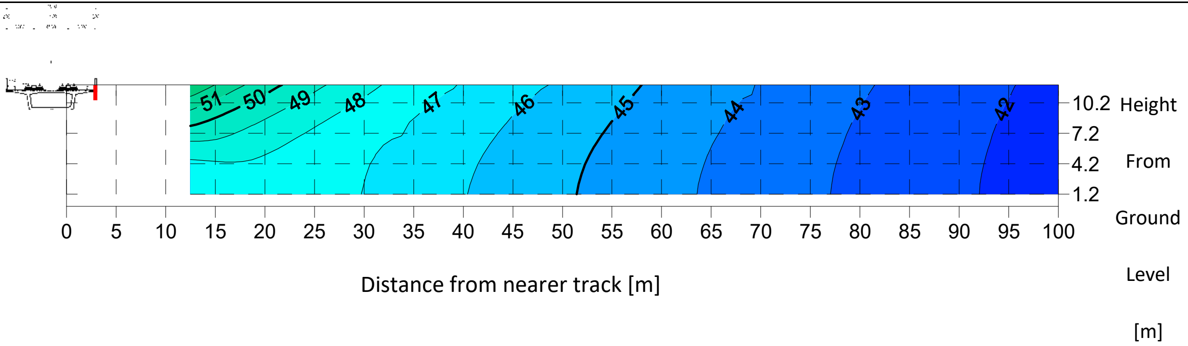
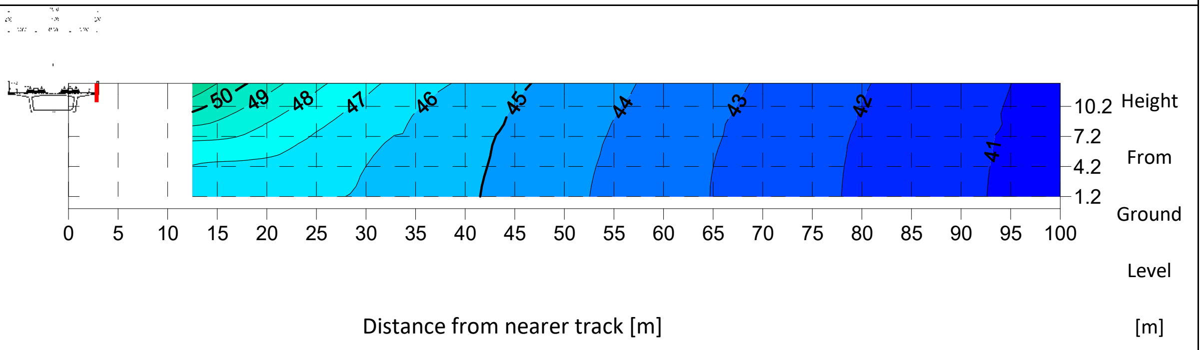
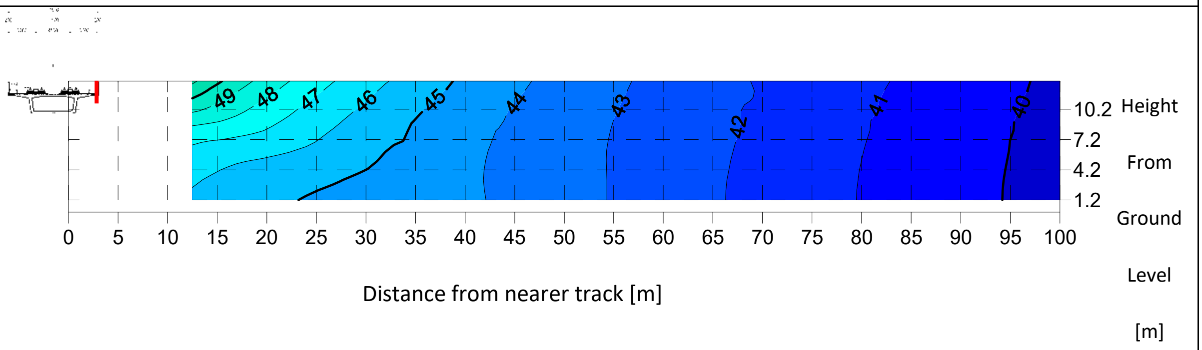
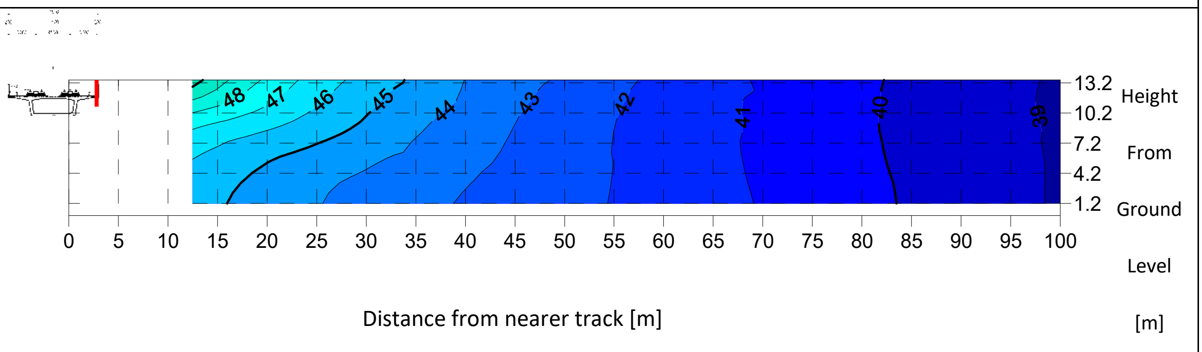
<table>
<tr><td>Height of sound barrier</td><td>[Other conditions]
Category: A-1, Target year: 2023(Initial phase), No. of cars: 10, TrainSpeed:320 km/h
Height of the railway level from ground: 10 m</td></tr>
<tr><td>2.0 m</td><td>
</td></tr>
<tr><td>2.5 m</td><td>
</td></tr>
<tr><td>3.0 m</td><td>
</td></tr>
<tr><td>3.5 m</td><td>
</td></tr>
</table>

Exhibit 5.1.8 (2): Sound Level Contour of L_{Aeq} during Night Time

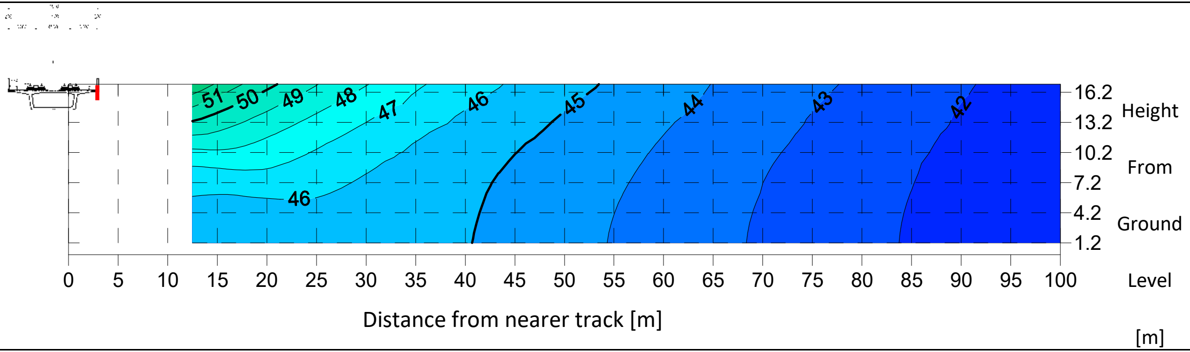
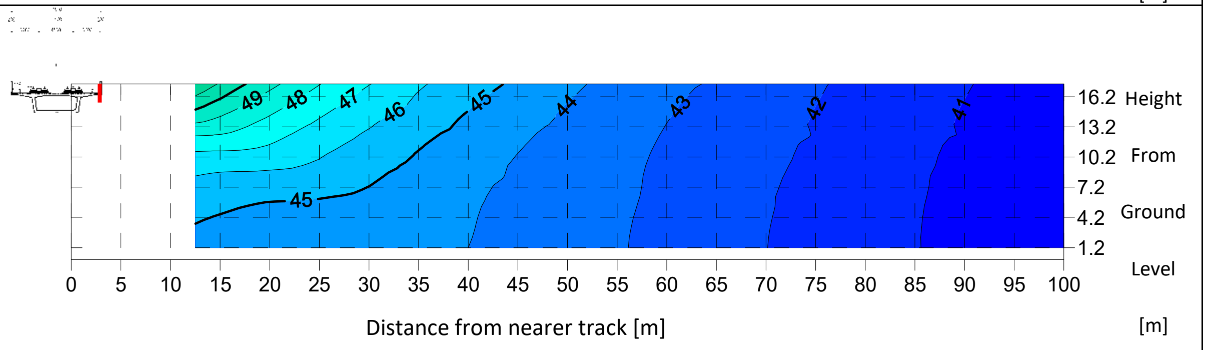
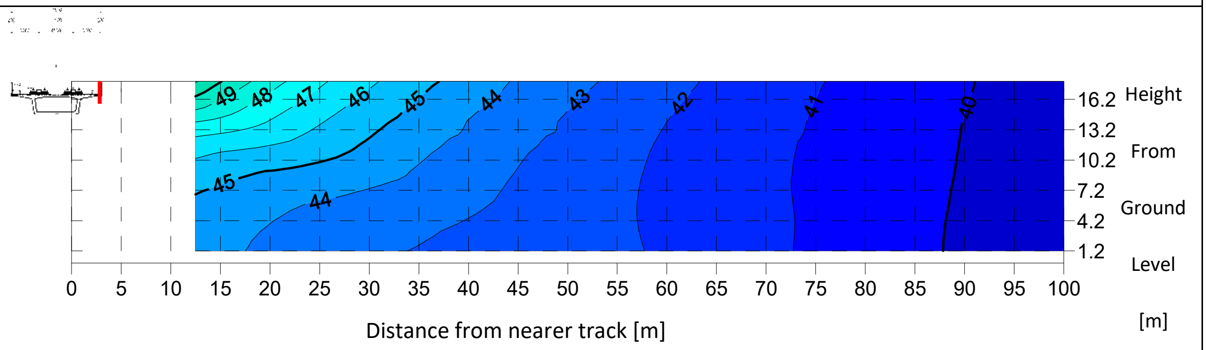
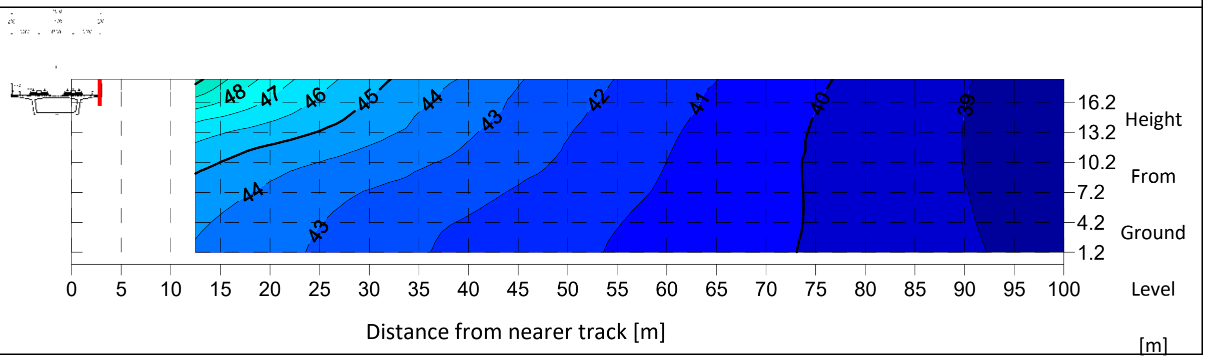
Height of sound barrier	[Other conditions] Category: A-2, Target year: 2023(Initial phase), No. of cars: 10, TrainSpeed:320 km/h Height of the railway level from ground: 15 m
2.0 m	
2.5 m	
3.0 m	
3.5 m	

Exhibit 5.1.8 (3): Sound Level Contour of L_{Aeq} during Night Time

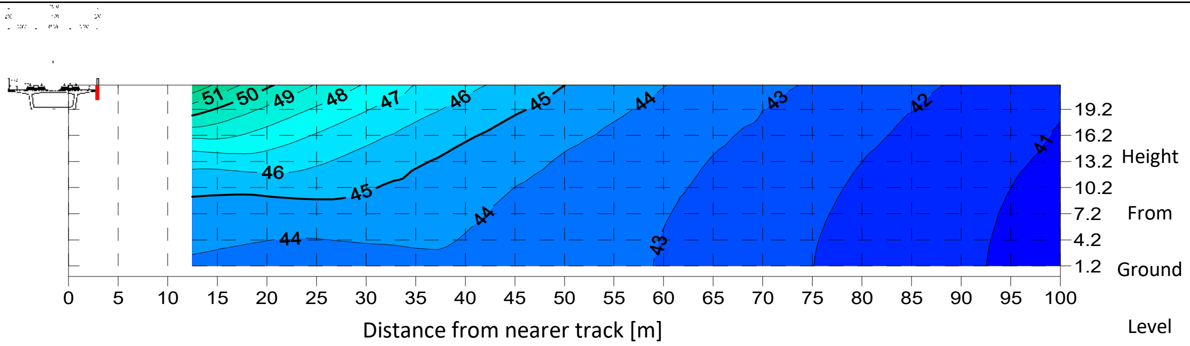
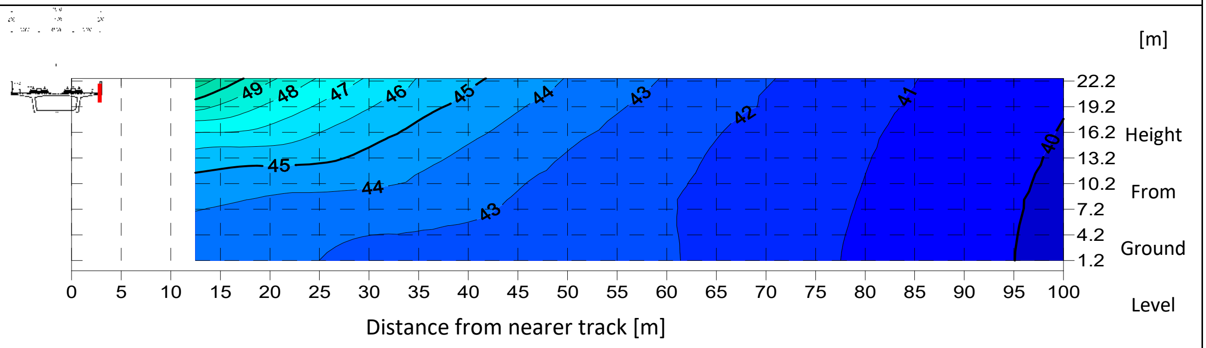
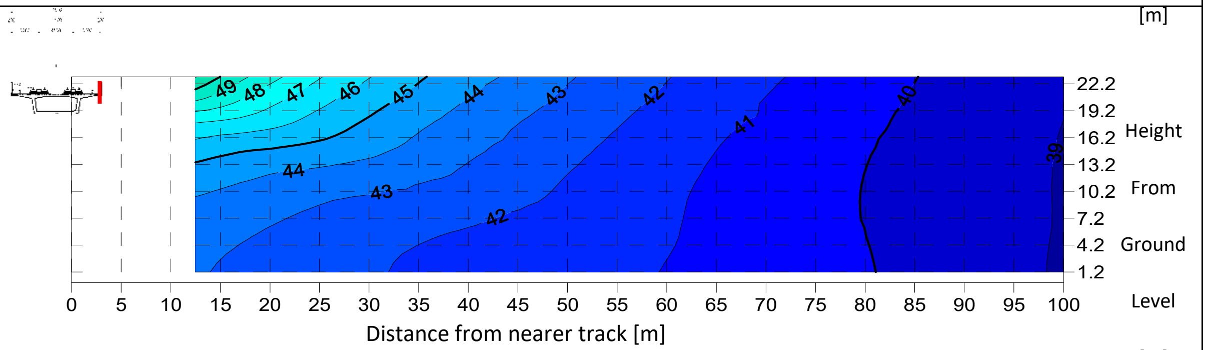
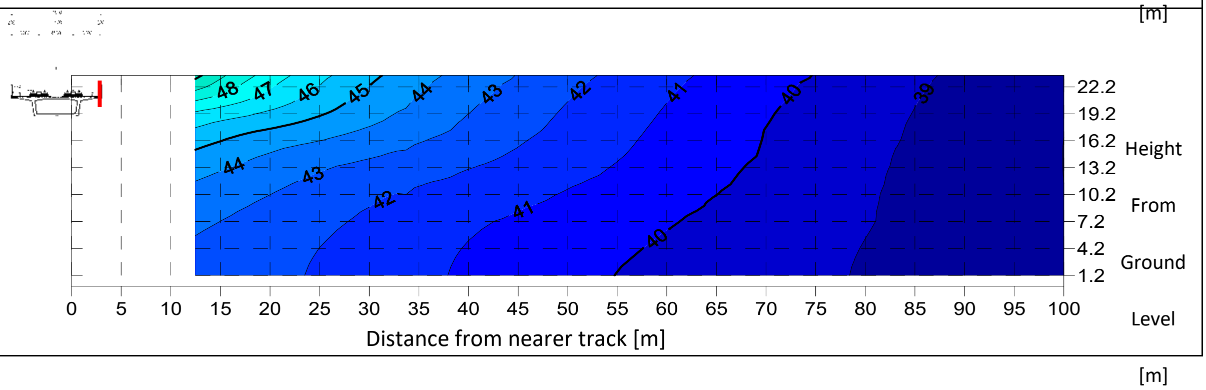
Height of sound barrier	[Other conditions] Category: A-3, Target year: 2023(Initial phase), No. of cars: 10, TrainSpeed:320 km/h Height of the railway level from ground: 20 m
2.0 m	
2.5 m	
3.0 m	
3.5 m	

Exhibit 5.1.8 (4): Sound Level Contour of L_{Aeq} during Night Time

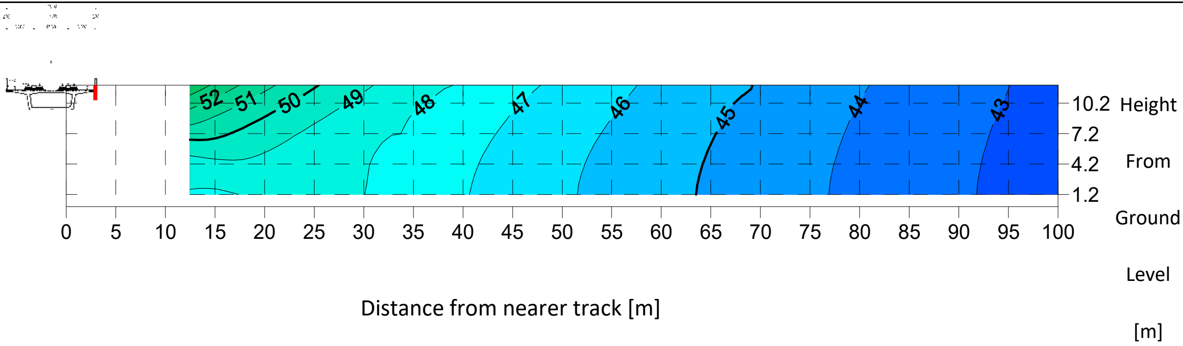
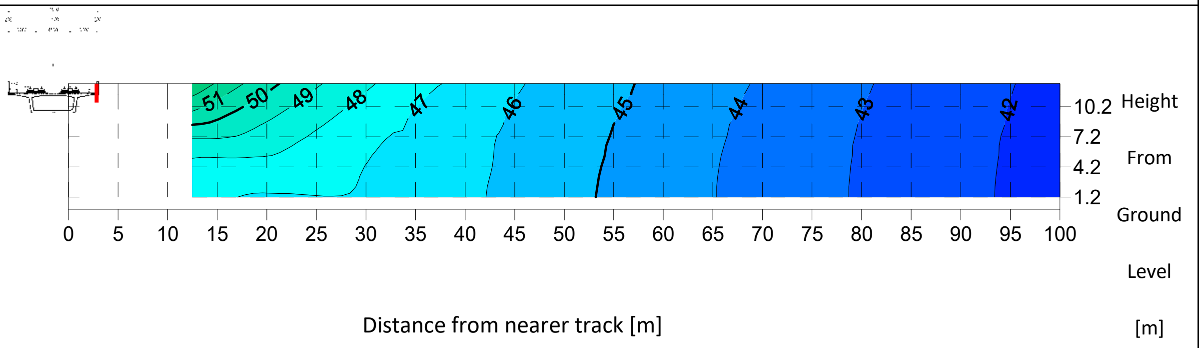
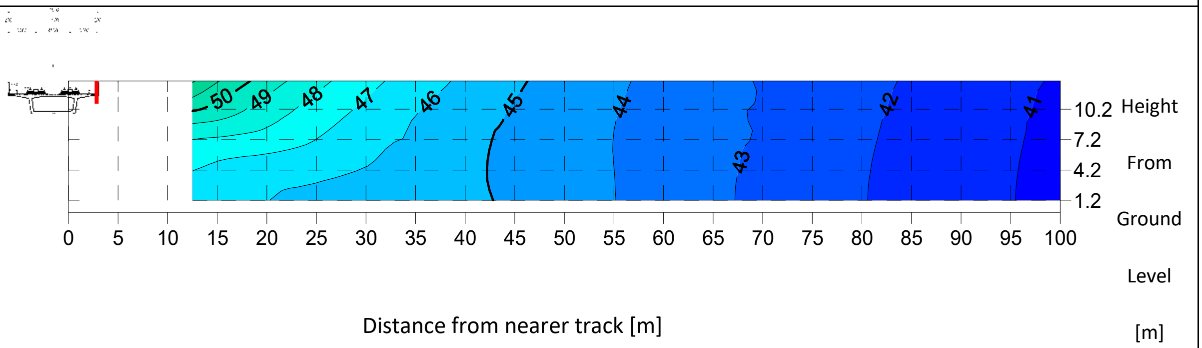
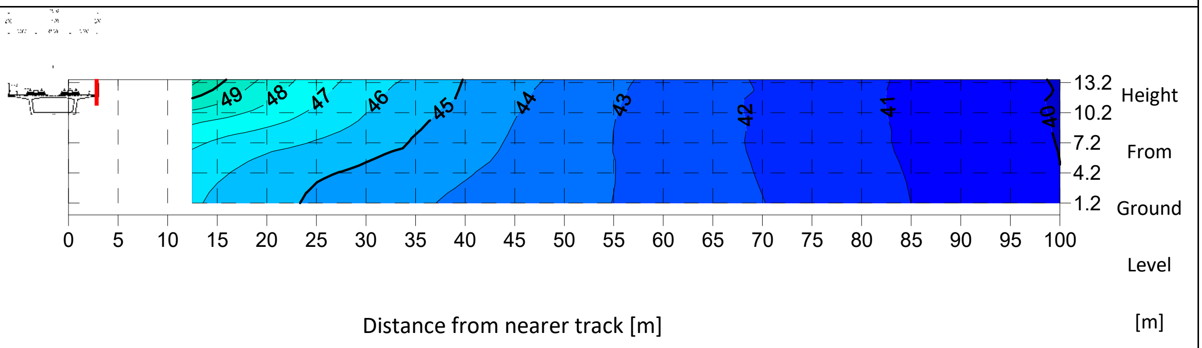
<table>
<tr><td>Height of sound barrier</td><td>[Other conditions]
Category: B-1, Target year: 2023(Initial phase), No. of cars: 10, TrainSpeed:350 km/h
Height of the railway level from ground: 10 m</td></tr>
<tr><td>2.0 m</td><td>
</td></tr>
<tr><td>2.5 m</td><td>
</td></tr>
<tr><td>3.0 m</td><td>
</td></tr>
<tr><td>3.5 m</td><td>
</td></tr>
</table>

Exhibit 5.1.8 (5): Sound Level Contour of L_{Aeq} during Night Time

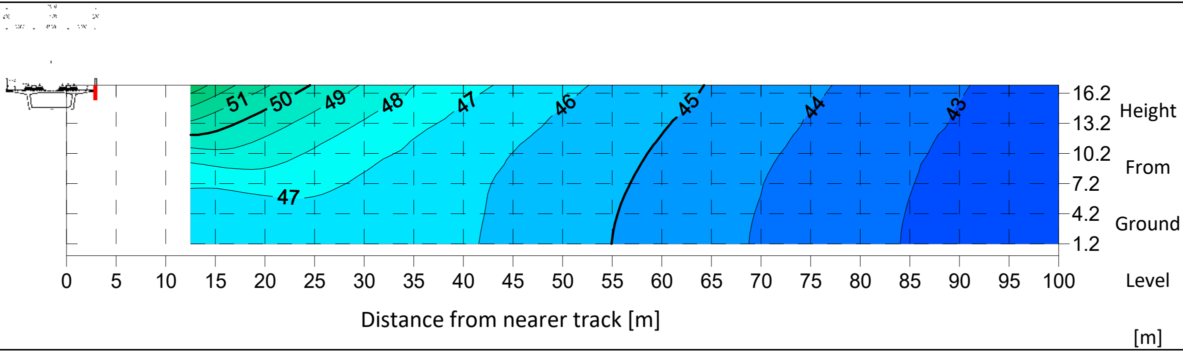
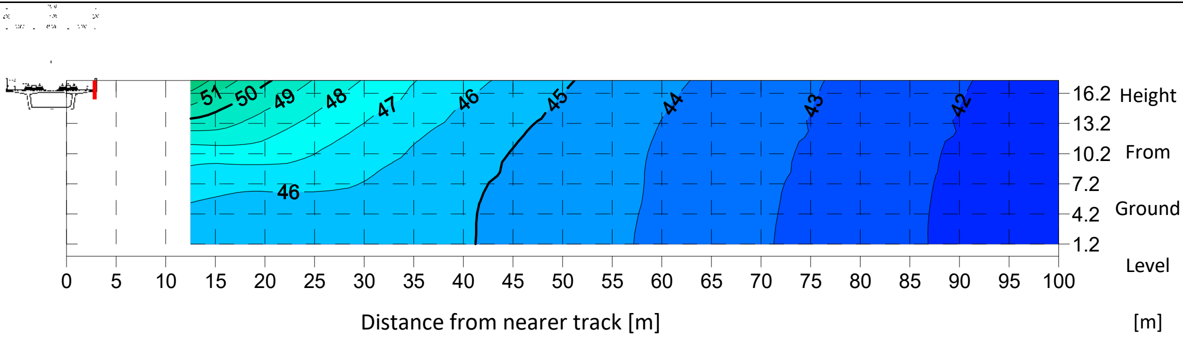
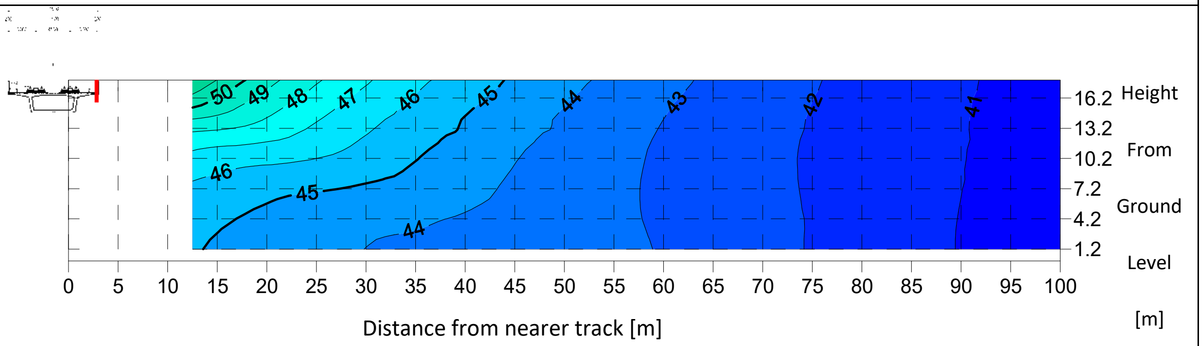
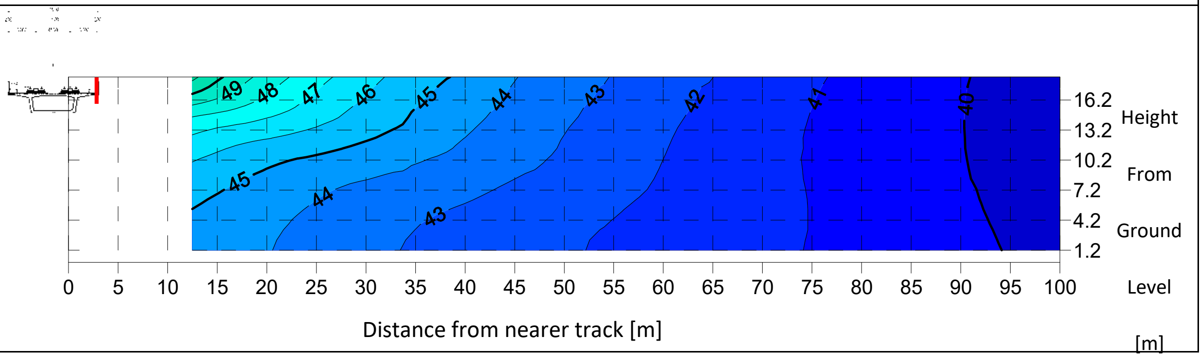
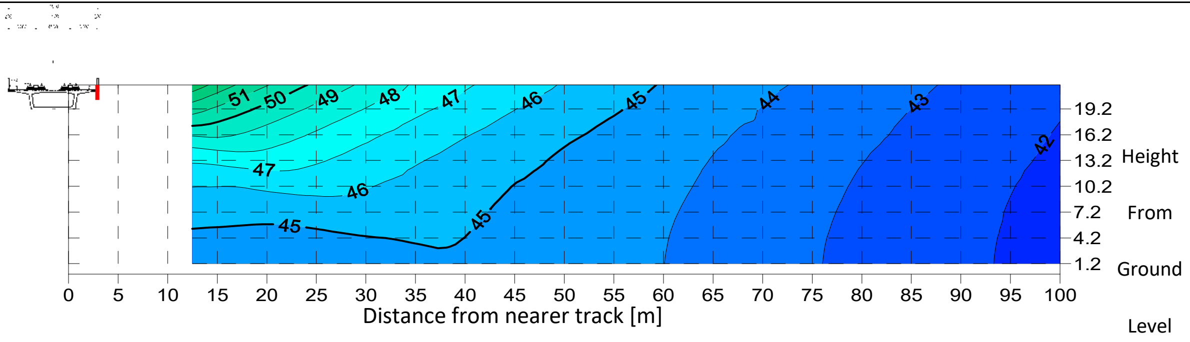
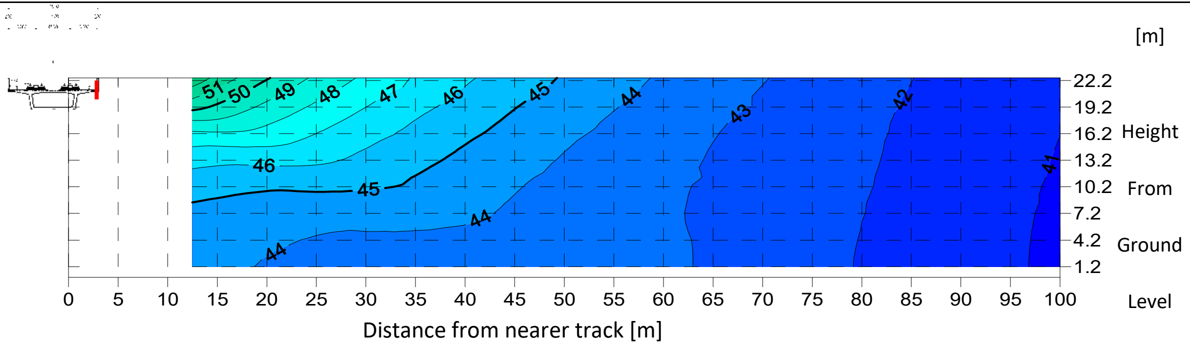
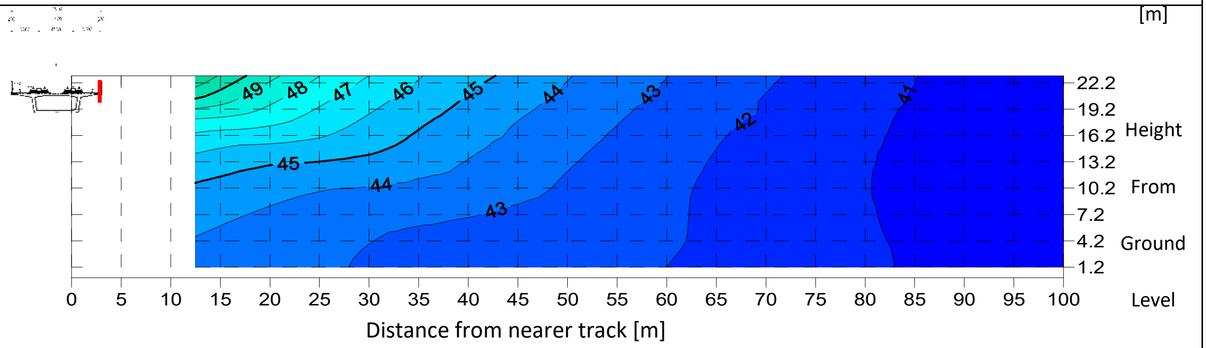
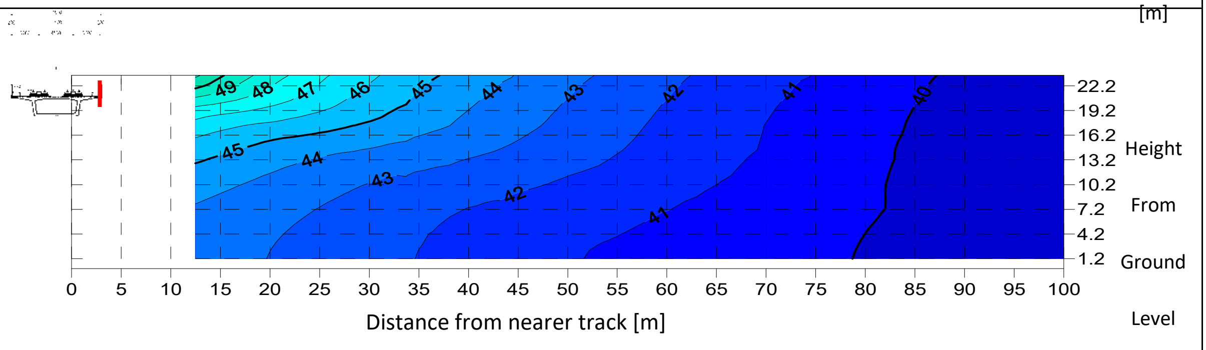
Height of sound barrier	[Other conditions] Category: B-2, Target year: 2023(Initial phase), No. of cars: 10, TrainSpeed:350 km/h Height of the railway level from ground: 15 m
2.0 m	
2.5 m	
3.0 m	
3.5 m	

Exhibit 5.1.8 (6): Sound Level Contour of L_{Aeq} during Night Time

Height of sound barrier	[Other conditions] Category: B-3, Target year: 2023(Initial phase), No. of cars: 10, TrainSpeed:350 km/h Height of the railway level from ground: 20 m
2.0 m	
2.5 m	
3.0 m	
3.5 m	

[m]

Exhibit 5.1.8 (7): Sound Level Contour of L_{Aeq} during Night Time

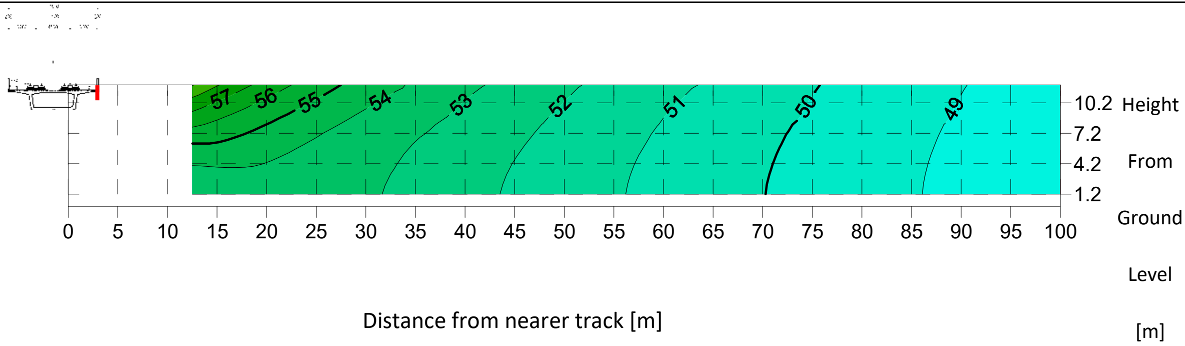
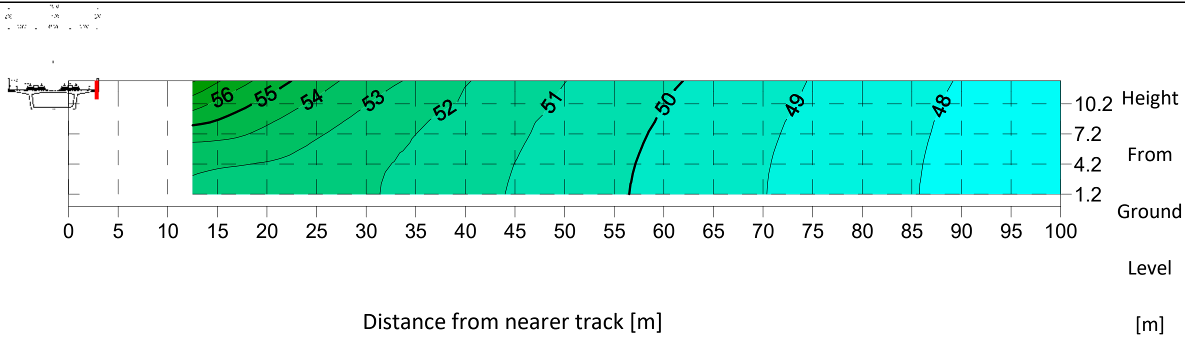
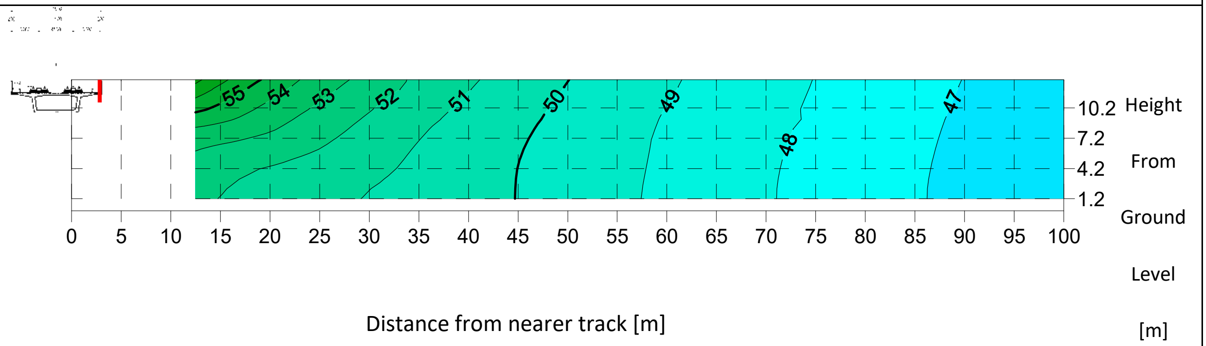
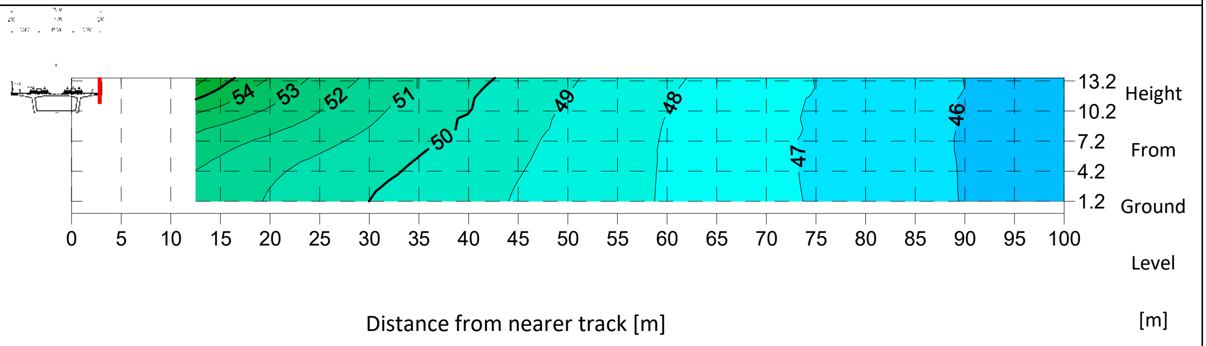
Height of sound barrier	[Other conditions] Category: C-1, Target year: 2053(Operation peak), No. of cars: 16, TrainSpeed:320 km/h Height of the railway level from ground: 10 m
2.0 m	
2.5 m	
3.0 m	
3.5 m	

Exhibit 5.1.8 (8): Sound Level Contour of L_{Aeq} during Night Time

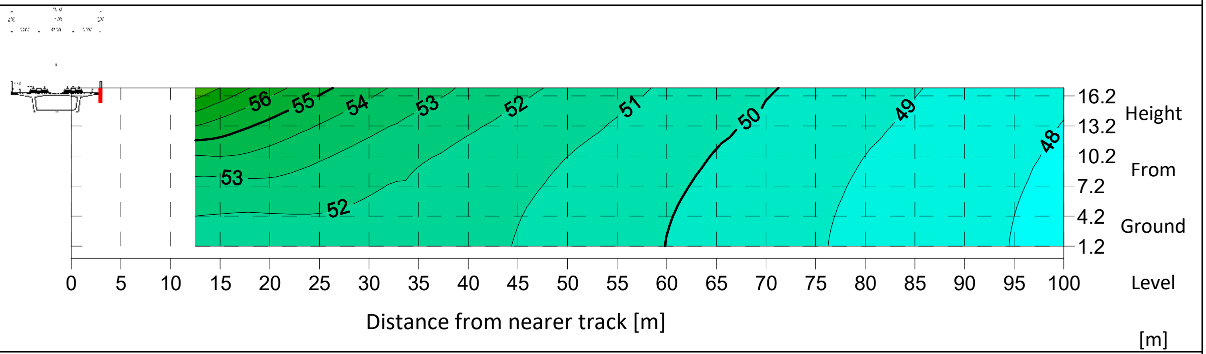
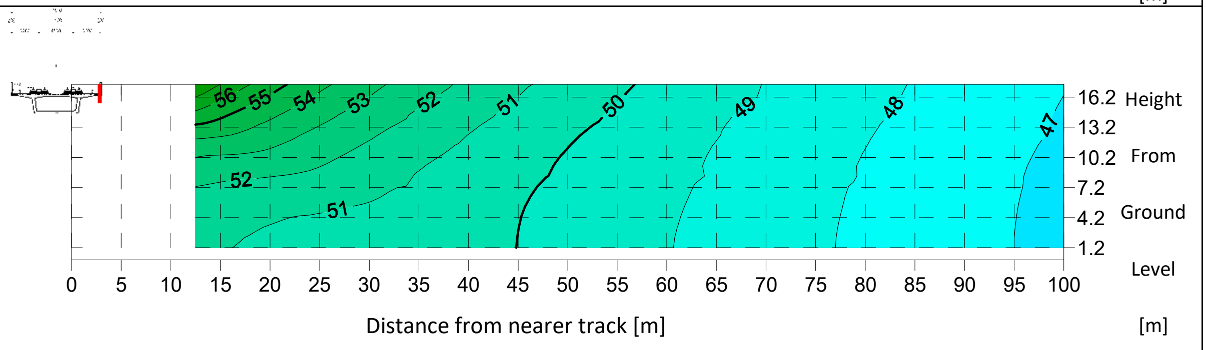
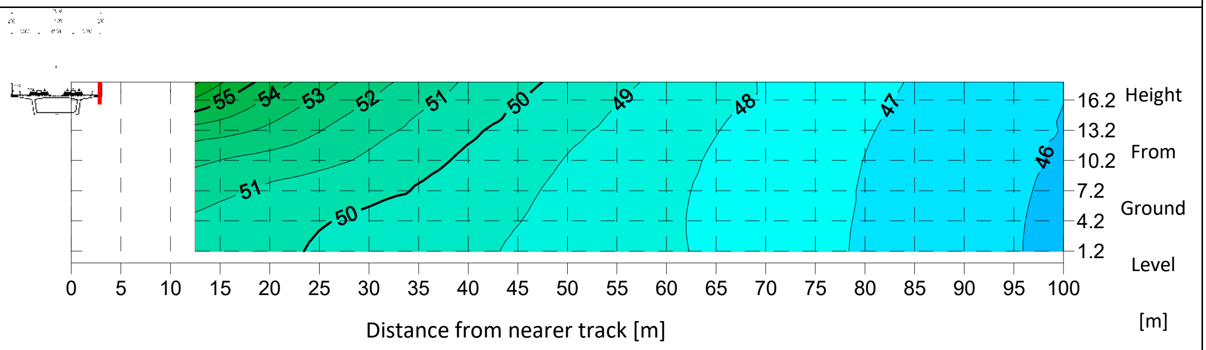
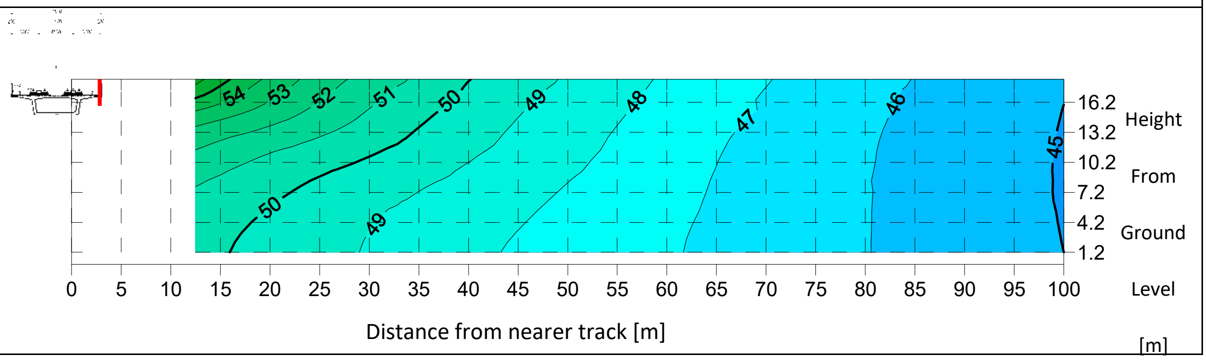
Height of sound barrier	[Other conditions] Category: C-2, Target year: 2053(Operation peak), No. of cars: 16, TrainSpeed:320 km/h Height of the railway level from ground: 15 m
2.0 m	
2.5 m	
3.0 m	
3.5 m	

Exhibit 5.1.8 (9): Sound Level Contour of L_{Aeq} during Night Time

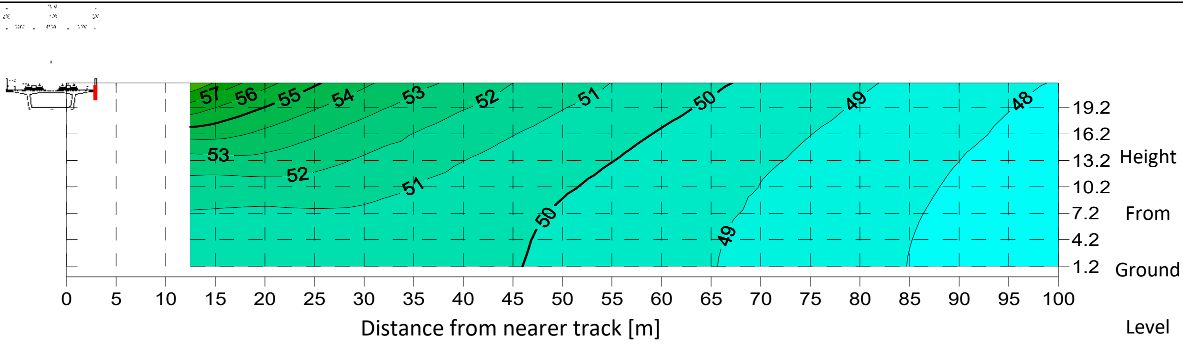
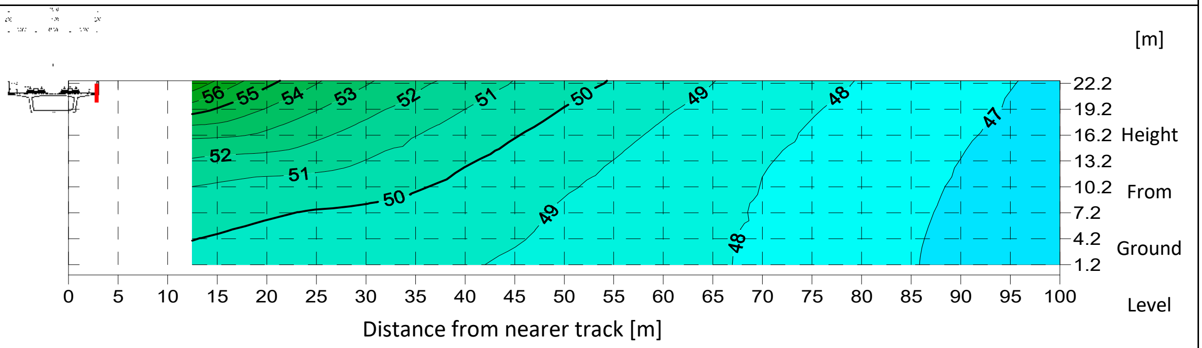
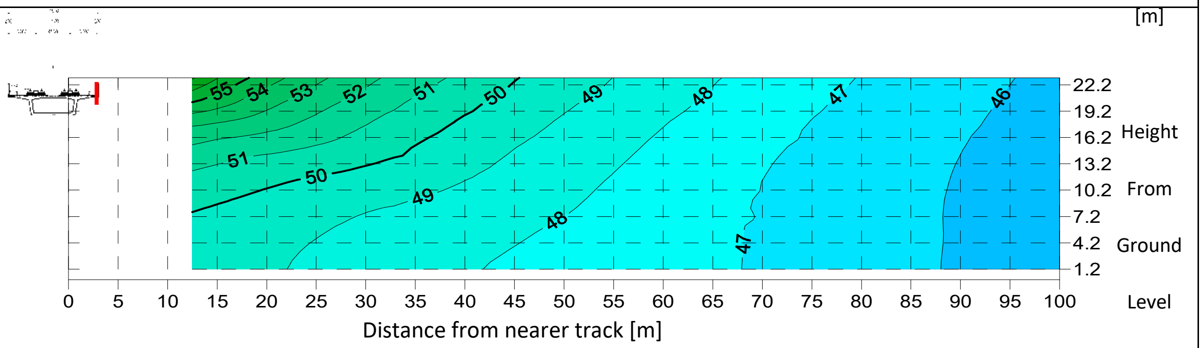
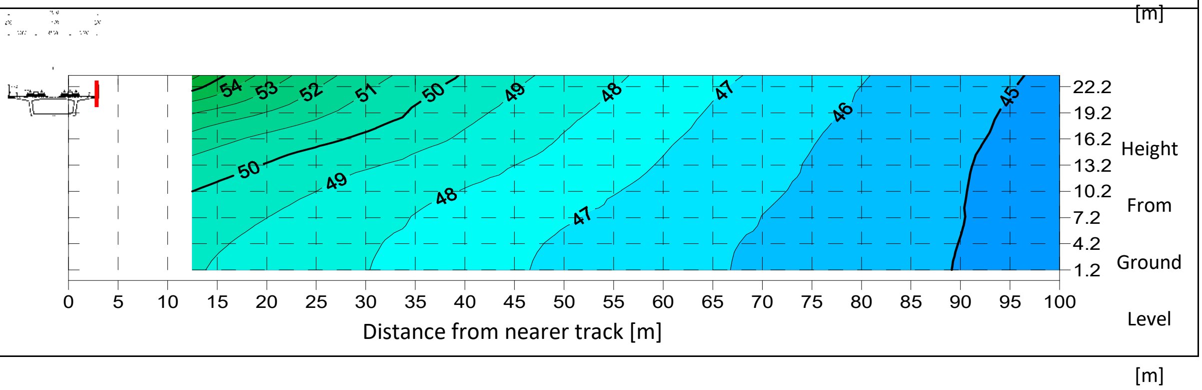
Height of sound barrier	[Other conditions] Category: C-3, Target year: 2053(Operation peak), No. of cars: 16, TrainSpeed:320 km/h Height of the railway level from ground: 20 m
2.0 m	
2.5 m	
3.0 m	
3.5 m	

Exhibit 5.1.8 (10): Sound Level Contour of L_{Aeq} during Night Time

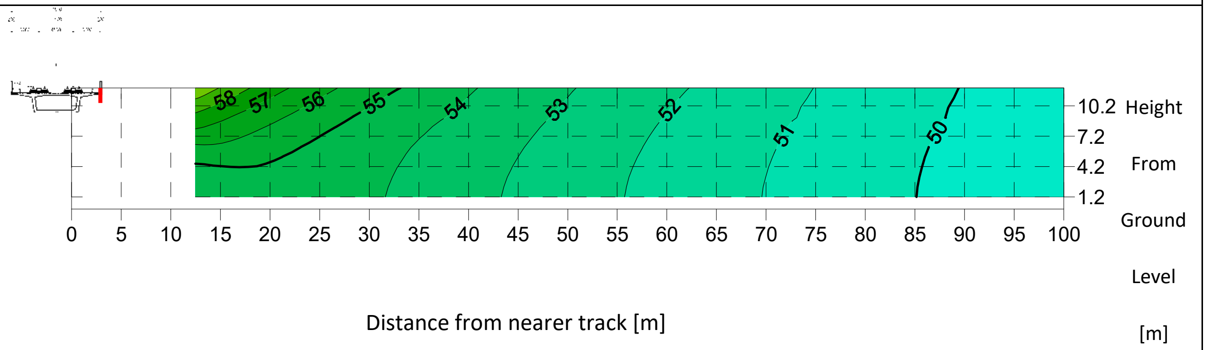
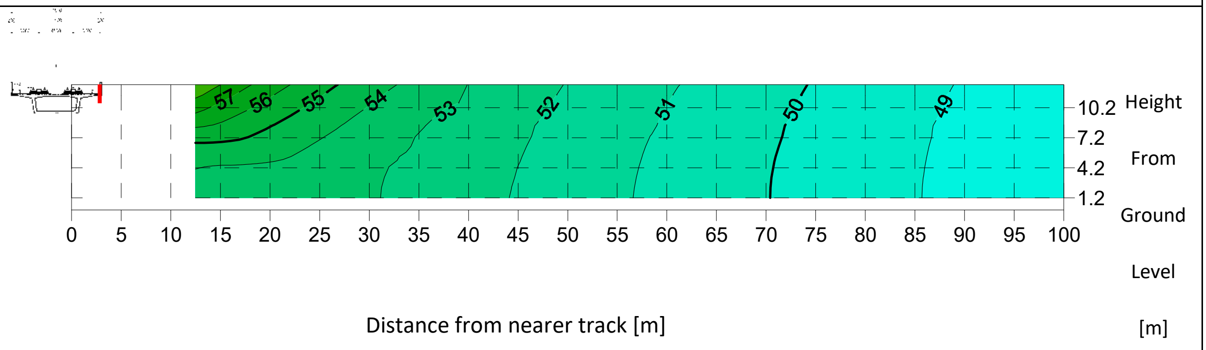
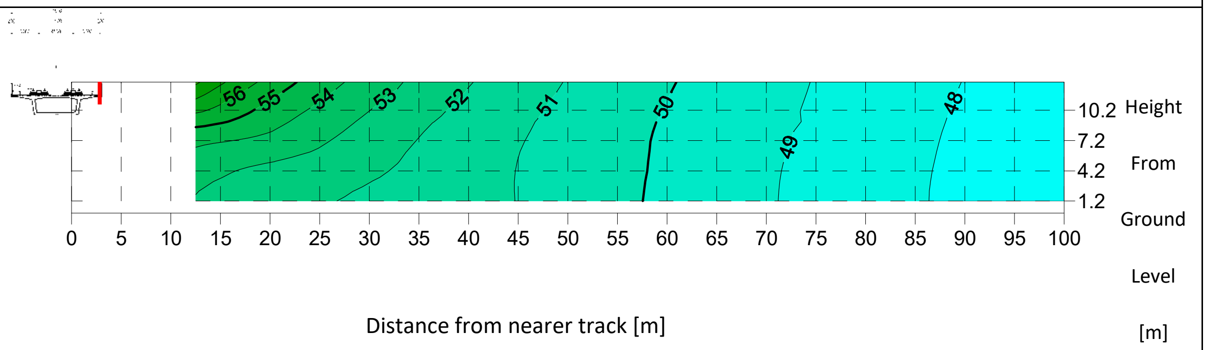
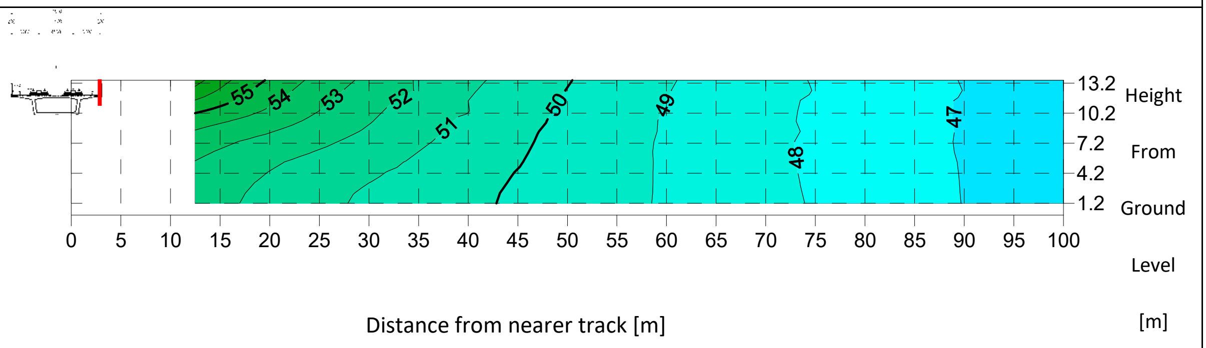
<table>
<tr><td>Height of sound barrier</td><td>[Other conditions]
Category: D-1, Target year: 2053(Operation peak), No. of cars: 16, TrainSpeed:350 km/h
Height of the railway level from ground: 10 m</td></tr>
<tr><td>2.0 m</td><td>
</td></tr>
<tr><td>2.5 m</td><td>
</td></tr>
<tr><td>3.0 m</td><td>
</td></tr>
<tr><td>3.5 m</td><td>
</td></tr>
</table>

Exhibit 5.1.8 (11): Sound Level Contour of L_{Aeq} during Night Time

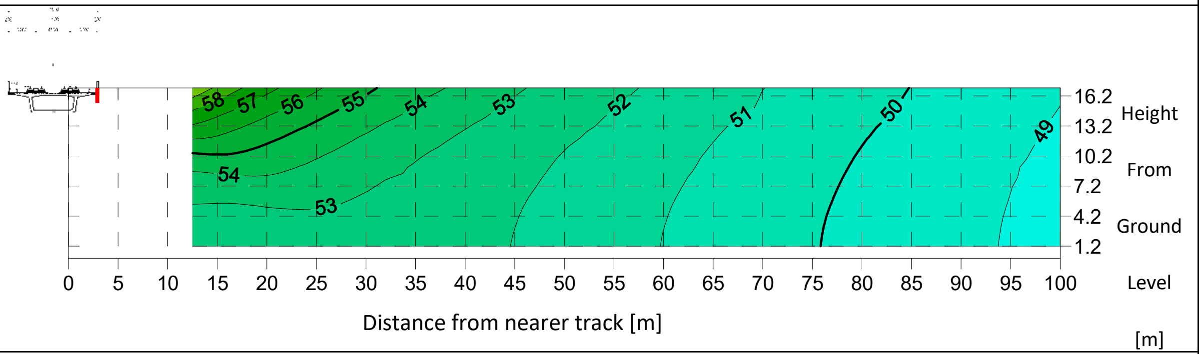
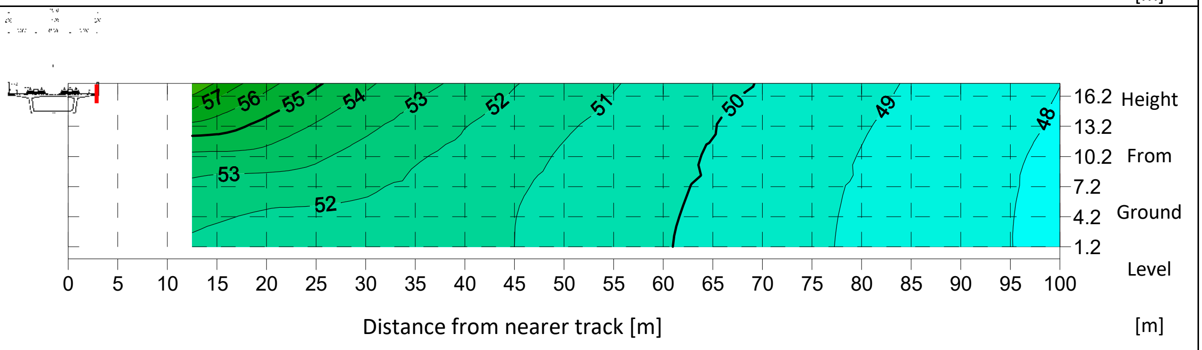
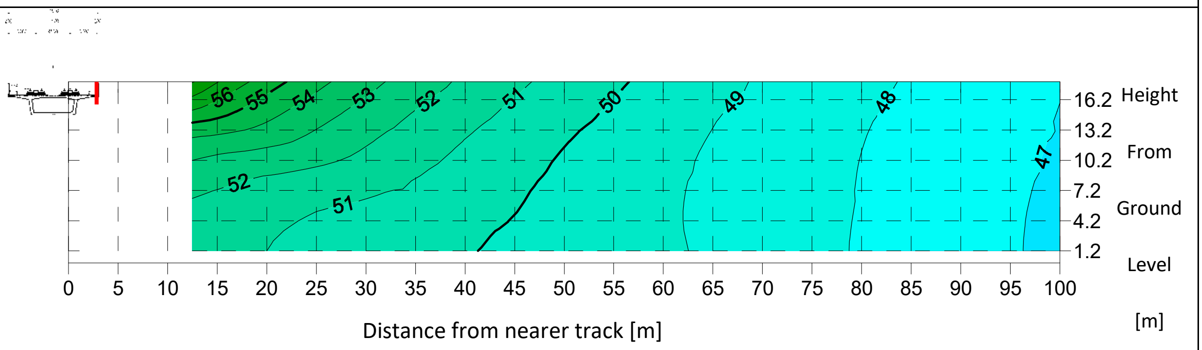
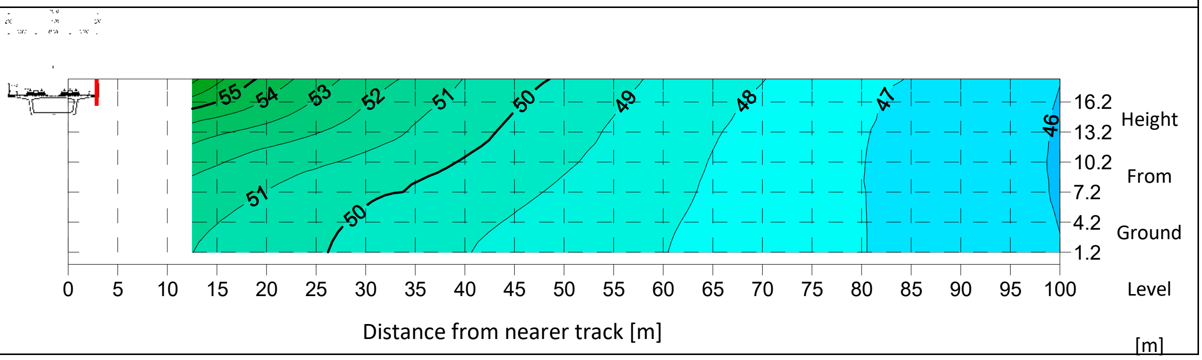
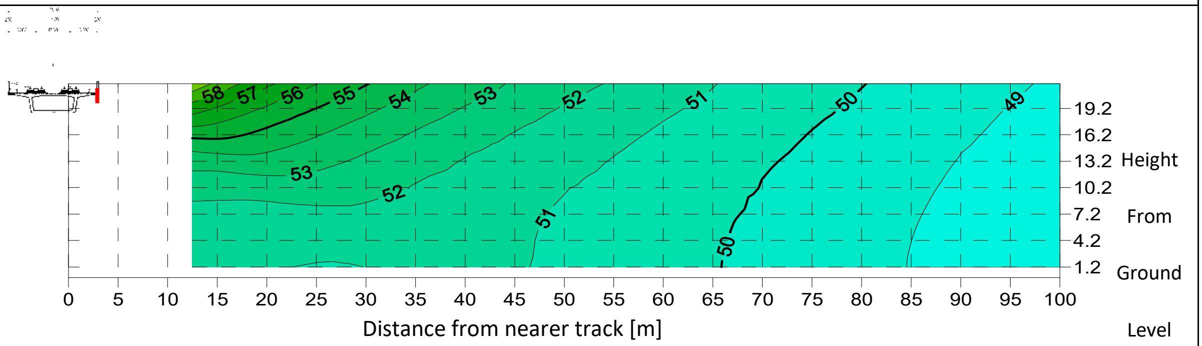
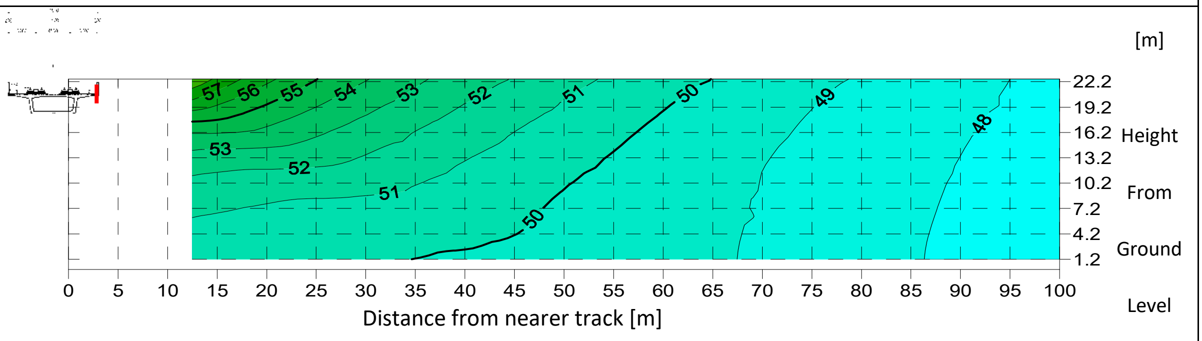
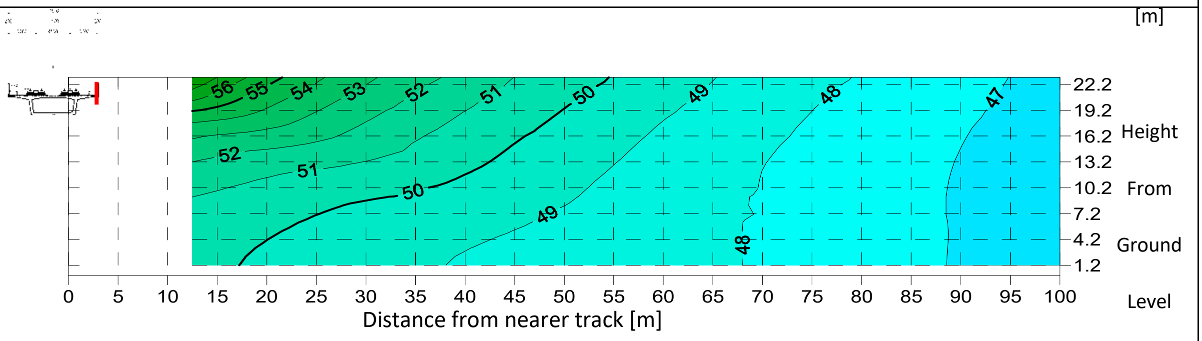
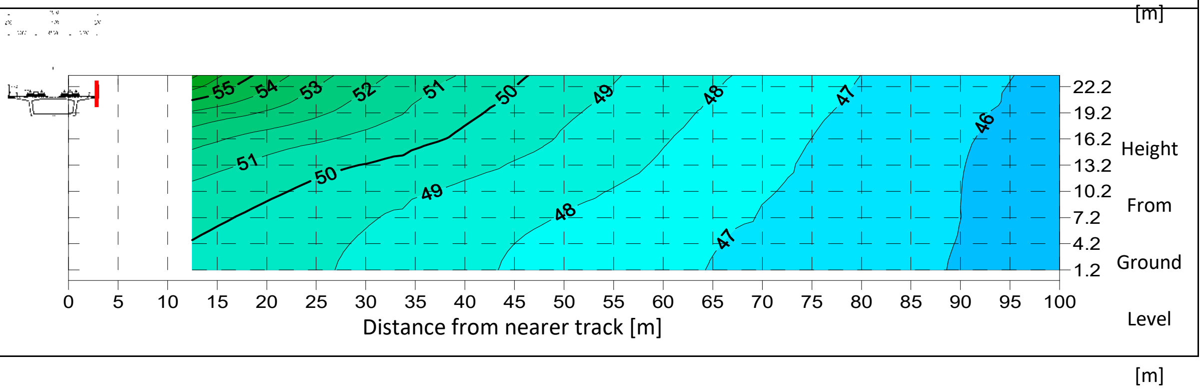
<table>
<tr><td>Height of sound barrier</td><td>[Other conditions]
Category: D-2, Target year: 2053(Operation peak), No. of cars: 16, TrainSpeed:350 km/h
Height of the railway level from ground: 15 m</td></tr>
<tr><td>2.0 m</td><td>
</td></tr>
<tr><td>2.5 m</td><td>
</td></tr>
<tr><td>3.0 m</td><td>
</td></tr>
<tr><td>3.5 m</td><td>
</td></tr>
</table>

Exhibit 5.1.8 (12): Sound Level Contour of L_{Aeq} during Night Time

<table>
<tr><td>Height of sound barrier</td><td>[Other conditions]
Category: D-3, Target year: 2053(Operation peak), No. of cars: 16, TrainSpeed:350 km/h
Height of the railway level from ground: 20 m</td></tr>
<tr><td>2.0 m</td><td>
</td></tr>
<tr><td>2.5 m</td><td>
</td></tr>
<tr><td>3.0 m</td><td>
</td></tr>
<tr><td>3.5 m</td><td>
</td></tr>
</table>

5.1.4 Study on Extent of the Impact and Measures alongside of the Railway

(1) Study on Extent of the Impact

Based on the determination of the threshold value (see Section 5.1.3 (5), c), ii)), the extent of noise level exceedance beyond the threshold value (Day time: 60dB, Night time: 50dB) for the Silence Zone is shown in Table 5.1.10. There is no exceedance for the Residential area. Although the extent of impact does not exist at the time of the start of operation (year 2023), some extent of impact with the low height of sound barrier are seen at the peak operation (year 2043), with the viaduct height 10m and the height of sound barrier less than 3.0m. The maximum distance ow the extent is 47m. During the night time, exceedance of the threshold vale can be seen with all viaduct height, and the maximum distance reaches 86m.

Table 5.1.10 (1): Extent of Noise Level Exceedancefor the Silence Zone (Day time)

Case	Target year	No. of cars	Train Speed	Viaduct structure	Height from the ground to the rail level	The farthest distance from the railroad track [m]			
						2.0	2.5	3.0	3.5
A-1	Initial phase in 2023 62 trains at day time 8 trains at night time	10cars 253m Length	320km/h	Concrete	10m	—	—	—	—
A-2					15m	—	—	—	—
A-3					20m	—	—	—	—
B-1			350km/h		10m	—	—	—	—
B-2					15m	—	—	—	—
B-3					20m	—	—	—	—
C-1	Peak number train period in 2053 192 trains at day time 18 trains at night time	16cars 403m Length	320km/h	Concrete	10m	35	14	—	—
C-2					15m	—	—	—	—
C-3					20m	—	—	—	—
D-1			350km/h		10m	47	36	16	—
D-2					15m	—	—	—	—
D-3					20m	—	—	—	—

Note: "-" means that the extent of impact does not reach beyond 25m from the center of railway track.

Table 5.1.10 (2): Extent of Noise Level Exceedancefor the Silence Zone (Night time)

Case	Target year	No. of cars	Train Speed	Viaduct structure	Height from the ground to the rail level	The farthest distance from the railroad track[m]			
						2.0	2.5	3.0	3.5
A-1	Initial phase in 2023 62 trains at day time 8 trains at night time	10cars 253m Length	320km/h	Concrete	10m	—	—	—	—
A-2					15m	—	—	—	—
A-3					20m	—	—	—	—
B-1			350km/h		10m	—	—	—	—
B-2					15m	—	—	—	—
B-3					20m	—	—	—	—
C-1	Peak number train period in 2053 192 trains at day time 18 trains at night time	16cars 403m Length	320km/h	Concrete	10m	71	57	45	30
C-2					15m	60	46	24	16
C-3					20m	46	—	—	—
D-1			350km/h		10m	86	71	58	43
D-2					15m	76	61	42	27
D-3					20m	66	35	18	—

(2) Study on Impact Measures Alongside of the Railway

Other than the physical measures (refer Exhibit 5.1.2), such as measures to sound source (improvement of train car) and measures to sound propagation path (installment of sound barrier), soft measures, such as policy measures to prevent the issues in advance. In this section, case study in Japan for land-use measures and housing measures is discussed to consider the application along the highspeed railway in India, based on the impact extent discussed above section.

a) Case Study of Land-Use Measures in Japan

As a case of community renovation in Japan, control and derivation of land-use is carried out by municipality basis to harmonize between transport infrastructure and area along the infrastructure. Enforcement policy for regulating and guiding land-use is shown in Table 5.1.11. And cases of regulating and guiding, targeting the railway facility, are shown in Table 5.1.12.

Table 5.1.11: Enforcement Policy for Regulating and Guiding Land-use

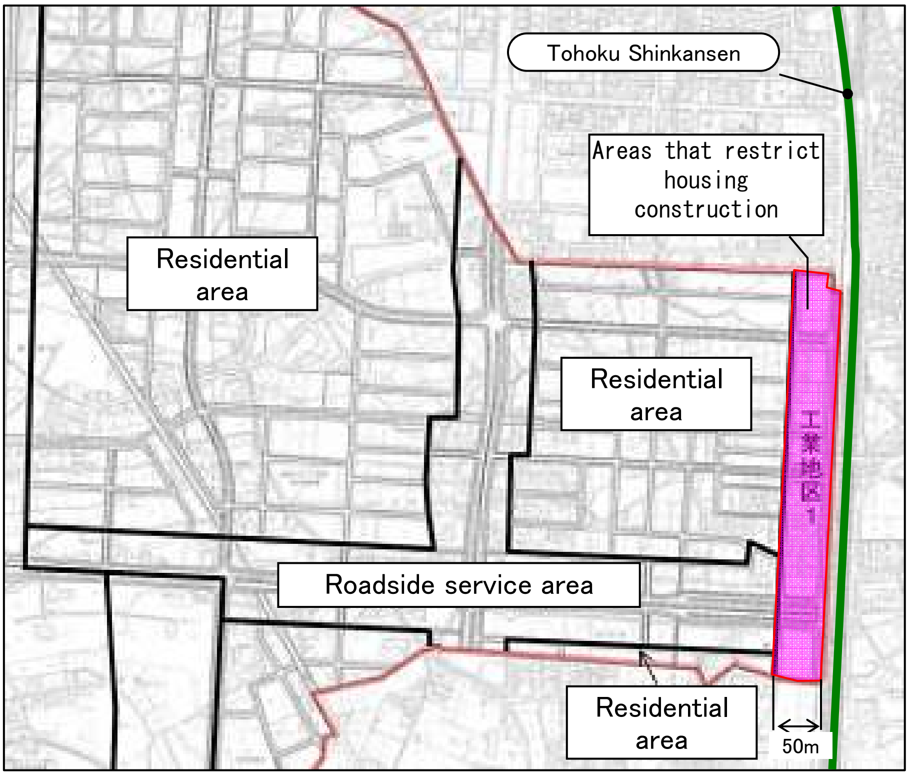
Policy	Contents	Basis
Masterplan for city plan	To specify the basic policy for city planning by the prefecture	City planning act, 1969 Article 18.2
Application plan	To determine the application of the area (district, zone, block). Depending on the application of the area, the kind of building is regulated.	City planning act, 1969 Article 8
District plan	To stipulate the area (district, zone, block) to establish the detailed regulation	City planning act, 1969 Article 12.4
Allocation of buffer zone, such as park and green belt	To establish park or green belt to function as a buffer zone. There are two (2) types of buffer zone: 1) installed by municipality and 2) by the area developer.	Approach based on the city plan

Table 5.1.12: Cases of Regulating and Guiding, Targeting the Railway Facility

Municipality	Facility	Activity	Contents	Note
Yatsushiro City	Kyushyu Shinkansen	Involvement into the city master plan	The city enhances location of commercial and business facilities around the area, considering the unified urban development and good living environment.	Around the Shinkansen station
Kawasaki city	Conventional railway		The city leads the land-use diversion in a strategic and agile manner to unify industrial function and living environment.	
Itami city	Sanyo Shinkansen		The city plans to install green line along the Shinkansen railway to formulate an urban space, where the user can feel a nature closely.	Focusing the contact with nature
Ministry of Envir onment	Kyusyu Shinkansen	Ministry notification regarding the area application	The ministry suggests follows, considering the optimized land-use to satisfy the environmental standard: 1) To avoid using the area as a residential area. 2) To lead a land-use which is not negatively impacted by the noise caused by Shinkansen.	Kagoshima Prefecture has changed the application area & categorization area for noise standard

Municipality	Facility	Activity	Contents	Note
Morioka city	Tohoku Shinkansen	Regulation of hose construction along the railway	The city has limited the development of residential area along the railway.	Refer to Figure 5.1.9
Toda city	Tohoku-Zyoetsu Shinkansen	Installment of buffer-green zone along the railway	The city is improving the both side of Shinkansen and conventional railway as buffer zones (20m each side).	Improvement-from-possible-area approach

Exhibit 5.1.9: Limitation of Development as a Residential Area by Morioka City



Source:
http://www.city.morioka.iwate.jp/_res/projects/default_project/_page_/001/
009/898/19-seinan.pdf

b) Case Study of Housing Measures in Japan

Housing measure is a policy to lead residential development with high acoustical insulation. In Japan, local government leads/requires estate developer to install that kind of facility by announcement of municipal bylaw or guideline. Since this measure targets each individual house, clarifying the technical matters (detailed capability, architectural standard, confirmation method of acoustic insulation capability) and establishment of management structure to secure the sustainability of the policy are necessary. Table 5.1.13 shows the cases of housing measure in Japan.

Table 5.1.13: Cases of Housing Measure in Japan.

Municipality	Activity	Detail
Yokohama city	Setting of target value for the measure	・60dB (Averaged maximum sound level (L_{Asmax})in the room) <http://www.city.yokohama.lg.jp/kankyo/mamoru/koutsukankyo/bouon/index/bouon.pdf>
Osaka city		・<45dB during day time, <40dB during night time (Equivalent sound (L_{Aeq}) in the room) ・60dB (Averaged maximum sound level (L_{Asmax}) of top 10 in the room) <http://www.city.osaka.lg.jp/toshikeikaku/page/0000200720.html>
Yokohama city	Advanced explanation to the new resident	・Developers must explain about the impact of noise in advance to the new residents. ・Impact of noise must be clearly explained in the brochure of the residence. ・Developers must remind the new residents about the impact of noise upon signing the contract. <http://www.city.yokohama.lg.jp/kankyo/mamoru/koutsukankyo/bouon/index/bouon.pdf>
Osaka city		・Developers must explain about the impact of noise, source of noise and its measures in advance to the new residents. <http://www.city.osaka.lg.jp/toshikeikaku/page/0000200720.html>

5.1.5 Discussion and Conclusion

(1) Comparison With Other Studies

The results from three (3) different studies with different approach are compared in Table 5.1.14

Table 5.1.14: Comparison of Noise Level (L_{Aeq}) from Different Study

Unit: dB

No	Day time			Night time		
	EIA F/S	**S-EIA**	**JPN**	**EIA F/S**	**S-EIA**	**JPN**
Case I	45	48	51	39	41	42
Case II	52	55	59	45	48	49

Source: EIA F/S: EIA prepared during the Feasibility Study

S-EIA: Supplemental EIA, this study

JPN: Additional study using prediction method in Japan

Note:

Case I – initial phase after 2023 commissioning where train length of 253m (10 cars), train speed of 320 km/h, number of trains (single side) of 35 (31 day time, 4 night time) per day is assumed.

Case II – 2053 peak train number period, where train length of 403m (16 cars), train speed of 320 km/h, number of trains (single side) of 105 (96 day time, 9 night time) per day is assumed.

Although predicted noise levels differ slightly, the levels are still within the threshold value [see Section 5.1.3 (5), c), ii)].

(2) Conclusion and Recommendaton

Based on the results discussed above, it is considered that the impact of noise caused by the operation of high speed railway is limited and small, since the extent of impact, exceeding the threshold value, is not considered at the start of operation (year 2023) and is limited even in the peak operation (year 2053) (refer Section 5.1.4).

Special measures, other than the linear wall sound barrier at the railway, is not considered necessary during the start of operation, since the number of train is small. However, maximum sound level might exceed 75dB with the low height sound barrier, and, therefore, it is recommended to use higher sound barrier (refer Table 5.1.10).

For the consideration to silence zone, in which lower noise standard value is applied, either installment of acoustic insulation facility, such as double wall grass windows with air conditioning or sound barrier outside of the building might be prioritized, since the noise extent higher than the ambient noise standard level exist till 50m to 100m horizontally from the railway center line, according to the predicted results. And eventually, relocation of the building might be considered along with the modification of city plan.

During the operation peak, the impact to the area alongside of the railway is considered increase with the increase of number of train and operation speed. Expansion of residential area with the increase of population is also considered, causing expose of noise impact.
Thus, planning for introduction of physical measures and soft approach such as policy dissemination, considering the involvement of the policy into the city plan, must be important [refer 7.1.5 (2)].

Approaches for improvement the noise impact are summarized as below:

- To regulate the land-use alongside of the railway for commercial or business purpose to avoid the noise impact
- To install buffer zone or green belt to secure the seriously impacted area
- To lead land developers to install high acoustic insulation residence.
- To carry out the above policies for already densely built-up area when a land redevelopment is arisen.

To know the situation of noise impact and effectiveness of mitigation measures, continuous monitoring of sound level along the railway is highly recommended.

5.2 VIBRATION

5.2.1 Methodology

Desktop study, using available reports regarding Shinkansen, was carried out to understand the actual vibration levels on operation of high speed railway. Based on the desktop study, vibration level alongside the highspeed rail arraignment was qualitatively predicted.

5.2.2 Desktop Study

(1) Items of Desktop Study

Following items were studied, reviewing available reports in Japan regarding Shinkansen.

- Actual level of vibration on operation of E5 type Shinkansen
- Measures to vibration in Japan
- Advantage of measures

(2) Results of The Desktop Study

In total 4 reports, prepared by 4 prefectures where Shinkansen passes, were reviewed to understand the actual vibration levels. The measurement point of vibration in the reports is uniformly set on the ground surface at 12.5m or 25m horizontally from the center of rail way. Since planed operation speed in India is 320km/h, the results of vibration measurement at passing speed over 300km/h were chosen. The number of data is 14.

The vibration levels vary between 52 and 58dB at 12.5m and 45 and 62dB at 25m.The clear relationship between train speed and vibration level was not seen.

5.2.3 Vibration Prediction

(1) Methodlogy

Vibration level was qualitatively predicted at ground surface along the railway, based on the results of the desktop study.

Since ambient vibration standard for train is not available in India and world organization such as WHO, the result was compared with a guideline value[4] in Japan. The guideline value, 70dB, was set as a threshold to avoid the unacceptable impact and this value does not secure an ideal living environment.

(2) Result of The Prediction

Actual vibration level when Shinkansen passes with the speed over 300km/h varies between 52dB and 58dB at 12.5m from the center of railway track and varies between 45dB and 62dB at 25m from the center of railway track. The guideline value [refer Section 5.2.3 (1)] in Japan is 70dB, and the actual vibration values were all less than the guideline value.

Therefore, if the same construction technique and measures are introduced to the planning of the highspeed railway in India, the impact caused by vibration is not considered. However, the guideline value is set as a threshold to avoid the unacceptable impact and this value does not secure an ideal living environment.

5.2.4 Dicussion and Conclusion

(1) Comparison with other Studies

The precious EIA during the Feasibility Study concludes and the supplemental EIA both conclude qualitatively that some mitigation measures not to exceed the reference value (70dB: recommended level of vibration caused by Shinkansen in Japan) shall be considered.

[4]Guideline for Vibration of Shinkansen Railway, 1976, Ministry of Environment, Japan

(2) Conclusion and Recommendation

The actual vibration levels when Shinkansen passes with the speed over 300km/h do not exceed the guideline value in Japan.

Therefore, if the same construction technique and measures are introduced to the planning of the highspeed railway in India, the impact caused by vibration is not considered.
Since the guideline value set as a threshold to avoid the unacceptable impact and this value does not secure an ideal living environment, continuous monitoring of vibration level along the railway is necessary.

Annexure 5 (c)

(Note: This part is an excerpt from the EIA of F/S stage)

[illegible]

[illegible]

[illegible]

[illegible] summarized in the next section.

a) SHINKANSEN NOISE REDUCTION MEASURES

In the 50 years since its commissioning, Shinkansen would have previously implemented various noise reduction measures. The main measures are listed below.

- Provision of Sound Insulating Wall
- Reduces generated noise through diffraction/attenuation.

Exhibit5.2.3:E5 Series Running Through a Section with Sound Insulating Wall

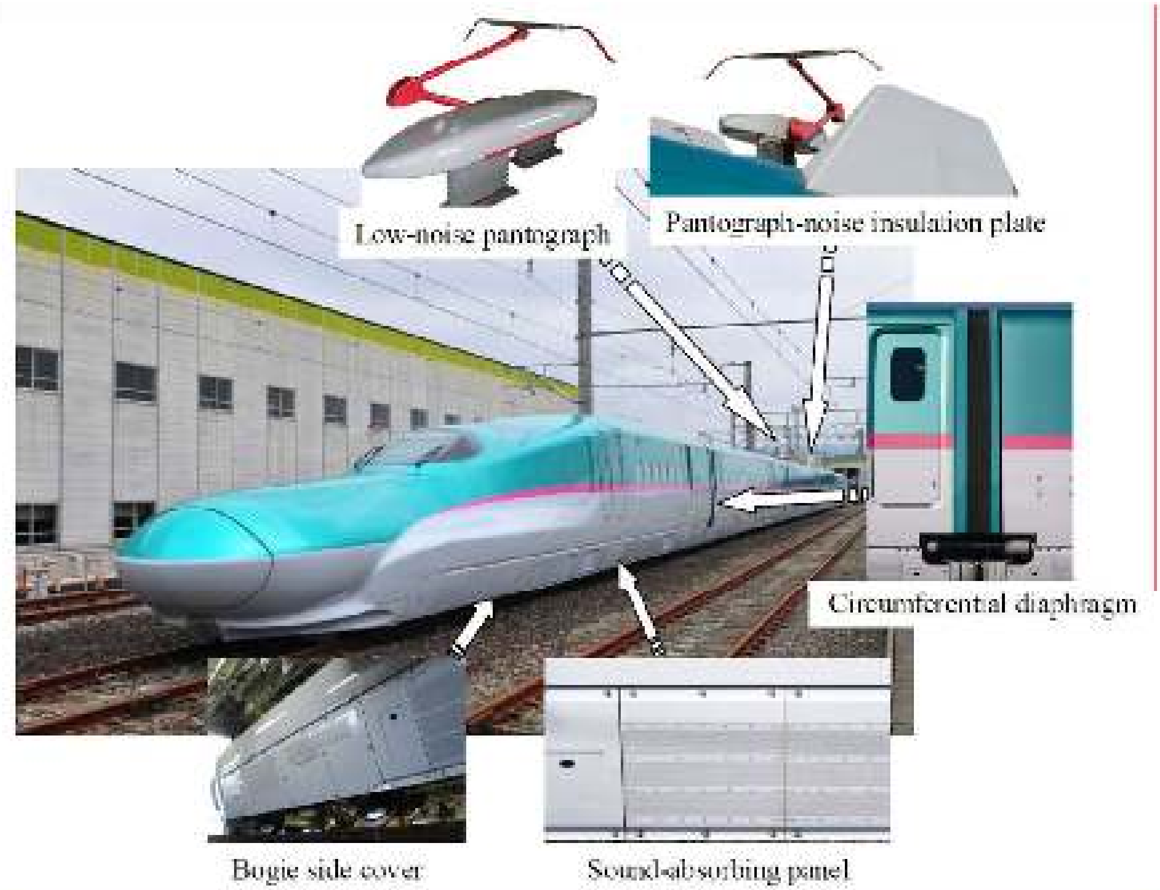
Source: Sample Photo from Internet

- Adoption of Long Rails
- Reduces percussive noises by reducing the number of rail joints.
- Track and Wheel Maintenance
- Reduces noise generated due to uneven wear through regular track and car (Wheel) maintenance.

Currently in Japan, new car developments aim to reduce noise at operational speeds of 320km/h. Noise reduction measures for the E5 series being considered in this study are listed below.

- Low-noise pantograph
- Pantograph-noise insulation plate
- Circumferential diaphragm
- Sound-absorbing panel
- Bogie side cover

Exhibit5.2.4: Noise Reduction Measures for High Speed Train



Source: Development of External-Noise Reduction Technologies for Shinkansen High Speed Trains

Exhibit 5.2.5: Noise Reduction Measures Adopted in Different Countries


Denver, Colorado


Slovenia, Italy


Sha Tin, Hong Kong


Loire Valley, France

Exhibit 5.2.6: Noise Reduction Measures Adopted – Sound Proof Wall

- **Characteristics:** The effect of the installation is predictable.
- **Advantages:** It is possible to reduce noise of the lower part of car mainly.
- **Disadvantages:** There are some problems of sunshine obstruction and view from the car window.
- **Workability:** Relatively easy, but it is necessary to set up the base.
- **Expected Results:** Big
- **Cost:** Relatively cheap

Exhibit 5.2.7: Noise Reduction Measures Adopted –Long Rail and Expansion Joint (EJ)

- **Characteristics:** It is possible to reduce noise by reducing the number of joints by adopting longer rails.
- **Advantages:** It is possible to reduce not only noise but also vibration.
- **Disadvantages:** When replacing the rails, workability is relatively difficult.
- **Workability:** It requires professional and special hardware for the rail welding.
- **Expected Results:** Big
- **Cost:** Relatively expensive (as part of project costs)

Exhibit 5.2.8: Noise Reduction Measures Adopted –Thorough Maintenance of Tracks such as Grinding Rail

- **Characteristics:** Adjust the wear-out of running surface of rail or the track part above the ground to reduce operation noise.
- **Advantages:** It can be done as part of routine maintenance. It is possible to reduce not only noise but also vibration.
- **Disadvantages:** The effect is relatively short in a few months by the realignment of track.
- **Workability:** It requires special devices or skills for grinding rail or track realignment.
- **Expected Results**: Medium
- **Cost**: As part of maintenance costs (Relatively expensive for procurement of a grinding car)

Exhibit 5.2.9: Noise Reduction Measures –Streamlined Head Shape

- **Characteristics:** By streamlining the car body, aerodynamic noise can be reduced by reducing constant drag (CD) value.
- **Advantages:** The effect is continuously maintained.
- **Disadvantages:** The trial of obtaining effect of reducing noise will be required
- **Workability:** As it is not easy after the operation, streamlining of the cars needs to be considered from the planning and order stages.
- **Expected Results:** Big
- **Cost:** Part of car procurement costs.

Exhibit5.2.10: Noise Reduction Measures –Smoothened Car Shape

- **Characteristics:** By decreasing the roughness of the car body, aerodynamic noise can be reduced by reducing CD value.
- **Advantages:** The effect is continuously maintained.
- **Disadvantages:** The trial of obtaining effect of reducing noise will be required
- **Workability:** As it is not easy after the operation, smoothening of the car shape needs to be considered from the planning and order stages.
- **Expected Results:** Small
- **Cost:** Part of car procurement costs.

Exhibit 5.2.11: Noise Reduction Measures –Low-Noise Type Pantograph and Reduction of its Number

Advanced pantograph and pantograph cover

- Characteristics: By decreasing the opportunities interaction between electric cables and pantographs, it is possible to reduce the noise.
- Advantages: It changes dramatically only by changing the pantograph and the cover.
- Disadvantages: The trial of obtaining effect of reducing noise will be required
- Workability: It takes time to change at the car factory.
- Expected Results: Big
- Cost: Relatively expensive (part of car procurement costs).

Exhibit 5.2.12: Noise Reduction Measures –Covering of Vehicle Seam Part

- Characteristics: By decreasing the roughness of the car body, aerodynamic noise can be reduced.
- Advantages: It is possible to repair partly between boogies.
- Disadvantages: The trial of obtaining effect of reducing noise will be required.
- Workability: It takes time to covering works at the car factory. But, adoption of covers needs to be considered from the planning and order stages.
- Expected Results: Small
- Cost: Relatively cheap (part of car procurement costs)

Under an operational speed of 320km/h, these noise reduction measures effectively suppress the noise level at a location 25m from the track to under 70dB – 75dB ($L_{A,max}$).

Annexure 5 (d)

(Note: This part is an excerpt from the EIA of F/S stage)

DETAILED MEASURES PROPOSED FOR VIBRATION WHICH ARE SIMILAR TO THE SHINKESAN

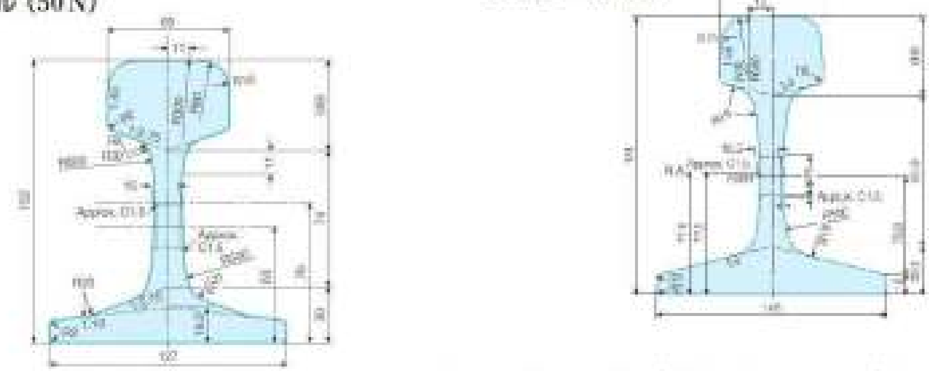
1) VIBRATION COUNTER MEASURES FOR SHINKANSEN

Currently in Japan, in order to ensure that impact from vibration is minimized at an operational speed of 320 km/h, the following measures are being taken. Due to these measures, the vibration countermeasure target for Shinkansen of 70dB or less is being met. Exhibit 5.3.1 shows the kind of Rail to be used for a high speed train

Exhibit 5.3.1: 50kg/m Rail and 60kg/m Rail

50kg Nレール (50N)

60kg レール (60)



Source: Nippon Steel & Sumitomo Metal Corporation

a) Track Structure

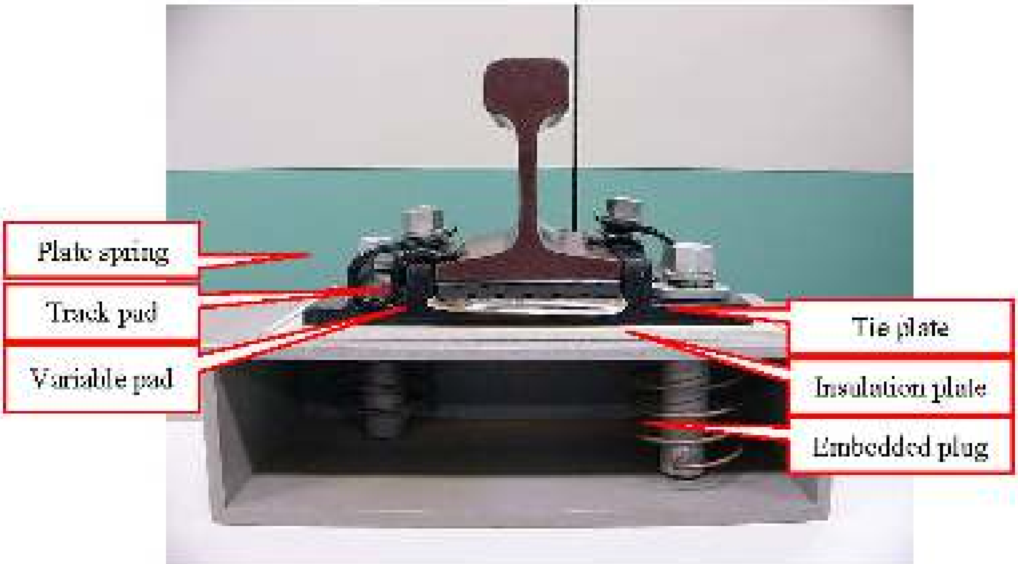
Exhibit 5.3.2 shows the track structure used for high speed train.
Weighting of Rails: 60kg/m rails are being adopted.

Lightening of Cars : Early Shinkansen weighed 60t per car, whereas through lightening measures the latest E5 series weigh only 45t per car.

Adoption of Long Rails: By adopting long rails which have less number of joints, vibration can be greatly reduced.

Track Pads: With track pads inserted between rails and sleepers to absorb springiness, vibration propagation can be reduced.

Exhibit 5.3.2: Track Structure (Track Pad)



Source: JICC Study Team

b) Track and Wheel Maintenance

By striving to have constant smoothness through regular track and wheel maintenance, the generation of unnecessary vibration can be prevented. Exhibit 5.3.3 shows the rail grinding machine.

Exhibit 5.3.3: Rail Grinding Machine

Source: Sample Photo from Web

[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

- [illegible]
- [illegible]

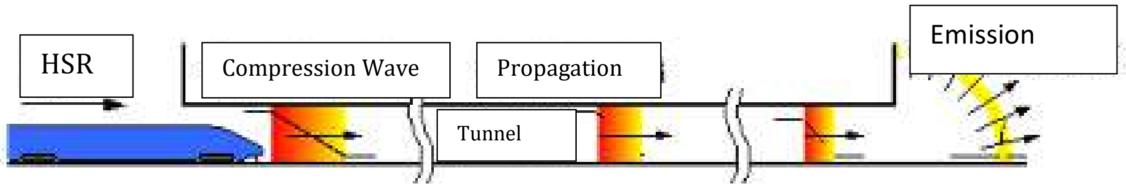
Annexure-5 (e)

(Note: This part is an excerpt from the EIA of F/S stage)

DETAILED MEASURES PROPOSED FOR TUNNEL BOOM AS BEING IIN SHINKANSEN

The phenomenon is called Tunnel Boom with low frequency wave composition of 20Hz or less. The principle of tunnel boom is described in Exhibit 5.4.1 below.

Exhibit 5.4.1: Tunnel Boom



Source: RTRI HP

The following are the features of Tunnel Boom (micro pressure wave) generation.

- Tunnel boom is correlated with train speed. The faster the train speed is, the bigger it is.
- The longer a tunnel is, the bigger the tunnel boom is.
- Tunnel boom is bigger with slab tracks than with ballast tracks.
- The larger the car– tunnel cross section ratio is, the bigger the tunnel boom is.

5.4.2 Micro Pressure Wave Standards and Countermeasures

The target for tunnel boom reduction in Japan is set to 20Pa at a distance of 20m from the cars in case of existence of residential areas and 50Pa in case of non-existence of residential areas adjacent to the tunnel ends. In the efforts of attaining the targets, long nose design at the head portion and its figure optimization are made for cars, tunnel entrance hoods are installed for tunnels. These measures are effective in reducing tunnel boom. The Exhibit 5.4.2 shows the head car with elongated nose and Exhibit 5.4.3 shows the tunnel boom insulation.

Exhibit 5.4.2: E5 Series Head Car with Elongated Nose

Source: JR East HP

Exhibit 5.4.3: Tunnel Boom Insulation

Source: JR East HP

5.4.3 Prediction of Tunnel Boom

The list of tunnels designed for the project is presented in Table 5.4.1.

Table 5.4.1: Location of the Tunnel on the Proposed MAHSR

Tunnel Chainage		Length	Type
Start Chainage	**End Chainage**		
0+439	20+815	20.375 km	TBM, NATM
52+535	53+275	740 m	NATM
54+705	54+850	145 m	NATM
65+577	68+140	2563 m	NATM
76+660	78+040	1380 m	NATM
127+830	128+210	380m	NATM
131+100	131+440	340 m	NATM
156+735	157+015	280 m	NATM

Source: JICC StudyTeam

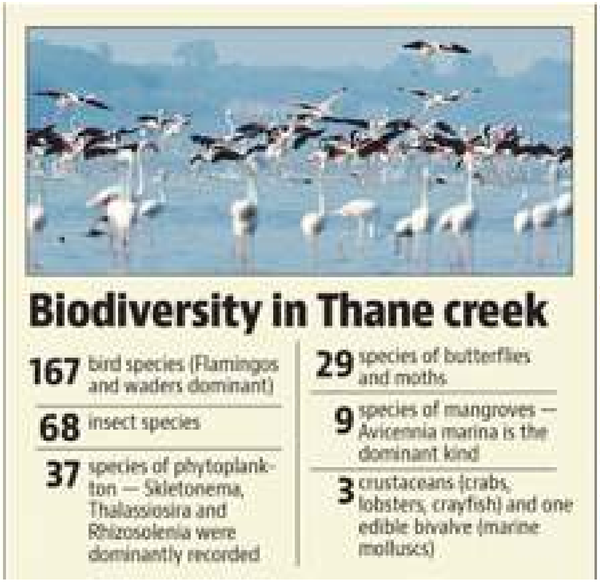
As aforementioned, tunnel boom is reduced in Japan by taking counter measures with satisfactory results being attained, with 20 Pa in residential areas and 50Pa in non-residential at a distance of 20m from tunnels. Since there is no tunnel boom standards in India, if we set the same targets as those of Japan, and since the project will have similar cars and operational speeds as the E5 series, we predict that by installing tunnel entrance hoods, if there exist residences at a proximity to a tunnel exit impact will be minimized. In addition, as a larger tunnel cross section of $80m^2$ is designed for this project than that of Japan ($64m^2$), we can safely predict that tunnel boom will be smaller for this project than that in the standard Shinkansen tunnels of Japan.

In the meantime, the proposal of defining tunnel boom standard will be presented at a later stage and monitoring as required shall be made to check the actual status of the tunnel boom.

Annexure 5 (f)

DISCUSSION ON POTENTIAL ADVERSE IMPACTS ON FLAMINGO POPULATION DUE TO NOISE AND VIBRATIONS OF MAHSR

Thane creek (particularly the area demarcated as flamingo sanctuary) receives close to more than 50,000 migratory birds, including flamingos every year. The Thane creek area, which is rich in food (fish from ther creek) and offers a resting place in the mudflats along the banks of the creek, serves as a favourite location for the birds to throng during the winters.



The area is already having several infrastructure projects such as the Airoli and Vashi creek bridges, railway bridge as well as some new developments along the creek area.

The tunneling activity in the Thane creek, in the construction phase is not expected to generate vibration that could impact the surface area due to the following reasons (based on discussion with Japanese experts):

1. The tunnel will be carried out using a mix of TBM and NATM technologies at a depth of about 40m and will be bored in rock (deccan trap basalt) thus stiffling any residual vibration
2. The boring technology and construction practices have inbuilt mechanisms to dampen the noise and vibration based on the soil / rock in the area
3. Observations made in the area indicate that the birds have adapted well to the physical changes in this habitat and are not adversely affected in the long term, by the noise and vibration generated due to surrounding infrastructure.

Other references reviewed in this context and their summary observations are listed below:

Hiroshi Momose, Sound impact to raptor by construction project, Technical seminar presentation, 2005

1. Through an experiment, auditory area of raptor is between 1kHz- 4kHz, which is much narrower than human beings.
2. Higher frequency (greater than 8kHz) and lower frequency less than 250Hz is not audible to them.
3. However, sensitivity in the auditory area is much higher than human beings.
4. They usually get used to irregular but steady sound.
5. Sound and vibration simulator can be downloaded at http://www.nilim.go.jp/lab/ddg/naiyo/shindou/shindou.html.

Knowledge of noise impact to birds

6. A half of a clump of birds moves head at 65db, are cautious at 70db and flap wings or fly at 80-90db.
7. A part of Raptors tend to fly at 90-100db.

Environmental mitigation on fauna, flora and ecosystem, Ministry of Environment of Japan

http://www.env.go.jp/policy/assess/4-2preservation/03_typical/

8. Appropriate mitigation can help in reducing N&V impacts on birds (low noise construction machinery), monitoring plan and adaptive management.

Environmental mitigation to birds, National Institute for Land and Infrastructure Management

http://www.pref.osaka.lg.jp/kankyohozen/assess/yodogawasagansen.html

1. To reduce construction load and scheduling during breeding period if the location is close to the breeding area.
2. Conditioning (gradual adaptation to the construction environment) can be considered.
3. Monitoring and counter measures if unusual behavior is observed.
4. Generation of new habitat (creation of new mad flat).

M. Matsue et al., Study on Methods for Monitoring Rare Raptors, Technical Note of NILIM No.207, 2004

1. Field survey is divided into 3 steps, nesting place, breeding and area of activity.
2. As a mitigation measures, induction of nesting place can be considered.
3. If lost area of feeding place is small, it is considered that the impact is small, because raptors can find another place.
4. If the lost area is great, generation of feeding place is possible as a mitigation.

Assessment report of underwater tunnel:
http://www.pref.osaka.lg.jp/sokei/yodogawasagan/

1. Noise and vibration of underwater tunnel on operation phase were not estimated, because both were considered much lower than the standard.
2. The depth of the tunnel is 10-80m.
3. Levels during construction phase was also considered low and, therefore, it is not handled.

Monitoring study of behavior of four pairs of raptor during construction of bridge in a canyon in Japan

1. During the construction, the sound level generated from construction machineries

and vehicles ranged between 40 and 60dB. The highest level was 74dB while steel pile driving.
2. Background level was 35dB.
3. The sound above did not affect the behavior of the four pairs.
4. Monitoring during non-construction was also conducted and the behavior of the four pairs were the same.
5. Some of them breeding behavior showed.

Monitoring study of behavior of one pair of raptor during construction of tunnel using torpedo in a canyon in Japan
1. The sound level generated from torpedo ranged between 67dB and 88dB.
2. The sound did not affect the behavior of the pair.
3. Other birds also did not fly on the blast, even it is in the night time.

Y. Kimura et al., Measures on geologic survey at the location close to raptor, Ministry of Land, Infrastructure, Transport and Tourism,
1. No affect to raptors was observed during boring and seismic survey within their territories.
2. While the surveys were undertaken, workers put on inconspicuous wear and acoustic insulation sheets were installed around the survey equipment.

Conclusion and Recommendations

As seen in the discussion above, while the overall impact on the avian fauna in Thane creek due to noise and vibration is expected to be low / insignificant, the precise nature and extent of the impact is srtill unknown due to lack of adequate information and past studies in the region.

It is therefore recommended (and discussed in the EMP – Chapter 6) to adopt the following measures:
1. Design and Engineering to adopt preventive mitigation measures in tunneling technology
2. Contractor to implement measures as outlined in the EMP to reduce impact of noise and vibrations
3. NHSRCL to implement a comprehensive ecological monitoring plan in the Thane creek area, to continuously monitor impacts on avian fauna during operational phase of the MAHSR

Annexure 6(a)

Attachment-7 Construction Environmental Management Plan Format

Mumbai Ahmedabad High Speed Railway Project

Package No. MAHSR-***

Construction Environmental Management Plan (CEMP)

DD/MMM/YYYY

NAME of the CONTRACTOR/JV

CONTENTS

A. RATIONAL

1. Legal Bases

The Contract xxxx dated dd MMM 20yy between National High Speed Rail Corporation Limited (the Employer) and XYZ (the Contractor) defines the Contractor's responsibilities. Based on the Contract, activities of the Work and proposed methodologies, the Contractor prepared this work specific construction environmental management plan (CEMP) to the Employer for ensuring the Employers' requirements and compliances of the applicable law and regulations.

The objectives of CEMP are to:

- describe the expected activities and their environmental and social impacts,
- propose the Contractor' mitigation measures as per the Contract as well as the requirements of the competent authorities relevant to the project activities,
- set up monitoring systems to ensure the proposed mitigation measures,
- detect and correct non-conformances, and
- identify unanticipated impacts and implement necessary mitigation measures.

CEMP is the legally binding document between the Employer and the Contractor to commit the environmental and social protection.

2. Scope of the CEMP

With reference to the section 08040 of the General Specification, enforcement of mitigation measures is as follow;

1 General conduct of the Works
2 Legislation
3 Site preparation
4 Accommodation camp management
5 Borrow pits and quarry sites
6 Construction Water and Rain Water Harvesting
7 General pollution control
8 Pollution from vehicles, machinery and equipment
9 Water quality management
10 Air quality control
11 Noise control
12 Vibration control
13 Waste management
14 Hazardous waste storage and management
15 Use of land for construction purposes
16 Protection of community values
17 Energy conservation
18 Archaeology
19 Contractor's Demobilization
20 Monitoring and reporting

3. Updates of Relevant Legal Framework

Updates of legal and policy frameworks relevant to the environment and social consideration are summarized as follows (cf. GS 08040 and section 7 of Appendix 08000-1 of SHE manual);

Title	Summary
3.1 ENVIRONMENT	
Formal Name of legal and policy with competent authority	Key changes and primary points
Forest Department	Tree cutting/Plantation
SPCB	Consent to Establishment and Operate if any machinery
Municipal Corporation	Waste disposal, use of potable water
Public Health Department	Water Quality
Wildlife Warden	Any change in their judiciary
Central Ground Water Authority	Extraction of Ground Water
District Collector	Use of sand, Borrow pit, Quarry
Transport Department	Traffic Diversion
Electric Authority	Use of Electricity
District collector	Temporary construction of camp/storage/debris
3.2 SOCIAL AND PUBLIC HEALTH	
Formal Name of legal and policy with competent authority	Key changes and primary points
District Collector	Compensation issues if any diversion
Health Department	Regular Check-up, Labor camps
Panchayat	Noise and Dust issue nearby habitation
Municipal Corporation	Community facility use (water, road, drainage)
PWD/NHAI	Diversion of any road
Police	Law and Order issue

3.3 OTHERS RELATED TO THE WORK

Formal Name of legal and policy with competent authority	Key changes and primary points
Panchayat/Local	Working schedule (if proposed in night)
Villagers Sensitive Receptors like Hospital and School	Working time and Noise management/ construction of temporary noise barrier/ protection/ dust control
Temple/ Shrine/ Gurudwara	Protection, dust and noise control,

B. Project Activity Summary

1. Chainage-wise project activity summary and their proposed methodologies
2. Expected schedule for the chainage-wise activity plan
3. Activities-wise expected environmental and social impacts

C. **Public Relations and Complaint Responses**

1. Proposed Public Relations Plan as per General Specification 08050
2. Proposed internal grievance redress mechanism (GRM), structure and persons in charge of the internal GRM system
3. Proposed mechanism to use the Employers GRM to solve the dispute cases after the internal GRM

D. **Environmental Protection Commitment & Monitoring**

<The Contractor shall demonstrate the commitment of the environmental and social protection in this chapter>

1. General conduct of the Works
2. Legislation
3. Site preparation
4. Accommodation camp management
5. Borrow pits and quarry sites
6. Construction Water and Rain Water Harvesting
7. General pollution control
8. Pollution from vehicles, machinery and equipment
9. Water quality management
10. Air quality control
11. Noise control
12. Vibration control
13. Waste management
14. Hazardous waste storage and management
15. Use of land for construction purposes
16. Protection of community values
17. Energy conservation
18. Archaeology
19. Contractor’s Demobilization
20. Monitoring and reporting

20.1 Disclosure of qualified monitoring agencies and laboratories
20.2 Monitoring items and monitoring standards if changes from the Contract
20.3 Proposed daily inspection record format

As per the subsection 7.19 Monitoring and Reporting of Appendix 08000-1 SHE manual, daily inspection record format(s) is/are proposed in appendix D-1.

20.4 Monitoring locations

Category	Location	Location ID	Chainage (KM???+???)	Geo Coordination (Lat. / Long.) (dd, mm.mm / dd, mm.mm) WGS84
Air	one representative location within each construction camp		Location of Quarterly	Location of Quarterly
	the closest residential or commercial facility (one location) within 100m from each active construction section/site		Locations of Monthly	Locations of Monthly
Noise	the closest residential or commercial facility (one location) within 100m from each active construction section/site		Locations of Weekly	Locations of Weekly
Vibration	the closest residential or commercial facility (one location) within 100m from each active construction section/site		Locations of Weekly	Locations of Weekly
Drinking Water Quality-Ground Water	Drinking water: construction yards and labour camps		Locations of Quarterly	Locations of Quarterly
	Groundwater: one representative tube/bore well in the adjacent residential area within 100m from the active construction sections/sites		Locations of Monthly	Locations of Monthly

Category	Location	Location ID	Chainage (KM???+???)	Geo Coordination (Lat. / Long.) (dd, mm.mm / dd, mm.mm) WGS84
Water Quality-Surface Water	Upstream and downstream of the river/stream and any natural water (ex. pond) course located within 100 m of each construction yard, labour camp, and active construction section/site		Locations of Quarterly	Locations of Quarterly
Waste	Each construction camp		Locations of Monthly	Locations of Monthly
	Each active construction section/site wise		Locations of Monthly	Locations of Monthly
Hazardous waste	Each construction camp		Locations of Monthly	Locations of Monthly
	Each active construction section/site wise		Locations of Monthly	Locations of Monthly
Complaints and PR activities	All Works' related locations		Locations of weekly	Locations of weekly
Visual site observation	All Works' related locations		Locations of Weekly	Locations of Weekly
Regulatory framework updates	All Works' related locations and their authority office or websites			

20.5 Summary of baseline monitoring results and comparison with the permissive standards

<baseline monitoring results should cover all items>

Category	Parameters	Permissive Level	Summary/Range of Monitoring Results
Air	PM_{10}		xx.xx – xx.xx
	$PM_{2.5}$		
	SO_2		
	NO_X		
	CO		
Noise	L_{eq}, L_{max}, L_{day}, L_{night}		
Vibration	PPV (mm/sec)		
Drinking Water Quality-	All the parameters specified in per IS		

Category	Parameters	Permissive Level	Summary/Range of Monitoring Results
Ground Water	10500:2012		
Water Quality-Surface Water	All the parameters as per IS 2296		
Waste	All items specified by the Solid Management Rules 2016 & the Construction and Demolition Waste Management Rules 2016, and any specified parameters specified by local authorities		
Hazardous waste	All items specified by the Hazardous and Other Wastes (Management and Transboundary Movement) Rules 2016, and any specified parameters specified by local authorities		
Complaints and PR activities	Complaints: Phone logs, emails, written complaints, minutes of the meetings, consent documents, etc. PR: activity logs (ex. PR news, event)		
Visual site observation	Environmental monitoring items specified by CEMP and instructed by the Employer/Engineer		
Regulatory framework updates	Any update of the relevant environmental and social safeguard regulatory frameworks		

APPENDIX A: Copy of updated legal and policy frameworks, approvals
APPENDIX C: Copy of complaints, minutes, agreement
APPENDIX D-1: Environmental Daily Site Inspection Record Format
<Refer to Attachment 8 Form Env.1 of daily inspection record format(s)

APPENDIX D-2: Baseline Monitoring Data (field and laboratory test results)

1) Certification of monitoring agencies

2) Certification of laboratories

3) Calibration certificates for monitoring and laboratory testing equipment as per

sampling standards

4) Monitoring Parameter-wise Monitoring Results at Each Location

Category	Parameters	Permissive Level	Location ID	Monitoring Results

Attachment-8 Environmental Inspection and Reporting Formats

Form Env.1

SAMPLE Environmental Daily Site Inspection Records ver. x.x

Site inspection records shall be used to confirm the compliance with the Contractor's CEMP and regulatory requirements by the Contractor itself. Non-compliance shall be recorded, and practical/realistic self-improvement measures should be proposed to commit the conditions of the Contract.

<This form shall be revised and proposed by the Contractor at the time of the Construction Environmental Management Plan (CEMP) submission first. Then, the Contractor is responsible to continuously improve the initial form or propose other daily site inspection records to adapt the changes of construction activities and the daily inspection.>

I. General Information:

1. Package: ....
2. Active section from: Chainage KM + , Lat. / Long.(dd, mm.mm) ....
   Active section to: Chainage KM + , Lat. / Long.(dd, mm.mm) ....
3. Inspection from: Chainage KM + , Lat. / Long.(dd, mm.mm) ....
   Inspection to: Chainage KM + , Lat. / Long.(dd, mm.mm) ....
4. Primary Contractor: ....
5. Person in charge of this daily site inspection...
6. Sub-Contractors: *name & activities* ....

II. Construction activities (inspection area only)

1. Work item:
2. Construction machine:
3. Number of workers prime: sub-contractor A: sub-contractor B:

III. Compliance with CEMP (inspection area only)

Contents	Evaluation	
	OK	Issues to be solved
1. General Conduct of the Works		
+ Public relations + Public notice for the Work activities		1. issue: 1.2 person in charge: 1.3 target date to be solved: 2. issue:
+ Compliance with labour laws/Child labour/working condition:		
2. Site Preparation		
+ Preservation of Trees:		
+ Vegetation removal:		
+ Topsoil Removal and Storage:		
+ Sites of temporary works/no activities out of ROW:		
+ Flood prevention:		
3. Accommodation camp management / labour rest/shade, drinking water and sanitation		
+ Wastewater management & discharge		
+ Waste collection, separation, temporary storage and disposal agents approved by local authority		
+ Labour health education (transmitting disease control etc.)		
+		
4. Borrow pits and quarry sites		
+		
5. Construction Water and Rain Water Harvesting		
+		
6. Pollution from Vehicles, Machinery and Equipment:		
+		
7. Water Quality Management:		
+Siltation control		
+Erosion control		
+wastewater disposal		
+accidental spillage		
+		
8. Air Quality Control:		
+Dust control		
+		
9. Noise Control:		
+		
10. Vibration Control:		
+		
11. Waste management:		
+ Waste collection, separation, temporary storage system:		
+ Appointment of waste management/disposal		

Contents	Evaluation	
	OK	Issues to be solved
agents:		
+ Certifications of the waste management agents by competent authority:		
+		
12. Hazardous Waste storage and management:		
+		
13. Protection of Community Values and Archaeology:		
+ Sign boards and fences (public safety):		
+ Impacts on sensitive areas adjacent to construction sites and site access roads:		

IV. Conclusion: ....

....

....

....

The Contractor	**GC/PMC Engineer** (if applicable)
(Signature, full name, title)	*(Signature, full name, title)*

Annexure 6 (b)

GUIDELINE FOR PLANTATION

As part of the project implementation, the NHSRCL plans to undertake plantation and maintenance and protection of the vegetation along the project corridor where ever land is available and suitable for plantation (in addition to the compensatory afforestation that has been proposed by the Forest Department, Government of Maharashtra and Gujrat). The maintenance of these plantations would be entrusted to an NGO/Local Forest Department/or plantation company. The environmental responsibilities of the above said authority/department include the maintenance of plantations and conservation of biodiversity. The specific roles and responsibilities of the NGO/Local Forest Department/or plantation company or authority include:

- Provide, plant and maintain three-year-old saplings along the free lands and unclassified forestlands along the project corridor.
- Indigenous species would be selected for plantation considering availability and space of land from the route and maintained for five years, including training, pruning, manuring, irrigation, replacement of died plants, protection and monitoring of the survival.
- Undertake adequate measures to ensure maximum survival of the saplings during transportation to the site, and post plantation by proper handling and maintenance.
- Ensure proper watering, removal of weed, litter and debris from the vicinity of the plantation. The plantation authority will ensure the protection of the fencing provided to the saplings from trampling and browsing by the cattle.
- Periodically visit the construction activities in the Important Biological Areas identified along the corridor and ensure that the construction activities are taken with due precautionary arrangements. In case of any non-compliance, will report to the Environmental Engineer of the PIU/NHSRCL and the Environmental Specialist of the Supervision consultant for further action.

	NHRSCL	Local government	NGO
Planning			
Budget			
Plantation			
Maintenance			
Watering			

Annexure 6 (c)

GUIDELINES FOR QUARRY MANAGEMENT

The Contractor will finalize the locations from the list given by Feasibility Consultant's for procuring materials. The Contractor shall establish a new quarry only with the prior consent of the PMC only in cases when: (i) Lead from existing quarries is uneconomical and (ii) Alternative material sources are not available. The Contractor shall prepare a Redevelopment Plan for the quarry site and get it approved by the PMC.

The construction schedule and operations plan to be submitted to the PMC prior to commencement of work shall contain a detailed work plan for procuring materials that includes procurement, transportation and storage of quarry materials.

Operation & redevelopment plan (if a new quarry is opened)
• Photograph of the quarry site prior to commencement • The quarry boundaries as well as location of the materials deposits, working equipments, stockpiling, access roads and final shape of the pit. • Drainage and erosion control measures at site. • Safety Measures during quarry operation. • Design for redevelopment of exhaust site. *Option-A: Revegetating the quarry to merge with surrounding landscape:* This is done by conserving and reapplying the topsoil for the vegetative growth. *Option-B: Developing exhausted quarries as water bodies:* The pit shall be reshaped and developed into pond, for harvesting rainwater. This option shall only be considered where the location of quarry is at the lowest point, i.e. surrounding areas/natural drainage slopes towards it.

1) Construction Stage

Development of site: To minimize the adverse impact during excavation of material following measures are need to be undertaken:

i) Adequate drainage system shall be provided to prevent the flooding of the excavated area
ii) At the stockpiling locations, the Contractor shall construct sediment barriers to prevent the erosion of excavated material due to runoff
iii) Construction of offices, laboratory, workshop and rest places shall be done in the up-wind of the plant to minimize the adverse impact due to dust and noise.
iv) The access road to the plant shall be constructed taking into consideration location of units and also slope of the ground to regulate the vehicle movement within the plant.
v) Incase of storage of blasting material, all precautions shall be taken as per The Explosive Rules, 1983.

2) Quarry operations including safety:

i) Overburden shall be removed and disposed inline with Guidelines of Disposal Management
ii) During excavation, slopes shall be flatter than 20 degrees to prevent their sliding. Incases where quarry strata are good and where chances of sliding are less this restriction can be ignored.

iii) Incase of blasting, procedure and safety measures shall be taken as per The Explosive Rules, 1983
iv) The contractor shall ensure that all workers related safety measures shall be done as per guidelines for Workers and Safety.
v) The Contractor shall ensure maintenance of crushers regularly as per manufacturer's recommendation.

Topsoil will be excavated and preserved during transportation of the material measures shall be taken to minimize the generation of dust and prevent accidents.

The PMC and the Technical Examiner shall review the quarry site for the management measures during quarry operation, including the compliance to pollution norms.

3) Post Construction Stage

The Contractor shall restore all haul roads constructed for transporting the material from the quarries to construction site to their original state.

The PMC and the Technical Examiner shall be entrusted the responsibility of reviewing the quarry site for the progress of implementation of Redevelopment Plan. These shall include the following two cases;

- Redevelopment of quarries opened by the Contractor for the project
- Redevelopment of existing quarries operated by other agencies

In the first case, the Contractor shall be responsible for the Redevelopment Plan prior to completion after five years, during the defect liability period. The PMC shall be responsible for reviewing this case of redevelopment prior to the issuing the defect liability certificate.

In the second case, the redevelopment of exhaust quarry shall be the responsibility of the agency providing the permit to ensure the implementation of Redevelopment Plan.

Annexure 6 (d)

GUIDELINES FOR DISPOSAL SITE MANAGEMENT

The locations of Disposal sites have to be selected such that:

- No residential areas are located downwind side of these locations,
- Disposal sites are located at least 1000 m away from sensitive locations like Settlements, Water body notified forest areas, Sanctuaries or any other sensitive Locations.
- Disposal sites do not contaminate any water sources, rivers etc for this site should be located away from waterbody, Disposal site should be lined properly to prevent infiltration of water.
- Public perception about the location of debris disposal site has to be obtained before finalizing the location.
- Permission from the Villager/local community is to be obtained for the Disposal site selected
- The Plan must be approved by Environment Engineer of PMC.

PRECAUTIONS TO BE ADOPTED DURING DISPOSAL OF DEBRIS / WASTE MATERIAL

The contractor shall take the following precautions while disposing off the waste material

- During the site clearance and disposal of debris, the contractor will take full care to ensure that public or private properties are not damaged/affected, there is no dwellings below the dumpsite and that the traffic is not interrupted.
- Contractor will dispose off debris only to the identified places or at other places only with prior permission of Engineer-in-Charge of works.
- In the event of any spoil or debris from the sites being deposited on any adjacent land, the contractor will immediately remove all such spoil debris and restore the affected area to its original state to the satisfaction of the Engineer-in-Charge of works.
- The contractor will at all times ensure that the entire existing canal and drains within and adjacent to the site are kept safe and free from any debris.
- Contractor will utilize effective water sprays during the delivery and handling of materials when dust is likely to be created and to dampen stored materials during dry and windy weather.
- Materials having the potential to produce dust will not the loaded to a level higher than the side and tail boards and will be covered with a tarpaulin in good condition.
- Any diversion required for traffic during disposal of debris shall be provided with traffic control signals and barriers after the discussion with local people and with the permission of Engineer-in-Charge of works.
- During the debris disposal, contractor will take care of surrounding features and avoid any damage to it.

While disposing debris / waste material, the contractor will take into account the wind direction and location of settlements to ensure against any dust problems.

Guidelines for Rehabilitation of Disposal Sites

The dumpsites filled only upto the ground level could be rehabilitated as per guidelines below and to be decided by the engineer and the supervision consultant

- The dumpsites have to be suitably rehabilitated by planting local species of shrubs and other plants. Local species of trees has also to be planted so that the landscape is coherent and is in harmony with its various components.
- In cases where a dumpsite is near to the local village community settlements, it could be converted into a play field by spreading the dump material evenly on the ground. Such playground could be made coherent with the landscape by planting trees all along the periphery of the playground.
- Some of the dumpsites could be used either for plantation or for growing agricultural produce such as ginger, turmeric or oranges *etc*.
- Care should always be taken to maintain the hydrological flow in the area.

Annexure 6(e)

[illegible]

[illegible]

[illegible]

Annexure 6 (f)

GUIDELINES FOR TOP SOIL MANAGEMENT

Topsoil is considered to be the natural soil covering, including all the vegetation and organic matter. It is rich in organic-matter, has friable consistence, water-holding capacity, and nutrient content and is a better growth medium.

Topsoil shall be removed from all areas where physical disturbance of the surface (excavation, filling or compaction by equipment) will occur and shall be stored and adequately protected. Topsoil from the areas that will be used for storing topsoil or subsoil should not be stripped / removed.

The contractor will provide for the stripping and stockpiling of topsoil from the site for later re-use.
Depth of topsoil will vary at each site but generally applies as given below:

- 50 to 60 cm of total soil depth removal over bed rock (combined topsoil and subsoil)
- 20 to 30 cm of total soil depth removal over loose rock
- 20 to 25 cm of total soil depth removal over normal earth

Topsoil should be stored in stockpiles not more than 2m high with slopes not over 45° and should be drained with open ditches. The surface of the stockpile should be compacted just enough to reduce rainfall penetration but not so much that it can promote anaerobic conditions.

All topsoil stockpiles and windrows shall be maintained throughout the contract period in a weed-free condition. Weeds appearing on the stockpiled or windrowed topsoil shall be removed by hand.
Stockpile should be protected by temporary seeding within 30 working days after formation of stockpile. If stockpiles are not used within 12 months, permanent vegetation should be done to control erosion and weed growth.

Soils contaminated by hazardous substances shall be disposed of at an approved waste disposal site. The topsoil stockpiles shall be stored, shaped and sited in such a way that they do not interfere with the flow of natural drainage of water to cause ponding or erosion, or itself be eroded by the action of water. The Contractor shall ensure that no topsoil is lost due to erosion – either by wind or water. Areas to be top-soiled and grassed shall be done so systematically to allow for quick cover and reduction in the chance of heavy topsoil losses due to unusual weather patterns. The Contractor's programme shall clearly show the proposed rate of progress of the application of topsoil and grassing.

The Contractors shall be responsible for the replacement, at their own cost, for any unnecessary loss of topsoil due to their failure to work according to the progress plan approved by the Engineer. The Contractor's responsibility shall also extend to the clearing of drainage or water systems within and beyond the boundaries of the drainage route reserve that may have been affected by such negligence.

ii) Subsoil

The subsoil is the layer of soil immediately beneath the topsoil. It shall be removed, to a depth instructed by the engineer, and if not used for service road construction it shall be stored and maintained separately from the topsoil so that neither stockpile is contaminated by the other. This soil shall be used for rehabilitation purposes by first spreading it over the excavated slopes without interfering with or contaminating the stockpiled topsoil. Whilst in stockpile it shall be maintained free from erosion and weed infestation in the same way as for topsoil stockpile maintenance.

Topsoil Reinstatement

All temporary arrangements made for stockpile preservation and erosion control are to be removed by the Contractor after reusing the stockpile material.

The topsoil should be laid back to its original state once the construction and related work are completed or laid to the surface where the vegetation is to be restored (for instance turfing and median in road projects as practically possible).

a) Reinstatement includes roughening and spreading of topsoil prior to seeding.
b) *Roughening:* Immediately prior to spreading the topsoil, the sub grade should be loosened by disking or scarifying to a depth of at least 15 to 30cm to ensure bonding.
c) *Spreading Topsoil:* The topsoil should be uniformly spread to a minimum compacted depth of 10 cm. For long-term growth of vegetation without irrigation, minimum soil depth (subsoil and topsoil) should be 20 to 30 cm over loose sand or rock fragments, and 60 cm depth over bedrock.

Annexure 6 (g)

Sample Format of Environmental Monitoring Report for NHSRCL (Costruction phase)

Mumbai Ahmedabad High Speed Railway Project
Package No. MAHSR-***

Quarterly Environmental Monitoring Report

Pre.Construction / Construction Phase (APR – JUN 20yy)

Pre.Construction / Construction Phase (JUL – SEP 20yy)

Pre.Construction / Construction Phase (OCT – DEC 20yy)

Pre.Construction / Construction Phase (JAN – MAR 20yy)

CONTENTS

A. RATIONAL

1. LEGAL BASES

The Contract xxxx dated dd MMM 20yy between National High Speed Rail Corporation Limited (the Employer) and XYZ (the Contractor) defines the Contractor's responsibilities. Based on the Contract, the Contractor prepared its work specific construction environmental management plan (CEMP) and submit this environmental monitoring report to the Employer for evaluation and ensuring the compliances of the applicable environmental requirements..

The objectives of environmental monitoring report are to:

i) evaluate the adequacy of the approved CEMP by confirming compliance status,

ii) detect and correct non-conformances, and

iii) identify unanticipated impacts and implement necessary mitigation measures.

The Quarterly monitoring report is the basis of JICA Loan compliance report to JICA by NHSRCL.

2. SCOPE OF THE QUARTERLY MONITORING REPORT

With reference to the subsection 7.19.5. Reporting, Appendix 08001 of the general descriptions, reporting items are as follow;

- Updates of relevant legal and policy framework
- Chainage-wise project activity summary
- Chainage-wise activity plan for next four months
- Summary of PR activities if any
- Complaints by public or authorities and the Contractor's responses or action plans
- Quarterly summary of the weekly and monthly monitoring items
- All applicable items specified in the table in the section 7.19.3 Monitoring
- Compliances of the monitoring items and counter measures if it is applicable within next quarter

3. UPDATES OF RELEVANT LEGAL FRAMEWORK

Updates of legal and policy frameworks relevant to the environment and social consideration are summarized as follows;

Title	Summary
3.1 ENVIRONMENT	
Formal Name of legal and policy with competent authority	Key changes and primary points
Forest Department	Tree cutting/Plantation
SPCB	Consent to Establishment and Operate if any machinery
Municipal Corporation	Waste disposal, use of potable water
Public Health Department	Water Quality
Wildlife Warden	Any change in their judiciary
Central Ground Water Authority	Extraction of Ground Water
District Collector	Use of sand, Borrow pit, Quarry
Transport Department	Traffic Diversion
Electric Authority	Use of Electricity
District collector	Temporary construction of camp/storage/debris
3.2 SOCIAL AND PUBLIC HEALTH	
Formal Name of legal and policy with	Key changes and primary points

competent authority	
District Collector	Compensation issues if any diversion
Health Department	Regular Check-up, Labor camps
Panchayat	Noise and Dust issue nearby habitation
Municipal Corporation	Community facility use (water, road, drainage)
PWD/NHAI	Diversion of any road
Police	Law and Order issue

3.3 OTHERS RELATED TO THE WORK

Formal Name of legal and policy with competent authority	Key changes and primary points
Panchayat/Local	Working schedule (if proposed in night)
Villagers	Working time and Noise management/ construction of temporary noise barrier/ protection/ dust control
Sensitive Receptors like Hospital and School	Protection, dust and noise control,
Temple/ Shrine/ Gurudwara	

B. Project Activity Summary

1. Chainage-wise project activity summary for reporting period

2. Chainage-wise activity plan for next four months

C. Public Relations and Complaint Responses

1. Summary of Public Relations Activities
2. Complaints by public or authorities and the Contractor's responses or action plans

D. Environmental Protection Commitment & Monitoring

1. Summary of Identified Issues for Reporting Periods

2. Environmental Monitoring

2.1 Disclosure of qualified monitoring agencies and laboratories
2.2 Changes of the monitoring items and monitoring standards
2.3 Monitoring locations

Category	Location	Location ID	Chainage (KM???+???)	Geo Coordination WGS84 <Lat. / Lng.> (dd, mm.mm / dd, mm.mm)

Category	Location	Location ID	Chainage (KM???+???)	Geo Coordination WGS84 <Lat. / Lng.> (dd, mm.mm / dd, mm.mm)
Air	one representative location within each construction camp		Location of Quarterly	
	the closest residential or commercial facility (one location) within 100m from each active construction section/site		Locations of Monthly	
Noise	the closest residential or commercial facility (one location) within 100m from each active construction section/site		Locations of Weekly	
Vibration	the closest residential or commercial facility (one location) within 100m from each active construction section/site		Locations of Weekly	
Drinking Water/Wastewater Quality **& Ground Water**	1) Drinking water: construction yards and labour camps (contractor monitoring) 2) Drinking water and wastewater discharge at selected labour camps (NHSRCL audit)		Locations of Quarterly	
	Groundwater: one representative tube/bore well in the adjacent residential area within 100m from the active		Locations of Monthly	

Category	Location	Location ID	Chainage (KM???+???)	Geo Coordination WGS84 <Lat. / Lng.> (dd, mm.mm / dd, mm.mm)
	construction sections/sites			
Water Quality-Surface Water	Up - Downstream of the river/ stream and any natural water (ex. pond) course located within 100 m of each construction yard, labour camp, and active construction section/site		Locations of Quarterly	
Waste	Each construction camp		Locations of Monthly	
	Each active construction section/site wise		Locations of Monthly	
Excess earth	Each active construction section/site wise		Locations of weekly	
	Dumping site		Locations of weekly	
Hazardous waste	Each construction camp		Locations of Monthly	
	Each active construction section/site wise		Locations of Monthly	
Complaints and PR activities	All Works' related locations		Locations of weekly	
Visual site observation	All Works' related locations		Locations of Weekly	
Tree cuttings	cutting site		Locations of Monthly	
Compensatory afforestation**	afforestation		Each offsite afforestation	
Ecological Study	Entire stretch of MAHSR particularly at identified sensitive locations		Locations of Quarterly	

Category	Location	Location ID	Chainage (KM???+???)	Geo Coordination WGS84 <Lat. / Lng.> (dd, mm.mm / dd, mm.mm)
	viz.TCFS, SGNP, TWLS, CRZ area			
Regulatory framework updates	All Works' related locations and their authority office or websites			

2.4 Summary of Monitoring results and compliance with the permissive standards <monitoring results should cover all items>

Category	Parameters	Permissive Level	Summary/Range of Monitoring Results
Air	PM_{10}	100 μg/m^3	xx.xx – xx.xx
	$PM_{2.5}$	60 μg/m^3	
	SO_2	80 μg/m^3	
	NO_X	80 μg/m^3	
	CO	4 μg/m^3(1-hourly)	
Noise	$L_{eq\text{-}day}$, $L_{eq\text{-}night}$	Residential: Day-55 dB(A) Night-45 dB(A)	
Vibration (active construction sites by contractor)	Peak Particle Velocity (PPV) (mm/sec)	DGMS (Tech) (S&T) Circular No.7 of 1997*	
Vibration (fixed monitoring sites by NHSRCL)	Root Mean Square (RMS) in $L_{Veq\text{-}day}$, $L_{Veq\text{-}night}$ (dB)	No Indian standards	
Drinking Water and wastewater discharge Quality & Ground Water	All the parameters specified as per IS 10500:2012 IS 2296 (1982) Schedule VI the Environment (Protection) Rules (1986) & ground water level (if applicable)		
Water Quality-Surface Water	All the parameters as per IS 2296		
Waste	All items specified by the Solid Management Rules 2016 & the Construction and Demolition Waste Management Rules 2016, and any specified parameters specified by local authorities		

Category	Parameters	Permissive Level	Summary/Range of Monitoring Results
Hazardous waste	All items specified by the Hazardous and Other Wastes (Management and Transboundary Movement) Rules 2016, and any specified parameters specified by local authorities		
Excess earth	Volume of excess earth Reused volume		
Dumping site	Dumping contents Name of dumping site (public, private) Dumping volume		
Complaints and PR activities	Complaints: Phone logs, emails, written complaints, minutes of the meetings, consent documents, etc. PR: activity logs (ex. PR news, event) Each location		
Visual site observation	Environmental monitoring items specified by CEMP and instructed by the Employer/Engineer		
Tree cutting	Number of trees Species		
Compensatory afforestation**	Number of trees Species Planted area (completed are out of total area) Survival rate of planted trees		
Ecological Study	Scientific study (Transition of species composition of Fauna and Flora)	Comparisons between baseline and construction stage survey results	
Regulatory framework updates	Any update of the relevant environmental and social safeguard regulatory framework		

* DGMS (Tech) (S&T) Circular No.7 of 1997: Vibration Standards

Depending on the type of structures and the dominant excitation, the peak particle velocity (ppv) on the ground adjacent to the structure shall not exceed the values (mm/s) given below in the table.

Type of structure	**Dominant excitation frequency and each permissible ppv (mm/s)**		
	<8 Hz	8-25 Hz	**>25 Hz**
(A) Buildings/structures not belong to the owner			
(i) Domestic houses/structures (kuchha brick & cement)	5	10	15
(ii) Industrial Buildings (RCC & Framed structures)	10	20	25
(iii) Objects of historical importance & sensitive structures	2	5	10
(B) Buildings belonging to owner with limited span of life			
(i) Domestic houses/structures (kuchha brick & cement)	10	15	25
(ii) Industrial Buildings (RCC & Framed structures)	15	25	50

Source: DGMS (Tech) (S&T) Circular No.7 of 1997

** NHSRCL shall continuously communicate with concerned forest authorities and acquire necessary reporting information from the forest authorities.

2.5 Excess locations against permissive levels, and their causes and countermeasures

Description of the excess parameters and their locations	Causes	Countermeasures & their results

3. Improvement of Construction Environmental Management Plan (CEPM)

If the Contractor wishes to improve the approved CEMP), the Contractor is requested to propose the changes from the approved CEMP.

3.1 Section of the approved CEMP that the Contractor wishes to improve

3.2 Proposed CEMP to adapt present issues and comply with permissive standards

APPENDIX A: Copy of updated legal and policy frameworks, approvals

APPENDIX C: Copy of complaints, minutes, agreements

APPENDIX D: Monitoring Data (field and laboratory test results)

1) Certification of monitoring agencies

2) Certification of laboratories

3) Calibration certificates for monitoring and laboratory testing equipment as per sampling standards

4) Monitoring Parameter-wise Monitoring Results at Each Location

- Active construction locations and Sampling locations on the MAPs

Category	Parameters	Permissive Level	Location ID	Monitoring Results

Sample Format of Environmental Monitoring Report for NHSRCL (Operation phase)

Mumbai Ahmedabad High Speed Railway Project
Package No. MAHSR-***

Quarterly Environmental Monitoring Report

Pre.Construction / Construction Phase (APR – JUN 20yy)

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Public Health Department	Water Quality
Wildlife Warden	Any change in their judiciary
Central Ground Water Authority	Extraction of Ground Water
District Collector	Use of sand, Borrow pit, Quarry
Transport Department	Traffic Diversion
Electric Authority	Use of Electricity
District collector	Temporary construction of camp/storage/debris
3.2 SOCIAL AND PUBLIC HEALTH	
Formal Name of legal and policy with competent authority	Key changes and primary points

District Collector	Compensation issues if any diversion
Health Department	Regular Check-up, Labor camps
Panchayat	Noise and Dust issue nearby habitation
Municipal Corporation	Community facility use (water, road, drainage)
PWD/NHAI	Diversion of any road
Police	Law and Order issue

3.3 OTHERS RELATED TO THE WORK

Formal Name of legal and policy with competent authority	Key changes and primary points
Panchayat/Local	Working schedule (if proposed in night)
Villagers	Working time and Noise management/ construction of temporary noise barrier/ protection/ dust control
Sensitive Receptors like Hospital and School	Protection, dust and noise control,
Temple/ Shrine/ Gurudwara	

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C. Public Relations and Complaint Responses

1. Summary of Public Relations Activities
2. Complaints by public or authorities and the Contractor's responses or action plans

D. Environmental Protection Commitment & Monitoring

1. Summary of Identified Issues for Reporting Periods
   - 1.1 Identified issues in weekly monitoring
   - 1.2 Identified issues in monthly monitoring
   - 1.3 Identified issues in quarterly monitoring

2. Environmental Monitoring

- 2.1 Disclosure of qualified monitoring agencies and laboratories
- 2.2 Monitoring items and monitoring standards if changes from the Contract
- 2.3 Monitoring locations

Category	**Location**	**Location ID**	**Chainage (KM???+???)**	**Geo Coordination (Lat. / Long.) (dd, mm.mm / dd, mm.mm) WGS84**
Air	Fixed and continuous			

Category	Location	Location ID	Chainage (KM???+???)	Geo Coordination (Lat. / Long.) (dd, mm.mm / dd, mm.mm) WGS84
Noise	monitoring stations			
Vibration				
Drinking Water/Wastewater Quality **& Ground Water**	Drinking water and wastewater discharge at 15 locations (stations and depots)			
	Groundwater: 10 representative tube/bore wells in the adjacent residential area within 100m from the alignment			
Bird strike	Each bird strike point		Each location	
Complaints and PR activities	Complaints: Phone logs, emails, written complaints, minutes of the meetings, consent documents, etc. PR: activity logs (ex. PR news, event)			Each location
Compensatory afforestation**	afforestation		Each offsite afforestation	
Ecological Study	Entire stretch of MAHSR particularly at identified sensitive locations viz.TCFS, SGNP, TWLS, CRZ area		Locations of biannually	
Regulatory framework updates	All related locations and their authority office or websites			

2.4 Summary of Monitoring results and compliance with the permissive standards <monitoring results should cover all items>

Category	Parameters	Permissive Level	Summary/Range of Monitoring Results
Air	PM_{10}	100 µg/m^3	xx.xx – xx.xx
	$PM_{2.5}$	60 µg/m^3	
	SO_2	80 µg/m^3	
	NO_X	80 µg/m^3	
	CO	4 µg/m^3(1-hourly)	
Noise*	$L_{eq\text{-}day}$, $L_{eq\text{-}night}$	Residential*: Day-65 dB(A) Night-55	

Category	Parameters	Permissive Level	Summary/Range of Monitoring Results
		dB(A)	
Vibration	Root Mean Square (RMS) in $L_{Veq\text{-}day}$, $L_{Veq\text{-}night}$ (dB) Comparison with construction stage baseline data	No Indian Standards	
Drinking Water and wastewater discharge Quality & Ground Water	All the parameters specified as per IS 10500:2012 IS 2296 (1982) Schedule VI the Environment (Protection) Rules (1986) & ground water level (if applicable)		
Bird strike	Species Number of birds		
Complaints and PR activities	Complaints: Phone logs, emails, written complaints, minutes of the meetings, consent documents, etc. PR: activity logs (ex. PR news, event)		
Compensatory afforestation**	Number of trees Species Planted area (completed are out of total area) Survival rate of planted trees		
Ecological Study	Scientific study (Transition of species composition of Fauna and Flora)	Comparisons among baseline, construction stage, and operation stage survey results	
Regulatory framework updates	Any update of the relevant environmental and social safeguard regulatory frameworks		

* Due to the no regulatory requirements in India in September 2018, "Indicative permissive values" of the noise values in Leq. (dB) are set based on 10dB above the residential area noise standards of the Noise Pollution (Regulation and Control) Rules (2000). Once a national standard for the high-speed railway standards are set, NHSRCL shall replace the permissive level values upon the consent of JICA.
** NHSRCL shall continuously communicate with concerned forest authorities and acquire necessary reporting information from the forest authorities.

3. Improvement of Construction Environmental Management Plan (CEPM)

If the Contractor wishes to improve the approved CEMP), the Contractor is requested to propose the changes from the approved CEMP.

3.1 Section of the approved CEMP that the Contractor wishes to improve
3.2 Proposed CEMP to adapt present issues and comply with permissive standards

APPENDIX A: Copy of updated legal and policy frameworks, approvals
APPENDIX C: Copy of complaints, minutes, agreements
APPENDIX D: Monitoring Data (field and laboratory test results)

1) Certification of monitoring agencies

2) Certification of laboratories

3) Calibration certificates for monitoring and laboratory testing equipment as per sampling standards

4) Monitoring Parameter-wise Monitoring Results at Each Location

Category	Parameters	Permissive Level	Location ID	Monitoring Results

Annexure 6 (h)

List of Environmental Monitoring Standards and Guidelines

The table below lists the key standards and guidance manuals applicable for the monitoring, measurement, analysis and management of air, water, noise and associated environmental parameters. While an attempt has been made to populate the list based on the latest resources available from the regulatory authorities, contractors are advised to use updated and more recent guidance available at the time of execution of the works.

Sr. No.	List of Environmental Monitoring Standards and Guidelines (revision or additional standards might be applicable upon the instruction of the concerned authorities)
Drinking Water	
1.	Drinking Water Specification - IS 10500, 2012, Bureau of Indian Standards (BIS)
Environmental Emission and Discharge Standards	
2.	Environmental Emission / Discharge Standards, Schedules I, III, IV, VI and VII, Environmental Protection Rules, 1986 and Amendments thereof
Waste Water	
3.	Methods of Sampling and Test (physical and chemical) for water and wastewater, BIS 3025 (Part 1): Reprint 2008 Additional Parts under IS 3025 cover analytical methods of specific wastewater parameters. IS 2296 (1982) provides the water quality standards for surface water bodies as per CPCB
4.	Guidelines for Water Quality Monitoring, MINARS /27/2007-08
5.	Designated Best Uses of Water by Class of River, The Environment (Protection) Rules, 1986, Central Pollution Control Board
6.	Guidelines on Construction & Maintenance of Bore wells and Tube wells, Ministry of Railways, GoI, 2014
7.	Guide Manual: Water and Wastewater Analysis, Central Pollution Control Board (CPCB), 2012
8.	Manual on Sewerage and Sewage Treatment, Central Public Health and Environmental Engineering Organization, 2012

Sr. No.	List of Environmental Monitoring Standards and Guidelines (revision or additional standards might be applicable upon the instruction of the concerned authorities)
Air, Noise and Vibration	
9.	Guidelines for the Measurement of Ambient Air Pollutants, Manual Sampling & Analyses – Volume I, Central Pollution Control Board (CPCB), 2011
10.	Guidelines for the Measurement of Ambient Air Pollutants, Real Time Sampling & Analyses – Volume II, Central Pollution Control Board (CPCB), 2011
11.	Protocol for Ambient Level Noise Monitoring, Central Pollution Control Board (CPCB), 2015 Noise Pollution (Regulation and Control) Rules, 2000
12.	Stack Monitoring – Material and Methodology for Isokinetic Sampling, Central Pollution Control Board (CPCB)
13.	Monitoring Guidelines (Draft) of Indoor Air Pollution, Central Pollution Control Board (CPCB), 2014
14.	IS 14884 (2000): Mechanical Vibration and Shock – Vibration of Buildings - Guidelines for the Measurement of Vibrations and Evaluation of Their Effects on Buildings [MED 28: Mechanical Vibration and Shock]
Waste	
15.	Manual on Sampling, Analysis and Characterization of Hazardous Waste, Central Pollution Control Board (CPCB), 2014
16.	Guidelines on Implementing Liabilities for Environmental Damages due to Handling & Disposal of Hazardous Waste and Penalty, Central Pollution Control Board (CPCB), 2016
17.	Guidelines on Environmental Management of Construction & Demolition (C & D) Wastes, Central Pollution Control Board (CPCB), 2017

Annexure 7.1

Summary of Environment information Disclosure & Public Consultation

S. No	District	Venue	Date &Time	Press Notification	Total Attendees	Male	Female
GUJARAT							
1	Ahmedabad	Near Baliya Dev Temple, Village – Ropda, Taluka – Daskoi, Ahmedabad	09-05-2018 1500 HRS	3/5/2018 Gujarat Samachar	52	42	10
2	Kheda	Ambedkar Bhawan, Kheda	04-04-2018 1100 HRS	25/3/2018 Gujarat Samachar	114	109	5
3	Anand	Town Hall, Anand	30-04-2018 1000HRS	27/4/2018 Gujarat Samachar	161	151	10
4	Vadodara	Dr.B.R. Ambedkar Bhawan, Alkapuri, Vadodara	30-04-2018 1700 HRS	26/4/2018 Gujarat Samachar	37	32	5
5	Bharuch	Dr.Bhim Rao Ambedkar Bhawan, Near DC Office, Bharuch	10-05-2018 1230 HRS	3/5/2018 Gujarat Samachar	70	65	5
6	Navsari	Shree Navsari Kshatriya Sanskrutik Bhawan, Navsari	29-05-2018 1500 HRS	22/5/2018 Gujarat Samachar	92	81	11
7	Surat	Gandhi Smruti Bhavan, Surat	14-05-2018 1500 HRS	9/5/2018 Sandesh	202	192	12
8	Valsad	Morarji Desai Auditorium, Valsad	30-05-2018 1500HRS	22/5/2018 Gujarat Samachar	206	184	22
DADRA AND NAGAR HAVELI							
9	DNH-Silvasa	Community Hall, Naroli Panchayat, Silvasa	16-04-2018 1130 HRS	22/4/2018	45	37	8
MAHARASHTRA							
10	Palghar	S. Tu. Kadam Madhyamik Vidyalaya, Jivan Vikas Shiksha Sanstha, Boisar Road, Palghar	02-06-2018 1000 HRS	30/5/2018 Lokmat	271	219	52
11	Thane	Ram Ganesh Gadkari Rangayatan, Thane (W)	29-05-2018 1100 HRS	14/5/2018& 21/5/2018 Maharashtra Times	250	220	30
12	Mumbai Suburban	Conference Hall, Office of the District Collector, Bandra	30-05-2018 1600 HRS	21/5/2018 Lokmat& Maharashtra Times	16	14	2

Pictures of EPC of the Districts

 **Ahmedabad**	 **Kheda**
 **Anand**	 **Vadodara**
 **Bharuch**	 **Navsari**

 **Surat**	 **Valsad**
 **Silvasa**	 **Mumbai**
 **Thane**	 **Palghar**

Office of the District Collector, Ahmedabad
Ashram Road, Subhash Bridge Circle, HridayaKunj, Near R.T.O Office, Old Wadaj, Ahmedabad, Gujarat 380027

ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION PROCEEDING

It is hereby informed that environment information disclosure & public consultation at district level was organized in compliance to the JICA's Guidelines on Environmental and Social Consideration, April 2010 for Ahmedabad District at Ropada Village, Taluka-Daskoi, Ahmedabad on 9th May 2018, 1500 hrs for the proposed Mumbai-Ahmedabad High Speed Railway Project (MAHSR) implemented by National High Speed Rail Corporation Limited (A Joint Venture of Government of India and Participating State Governments).

National High-Speed Rail Corporation Limited (NHSRCL) intends to implement the first ever bullet train in India under the Mumbai-Ahmedabad High Speed Railway Project (MAHSR).

A notification for Environmental Information Disclosure & Public Consultation was published in the daily newspaper Gujarat Samachar on 03-May-2018.

The public consultations were conducted after circulation of the executive summary of the Supplemental Environmental Impact Assessment (S-EIA) report in advance to the affected panchayat. During the public consultations, a detailed presentation was given on findings of S-EIA in local language, so that local public understand about the findings, such as project details, considered impact and its mitigation measures

A copy of the Summary of Draft S-EIA Report was also made available at District Collector Office, Vadodara for inspection to the public during normal office hours till the public consultation is over.

Comments / views of concerned persons having plausible stake in the environmental aspects of the Project were heard during the consultation meeting and they were requested to send their response in writing to the concerned district collectorate.

Shri Dr. Vikrant Pandey, District Collector Ahmedabad supervised and presided over the entire Environmental Information Disclosure & Public Consultation proceeding.

Following officials of District Administration and Project Authority were present in the Environmental Information Disclosure & Public Consultation meeting.

Officials of District Administration
Shri Dr. Vikrant Pandey, District Collector Ahmedabad
Mr. Mehul Dave (ADC)
Mrs. Neha Singh, SDM (Daskoi)
Mr. M.N.Jadeja, (In-charge SP)
Mr. Pradeep Parmar (MLA)Asarva

Officials of NHSRCL
Sh. Neeraj K Singh, CPM, Ahmedabad
Sh K.K Verma Dy. CPM, Ahmedabad
Sh. Anand Kumar, Manager, Ahmedabad

Sh. Pritesh Patel, representative of M/s GPS Technologies Pvt. Ltd. gave the presentation highlighting project details and the key findings of the S-EIA study.

Upon completion of the presentation, DM, Ahmedabad addressed the participants about the project and need of the public consultation and invited the participants to express their views, suggestions and issues related to environment, if any.

The list of the participants (attendance sheet) is attached as Annexure-A.

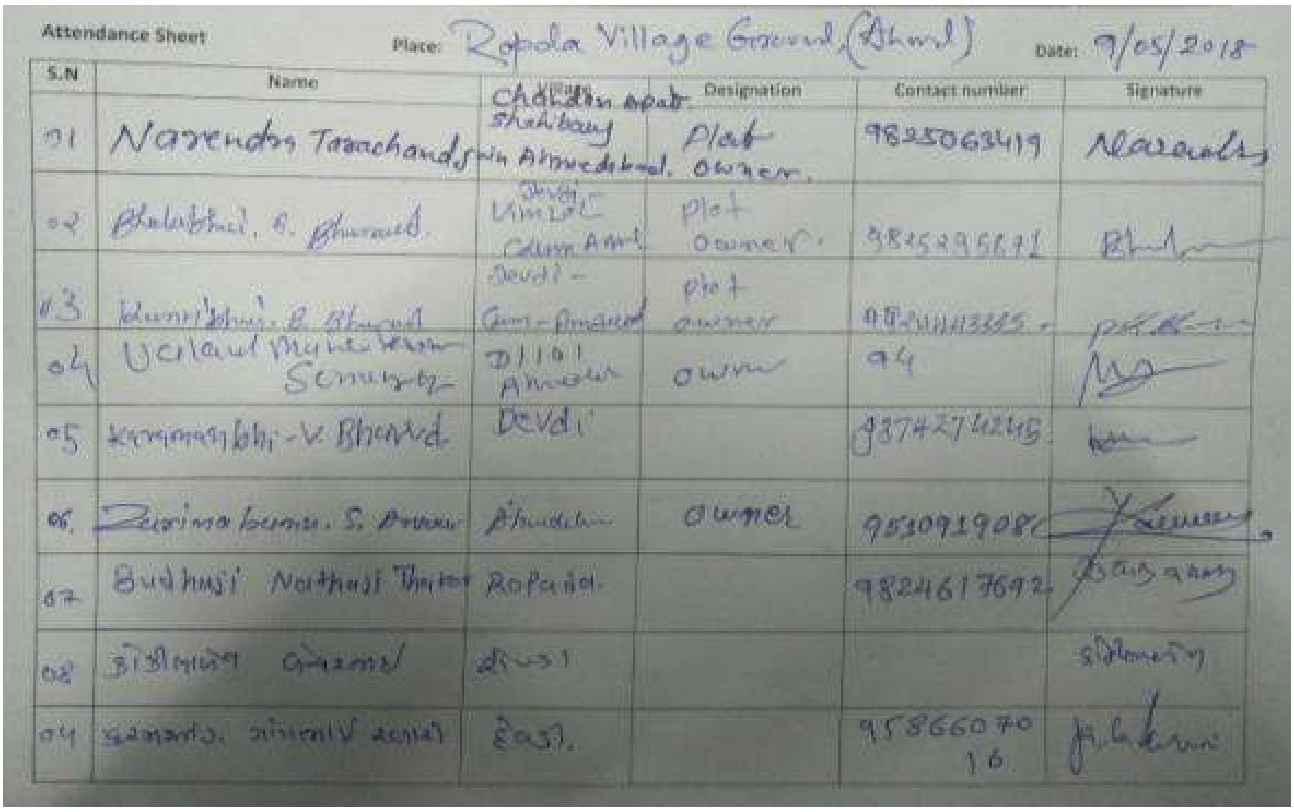
The issues raised by the participants during the Environmental Information Disclosure & Public Consultation along with the response of the NHSRCL is attached as Annexure-B (in English).

After the discussion session, DM, Ahmedabad announced the closure of the Environmental Information Disclosure & Public Consultation.

DM informed that the written response to the issues raised by the public shall be communicated by the Office of the District Collector, Ahmedabad.

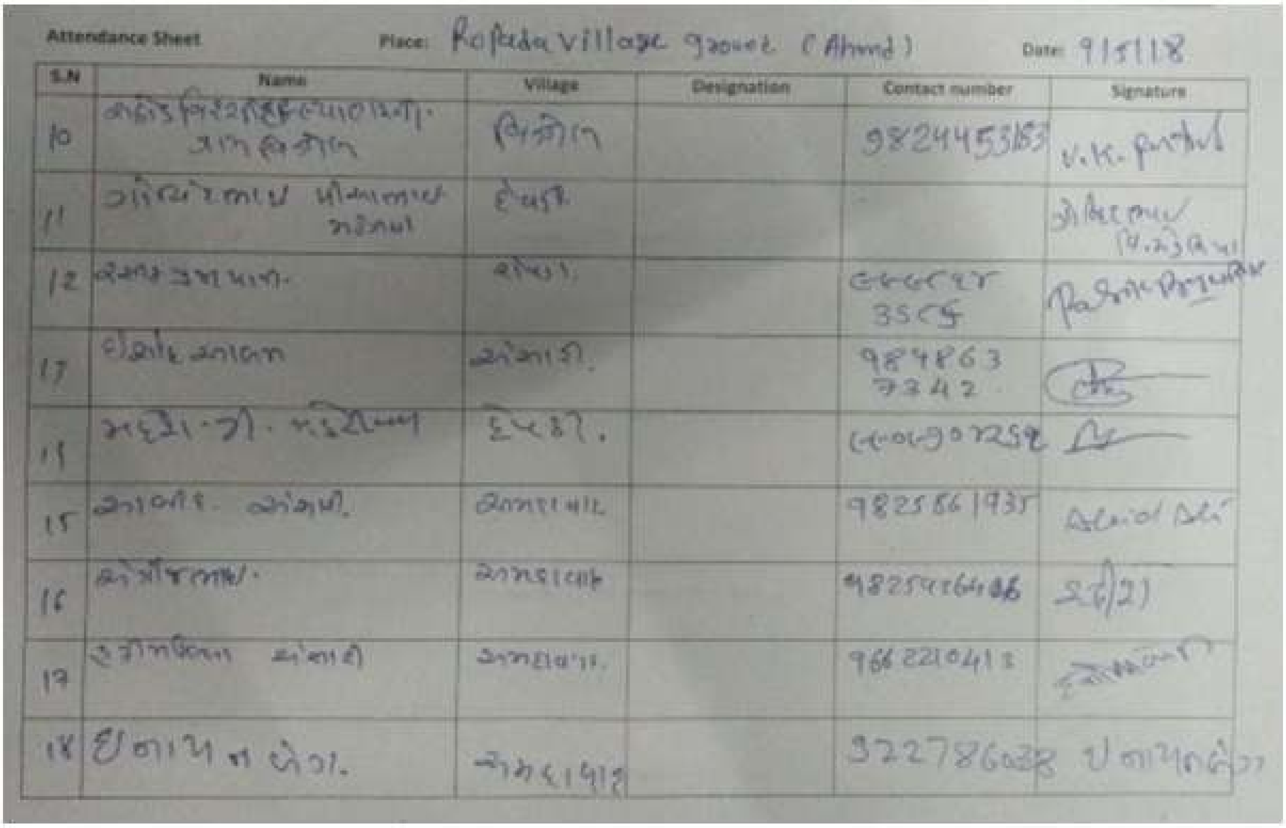
Annexure-A

Attendance Sheet



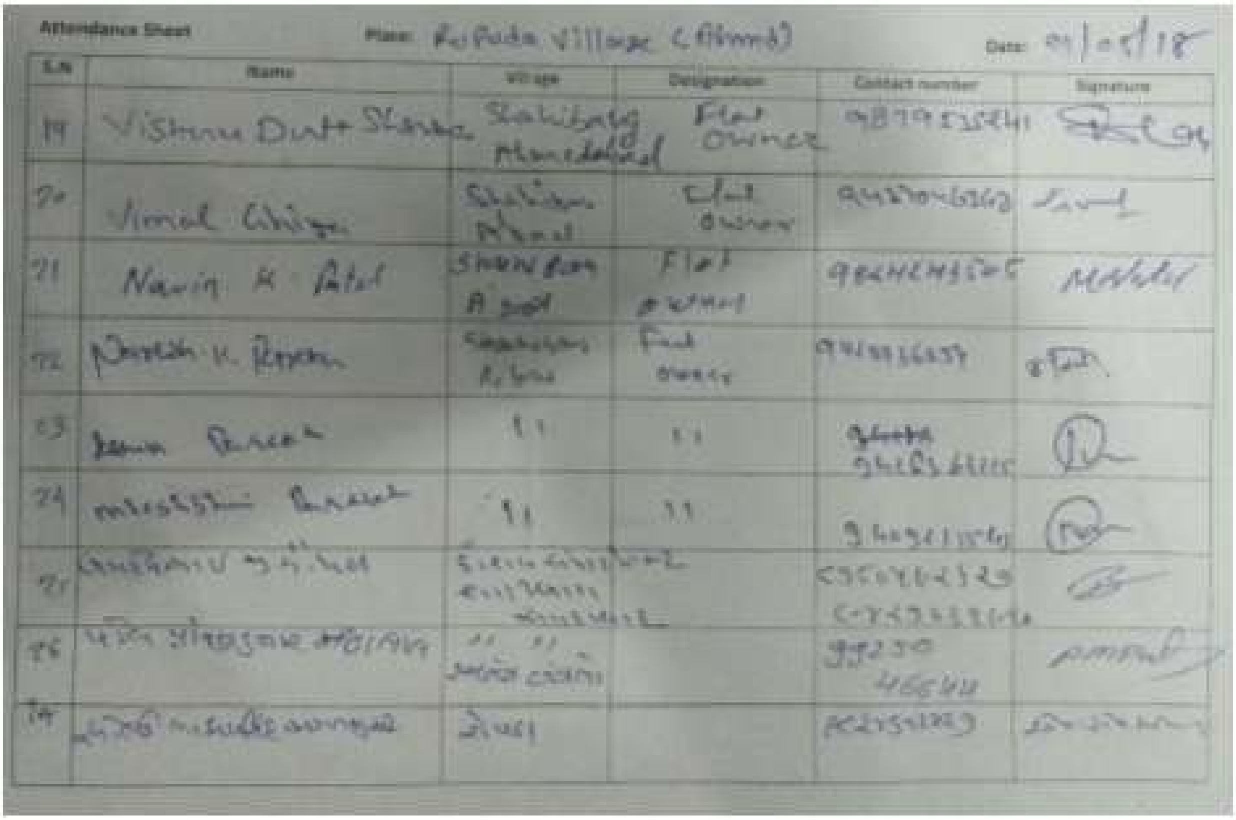
Attendance Sheet Place: Ropada Village Ground (Ahmd) Date: 9/05/2018

S.N	Name	Village	Designation	Contact number	Signature
01	Narendra Tarachand	Chandan Apartment Shahibaug Ahmedabad	Plot owner	9825063419	Narendra
02	Bhalabhai G. Bharvad	Vinzol Gam Amd	Plot owner	9825295671	[illegible]
03	Kanubhai B. Bharvad	Devdi Gam Amd	Plot owner	9824413355	[illegible]
04	Valand Mukeshkumar Somabhai	D/101 Ahmedabad	owner	94	[illegible]
05	[illegible] V. Bharvad	Devdi		9374274245	[illegible]
06	Zarinabanu S. Ansari	Ahmedabad	owner	9510919080	[illegible]
07	Budhaji Nathaji Thakor	Ropada		9824617692	[illegible]
08	[illegible]	[illegible]			[illegible]
09	[illegible]	[illegible]		9586607016	[illegible]



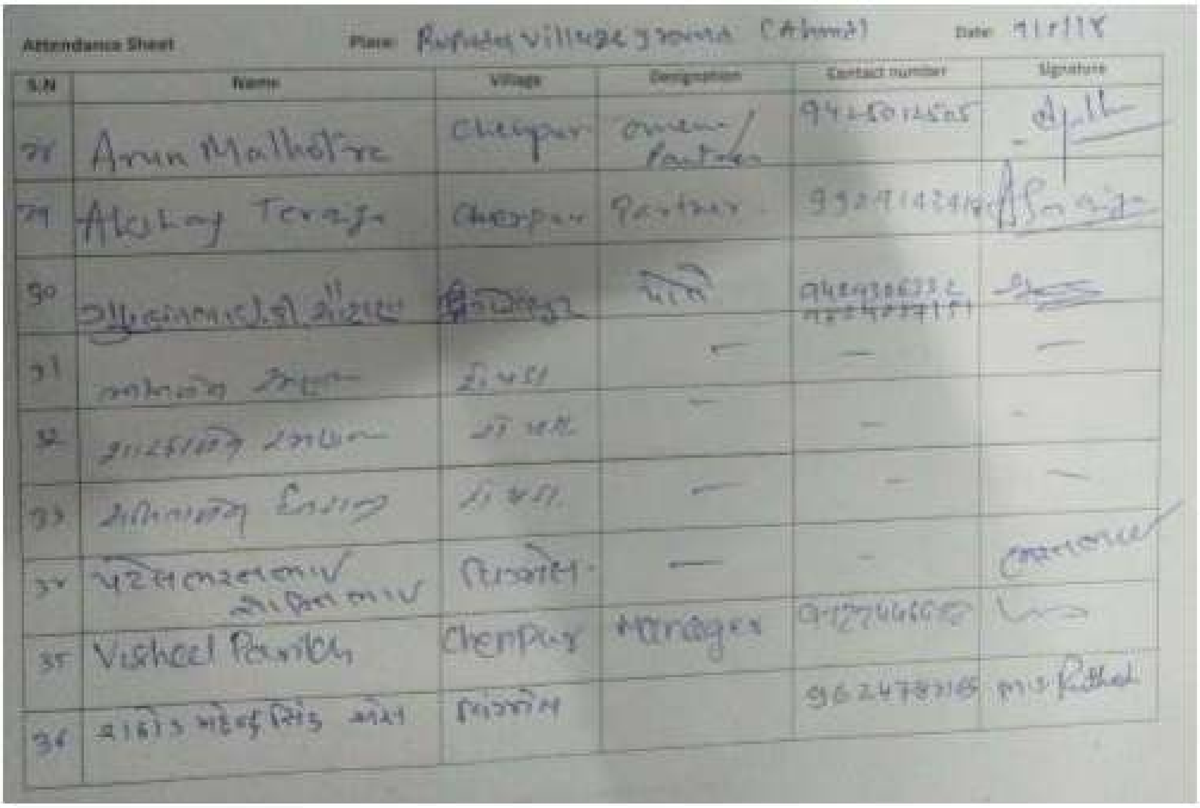
Attendance Sheet Place: Ropada village ground (Ahmd) Date: 9/5/18

S.N	Name	Village	Designation	Contact number	Signature
10	[illegible]	[illegible]		9824453183	V.K. Parmar
11	[illegible]	[illegible]			[illegible]
12	[illegible]	[illegible]		[illegible] 35C5	[illegible]
13	[illegible]	[illegible]		984863 7342	[illegible]
14	[illegible]	[illegible]		[illegible]	[illegible]
15	[illegible]	[illegible]		9825861935	[illegible]
16	[illegible]	[illegible]		9825426486	[illegible]
17	[illegible]	[illegible]		9662210413	[illegible]
18	[illegible]	[illegible]		3227860328	[illegible]



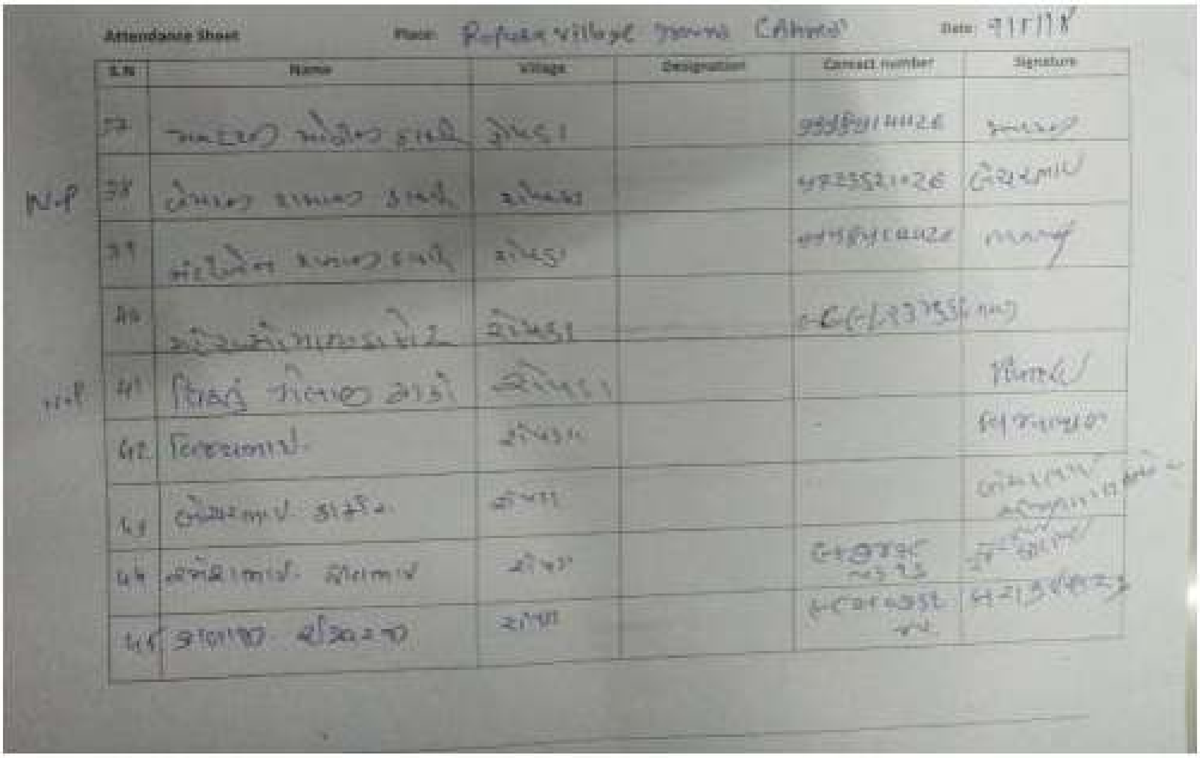
Attendance Sheet Place: Rupada Village (Ahmd) Date: 09/08/18

S.N	Name	Village	Designation	Contact number	Signature
19	Vishnu Dutt Sharma	Shahibaug Ahmedabad	Flat Owner	9879535841	[illegible]
20	Vimal Chhajer	Shahibaug Ahmd	Flat Owner	[illegible]	[illegible]
21	Navin K. Patel	Shahibaug Ahmd	Flat owner	[illegible]	[illegible]
22	[illegible]	Shahibaug Ahmd	Flat owner	[illegible]	[illegible]
23	[illegible]	"	"	[illegible]	[illegible]
24	[illegible]	"	"	[illegible]	[illegible]
25	[illegible]	[illegible]		[illegible]	[illegible]
26	[illegible]	" " [illegible]		99250 46644	[illegible]
27	[illegible]	[illegible]		[illegible]	[illegible]



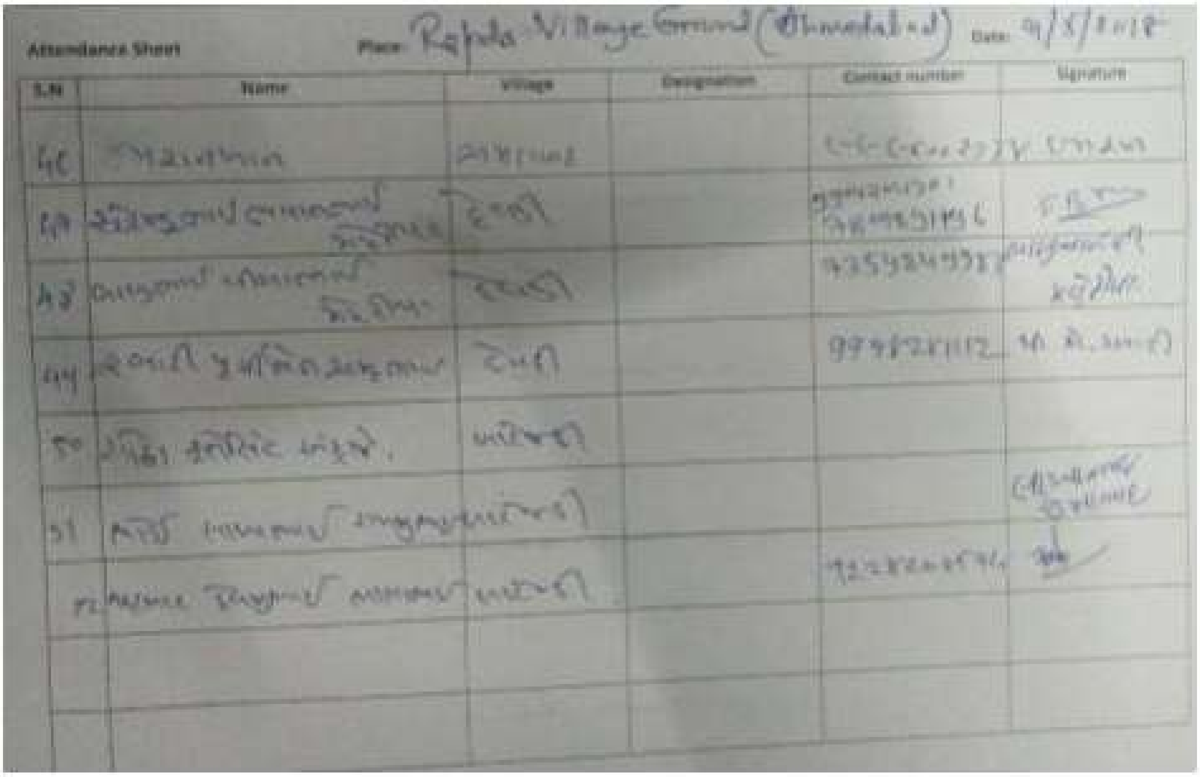
Attendance Sheet Place: Rupada village Gram (Ahmd) Date: 9/8/18

S.N	Name	Village	Designation	Contact number	Signature
28	Arun Malhotra	Chenpur	Owner/Partner	9425012505	[illegible]
29	Akshay Teraiya	Chenpur	Partner	[illegible]	[illegible]
30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
31	[illegible]	[illegible]	—	—	—
32	[illegible]	[illegible]	—	—	—
33	[illegible]	[illegible]	—	—	—
34	[illegible]	[illegible]	—	—	[illegible]
35	Vishal Parikh	Chenpur	Manager	[illegible]	[illegible]
36	[illegible]	[illegible]		9624783185	[illegible]



Attendance Sheet Place: Rajpura village ground (Ahmedabad) Date: 9/5/18

S.N	Name	Village	Designation	Contact number	Signature
37	[illegible]	[illegible]		9558914426	[illegible]
38	[illegible]	[illegible]		9723552026	[illegible]
39	[illegible]	[illegible]		[illegible]	[illegible]
40	[illegible]	[illegible]		[illegible]	
41	[illegible]	[illegible]			[illegible]
42	[illegible]	[illegible]		-	[illegible]
43	[illegible]	[illegible]			[illegible]
44	[illegible]	[illegible]		[illegible]	[illegible]
45	[illegible]	[illegible]		[illegible]	[illegible]



Attendance Sheet Place: Rajpura Village Ground (Ahmedabad) Date: 9/5/2018

S.N	Name	Village	Designation	Contact number	Signature
46	[illegible]	[illegible]		[illegible]	[illegible]
47	[illegible]	[illegible]		[illegible]	[illegible]
48	[illegible]	[illegible]		9359849937	[illegible]
49	[illegible]	[illegible]		9974924412	[illegible]
50	[illegible]	[illegible]			
51	[illegible]	[illegible]			[illegible]
52	[illegible]	[illegible]		[illegible]	[illegible]

Annexure-B

Brief Issues/concern raised during the Environment Information Disclosure & Public Consultation

AHMEDABAD

Ahmedabad (Gujarat)- 09/05/2018	○ How will farmers get the compensation?	Amount of compensation will be credited in the bank account of PAHs directly and compensation will be paid as per Jantri published in 2013.
	○ If our house is partly affected in this project, so what about compensation?	During the Joint Feasibility Study Stage, we conducted tentative survey and that time alignment was not fixed. But now we have exact alignment and after Joint Measurement Survey we have actual figure of all affected plots and their alignment. We will also build concrete pillars for RoW. If your house is partly affected, you will get full compensation.

Ahmedabad EPC pictures

Kheda

ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION PROCEEDING

It is hereby informed that environment information disclosure & public consultation at district level was organized in compliance to the JICA's Guidelines on Environmental and Social Consideration, April 2010 at District Kheda at Ambedkar Bhawan on 4th April 2018, 1100 hrs for the proposed Mumbai-Ahmedabad High Speed Railway Project (MAHSR) implemented by National High Speed Rail Corporation Limited (A Joint Venture of Government of India and Participating State Governments).

National High Speed Rail Corporation Limited (NHSRCL) intends to implement the first ever bullet train in India under the Mumbai Ahmedabad High Speed Railway Project (MAHSR).

A notification for Environmental Information Disclosure & Public Consultation was published in the daily newspaper Gujarat Samachar on 25-March-2018.

The public consultations were conducted after circulation of the executive summary of the Supplemental Environmental Impact Assessment (S-EIA) report in advance to the affected panchayat. During the public consultations, a detailed presentation was given on findings of S-EIA in local language, so that local public understand about the findings, such as project details, considered impact and its mitigation measures

A copy of the Summary of Draft S-EIA Report was also made available at District Collector Office, Kheda for inspection to the public during normal office hours till the public consultation is over.

Comments / views of concerned persons having plausible stake in the environmental aspects of the Project were heard during the consultation meeting and they were requested to send their response in writing to the concerned district collectorate.

Dr. Kuldeep Arya, IAS, District Collector of District: Kheda, supervised and presided over the entire Environmental Information Disclosure & Public Consultation process.

Following officials of District Administration and Project Authority were present in the Environmental Information Disclosure & Public Consultation meeting.

Officials of District Administration
DrKuldeep Arya, IAS, District Collector
Smt. R A Pandya, Dy. Collector and SDM, Kheda

Officials of NHSRCL
Mr. R S Rathore, DGM-EHS, HQ, New Delhi
Mr. Pankaj Uke, GM-Operations, CPM's office, Mumbai
Mr. P B Ghataliya, Dy. Collector (Retired)
Mr. Niraj Kumar Verma, CPM, Ahmedabad
Mr. SimanchalPadhy, Sr. Manager, Civil, Vadodara
Mr. Manjunath, Manager Vadodara

MrGhatiyal, Dy. Collector (Retired), NHSRCL welcomed the dignitaries followed by introductory session by Mr. SimanchalPadhy.

Dr D K Pandey, - National Environmental Expert, JICC supported by EIA Consultants M/s GPS Technologies Pvt. Ltd. gave the presentation highlighting project details and the key findings of the S-EIA study.

Upon completion of the presentation, District Collector, Kheda addressed the participants about the project and need of the public consultation and invited the participants to express their views, suggestions and issues related to environment, if any.

The list of the participants (attendance sheet) is attached as Annexure-A.

The issues raised by the participants during the Environmental Information Disclosure & Public Consultation along with the response of the NHSRCL is attached as Annexure-B (in English).

After the discussion session, District Collector, Kheda announced the closure of the Environmental Information Disclosure & Public Consultation.

Annexure-A

Attendance Sheet

ANNEXURE - A

ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION AT DISTRICT LEVEL ORGANIZED IN COMPLIANCE TO THE JICA'S GUIDELINES ON ENVIRONMENTAL AND SOCIAL CONSIDERATION APRIL 2010 AT DISTRICT KHEDA AT AMBEDKAR BHAWAN FROM 1100 HRS FOR THE PROPOSED MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT (MAHSR) IMPLEMENTED BY NATIONAL HIGH SPEED RAIL CORPORATION LIMITED (NHSRCL).

LIST OF PARTICIPANTS PRESENT DURING THE ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION HELD ON 04-APRIL-2018 AT AMBEDKAR BHAWAN, KHEDA.

Sr. No.	Name	Address & Mobile No.	Signature
1.	V. J. Prajapati	Dayadra Taloti - 9624688146	
2.	Hasmukhbhai R Parmar	Dejam - 7600717399	
3.	R. B. Patel	Bhavani - 9265400519	
4.	JIGNESH SOLANKI	ARCADIS	
5.	C. S. SOLANKI	ARCADIS	
6.	P. D. KHATOLIYA	D.J. COLL.	
7.	NILESH VASHI	SURAT / 99365889 11	
8.	D. K. GOHSAR	ARCADIS ANAND / 98845 [illegible]	
9.	R. M. AMIN	ARCADIS NADIAD / [illegible]	
10.	LALJIBHAI JADAV	KANIJ /	
11.	ALTIBHAI K JADAV	KANIJ / 9723346 1226	
12.	ROHIT PRAJAPATI	VADODARA 9408986452 Paryavaran Suraksha Samiti	
13.	JAYESH PATEL	SURAT, Khedut Samaj Gujarat	
14.	RAJESHBHAI PATEL	BHUMEL / 9723677469	
15.	ARVINDBHAI PATEL	BHUMEL / 9624 534263	
16.	SUBHASHBHAI PATEL	DAVDA / 9725111 800	
17.	SURESHBHAI J PATEL	UTTARSANDA / 9662978950	
18.	RAVJIBHAI J PARMAR	UTTARSANDA / 9924410482	
19.	Vibha Singh	Delhi / GPS / 9810694396	
20.	Deepak Juneja	Delhi / GPS / 9910948112	
21.	Vishal Shrivastava	Delhi / GPS / 9997794495	
22.	Akshay Tripathi	Delhi / GPS / 7836[illegible]	
23.	Shashank Sharma	Delhi / GPS / 99114[illegible]	

Sr. No.	Name	Address & Mobile No.	Signature
24.	NITINBHAI J. PATEL	KATAKPURA / 9979655166	[illegible]
25.	PATEL RAJKAMAL D.	KATAKPURA / 99245 12330	[illegible]
26.	KIRITBHAI C. PATEL	UTTARSANDA / 9898870235	[illegible]
27.	NIRMALBHAI M. PATEL	KATAKPURA / 9879329918	[illegible]
28.	AMRUTBHAI PATEL	KATAKPURA / 9727585735	[illegible]
29.	RAMANBHAI A. BHOI	CHAKLASHI / 9284806290	[illegible]
30.	DILIPBHAI A. PATEL	KANIJ / 9913048081	[illegible]
31.	HARSHADBHAI M. SOLANKI	ZAROL / 9728729752	[illegible]
32.	BHAILALBHAI PATEL	BHUMEL / 9574783073	[illegible]
33.	PATEL KAMLESH. C.	DUMRAL / 9537049977	K. C. Patel
34.	RAVJIBHAI M. PATEL	PIPLAG / 9558197922	[illegible]
35.	SHIVABHAI J. JADAV	CHAKLASHI / 7202012750	[illegible]
36.	KAMLESHBHAI F. PATEL	UTTARSANDA / 9662369062	K. F. Patel
37.	VAJESINGH F. CHAUHAN	BANARA / 7622895016	[illegible]
38.	Ajitsinh m [illegible]	[illegible] 8140225661	[illegible]
39.	Vikrambhai S.		[illegible]
40.	Ranjitsinh S.		[illegible]
41.	Karanbhai		[illegible]
42.	Narshibhai	Degam 9726656761	[illegible]
43.	BHUMEL	HASMUKH PATEL	[illegible]
44.	[illegible]	[illegible]	[illegible]
45.	[illegible]	B. R. P	[illegible]
46.	Mukeshbhai m. patel	Gothaj Ta mahemdavad kheda	Mukesh
47.	patel parsottamdas	Gothaj " "	[illegible]
48.	[illegible]	[illegible] " "	[illegible]
49.	[illegible]	[illegible] [illegible]	[illegible]
50.	[illegible]	Gothaj 9904958814 [illegible] 9904958814	[illegible]
51.			
51.	Chirag R. Vyas	Degam. [illegible] 9423148711	C. Vyas
52.			
53.			

Sr. No.	Name	Address & Mobile No.	Signature
52.	PRASHANT D. PATEL	UTTARSANDA /	[illegible]
53.	(F) SEJAL D. PATEL	UTTARSANDA	S.P. Patel.
54.	INDUBHAI P. PATEL	UTTARSANDA / 98254 82856	I.P. Patel
55.	ARJUN S. CHAUHAN		[illegible]
56.	RATILAL D. PARMAR	DAVDA · SARPANCH / 9913000258	[illegible]
57.	NAYAN M. VAGHELA	UTTARSANDA / 9924670640	N.M. Vaghela
58.	RAMANBHAI C. PARMAR	UTTARSANDA / 9601186373	[illegible]
59.	PARESH. P. PATEL	BHUMEL / 9825720184	[illegible]
60.	ANILKUMAR R. PATEL	BHUMEL / 9904885346	[illegible]
61.	RASHIKBHAI. R. PATEL	BHUMEL / 9727129403	[illegible]
62.	PINAKINBHAI R. PATEL	PIPLAG / 9825553252	P.R. Patel
63.	NIRAV P. PATEL	" "	N.P. Patel
64.	ALPESH P. SUTHAR	BHUMEL / 9727720548	[illegible]
65.	JIVAR G. PATEL	BHUMEL / 9824364526	J.G. Patel
66.	PRAVINBHAI K. PATEL	UTTARSANDA / 9825814409	[illegible]
67.	MEHUL P. PATEL	" 9824452946	M.P. Patel
68.	BHARATBHAI P. PATEL	KANIJ / 9924451753	P.B.P
69.	J. B. RATHOD.	VADTALA / 9879800414	[illegible]
70.	MAYUR S. PATEL	UTTARSANDA / 7779937504	M.S. Patel
71.	N. J. PATEL	DEKAM / 9824033398	[illegible]
72.	NITIN HATHIVALA	VIROL / 9727471242	[illegible]
73.	ALPESHBHAI R. PATEL	DUMRAL / 9723466137	[illegible]
74.	PUNAMBHAI D. PARMAR	DAVDA / 9624229430	[illegible]
75.	RAVJBHAI M. PARMAR	" / 8140954343.	[illegible]
76.	S. B. RABARI	BHUMEL, TALATI / 9173159210	[illegible]
77.	M. I VOHRA	KUTAL, " / 8140924965	[illegible]
78.	M. S. PATEL	UTTARSAND / 9898192757	M.S. Patel
79.	HARIKRUSHNA. D. PATEL	DEKAM / 9723698192	[illegible]
80.	HIREN J. PATEL	BHUMEL / 9566096754	[illegible]
81.	VISHNUBHAI. K. JADAV	CHAKLASHI / 9556563524	V.K. Jadav
82.	RAMABHAI · U. JADAV	CHAKLASHI / 9601894537	R.U. [illegible]

	Sr. No.	Name	Address & Mobile No.	Signature
83	1	[illegible]	[illegible]	[illegible]
84	1	[illegible]	[illegible]	R.M. [illegible]
85	1	[illegible]	[illegible]	[illegible]
86	1	[illegible]	[illegible]	[illegible]
87	1	[illegible]	[illegible] 9879917703	[illegible]
88	1	[illegible]	[illegible]	[illegible]
89	1	[illegible]	[illegible]	[illegible]
90	1	[illegible]	[illegible]	A.K. [illegible]
91	1	[illegible]	[illegible]	B.R. Chauhan
92	[illegible]	[illegible]	[illegible]	
93	[illegible]	[illegible]	[illegible] 9998281686	[illegible]
94	[illegible]	[illegible]	[illegible] 9925790432	[illegible]
95	[illegible]	[illegible]	[illegible]	[illegible]
96		[illegible]		
97	[illegible]	[illegible]	[illegible]	[illegible]
98	[illegible]	[illegible]	[illegible]	[illegible]
99	[illegible]	[illegible]	[illegible]	[illegible]
100	[illegible]	[illegible]	[illegible] 9924378442	[illegible]
101	[illegible]	[illegible]	[illegible] 9714021623	[illegible]
102	[illegible]	[illegible]	[illegible]	[illegible]
103	[illegible]	[illegible]	[illegible]	[illegible]
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110	[illegible]	[illegible]	[illegible]	

S

Sr. No.	Name	Address & Mobile No.	Signature
111.	KRISHNAKANT.	SURAT PSS. / 9426608007	[illegible]
112.	CHANDUBHAI PATEL	BHUMEL / 9427852035	Cmp.
113.	CHANUBHA R. JADAV	CHAKLASHI / 9624211207.	C.R.-[illegible]
114.	ARVINDBHAI JADAV	CHAKLASHI / 9925918635	A.O.[illegible]

Annexure-B

Brief Issues/concern raised during the Environment Information Disclosure & Public Consultation

Kheda EPC

Kheda (Gujarat)- 04/04/2018	○ Impact on ground water due to pier foundation.	Geo-hydrological study has been conducted at each pier location and the foundation has been suitably designed to avoid any impact on the ground water aquifer. During construction of piers, care will be taken to ensure that groundwater quality is not adversely impacted
	○ How Domestic animals (cow, goat, buffalo *etc*.) will cross the farm fields after construction of the alignment.	Since the maintenance road planned along the alignment will not be fenced near the villages / habitation, it will allow free movement of people and livestock across the alignment.
	○ What is the Methodology used in the EIA study, what kind of experts are undertaking this study, EIA is planned according to which international/ treaty law.	Standard Methodology and Terms of Reference (ToR) of MoEFCC and JICA are followed in the S-EIA Study. Environmental experts certified by NABET have been engaged in the study. Governmental / Semi-governmental Institutions of repute such as Zoological Survey of India (ZSI), National Institute of Oceanography (NIO) and Mangrove Society of India (MSI) are also part of the study team.
	○ Was the EIA study carried out according to Himachal Pradesh High Court order of 2012?	The Study is being conducted as per JICA's Guidelines for Environmental and Social Considerations issued in April 2010.
	○ Is there any office at village level where local can submit their inputs regarding the Environment impact of the MAHSR Project?	Stakeholders may submit their written environmental concerns to the respective Chief Project Managers of NHSRCL (Ahmedabad, Vadodara, Thane/Palghar and Mumbai) or the main office of NHSRCL in Dwarka, New Delhi. The Environmental PCs are being conducted to seek suggestions and inputs from the local stakeholders at District Level. The comments/ suggestions received and issues raised have been duly addressed in the S-EIA Report which shall be uploaded on the NHSRCL website for public information.

		Suggestions / comments received after uploading the S-EIA Report, will also be reviewed and relevant suggestions shall be incorporated in the S-EIA Report as the EIA is a continuous process and shall be updated, as required.
	○ TOR of MoEFCC for this study?	The MAHSR Project (Railway sector projects being exempt) does not attract the provisions under EIA Notification, 2006 for a Prior EC and Public Hearing. The Study is being conducted as per JICA's Guidelines for Environmental and Social Considerations issued in April 2010.
	○ Was sensitization at local level was done, if not then, why?	During the Feasibility Study Stage the stakeholders meeting (SHM) was conducted at District level and locals were made aware of the project and EIA components. During 2017-18, various ground level teams of NHSRCL have been meeting villagers and local stakeholders and discussing various issues related to MAHSR project
	○ If the project is exempted from the EC, then why is money spent on the public consultation for EIA.	The MAHSR Project (Railway sector projects being exempt) does not attract the provisions under EIA Notification, 2006 for a Prior EC and Public Hearing. The Study is being conducted as per JICA's Guidelines for Environmental and Social Considerations issued in April 2010.
	○ How is loss of agricultural land compensated?	It is an irreversible impact and the loss of land is being compensated in terms of monetary value. This aspect has been addressed in the SIA and RAP report of the MAHSR project.
	○ How is the food for domestic and wild animal grown on the RoW of proposed alignment compensated? Has there been any study done on the subject?	The Land Acquisition Plan (LAP) indicates that there is no loss of grazing land along the proposed alignment of the MAHSR. However, it is expected that the grass carpeting (landscaping) on the shoulder of the maintenance road would act as grazing land for the livestock.


2018-4-4 11:29

Anand

ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION PROCEEDING

It is hereby informed that environment information disclosure & public consultation at district level was organized in compliance to the JICA's Guidelines on Environmental and Social Consideration, April 2010 at District Anand at Town Hall, Anand on 30th April 2018, 1000 hrs for the proposed Mumbai-Ahmedabad High Speed Railway Project (MAHSR) implemented by National High Speed Rail Corporation Limited (A Joint Venture of Government of India and Participating State Governments).

National High Speed Rail Corporation Limited (NHSRCL) intends to implement the first ever bullet train in India under the Mumbai-Ahmedabad High Speed Railway Project (MAHSR).

A notification for Environmental Information Disclosure & Public Consultation was published in the daily news paper Gujarat Samachar on 27-April-2018.

The public consultations were conducted after circulation of the executive summary of the Supplemental Environmental Impact Assessment (S-EIA) report in advance to the affected panchayat. During the public consultations, a detailed presentation was given on findings of S-EIA in local language, so that local public understand about the findings, such as project details, considered impact and its mitigation measures

A copy of the Summary of Draft S-EIA Report was also made available at District Collector Office, Anand for inspection to the public during normal office hours till the public consultation is over.

Comments / views of concerned persons having plausible stake in the environmental aspects of the Project were heard during the consultation meeting and they were requested to send their response in writing to the concerned district collectorate.

Shri Dilip Kumar Rana, IAS, District Collector, Anand supervised and presided over the entire Environmental Information Disclosure & Public Consultation proceeding.

Following officials of District Administration and Project Authority were present in the Environmental Information Disclosure & Public Consultation meeting.

Officials of District Administration
Shri Dilip Kumar Rana, IAS, District Collector, Anand
Smt. K S Patel, GAS, Dy. Collector (LR), Anand
Sh. A H Gadhvai, DCF, Anand
Sh. M MRajyaguru, ACF, Anand

Officials of NHSRCL
Sh. Pradeep Ahirkar, CPM, Vadodara
Sh. P B Ghataliya, Retired Dy. Collector, Vadodara
Sh. R. H. Upadhyay, Retired Dy. Collector, Vadodara
Sh. SimanchalPadhy, Senior Manager (Constn. /Civil), Vadodara,
Sh. Gaurav Srivastava, Manager (Civil), Vadodara
Sh. Vivek Joshi, DC, Vadodara
Sh. MuditRediwal, Sr.Exe. Engg., Vadodara

Sh. Ghataliya, Dy. Collector (Retired), NHSRCL welcomed the dignitaries followed by introductory session by Sh. SimanchalPadhy.

Sh. Pritesh Patel, representative of M/s GPS Technologies Pvt. Ltd. gave the presentation highlighting project details and the key findings of the S-EIA study.

Upon completion of the presentation, Shri Dilip Kumar Rana, IAS, District Collector, Anand addressed the participants about the project and need of the public consultation and invited the participants to express their views, suggestions and issues related to environment, if any.

The list of the participants (attendance sheet) is attached as Annexure-A.

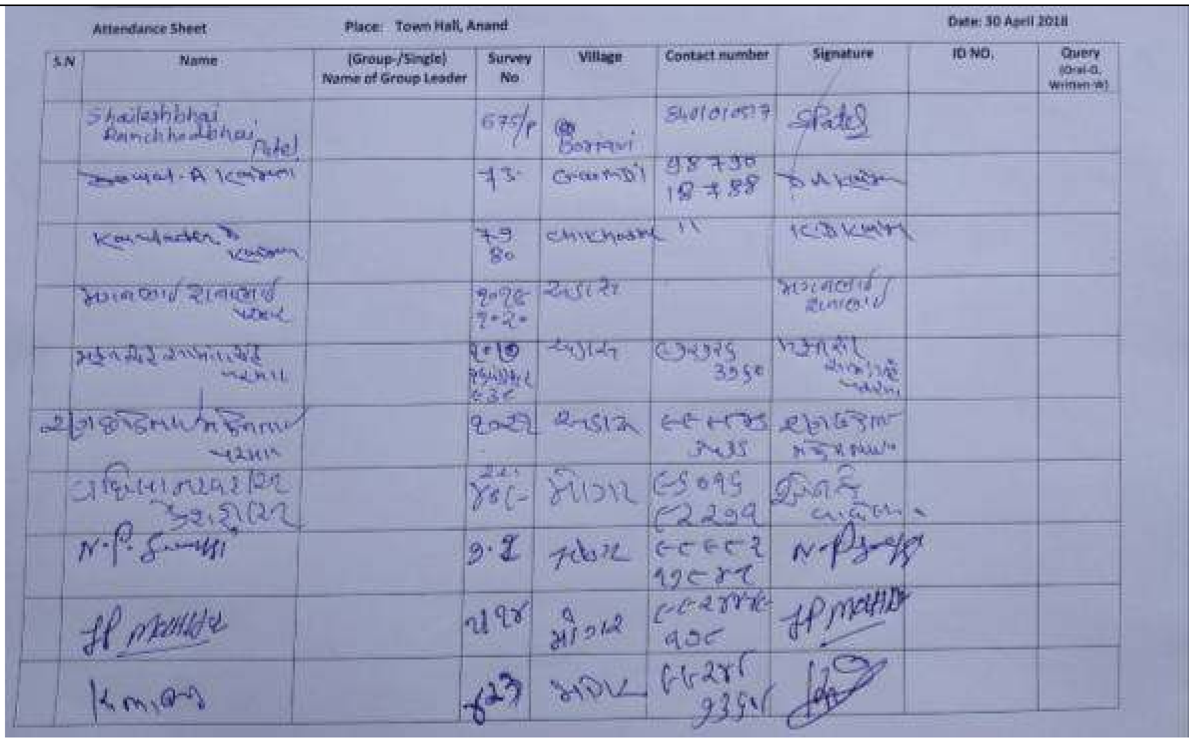
The issues raised by the participants during the Environmental Information Disclosure & Public Consultation along with the response of the NHSRCL is attached as Annexure-B (in English).

After the discussion session, Shri Dilip Kumar Rana, IAS, District Collector, Anand announced the closure of the Environmental Information Disclosure & Public Consultation.

DC informed that the written response to the issues raised by the public shall be communicated by the Office of the District Collector, Anand.

Annexure-A

Attendance Sheet



Attendance Sheet Place: Town Hall, Anand Date: 30 April 2018

S.N	Name	(Group-/Single) Name of Group Leader	Survey No	Village	Contact number	Signature	ID NO.	Query (Oral-O, Written-W)
	Shaileshbhai Ranchhodbhai Patel		675/P	Borsavi	8401010517	SPatel		
	[illegible]		73	Gamdi	98730 18788	[illegible]		
	Kantaben [illegible]		79 80	Chikhodra	"	[illegible]		
	[illegible]		[illegible]	[illegible]		[illegible]		
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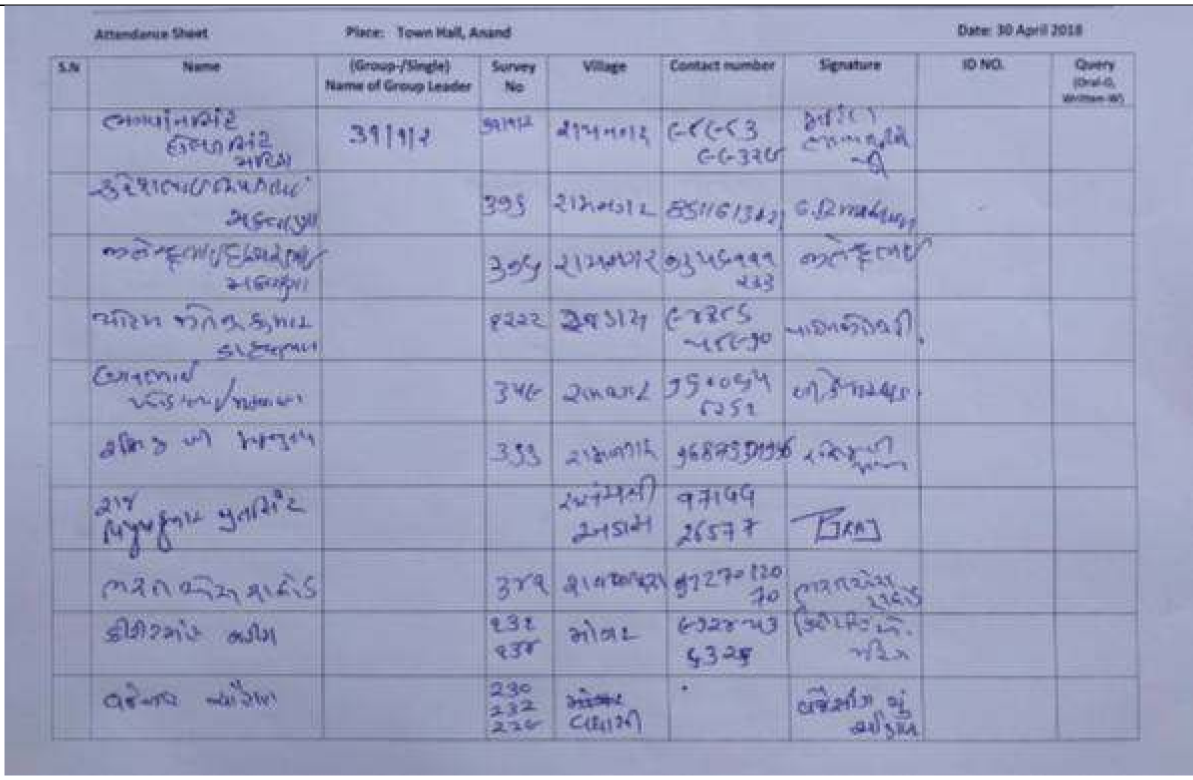
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
	N.P. [illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
	H Mahida		[illegible]	[illegible]	[illegible]	H Mahida		
	K.m.[illegible]		623	[illegible]	[illegible]	[illegible]		



Attendance Sheet Place: Town Hall, Anand Date: 30 April 2018

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	[illegible]		393	[illegible]	85116134[illegible]	C.R.mahida		
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]		346	[illegible]	[illegible]	[illegible]		
	[illegible]		353	[illegible]	96873[illegible]	[illegible]		
	[illegible]			[illegible]	97199 26577	[illegible]		
	[illegible]		379	[illegible]	[illegible]	[illegible]		
	[illegible]		231 237	[illegible]	[illegible] 6328	[illegible]		
	[illegible]		230 232 226	[illegible]	.	[illegible]		

Attendance Sheet   Place: Town Hall, Anand   Date: 30 April 2018

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	[illegible]		[illegible]	[illegible]	66439 [illegible]	S.S. Patel		
	[illegible]		〃	[illegible]	[illegible]	N.R. Patel		
	[illegible]		〃	[illegible]	820084 2207	[illegible]		
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Attendance Sheet   Place: Town Hall, Anand   Date: 30 April 2018

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	Ramanbhai Mohanbhai Patel	Single	442	Samarkha	9726579720	[illegible]		
	[illegible]		[illegible]	[illegible]	9537802437 [illegible]	P.R. Patel		
	Sanjesh Raojibhai Brahmbhatt			Adas	9375039770	[illegible]		
	[illegible]		237/2 238/3	[illegible]	9601713327	H.S. [illegible]		
	[illegible]		[illegible]	[illegible]	9428648425	A.A. Patel		
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
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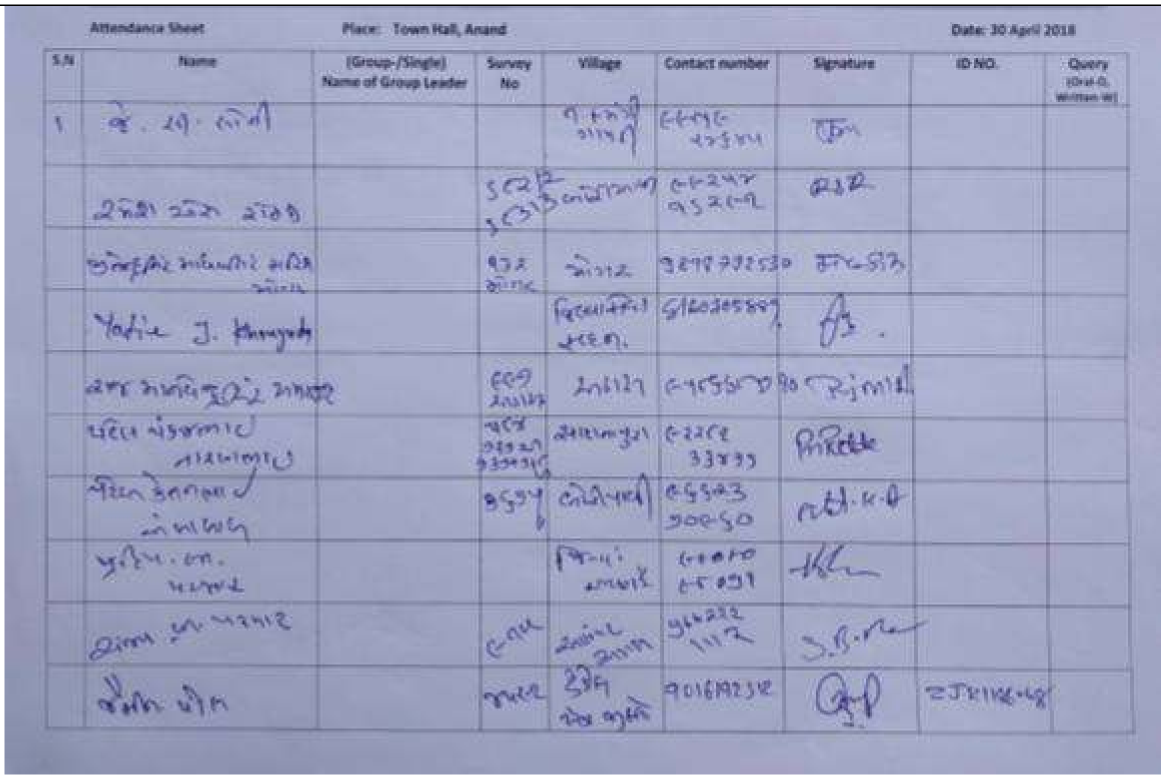

Attendance Sheet   Place: Town Hall, Anand   Date: 30 April 2018

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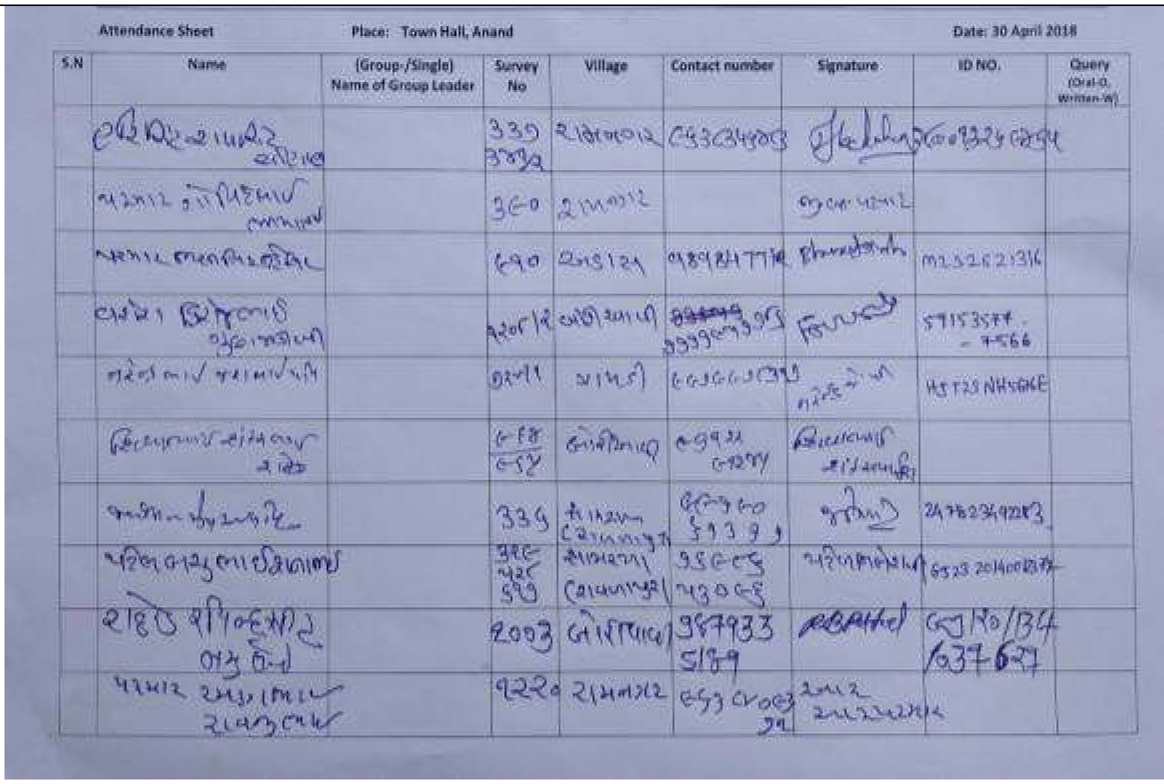

Attendance Sheet   Place: Town Hall, Anand   Date: 30 April 2018

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Attendance Sheet Place: Town Hall, Anand Date: 30 April 2018

S.N	Name	(Group-/Single) Name of Group Leader	Survey No	Village	Contact number	Signature	ID NO.	Query (Oral-O, Written-W)
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	M.L. Rabari			Supdt Engg. MGVCL Anand	9925208330	MLR		
	N H Rathod			EE(T) MGVCL Anand	9925208[illegible]	NR		
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
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	Dipak Bhatt			[illegible]	[illegible]	[illegible]		
	Mehul R. Patel.		565	Anand	9825[illegible]	[illegible]		
	S. B. Patel.		566	"	9825[illegible]	S.B. Patel		

Attendance Sheet Place: Town Hall, Anand Date: 30 April 2018

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Attendance Sheet Place: Town Hall, Anand Date: 30 April 2018

S.N	Name	(Group-/Single) Name of Group Leader	Survey No	Village	Contact number	Signature	ID NO.	Query (Oral-O, Written-W)
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	Vinod Trivedi Rakesh Patel		Mogar	Satyendra Packaging	96872 58858	[illegible]		
	Sulochanaben Vitthalbhai Patel / Balvantbhai Vitthalbhai		504/1	Gurandi	972588 2337	[illegible]		
	[illegible] C. Vora		131	Mogar	99898 73011	[illegible]		
	[illegible]		[illegible]	[illegible]	[illegible]			
	—	—	—	[illegible]	—	[illegible]		
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Attendance Sheet Place: Town Hall, Anand Date: 30 April 2018

S.N	Name	(Group-/Single) Name of Group Leader	Survey No	Village	Contact number	Signature	ID NO.	Query (Oral-O, Written-W)
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	[illegible]	[illegible]	[illegible]	[illegible]	9428469348			
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	R.B. [illegible]		
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]		[illegible]	78749 37136	[illegible]		
	[illegible]	[illegible]		[illegible]	98777 44764	[illegible]		

Attendance Sheet Place: Town Hall, Anand Date: 30 April 2018

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	Sami I. Patel	Vasad.	234/4	Vasad	9825239617	[illegible]	6723144 91423003	
	Dharmistha T. Patel			Vasad gurpanch	9816029944			
	Arvindbhai Govardhanbhai Patel	Gandi	50/1 55/2 55/3	Gandi	7405107155 9428648449	[illegible]		
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Attendance Sheet Place: Town Hall, Anand Date: 30 April 2018

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	~~[illegible]~~		453					
	[illegible] (DPDA, [illegible])				9909094348	Y.M.Patel		
	J.F. Patel		424	[illegible]		J.F. Patel		
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	Dr. B. G. Shah.	Civil Surgeon Petlad, Representative		Petlad	98255 99197	[illegible]	91106932 5500	

Attendance Sheet Place: Town Hall, Anand Date: 30 April 2018

S.N	Name	(Group-/Single) Name of Group Leader	Survey No	Village	Contact number	Signature	ID NO.	Query (Oral-O, Written-W)
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2	Sanjay [illegible] Patel [illegible] Boriyavi		[illegible]	Boriyavi	[illegible] 9924[illegible]	[illegible]	6812	
3	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
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4	[illegible]		29	[illegible]	982[illegible]	[illegible]	[illegible]	
	[illegible]		53	[illegible]	98253[illegible]	[illegible]	ARD[illegible]	
	[illegible]		33	"	98243 [illegible]92	[illegible]		
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	[illegible]		2234	[illegible]	831115[illegible]	[illegible]		
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Attendance Sheet Place: Town Hall, Anand Date: 30 April 2018

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	[illegible] B. Trivedi		677	BORIAVI	99790 55978	[illegible]		
	[illegible] J. [illegible]		[illegible]	BORIYAVI	[illegible]	[illegible]		
	[illegible] R. [illegible]		965	Boriyavi	99765 51768	[illegible]		
	[illegible]		[illegible] 33	[illegible]	[illegible]	[illegible] Patel		
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]		[illegible]	[illegible]	[illegible] 03542	[illegible]		
	[illegible]		282	[illegible]	98250 39977	[illegible]		
	[illegible]	M.G.V.C.L		[illegible]	992520 8345	[illegible]		
	[illegible]		532 533	[illegible]	99139 [illegible]	[illegible]		

Attendance Sheet Place: Town Hall, Anand Date: 30 April 2018

S.N	Name	(Group-/Single) Name of Group Leader	Survey No	Village	Contact number	Signature	ID NO.	Query (Oral-O, Written-W)
	[illegible]		[illegible]	[illegible]	97268 58965	[illegible]		
	[illegible]		[illegible]	[illegible]	97251 85784	K.L.P.		
	[illegible]		932	[illegible]	97238 24658	KSR		
	[illegible]		432	[illegible]	99798 09902.	[illegible]		
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]		[illegible]	[illegible]		[illegible]		
	[illegible]		245	[illegible]	[illegible]	[illegible]		
	[illegible]		245	[illegible]	[illegible]	[illegible]		
	[illegible]		[illegible]	[illegible]	[illegible] 35080	[illegible]		

Attendance Sheet Place: Town Hall, Anand Date: 30 April 2018

S.N	Name	(Group-/Single) Name of Group Leader	Survey No	Village	Contact number	Signature	ID NO.	Query (Oral-O, Written-W)
	Tanmay Acharya	Arcadis Vadodara CC.R]	—	—	—	Achar		
	Patel Ravi A	Arcadis Vadodara (CCR)	–	-	–	Ravi		
	Rammanikbhai Amin	Arcadis nadiad	-	-	94263 16069	[illegible]		
	Dr. [illegible]	" — [illegible]	–		99245 92906	[illegible]		
	[illegible]		[illegible]	[illegible]	99094 13230	[illegible]		
	[illegible]		[illegible]	[illegible]	99093 00807	[illegible]		
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]		633	[illegible]	[illegible] 93470	[illegible]		
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]		-	9825754256	[illegible]		

Attandance Sheet　　Place: Town Hall, Anand　　Date: 30 April 2018

S.N	Name	(Group-/Single) Name of Group Leader	Survey No	Village	Contact number	Signature	ID NO.	Query (Oral-O, Written-W)
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		

Annexure-B

Brief Issues/concern raised during the Environment Information Disclosure & Public Consultation

Anand (Gujarat)-30/04/2018	o NHSRCL should provide full time job to one family member for all project affected household (PAH).	NHSRCL will carry out local recruitment as per Rules & Regulations of the Railways. However, the preference shall be given to persons from project affected households (PAHs).
	o Will there be any NoC required to be obtained for construction of pipeline crossing the MAHSR RoW after commissioning?	NHSRCL will be acquiring land only for the 17.5m RoW. However, there is no such rule against the provision of immediate structure after the RoW. The bye-laws of the local municipal authority shall be applicable.
	o Can farmers use the road developed?	Yes. The villagers can use the maintenance road to be constructed along the viaduct alignment.

Anand EPC pictures

	
	

Vadodara

ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION PROCEEDING

It is hereby informed that environment information disclosure & public consultation at district level was organized in compliance to the JICA's Guidelines on Environmental and Social Consideration, April 2010 at District Vadodara at Dr. B R Ambedkar Bhawan, Vadodara on 30th April 2018, 1700 hrs for the proposed Mumbai-Ahmedabad High Speed Railway Project (MAHSR) implemented by National High Speed Rail Corporation Limited (A Joint Venture of Government of India and Participating State Governments).

National High Speed Rail Corporation Limited (NHSRCL) intends to implement the first ever bullet train in India under the Mumbai-Ahmedabad High Speed Railway Project (MAHSR).

A notification for Environmental Information Disclosure & Public Consultation was published in the daily news paper Gujarat Samachar on 26-April-2018.

The public consultations were conducted after circulation of the executive summary of the Supplemental Environmental Impact Assessment (S-EIA) report in advance to the affected panchayat. During the public consultations, a detailed presentation was given on findings of S-EIA in local language, so that local public understand about the findings, such as project details, considered impact and its mitigation measures

A copy of the Summary of Draft S-EIA Report was also made available at District Collector Office, Vadodara for inspection to the public during normal office hours till the public consultation is over.

Comments / views of concerned persons having plausible stake in the environmental aspects of the Project were heard during the consultation meeting and they were requested to send their response in writing to the concerned district collectorate.

Shri M. D. Chudasama, GAS, Prant Officer (SDM), Vadodara supervised and presided over the entire Environmental Information Disclosure & Public Consultation proceeding.

Following officials of District Administration and Project Authority were present in the Environmental Information Disclosure & Public Consultation meeting.

Officials of District Administration
Shri M. D. Chudasama, GAS, Prant Officer (SDM), Vadodara

Officials of NHSRCL
Sh. Pradeep Ahirkar, CPM, Vadodara
Sh P B Ghataliya, Retired Dy. Collector, Vadodara
Sh. R. H. Upadhyay, Retired Dy. Collector, Vadodara
Sh.SimanchalPadhy, Senior Manager (Constn./Civil), Vadodara,
Sh.Gaurav Srivastava, Manager (Civil), Vadodara
Sh. Vivek Joshi, DC, Vadodara

Sh. Ghataliya, Dy. Collector (Retired), NHSRCL welcomed the dignitaries followed by introductory session by Sh. SimanchalPadhy.

Sh. Pritesh Patel, representative of M/s GPS Technologies Pvt. Ltd. gave the presentation highlighting project details and the key findings of the S-EIA study.

Upon completion of the presentation, SDM, Vadodara addressed the participants about the project and need of the public consultation and invited the participants to express their views, suggestions and issues related to environment, if any.

The list of the participants (attendance sheet) is attached as Annexure-A.

The issues raised by the participants during the Environmental Information Disclosure & Public Consultation along with the response of the NHSRCL is attached as Annexure-B (in English).

After the discussion session, SDM, Vadodara announced the closure of the Environmental Information Disclosure & Public Consultation.

SDM informed that the written response to the issues raised by the public shall be communicated by the Office of the District Collector, Vadodara.

Annexure-A

Attendance Sheet

ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION AT DISTRICT LEVEL ORGANIZED IN COMPLIANCE TO THE JICA'S GUIDELINES ON ENVIRONMENTAL AND SOCIAL CONSIDERATION, APRIL 2010 AT DISTRICT VADODARA IN THE DR. AMBEDKAR BHAWAN ON 30-APRIL-2018 FROM 1700 HRS FOR THE PROPOSED MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT (MAHSR) IMPLEMENTED BY NATIONAL HIGH SPEED RAIL CORPORATION LIMITED (NHSRCL).

LIST OF PARTICIPANTS PRESENT DURING THE ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION HELD ON 30-APRIL-2018 AT DR. AMBEDKAR BHAWAN, VADODARA.

OFFICIALS OF DISTRICT ADMINISTRATION, NHSRCL

Sr. No.	Name	Address & Mobile No.	Signature
૧	[illegible]	[illegible] [illegible]	[illegible]
2	[illegible]	[illegible] [illegible]	[illegible]
3	[illegible]	[illegible] [illegible]	[illegible]
4.	Chaitali Raval	[illegible] 7226050392	[illegible]
5	K.K. Parekh	[illegible] 9712704213	[illegible]

AFFECTED

No	Name	Village/ City	Mobile No.
01	Ramesh bhai	Karjan Khanda	8153803273
02	Paresh. P Patel	Dasharath	9825699978
03	Mehul Patel	"	7725022046
04	Ghanshyam bhai	Chansad	96625 46225
05	Rahul Swaminarayan	"	7573031909
06	Anand Mozgaonkar	Bhili	9408209152
07	Parth Trivedi	Vadodara	9426617976
08	Shailaja Desai	Vadodara	9909280962
09	[illegible]	[illegible]	9328072166
10	Nirali Joshi	Vadodara	7208017574
11	[illegible]	[illegible]	[illegible]
12	R.M. Makwana	Hanelwa	7874568499
13	Rekhaben	Thekariya	7359106854
14	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]
18	Kiritbhai Mehandi	Karodiya	9979357562
19	[illegible]	[illegible]	9904268729
20	[illegible]	[illegible]	-"
21	[illegible]	[illegible]	7359106854
22	Chauhan Gopal S.	"	9737891186
23	[illegible]	[illegible]	[illegible]
24	Vinod. M. Patel.	Sankarda.	9824579340
25	Arunsinh D Rai	Mangrol	9974283499
26	Jashvantsinh R Raji.	Mangrol	9878816391
27	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]
29	[illegible]	"	8758429346
30	S. A. Patel	Akota	9925122817

AFFECTED

No	Name	Village/ City	Mobile No.
31	[illegible]	[illegible]	[illegible]
32	J. B. [illegible]	City Baroda	9924138079
33			
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Annexure-B

Brief Issues/concern raised during the Environment Information Disclosure & Public Consultation

Vadodara (Gujarat)- 30/04/2018	o Why you have not provided any information about environment to all farmers, if provided then in which form.	The Executive Summary (in English as well local language) of the Draft S-EIA Report was made available at the Office of the District Collector for public viewing and inspection well in advance before the Public Consultation. The copy of the Summary was also circulated to each gram Panchayat in advance during the handing over the individual notification about the Public Consultation.
	o When you start working on project at that time it's possible so many crops will be harm. Then will you provide them whatever they lose.	The compensation will be provided as per RFCT LARR Act 2013. However, the final decision on this will be taken by the District Administration. The value of the crops shall be evaluated by the concerned Agriculture Officer and the farmer shall get compensated.
	o Government of Gujarat is requested please to provide job to one family member of PAHS as per their qualification.	NHSRCL will carry out local recruitment as per Rules & Regulations of the Railways. However, NHSRCL shall impress upon the deployed contractors during the construction phase to give preference to locals for employment as per their skill, experience and qualification.

Vadodara EPC pictures

Bharuch

ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION PROCEEDING

It is hereby informed that environment information disclosure & public consultation at district level was organized in compliance to the JICA's Guidelines on Environmental and Social Consideration, April 2010 at Bharuch District at Dr. Bheem Rao AmbedkarBhavan Near DC Office, Bharuch on 10th May 2018, 12:30 hrs for the proposed Mumbai-Ahmedabad High Speed Railway Project (MAHSR) implemented by National High Speed Rail Corporation Limited (A Joint Venture of Government of India and Participating State Governments).

National High Speed Rail Corporation Limited (NHSRCL) intends to implement the first ever bullet train in India under the Mumbai-Ahmedabad High Speed Railway Project (MAHSR).

A notification for Environmental Information Disclosure & Public Consultation was published in the daily newspaper Gujarat Samachar on 03-May-2018.

The public consultations were conducted after circulation of the executive summary of the Supplemental Environmental Impact Assessment (S-EIA) report in advance to the affected panchayat. During the public consultations, a detailed presentation was given on findings of S-EIA in local language, so that local public understand about the findings, such as project details, considered impact and its mitigation measures

A copy of the Summary of Draft S-EIA Report was also made available at District Collector Office, Vadodara for inspection to the public during normal office hours till the public consultation is over.

Comments / views of concerned persons having plausible stake in the environmental aspects of the Project were heard during the consultation meeting and they were requested to send their response in writing to the concerned district collectorate.

Shri C.B.Balat (RAC-Bharuch), supervised and presided over the entire Environmental Information Disclosure & Public Consultation proceeding.

Following officials of District Administration and Project Authority were present in the Environmental Information Disclosure & Public Consultation meeting.

Officials of District Administration
Mr. C.B.Balat (RAC-Bharuch)
Ms. Yasmeen Sheikh (SDM-Bharuch)

Officials of NHSRCL
Sh. Pradeep Ahirkar, CPM, Vadodara
Sh P B Ghataliya, Retired Dy. Collector, Vadodara
Sh. Manjunatha G, Manager, Vadodara
Sh. Gaurav Srivastava, Engineer, Vadodara

Sh. Pritesh Patel, representative of M/s GPS Technologies Pvt. Ltd. gave the presentation highlighting project details and the key findings of the S-EIA study.

Upon completion of the presentation, RAC, Bharuch addressed the participants about the project and need of the public consultation and invited the participants to express their views, suggestions and issues related to environment, if any.

The list of the participants (attendance sheet) is attached as Annexure-A.

The issues raised by the participants during the Environmental Information Disclosure & Public Consultation along with the response of the NHSRCL is attached as Annexure-B (in English).

After the discussion session, RAC, Bharuch announced the closure of the Environmental Information Disclosure & Public Consultation.

SDM informed that the written response to the issues raised by the public shall be communicated by the Office of the District Collector, Bharuch.

Annexure-A

Attendance Sheet

Attendance Sheet Place: BHARUCH Date: 10/5/2018

S.N	Name	Village	Designation	Contact number	Signature
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	9824127736	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] J S.
	[illegible]	[illegible]	[illegible]	9898440557	[illegible]
	[illegible]	[illegible]	[illegible]	9426445198	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	9427167976	[illegible]
	[illegible] M. Salim [illegible]	[illegible]	[illegible]	9081589807	[illegible]
	Karan J. Chavda Dhaval M. Chavda	Tham	Farmer	7016632292	[illegible]

Attendance Sheet Place: BHARUCH Date: 10/5/2018

S.N	Name	Village	Designation	Contact number	Signature
	[illegible]	[illegible]	[illegible]	9156050581	[illegible]
	[illegible]	[illegible]	[illegible]	8324809 492	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	96875 67014	S V Patel
	[illegible]	[illegible]	[illegible]	9624013259	[illegible]

Attendance Sheet Place: Date:

S.N	Name	Village	Designation	Contact number	Signature
1	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]
	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	7096645332	Patel M.M
	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]
	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]
	[illegible]	[illegible]	ખેડૂત	[illegible]	
	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]

Attendance Sheet Place: Date:

S.N	Name	Village	Designation	Contact number	Signature
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	9727069006	[illegible]
	[illegible]	[illegible]	[illegible]		[illegible]
	Daniel Margaonkar	Bhayli	[illegible]	9969173751	Daniel
F –	Shailaja Desai	Vadodara	Student	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	9574508362	[illegible]
	[illegible]	[illegible]	[illegible]	9173006277	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Attendance Sheet Place: Date:

S.N	Name	Village	Designation	Contact number	Signature
	[illegible]	[illegible]	[illegible]	9913976633	[illegible]
	[illegible]	[illegible]	"	9712979923	[illegible]
	[illegible]	[illegible]	"	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]		[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	—	—	[illegible]	[illegible]

Attendance Sheet Place: Date:

S.N	Name	Village	Designation	Contact number	Signature
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	-	[illegible]
	[illegible]	[illegible]	[illegible]	9909837908	[illegible]
	[illegible]	[illegible]	[illegible]	9714050391	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Attendance Sheet Place: BHARUCH Date: 10/5/2018

S.N	Name	Village	Designation	Contact number	Signature
1	Viral K. Patel	Telod	Farmers	9825763892	[signature]
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Arunkumar I. Patel	[illegible]	[illegible]	[illegible]	[signature]
	Dr. Jashubhai B Patel	Telod	Farmer	990941 66[illegible]	[signature]
	Karamanan S [illegible]	Telod	Farmer	98025 23911	[signature]
	Mitesh [illegible]	Telod	[illegible]	9714141341	[signature]
	[illegible] M. Gosvami	Telod	farmar	9824262666	[illegible]
	Mahendrakumar. C.	Telod	farmar	7874933225	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	—	[signature]

Annexure-B

Brief Issues/concern raised during the Environment Information Disclosure & Public Consultation

Bharuch (Gujarat)- 10/05/2018	○ Asked to revise Jantri and provide compensation amount as per new Jantri rate. After 17.5m land acquisition, what about rest part of land? Can we get compensation about rest part of land?	The compensation will be provided as per RFCT LARR Act 2013. However, the final decision on this will be taken by the District Administration.
	○ What is the arrangement for crossing the animals/livestock for grazing?	The maintenance road shall not be fenced, and livestock/domestic animals can cross the maintenance road provided within RoW below the viaduct.
	○ Rate of Jantri is differing from village to village, so what about compensation?	The compensation shall be provided as per RFCT LARR Act 2013. However, the final decision on this will be taken by the District Administration.

Bharuch EPC pictures

Surat

ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION PROCEEDING

It is hereby informed that environment information disclosure & public consultation at district level was organized in compliance to the JICA's Guidelines on Environmental and Social Consideration, April 2010 at Surat at Gandhi SmrutiBhavan, Surat on 14th May 2018, 1500 hrs for the proposed Mumbai-Ahmedabad High Speed Railway Project (MAHSR) implemented by National High Speed Rail Corporation Limited (A Joint Venture of Government of India and Participating State Governments).

National High Speed Rail Corporation Limited (NHSRCL) intends to implement the first ever bullet train in India under the Mumbai Ahmedabad High Speed Railway Project (MAHSR).

A notification for Environmental Information Disclosure & Public Consultation was published in the daily news paper Sandesh on 9-May-2018.

The public consultations were conducted after circulation of the executive summary of the Supplemental Environmental Impact Assessment (S-EIA) report in advance to the affected panchayat. During the public consultations, a detailed presentation was given on findings of S-EIA in local language, so that local public understand about the findings, such as project details, considered impact and its mitigation measures

A copy of the Summary of Draft S-EIA Report was made available at District Collector Office, Surat for inspection to the public during normal office hours till the public consultation is over.

Comments / views of concerned persons having plausible stake in the environmental aspects of the Project were heard during the consultation meeting and they were requested to send their response in writing to the concerned district collectorate.

Shri. Dr. Dhawal Patel, IAS, District Collector of District Surat, supervised and presided over the entire Environmental Information Disclosure & Public Consultation process.

Following officials of District Administration and Project Authority were present in the Environmental Information Disclosure & Public Consultation meeting.

Officials of District Administration
Sh. DrDhawal Patel, IAS, District Collector, Surat
Sh. N.R Dhadhal, Dy, Collector (Land Reform), Surat

Officials of NHSRCL
Mr. Pradeep Ahirkar, CPM, Vadodara
Mr. P B Ghataliya, Dy. Collector (Retired)
Mr. Manjunath, Manager
Mr. Deepak Srivastava, Manager, Surat
Mr. Vishal Dani, Engineer, Surat
Mr. Gaurav Srivatsava, Engineer, Vadodara

Sh. Pritesh Patel, representative of M/s GPS Technologies Pvt. Ltd. gave the presentation highlighting project details and the key findings of the S-EIA study.

Upon completion of the presentation, DM, Surat addressed the participants about the project and need of the public consultation and invited the participants to express their views, suggestions and issues related to environment, if any.

The list of the participants (attendance sheet) is attached as Annexure-A.

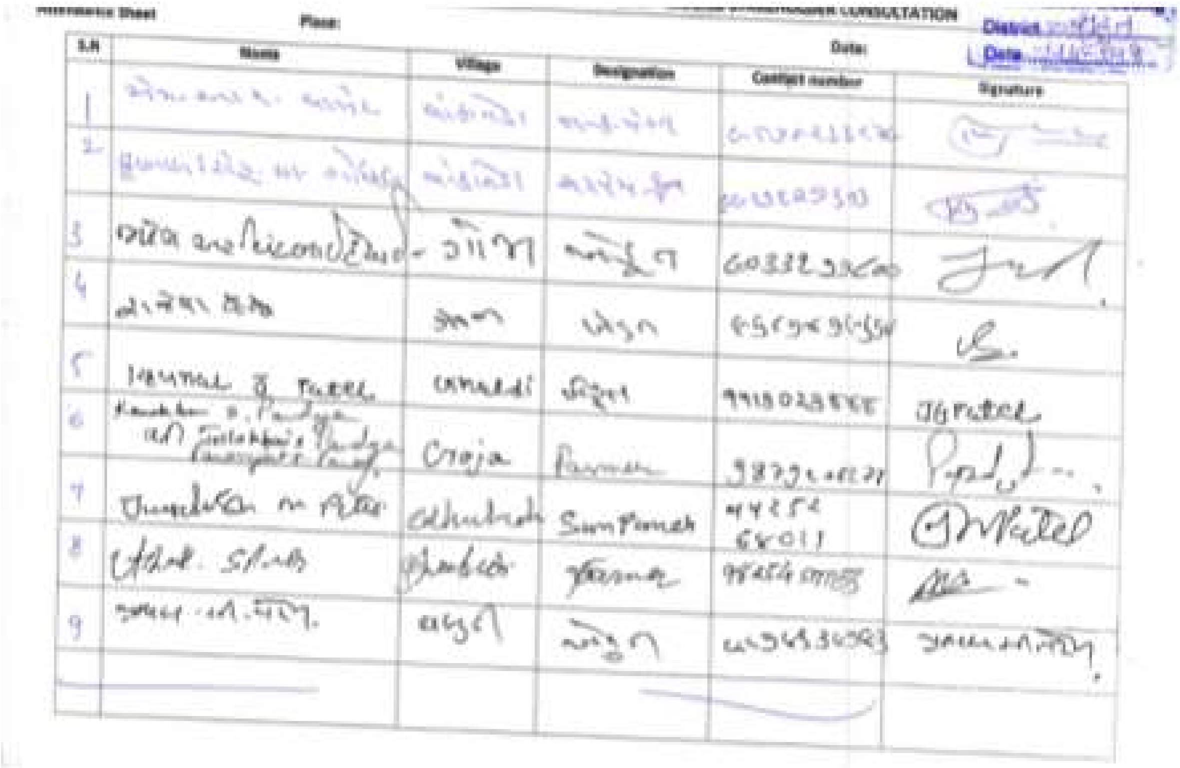
The issues raised by the participants during the Environmental Information Disclosure & Public Consultation along with the response of the NHSRCL is attached as Annexure-B (in English).

After the discussion session, DC, Surat announced the closure of the Environmental Information Disclosure & Public Consultation.

DC informed that the written response to the issues raised by the public shall be communicated by the Office of the District Collector, Surat.

Annexure-A

Attendance Sheet



S.N	Name	Village	Designation	Contact number	Signature
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible] Patel	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	Farmer	[illegible]	[illegible]
7	[illegible]	[illegible]	Sarpanch	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

S.N	Name	Village	Designation	Contact number	Signature
19	[illegible]	[illegible]	[illegible]	[illegible]	
20	[illegible]	[illegible]	[illegible]	[illegible]	
22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	B J Patel	[illegible]	Farmer	99096 32709	BJ Patel
25	[illegible]	HAJIPURA	[illegible]	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
28	Dinesh [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

STAKEHOLDER CONSULTATION

Place:

District: [illegible]

Date: 14-5-18

S.N	Name	Village	Designation	Contact number	Signature
30	Mahipalsinh N. Atodaria	Tarsadi	[illegible]	9099947203	[illegible]
31	[illegible]	[illegible]	[illegible]	6354633355	[illegible]
32	[illegible]	[illegible]	[illegible]	9905 91680	[illegible]
33	Hiren Shankbhai	Surat	[illegible]	[illegible]	[illegible]
34	Himmat Bhai T. Bhadai	[illegible]	[illegible]	9825162161	H.T. Bhadai
35	[illegible]	[illegible]	[illegible]	9909918[illegible]	[illegible]
36	Ranjitsinh T. Atodaria	Tarsadi	[illegible]	9825244799	[illegible]
37	Nimesh. N. Patel	Mohani	[illegible]	9898510[illegible]	[illegible]
38	Vikram D. Solanki	Dambha	[illegible]	9825612100	[illegible]
39	M. [illegible] P	[illegible]	[illegible]	[illegible]	[illegible]

Attendance Sheet

STAKEHOLDER CONSULTATION

Place:

District: [illegible]

Date: 14-5-18

S.N	Name	Village	Designation	Contact number	Signature
40	H. D. [illegible]	[illegible]			H.D. Patel
41	[illegible]	[illegible]		9274925[illegible]	[illegible]
42	[illegible]	[illegible]			[illegible]
43	[illegible]	[illegible]		9909678830	[illegible]
44	[illegible]	[illegible]		[illegible]	[illegible]
45	Goddy A Gandhi	Surat N.C.S		7016442586	[illegible]
46	Mahesh B. Gavande	Kosad		9601130900	[illegible]
47	[illegible]	[illegible]		6633[illegible]	[illegible]
48	[illegible]	[illegible]		9727237474	[illegible]
49	[illegible]	[illegible]	[illegible]	9723386044	[illegible]

Attendance Sheet Place: CONSULTATION District: [illegible] Date: 14-5-18

S.N	Name	Village	Designation	Contact number	Signature
50	Chetan Ramesh Patel	Kosmada	Kishan	[illegible]	[illegible]
51	Rohitbhai R. Desai	Kosmada	Kishan.	[illegible]	[illegible]
52	Satish N. Areniya	Hokad.	Owner	[illegible]	[illegible]
53	Bharat - B. Dand	Antrol	Owner	[illegible]	[illegible]
54	Neel. M. Vyas	Amroli	Khedut	9723201970	[illegible]
55	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
56	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
57	B. R. Ahir SDM Olpad	[illegible]	SDM		[illegible]
58	G. M. Borad	[illegible]	TDO		[illegible]
59	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Attendance Sheet Place: CONSULTATION District: [illegible] Date: 14-5-18

S.N	Name	Village	Designation	Contact number	Signature
60	Dhiraj. Jogani	Surat	[illegible]	[illegible]	[illegible]
61	Mukeshbhai [illegible]	Surat	[illegible]	9909095895	[illegible]
62	Manjibhai Virani	Surat	[illegible]	[illegible]	[illegible]
63	Bhailal bhai	Surat	[illegible]	[illegible]	[illegible]
64	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
65	[illegible]	SSIR	[illegible] SSIR	9924044530	Shridhar
66	[illegible]	SSIR	SSIR [illegible]	9624724755	[illegible]
67	[illegible]	SSIR	[illegible]	9824367672	[illegible]
68	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
69	Rajendra Singh	[illegible]	[illegible]	[illegible]	[illegible]

Attendance Sheet　Place:　District: [illegible]　Date: 14-5-18

Date:

S.N	Name	Village	Designation	Contact number	Signature
70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
71	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
72	Sajan mahesh [illegible]	[illegible]	Farmer	95586 47757	Patel S. [illegible]
73	Imtiyaz A.M. Belim	Kathor	farmer	99046 57213	Belim [illegible]
74	Sanjay [illegible]	[illegible]	Farmer	9567525744	[illegible]
75	[illegible]	[illegible]	Farmer	9998830168	[illegible]
75	Prashant K. Galliara	Kathor	Farmer	[illegible]	[illegible]
76	[illegible] Cold Storage	Kavarda.	Business man	9925195800	[illegible]
78	Dinesh bhai Savaniya	[illegible]	Farmer.	9825 36668	[illegible]
79	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

District: [illegible]　Date: 14-5-18

S.N	Name	Village	Designation	Contact number	Signature
80	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
81	[illegible]	[illegible]	[illegible]	9313003020	[illegible]
82	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
83	[illegible]	[illegible]	[illegible]	9924342905	[illegible]
84	Abhishek R. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
86	[illegible]	[illegible]	[illegible]	9535700024	[illegible]
87	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
88	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
89	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Attendance Sheet Place: District: [illegible] Date: 14-5-18

S.N	Name	Village	Designation	Contact number	Signature
90	Jitesh. n. Patel	MULAD	[illegible]	[illegible]	J.m.Patel
92	Hasmukh bhai R.	MULAD	[illegible]	[illegible]	[illegible]
93	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
94	Kalpesh M. patel	Kathor	[illegible]	9825634450	Kalpesh patel
95	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
96	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
97	Naren Dobaria	Kholvad	"	[illegible]	[illegible]
98	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
99	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Attendance Sheet Place: District: [illegible] Date: 14-5-18

S.N	Name	Village	Designation	Contact number	Signature
101)	Ankit Hasmukhkumar Patel	Antroli	Farmer	[illegible]	AHPatel
102)	[illegible]	Antroli	farmer	[illegible]	[illegible]
103)	Nirmal. A. Naik	Kathor	[illegible]	[illegible]	A.Naik
104)	Ankur Bhatt	"	"	9537743345	A.P.Bhatt
105	[illegible]	[illegible]	[illegible]	9898[illegible]	[illegible]
106	[illegible] M. chauhan	Kathor	farmer.	[illegible]	[illegible]
107	Chandrika Z. Patel	Goja	Taluka Cum Mantri	94265-[illegible]	[illegible]
108	[illegible]	[illegible]		[illegible]	[illegible]
109	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
110	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Attendance Sheet — Place: — SECOND STAKEHOLDER CONSULTATION — Date: 14-5-18

S.N	Name	Village	Designation	Contact number	Signature
111	Rakesh Jivanbhai Patel	Kathor	Farmer	9925243045	[illegible]
112	Mahesh Narvarbhai Patel	Kathor	Farmer	9427126211	[illegible]
113	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
114	Rasini b. Gamit	Tadkadi	Talati	7600223353	[illegible]
115	Parmar Alpaben R.	Niyol	Talati	8469838992	[illegible]
116	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
117	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
118	[illegible]	"	[illegible]	[illegible]	[illegible]
119	Rajendra. [illegible]	"	"	8980079311	[illegible]
120	[illegible]	"	"	99258 62454	[illegible]

Attendance Sheet — Place: — STAKEHOLDER CONSULTATION Consultation Meeting — Date: — District: [illegible] — Date: 14-5-18

S.N	Name	Village	Designation	Contact number	Signature
121	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
122	[illegible]	[illegible]	[illegible]	9979485045	[illegible]
123	Patel [illegible]	[illegible]		[illegible]	V. R. Patel
124	R. C. Patel	Kamrej	[illegible]	[illegible]	[illegible]
125	B. R. Tank	Olpad	Mam Olpad	99790 04965	[illegible]
126	Patel [illegible]	[illegible]		[illegible]	[illegible]
127	N. R. Chauhan, Mamlatdar Choryasi	Choryasi	Mamlatdar Choryasi	9427177365	[illegible]
128	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
129	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
130	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Attendance Sheet Place: District [illegible]

Date: Date 14-5-18

S.N	Name	Village	Designation	Contact number	Signature
131	Chavda Bhavesh A.	Kathor	Khedut		[illegible]
132	Niraj Patel	Kathor	Job		[illegible]
133	Pranav M	Kathor	Business		Mukhanju PK
134	[illegible]	[illegible]	k		[illegible]
135	[illegible]	11			[illegible]
136	Rajesh P. Patel	Kathor			[illegible]
137	[illegible] N. Chauhan	Kimandi	Sarpanch [illegible]	999800[illegible]	Chau
138	[illegible]	[illegible]	[illegible]	9879431[illegible]	[illegible]
139	[illegible]	[illegible]	[illegible]	9898[illegible]	[illegible]
140	[illegible]	[illegible]	VM	[illegible] 95323	[illegible]

Attendance Sheet Place: Date 14-5-18

Date:

S.N	Name	Village	Designation	Contact number	Signature
141	Jonish S. Patel	[illegible]	[illegible]	9979339[illegible]	[illegible]
142	Aravind N. Patel	11	11	9825342495	[illegible]
143	Minesh C. Patel	11	11	9925385694	[illegible]
144	Rajesh I. Patel	11	11	9925182034	[illegible]
145	[illegible] J. Patel	11	11	9909132223	[illegible]
146	Ketan [illegible]	[illegible]	11	[illegible]	[illegible]
147	Kalpesh B. Chauhan	Kathor	11		[illegible]
148	[illegible]	[illegible]	11	[illegible]	[illegible]
149	Ahir HR	Kosmd	11	9824761763	[illegible]
150	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Consultation Meeting
District [illegible]
Date: 16-5-18

S.N	Name	Village	Designation	Contact number	Signature
151	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
152	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
153	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
154	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
155	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
156	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
157	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
158	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
159	Prakash Manani	[illegible]	[illegible]	[illegible]	[illegible]
160	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Attendance Sheet Place:

Date: 16-5-18

S.N	Name	Village	Designation	Contact number	Signature
161	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
162	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
163	[illegible] P. PATEL	Nikol	[illegible]	8238888482	[illegible] P. Patel
164	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
165	[illegible] G Patel	Nikol	Farmer	[illegible]	Patel
166	DARSHIL B PATEL	NIKOL	Pharmacist	[illegible]	[illegible]
167	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
168	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
169	[illegible]	"	[illegible]	[illegible]	[illegible]
170	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Attendance Sheet Place: Date: District: [illegible] Date: 14-5-18

S.N	Name	Village	Designation	Contact number	Signature
171	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
172	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
173	[illegible]	[illegible]	[illegible]	2776249	[illegible]
174	GIRISH DELADIA	Kathor,	Engineer	9141030368	[illegible]
175	Sanah Patel	Kathor	Teacher	[illegible]	[illegible]
176	Kishan Chauhan	Kathor	[illegible]	7043630344	Kchauhan
177	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
178	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
179	[illegible]	[illegible]	[illegible]	7707493333	[illegible]
180	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Attendance Sheet Place: Date: District: [illegible] Date: 14-5-18

S.N	Name	Village	Designation	Contact number	Signature
181	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
182	[illegible]	[illegible]	[illegible]	9825541195	[illegible]
183	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
184	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
185	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
186	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
187	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
188	Shailesh Ramani	[illegible]	[illegible]	[illegible]	Ramani
189	[illegible]	[illegible]	[illegible]		[illegible]
190	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Attendance Sheet Place: Date: Date [illegible]

S.N	Name	Village	Designation	Contact number	Signature
191	R.U. Vasava	TCM Kuvarada	TCM	[illegible]	[illegible]
192	J.P. Rajput	ATDO [illegible]	ATDO	[illegible]	J.P.Rajput
193	Saamiya R. Saiyed	S.R.Saiyed	[illegible]	[illegible]	S.R.Saiyed
194	[illegible]	[illegible]	[illegible]	9586132[illegible]	J.[illegible]
195	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
196	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
197	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
198	Vishal [illegible]	[illegible]	TCM	[illegible]	[illegible]
199	[illegible]	[illegible]	TCM	[illegible]	[illegible]
200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Date: [illegible] Meeting District [illegible] Date 14-5-18

S.N	Name	Village	Designation	Contact number	Signature
201	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
202	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Annexure-B

Brief Issues/concern raised during the Environment Information Disclosure & Public Consultation

Surat (Gujarat)-14/05/2018	o Locals PAHs should be given priority in employment.	The priority shall be given to the local people depending on the skill, experience and qualification of the person. Detailed skill development and livelihood programme has been framed in the SIA.

Surat EPC pictures

Office of the District Collector, Kaliyawadi, Navsari, Gujarat 396427

ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION PROCEEDING

It is hereby informed that environment information disclosure & public consultation at district level was organized in compliance to the JICA's Guidelines on Environmental and Social Consideration, April 2010 for Navsari District at Shree Navsari Kshatriya SaskrutiBhavan, Navsari on 29th May 2018, 1500 hrs for the proposed Mumbai-Ahmedabad High Speed Railway Project (MAHSR) implemented by National High Speed Rail Corporation Limited (A Joint Venture of Government of India and Participating State Governments).

National High Speed Rail Corporation Limited (NHSRCL) intends to implement the first ever bullet train in India under the Mumbai-Ahmedabad High Speed Railway Project (MAHSR).

A notification for Environmental Information Disclosure & Public Consultation was published in the daily newspaper Gujarat Samachar on 22-May-2018.

A copy of the Summary of Draft S-EIA Report was made available at District Collector Office Navsari for inspection to the public during normal office hours till the public consultation is over.

Comments / views of concerned persons having plausible stake in the environmental aspects of the Project were heard during the consultation meeting and they were requested to send their response in writing to the concerned district collectorate.

Shri Mr. K.S Vasava, Resident District Collector Navsari supervised and presided over the entire Environmental Information Disclosure & Public Consultation proceeding.

Following officials of District Administration and Project Authority were present in the Environmental Information Disclosure & Public Consultation meeting.

<u>Officials of District Administration</u>
Mr. K.S Vasava, Resident District Collector

<u>Officials of NHSRCL</u>
Sh. Pradeep Ahirkar, CPM, Vadodara
Sh. Dy.CPM, Surat
Sh Manju G. Nath, Manager, Vadodara
Sh. Deepak Srivastava, Manager, Surat
Sh. Vishal Dani, Engineer, Surat

Sh. Pritesh Patel, representative of M/s GPS Technologies Pvt. Ltd. gave the presentation highlighting project details and the key findings of the S-EIA study.

Upon completion of the presentation, RAC, Navsari addressed the participants about the project and need of the public consultation and invited the participants to express their views, suggestions and issues related to environment, if any.

The list of the participants (attendance sheet) is attached as Annexure-A.

The issues raised by the participants during the Environmental Information Disclosure & Public Consultation along with the response of the NHSRCL is attached as Annexure-B (in English).

After the discussion session, RAC, Navsari announced the closure of the Environmental Information Disclosure & Public Consultation.

RAC informed that the written response to the issues raised by the public shall be communicated by the Office of the District Collector, Navsari.

Annexure-A

Attendance Sheet

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Attendance Sheet Place: Date:

…e Holder Consultation Meeting
District Navsari
Date 29/5/2018

S.N	Name	Village	Designation	Contact number	Signature	
1	[illegible]	[illegible]	[illegible]	7622901230	[illegible]	M
2	[illegible]	"	"	"	[illegible]	M
3	[illegible]	[illegible]	"	9898063908	K.M. Patel	F
4	[illegible]	[illegible]	[illegible]	7567758474	[illegible]	M
5	[illegible]	[illegible]	[illegible]	9909985828	[illegible]	M
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	M
7	[illegible]	[illegible]	[illegible]	9974760230	[illegible]	
8	[illegible]	[illegible]	[illegible]	9825862904	Suresh	M
9	[illegible]	[illegible]	[illegible]	9712630455	[illegible]	M
10	[illegible]	[illegible]	[illegible]	9427864558	[illegible]	M

2.

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Stake Holder Consultation Meeting
District: Navsari
Date: 29/5/2018

Attendance Sheet Place: Date:

S.N	Name	Village	Designation	Contact number	Signature	
11	[illegible] પટેલ	[illegible]	ખેડૂત	9428758036	[illegible]	M
12	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]	M
13	[illegible] પટેલ	[illegible]	ખેડૂત	9429205678	V.T. Patel	M
14	[illegible] પટેલ	[illegible]	ખેડૂત	9925839056	N. [illegible]	M
15	[illegible]	[illegible]	ખેડૂત	9426723593	[illegible]	F
16	[illegible] પટેલ	[illegible]	ખેડૂત	9712307007	[illegible]	M
17	[illegible] પટેલ	[illegible]	ખેડૂત	9714597965	V.J. Patel	M
18	[illegible] પટેલ	[illegible]	ખેડૂત	[illegible]	[illegible]	M
19	[illegible]	[illegible]	ખેડૂત	9924966167	[illegible]	M
20	[illegible] પટેલ	[illegible]	[illegible]	9586889196	[illegible]	F

3.

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Stake Holder Consultation Meeting
District: Navsari
Date: 29/5/2018

Attendance Sheet Place: Date:

S.N	Name	Village	Designation	Contact number	Signature	
21	[illegible] પટેલ	[illegible]	[illegible]	[illegible]	[illegible]	M
22	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]	M
23	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]	M
24	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]	M
25	[illegible]	[illegible]	ખેડૂત	9925825541	[illegible]	M
26	[illegible]	[illegible]	ખેડૂત	9824547435	V. g Patel	M
27	[illegible]	[illegible]	ખેડૂત	9825013118	[illegible]	M
28	[illegible]	"	"	9909109108	[illegible]	M
29	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]	M
30	[illegible]	[illegible]	ખેડૂત	[illegible]	J.D. Patel	M

4.

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Stake Holder Consultation Meeting
District: Navsari
Date: 29/5/2018

Attendance Sheet　　Place:　　Date:

S.N	Name	Village	Designation	Contact number	Signature	
31	અરુણા એસ. પટેલ	દાભાડા	તલાટી	9825872165	Patel	F
32	સવિતાબેન ડી. પટેલ	નાદરખા	સરપંચ	9979333720	[illegible]	F
33	અમિતા કે. પટેલ	કેસલી	સરપંચ	8154986793	Patel Amita K	F
34	વિરાજ કે. દેસાઈ	આમળખાડીલ	ખેડૂત	9913860389	[illegible]	M
35	સુરેશભાઈ એમ. પટેલ	સિસોદ્રા	ખેડૂત	9408246463	[illegible]	M
36	અશોક એમ. પટેલ	સિસોદ્રા	ખેડૂત	9427170114	[illegible]	M
37	સ્વાતિબેન ગોહિલ	ઈટાળવા	તલાટી	9909131992	[illegible]	F
38	નિખુલભાઈ બી. પટેલ	ઓંજલ	ખેડૂત આગેવાન	992451050	[illegible]	M
39	રશ્મિકાંત ડી. પટેલ	સિસોદ્રા	ખેડૂત	9625256544	[illegible]	M
40	અશોકભાઈ એમ પટેલ	ગાગાબા	ખેડૂત	9979912757	[illegible]	M

5.

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Stake Holder Consultation Meeting
District: Navsari
Date: 29/5/2018

Attendance Sheet　　Place:　　Date:

S.N	Name	Village	Designation	Contact number	Signature	
41	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]	M
42	Nimeshbhai A. Vashi	Pardi	Farmer	9875570306	[illegible]	M
43	આનંદ પી. દેસાઈ	આમરી	ખેડૂત	98241-85478	A.P.Desai	M
44	ગોવિંદભાઈ ડી ઠાકોર	આમરી [illegible]	તલાટી કમ મંત્રી	95375 07207	[illegible]	M
45	[illegible]	[illegible]	ખેડૂત	9229066111	[illegible]	M
46	ચંદ્રકાંત એમ સોલંકી	વંકાલ	ગ્રામ સેવક	9724370172	Solanki	M
47	ચિરાગ ડી. પટેલ	કાંદરખા	વેપાર Factory	9825306559 9825149099	[illegible]	M
48	ભાનુભાઈ એમ. પટેલ	કાંદરખા	વેપાર Business	9879585374	[illegible]	M
49	ભરતભાઈ ડી. પટેલ	કાંદરખા	વેપાર Factory	9825215991	[illegible]	M
50	[illegible]	ઈટાળ	ખેડૂત	98-255-09770	[illegible]	M

6.

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Attendance Sheet

Place:

Date:

Stake Holder Consultation Meeting

District: Navsari

Date 29/5/2018

S.N	Name	Village	Designation	Contact number	Signature	
51	સુધિરભાઈ વી. મહેતા	ધામણ	ખેડુત	9925497755	[illegible]	M
52	નીતિનભાઈ ડી પટેલ	ધામણ	ખેડુત	9925380282	[illegible]	M
53	સુમિત બી. પટેલ	નવાગામ	ખેડુત	9925438682	[illegible]	M
54	ભરતકુમાર બાબુભાઈ	ઉંડાચ	ઉદ્યોગપતિ	9825059082	[illegible]	M
55	ગિરીશભાઈ ડી. દેસાઈ	[illegible]	ખેડુત	9377782242	[illegible]	M
56	ઈશ્વરભાઈ મોરાર પટેલ	પીંજરા	ખેડુત		[illegible]	M
57	પરેશકુમાર સોમ પટેલ	પીંજરા	ખેડુત	9925045765	[illegible]	M
58	જીગ્નેશ સોમા નાયક	પડઘા	ખેડુત	9879772112	[illegible]	M
59	[illegible] પટેલ	સદલાવ	ખેડુત	94268 89335	[illegible]	M
60	દશરથભાઈ [illegible] દેસાઈ		ખેડુત	9427621521	D.N.Vasli	M

7.

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Attendance Sheet

Place:

Date:

Stake Holder Consultation Meeting

District: Navsari

Date 29/5/2018

S.N	Name	Village	Designation	Contact number	Signature	
61	બળવંતરાય ડી. પટેલ	પિંજરા	ખેડુત	8141362727	[illegible]	M
62	રાજેન્દ્ર કુમાર પટેલ	પિંજરા	ખેડુત	8758283101	[illegible]	M
63	બાબુભાઈ જી. પટેલ	-"-	ખેડુત	9724100717	[illegible]	M
64	નરેશભાઈ સોમ પટેલ	-"-	ખેડુત	9527995105 9724100519	[illegible]	M
65	દિલીપભાઈ બી. પટેલ	-"-	સરપંચ	9687004402 99965	[illegible]	M
66	પરિમલ સોમ પટેલ	-"-	ખેડુત	9825468732	પરિમલ સોમ પટેલ	M
67	સંજય ડી. મહેતા	[illegible]	ખેડુત	9879210387	[illegible]	M
68	રાજેશ કુમાર દેસાઈ	પડઘા	ખેડુત	9909109094	[illegible]	M
69	મિલન પટેલ	[illegible]	ખેડુત	9909114739	[illegible]	M
70	દિનેશ જે. રાઠોડ	[illegible]	સરપંચ	9375160247	[illegible]	M

8.

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Attendance Sheet

Place:

Date:

Stake Holder Consultation Meeting

District Navsari

Date 29/5/2018

S.N	Name	Village	Designation	Contact number	Signature	
71.	[illegible]	[illegible]	ખેડૂત	9712640996	[illegible]	
72	[illegible]	[illegible]	ખેડૂત	9825760577	[illegible]	M
73	[illegible]	[illegible]	ખેડૂત	9825864306	[illegible]	M
74.	[illegible]	[illegible]	[illegible] ખેડૂત	9726052599	[illegible]	M
75	[illegible]	"	"	"	[illegible]	M
76	[illegible]	"	"	"	[illegible]	M
77	[illegible]	[illegible]	[illegible]	9825737159	[illegible]	M
78	[illegible]	[illegible]	ખેડૂત	9727679254 9825114805	[illegible]	M
79.	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]	M
80	[illegible]	[illegible]	ખેડૂત	[illegible] [illegible]	[illegible]	M

9.

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Attendance Sheet

Place:

Date:

Stake Holder Consultation Meeting

District Navsari

Date 29/5/2018

S.N	Name	Village	Designation	Contact number	Signature	
81	હરિશ આર. પટેલ	[illegible]	ખેડૂત	9712619007	[illegible]	
82	હેમંત પી. પટેલ	[illegible]	ખેડૂત	9426771498	[illegible]	M
83	[illegible]	[illegible]	[illegible]	9762189398	[illegible]	M
84	[illegible]	[illegible]	[illegible]	9106516632	[illegible]	M
85	[illegible]	[illegible]	ખેડૂત	9328193061	[illegible]	F
86	[illegible]	[illegible]	ખેડૂત	9825419243	[illegible]	M
87	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]	
88	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]	
89						
90						

10

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Stake Holder Consultation Meeting

District Navsari

Date 29/5/2018

Attendance Sheet

Place:

Date:

S.N	Name	Village	Designation	Contact number	Signature	
89	Kamlesh Kumar Paragbhai Patel	Ganesh Sisodra	Farmer	9737034848	K.P. Patel	M
90	Heena A. Patel	Pathri	TCM	9979630125	[signature]	F
91	Vinal D. Patel	Munekpore	T.C.M.	9824657977	[signature]	F
92	Bhanubhai G. Ahir	Padgha	Farmer	9638906954	[signature]	F

Annexure-B

Brief Issues/concern raised during the Environment Information Disclosure & Public Consultation

Navsari (Gujarat)-29/05/2018	○ Why farmers and all were unaware of this meeting?	The notification of the Public Consultation was published well in advance in the local news papers and also the notice was also circulated to each Panchayat.
	○ Will farmers get employment due to MAHSR?	NHSRCL will carry out local recruitment as per Rules & Regulations of the Railways. However, the preference shall be given to persons from project affected households (PAHs).
	○ Why official notice was not passed to all the affected persons?	The notification of the Public Consultation was published well in advance in the local news papers and also the notice was also circulated to each Panchayat.
	○ When will we come to know about the exact alignment of the land?	Now the entire alignment has been finalized and the fixing of Centerline and RoW pillar is underway.

Navsari EPC pictures

District Collector Office, Jilla Seva Sadan, Opp. Kotak Mahindra Bank, Dharampur Road,Valsad, Gujarat,396001

ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION PROCEEDING

It is hereby informed that environment information disclosure & public consultation at district level was organized in compliance to the JICA's Guidelines on Environmental and Social Consideration, April 2010 at District Valsad at Moroji Desai Auditorium, Valsad on 30th May 2018, 1500 hrs for the proposed Mumbai-Ahmedabad High Speed Railway Project (MAHSR) implemented by National High Speed Rail Corporation Limited (A Joint Venture of Government of India and Participating State Governments).

National High Speed Rail Corporation Limited (NHSRCL) intends to implement the first ever bullet train in India under the Mumbai-Ahmedabad High Speed Railway Project (MAHSR).

A notification for Environmental Information Disclosure & Public Consultation was published in the daily news paper Gujarat Samachar on 22-5-2018.

A copy of the Summary of Draft S-EIA Report was made available at District Collector Office,Valsad for inspection to the public during normal office hours till the public consultation is over.

Comments / views of concerned persons having plausible stake in the environmental aspects of the Project were heard during the consultation meeting and they were requested to send their response in writing to the concerned district collectorate.

Shri Mr.C.RKharsan, IAS, District Collector, Valsad supervised and presided over the entire Environmental Information Disclosure & Public Consultation proceeding.

Following officials of District Administration and Project Authority were present in the Environmental Information Disclosure & Public Consultation meeting.

Officials of District Administration
Shri C.R Kharsan, IAS, District Collector, Valsad
Smt. K. J Bhagora, Prant Officer (LR), Valsad

Officials of NHSRCL
Sh. Pradeep Ahirkar, CPM, Vadodara
Sh. P B Ghataliya, Retired Dy. Collector, Vadodara
Sh. Chavda, Retired Dy. Mamaldar, Vadodara
Sh. Manju G.Nath, Manager (Civil), Vadodara
Sh. Vivek Joshi, DC, Vadodara

Sh. Pritesh Patel, representative of M/s GPS Technologies Pvt. Ltd. gave the presentation highlighting project details and the key findings of the S-EIA study.

Upon completion of the presentation, Shri C.R Kharsan, IAS, District Collector, Valsad addressed the participants about the project and need of the public consultation and invited the participants to express their views, suggestions and issues related to environment, if any.

The list of the participants (attendance sheet) is attached as Annexure-A.

The issues raised by the participants during the Environmental Information Disclosure & Public Consultation along with the response of the NHSRCL is attached as Annexure-B (in English).

After the discussion session, Shri C.R Kharsan, IAS, District Collector, Valsad announced the closure of the Environmental Information Disclosure & Public Consultation.

DC informed that the written response to the issues raised by the public shall be communicated by the Office of the District Collector, Valsad.

Annexure-A

Attendance Sheet

Consultation Meeting
District Valsad
Date 30-5-18

Attendance Sheet Place: Date:

S.N	Name	Village	Designation	Contact number	Signature	Gender
1	Shahbaz Bugar	Dungra	Dungra	9898122245	[illegible]	M
2	[illegible]	[illegible]	Farmer	9825502168	[illegible]	M
3	Jitendra [illegible]	[illegible]	Farmer	9825 [illegible]	[illegible]	M
4	Alpesh Patel	Pardi	—	9427870122	[illegible]	M
5	Amrut Patel	Ambach	Farmer	9909823051	[illegible]	M
6	Bhumit Patel	Dungra	Dungra	9662225976	[illegible]	M
7	Pathik Patel	Dungra	Dungra	9974439911	[illegible]	M
8	Sandipbhai S. Dhodi	Borigam	[illegible]	7696963009	[illegible]	M
7	[illegible]	[illegible]	[illegible]	9824149684	[illegible]	M

... RAILWAY PROJECT- STAKEHOLDER CONSULTATION

Consultation Meeting
District Valsad
Date 30-5-18

Attendance Sheet Place: Date:

S.N	Name	Village	Designation	Contact number	Signature	Gender
10	Jayeshbhai Ranchhodbhai Patel	Sonwada	[illegible]	9825894643	[illegible]	M
11	Nilesh kumar Dhirubhai Patel	Sonwada F. F.	[illegible]	8140829030	N. D Patel	M
12	Govindbhai Z. Patel	Pardi	[illegible]	9979903237	G.Z. Patel	M
13	[illegible]	[illegible]	[illegible]	—	[illegible]	M
14	[illegible]	[illegible]	[illegible]	9016240848	[illegible] N. Patel	M
15	[illegible]	[illegible]	[illegible]	8980454874	[illegible]	M
16	[illegible]	[illegible]	[illegible]	9586288325	Sp. Dhodi	M
17	[illegible]	[illegible]	[illegible]	9427870137	[illegible]	F
18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	M

Consultation Meeti

Attendance Sheet Place: Date: District Valsad Date 30/5/18

S.N	Name	Village	Designation	Contact number	Signature	
19	Sunil Desai	Kanwad	Farmer	9923472212	SGD.	M
20	Dilipbhai D. Patel	Chhanvi	[illegible]	9974237441	[illegible]	M
21	Prakash M. Ahir	Kanadi	Farm	98251-34733	[illegible]	M
22	Kishor J. Bhandari	Dungri, Valsad	Farm	9374991671	Kishor	M
23	Krishna Bhadu	Karan	Pramp	9998618487	[illegible]	M
24	Rohit M Shah	Paria	Farm	9825538390	Rohit	M
25	Dharmesh J. Tailor	Pardi	House	9712011437	Dhar	M
26	Rekha Bharatbhai Panchal	Paria	Land and house	7567465170	[illegible]	F
27	Bhikhubhai R. Patel	Khajurdi	ખેડૂત	8140720866	B.R.P.	M

...HIGH SPEED RAILWAY PROJECT- STAKEHOLDER CONSULTATION Consultation Meeting

Attendance Sheet Place: Date: District Valsad Date 30-5-18

S.N	Name	Village	Designation	Contact number	Signature	
28	[illegible]	[illegible]	[illegible]	9427946503	[illegible]	M
29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	M
30	Amrut. I. Boga	Dungra	[illegible]	9737709005	[illegible]	M
31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	F
32	[illegible]	[illegible]	[illegible]	9925346867	[illegible]	M
33	[illegible]	[illegible]	[illegible]	7567138439	D.K. Patel	M
34	[illegible]	[illegible]	[illegible]	"	R. D. Patel	F
35	[illegible]	[illegible]	[illegible]	9925500677	[illegible]	M
36	[illegible]	[illegible]	[illegible]	9879899827	[illegible]	M

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- STAKEHOLDER CONSULTATION

Consultation Meeting
District: [illegible]
Date: 30/5/18

Attendance Sheet Place:

S.N	Name	Village	Designation	Contact number	Signature	
37	[illegible]	[illegible]	[illegible]	7328687580	[illegible]	F
38	[illegible]	''	''	''	P.I. [illegible]	F
39	[illegible]	[illegible]			U. m. Patel	M
40	[illegible]	''	''		[illegible]	F
41	[illegible]	''	''		[illegible]	F
42	[illegible]	[illegible]	[illegible]	8128132701	[illegible]	M
43	[illegible]	[illegible]	[illegible]	7838109940	[illegible]	M
44	[illegible]	[illegible]	[illegible]	98257-10624	[illegible]	M
45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	M

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Consultation Meeting
District: Valsad
Date: 30/5/2018

Attendance Sheet Place: Date:

S.N	Name	Village	Designation	Contact number	Signature	
46	[illegible]	[illegible]	[illegible]	6352485303	[illegible]	M
47	[illegible]	[illegible]	''	6352098285	[illegible]	M
48	[illegible]	''	''		[illegible]	F
49	[illegible]	[illegible]	''	9624474568	[illegible]	M
50	[illegible]	[illegible]	''		[illegible]	M
51	[illegible]	[illegible]	''		[illegible]	M
52	[illegible]	[illegible]	''		[illegible]	M
53	[illegible]	[illegible]	''	98256 55447	[illegible]	M
54	[illegible]	[illegible]	''	9712227573	[illegible]	M
55	[illegible]	[illegible]	''	9979922299	[illegible]	M

… HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Stake Holder Consultation Meeting

Attendance Sheet Place: Date:

District: Valsad

Date: 30/07/18

S.N	Name	Village	Designation	Contact number	Signature	
56	Anilkumar C. Singh	Dungra	Commercial	9574261953	Anil Kumar C. Singh	M
57	[illegible]	[illegible]	[illegible]	7600689535	[illegible]	M
58	[illegible]	[illegible]	[illegible]	9054513192	[illegible]	M
59	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	M
60	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	F
61	[illegible]	[illegible]	[illegible]	9898590377	[illegible]	M
62	[illegible]	[illegible]	ખેડૂત	9898024341	N. K. Desai	M
63	[illegible]	[illegible]	[illegible]	9601516158	[illegible]	M
64	[illegible]	[illegible]	ખેડૂત	9879218550	[illegible]	M
65	[illegible]	[illegible]	ખેડૂત	[illegible]	[illegible]	M

… HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Stake Holder Consultation Meeting

Attendance Sheet Place: Date:

District: Valsad

Date: [illegible]

S.N	Name	Village	Designation	Contact number	Signature	
66	Kirit Mohanbhai Vantolia	PATHRI	[illegible]	9825122615	[illegible]	M
67	Kumud A. Patel for A.C. Patel	Andezgota	Farmer	9825823098	[illegible]	M
68	[illegible]	[illegible]	ખેડૂત	9737439044	[illegible]	M
69	[illegible]	[illegible]	ખેડૂત	9979688226	Patel H.C.	M
70	[illegible]	[illegible]	ખેડૂત	9925549045	G. N. Patel	M
71	[illegible]	[illegible]	ખેડૂત	9824776872	[illegible]	M
72	[illegible]	[illegible]	ખેડૂત	9375836551	[illegible]	M
73	[illegible]	[illegible]	ખેડૂત	9276158535	[illegible]	M
74	[illegible]	[illegible]	ખેડૂત	9726794664	[illegible]	M
75	[illegible]	[illegible]	ખેડૂત	9662016069	[illegible]	M

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- STAKEHOLDER CONSULTATION

Stake Holder Consultation Meeting
District: Navsari
Date: 30/5/18

Attendance Sheet Place: Date:

S.N	Name	Village	Designation	Contact number	Signature	
76	Patel Nilesh K	Chhaloi	Study	[illegible]	[illegible]	m
77	Patel Bhavin R	Chenvai	Khedut	98251-25380	[illegible]	m
78	Patel Dhansukhbhai	Pulum Kewada	Khedut	9909080812	D N Patel	m
79	Patel Hiralbhai Bikhubhai	Pulum Kewada	Khedut	97276 73776	Patel	m
80	Patel Parsottambhai Lallubhai	Pulum Kewada	Khedut	99097 14800	P. L. Patel	m
81	Patel Maheshbhai Dinkar	Pulum	"	92278 78777	[illegible]	m
82	Patel Dilipkumar Hasibhai	Pulum	"	99780 24581	Dilip..	m
83	Patel. Dhana. G.	Pania.	Sarpanch	4586523897	[illegible]	m
84	Mustak Baga	Dungra	Dungra	9408975443	[illegible]	m

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- STAKEHOLDER CONSULTATION

Stake Holder Consultation Meeting
District: Navsari
Date: 30/5/18

Attendance Sheet Place: Date:

S.N	Name	Village	Designation	Contact number	Signature	
85	Satish	Dungra		9327063694	[illegible]	m
86	Chandubhai	"			[illegible]	m
87	Hanubhai	"			[illegible]	m
88	Ramanbhai	"		9909003368	[illegible]	m
89	[illegible]	[illegible]	ખેડૂત	[illegible]	R.B. Patel	m
90	[illegible]	"	ખેડૂત	[illegible]	[illegible]	m
91	[illegible]	પરિયા	ખેડૂત.	9427946503	[illegible]	m
92	રમણીકલાલ ઉત્તમચંદ શાહ મીરા રમણીકલાલ શાહ	પરિયા	ખેડૂત	9824141562	[illegible]	m
93	[illegible]	પરિયા	ખેડૂત.	9427946636	[illegible]	m

STAKEHOLDER CONSULTATION

Consultation Meeting

Attendance Sheet Place:

District Valsad

Date: Date 30/5/18

S.N	Name	Village	Designation	Contact number	Signature	
94	[illegible]	[illegible]	[illegible]	9979469171	[illegible]	m
95	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	m
96	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	m
97	[illegible]	[illegible]	[illegible]	6806928299	[illegible]	m
98	[illegible]	[illegible]	[illegible]	6806928299	[illegible]	m
99	[illegible]	[illegible]	[illegible]	7567591248	[illegible]	m
100	[illegible]	[illegible]	[illegible]	9825172662	[illegible]	F
101	[illegible]	[illegible]	[illegible]	9825532237	[illegible]	m
102	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	m

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Stake Holder Consultation Meeting

Attendance Sheet Place:

District Valsad

Date: Date 30/5/18

S.N	Name	Village	Designation	Contact number	Signature	
103	[illegible]	[illegible]	[illegible]	9879635480	[illegible]	m
104	[illegible]	[illegible]	[illegible]	9979305150	x H.C. Tamboli	m
105	[illegible]	[illegible]	[illegible]	-	[illegible]	m
106	[illegible]	[illegible]	[illegible]	9069717190	x Vimal B Patel	F
107	[illegible]	"	"	"	x Vimal B Patel	m
108	[illegible]	[illegible]	[illegible]	9913158488	[illegible]	m
109	[illegible]	[illegible]	[illegible]	9974993432	[illegible]	m
110	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	m
111	[illegible]	[illegible]	[illegible]	9925126650	[illegible]	F
112	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	F

Attendance Sheet

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Stake Holder Consultation Meeting

Place:

District: Valsad

Date:

Date: 30/5/18

S.N	Name	Village	Designation	Contact number	Signature	
113	Rajesh A. Ahir	Zaroli	Farmer	9377018570	Rajesh	
114	[illegible]	[illegible]	[illegible]	8980032152	C.K.Ahir	m
115	Mahendra [illegible]	[illegible]	[illegible]	9173616107	Mehul	m
116	[illegible]	[illegible]	[illegible]	9898484[illegible]	[illegible]	m
117	[illegible]	[illegible]	[illegible]	9904729162	[illegible]	m
118	[illegible]	[illegible]	[illegible]		[illegible]	m
119	Ashish O. Patel	Vapi Karwad	[illegible]	9512712598	[illegible]	F
120	Govindbhai M. Patel	Enderpada	Farmer	8140742527	[illegible]	m
121	Uttam [illegible] Patel	Andergota	Farmer	9925114086	[illegible]	m
122	Manhar P. [illegible]	Karvad	Farmer	9377776865	[illegible]	m

Attendance Sheet

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Stake Holder Consultation Meeting

Place:

District: Valsad

Date:

Date: 30/5/18

S.N	Name	Village	Designation	Contact number	Signature	
123	[illegible]	[illegible]	[illegible]	98444766[illegible]	[illegible]	
124	[illegible]	[illegible]	[illegible]	9662048088	[illegible]	m
125	[illegible]	[illegible]	[illegible]	9825259294	[illegible]	m
126	[illegible]	[illegible]	[illegible]			m
127	[illegible]	[illegible]	[illegible]	9978498[illegible]	[illegible]	m
128	[illegible]	[illegible]	[illegible]	8758359110	[illegible]	m
129	[illegible]	[illegible]	[illegible]	8347353590	[illegible]	F
130	[illegible]	[illegible]	[illegible]		[illegible]	F
131	[illegible]	[illegible]	[illegible]	9978914191	[illegible]	m
132	Ritesh P. [illegible]	[illegible]	[illegible]	9978208913	[illegible]	m
		[illegible]	[illegible]	9723733695	[illegible]	m

Attendance Sheet ... RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION
Consultation Meeting

Place:
District: [illegible]
Date: Date: [illegible]

S.N	Name	Village	Designation	Contact number	Signature	
133	[illegible]	[illegible]	[illegible]	02632-285-[illegible] M-[illegible]	D. R. Patel	m
134	[illegible]	[illegible]	[illegible]	8238250330	[illegible]	m
135	[illegible]	[illegible]	[illegible]	9825040997	[illegible]	m
136	[illegible]	[illegible]	[illegible]	9141852970	[illegible]	F
137	[illegible]	[illegible]	[illegible]	9574351122	D.V. Patel	m
138	[illegible]	[illegible]	[illegible]	8141572001	[illegible]	m
139	[illegible]	[illegible]	[illegible]	9909080700	[illegible]	m
140	[illegible]	[illegible]	[illegible]	9825574529	M.D. Patel	m
141	[illegible]	[illegible]	[illegible]	9825574529	D.M. Patel	m
142	[illegible]	[illegible]	[illegible]	09320055610	[illegible]	m

[illegible] 83

STAKEHOLDER CONSULTATION
Consultation Meeting

Attendance Sheet
Place:
District Valsad
Date: Date 30/5/18

S.N	Name	Village	Designation	Contact number	Signature	
143	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	m.
144	[illegible]	[illegible]	[illegible]	9925567252	[illegible]	m
145	[illegible]	[illegible]	[illegible]	9924137392	D Patel	m
146	[illegible]	[illegible]	[illegible]	9727169041	[illegible]	m
147	[illegible]	[illegible]	[illegible]	9819463672	[illegible]	m
148	[illegible]	[illegible]	[illegible]	9979402343	[illegible]	m
149	[illegible]	[illegible]	[illegible]	9925115788	M.B Patel	m
150	[illegible]	[illegible]	[illegible]	9825479575	K.T. Patel	m
151	[illegible]	[illegible]	[illegible]	9714470814	[illegible]	m.

...AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION

Attendance Sheet

Place:

Date:

Stake Holder Consultation Meeting

District: Valsad

Date: 30/5/18

S.N	Name	Village	Designation	Contact number	Signature	
152	કિશોરભાઈ છોટુભાઈ સુરતી	[illegible]	ખેડુત	9924304521	[illegible]	
153	કિશનભાઈ ખુશાલભાઈ પટેલ	[illegible]	ખેડુત	9879271780	[illegible]	m
154						m
155	[illegible]	[illegible]	ખેડુત	[illegible]	[illegible]	F
156	[illegible]	[illegible]	ખેડુત		[illegible]	
157	[illegible]	[illegible]	ખેડુત	9978312[illegible]	[illegible]	m
158	[illegible]	[illegible]	[illegible]	9712055471	[illegible]	m
159	[illegible]	[illegible]	ખેડુત		[illegible]	F
160	[illegible]	[illegible]	[illegible]	9426970989	[illegible]	F
161	Pramila Devi	[illegible]	11	8000103934	Ram prakash Pal	m

S.N	Name	Village	Designation	Contact number	Signature	
162	[illegible]	[illegible]	ખેડુત [illegible]	9712682917	[illegible]	m
163	[illegible]	[illegible]	11	9925742236	[illegible]	F
164	[illegible]	11	11	11	[illegible]	F
165	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	m
166	[illegible]	[illegible]	[illegible]	9427468990	[illegible]	m
167	[illegible]	[illegible]	[illegible]	9904827677	[illegible]	m
168	[illegible]	[illegible]	[illegible]	9099100747	[illegible]	m
169	[illegible]	[illegible]	[illegible]	9824123518	[illegible]	m
170	[illegible]	[illegible]	[illegible]	9[illegible]123234	[illegible]	m
171	[illegible]	[illegible]	[illegible]	967951[illegible]		m

Attendance Sheet Place: ...AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION Consultation Meeting District...Valsad Date...30/5/18

S.N	Name	Village	Designation	Contact number	Signature	
172	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
173	[illegible]	[illegible]	[illegible]	9099907176	[illegible]	m
174	[illegible]	[illegible]	[illegible]	9926314753	[illegible]	m
175	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	m
176	[illegible]	[illegible]	[illegible]	9223463399	[illegible]	m
177	[illegible]	[illegible]	[illegible]	9081956[illegible]	[illegible]	m
178	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	m
179	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	m
180	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	m
181	[illegible]	[illegible]	[illegible]	9586164925	[illegible]	m

Attendance Sheet Place: ...AHMEDABAD HIGH SPEED RAILWAY PROJECT- SECOND STAKEHOLDER CONSULTATION Consultation Meeting District......Valsad Date......[illegible]

S.N	Name	Village	Designation	Contact number	Signature	
182	Anila.N. Patel	Palan	Sarpanch	963880146[illegible]		
183	[illegible]	[illegible]	[illegible]	9687781780	A Patel	m
184	[illegible]	[illegible]	[illegible]	9879420833	B.P. Patel	m
185	NARUN GARG	KARVAD	11	9601188292	[illegible]	m
186	[illegible]	[illegible]			[illegible]	m
187	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	m
188	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	m
189	Mikesh C. Desai	Balda	[illegible]	[illegible]	[illegible]	m
190	[illegible]	Balda	Farmer	9820078866	[illegible]	m
191	Rajesh C. Desai	Balda	[illegible]	9820078866	[illegible]	m
		Balla	Farmer	-do-	[illegible]	m

STAKEHOLDER CONSULTATION

Stake Holder Consultation Meeting
District Navsari
Date 30-5-18

Attendance Sheet Place: Date:

S.N	Name	Village	Designation	Contact number	Signature	
192	Patel HARDIK	ANKHARA	[illegible]	8000535417	PatelH	M
193	Ronak. B. Desai	Khajurdi	[illegible]	9099493351	[illegible]	M
194	Jayesh. D. Patel	Sonwadi	Sarpanch.	989866120	[illegible]	M
195	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	M
196	[illegible]	[illegible]	[illegible]	9825109217	[illegible]	M
197	[illegible]	[illegible]	[illegible]	9824508082	[illegible]	M
198	[illegible]	[illegible]		8866079399	Rakesh	M
199	[illegible]	[illegible]	[illegible]	9819794871	[illegible]	M
200	Hitesh A. Desai	Kasvad	Farmer	9727759097	[illegible]	M

MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT- STAKEHOLDER CONSULTATION

Stake Holder Consultation Meeting
District Valsad
Date 30-5-18

Attendance Sheet Place: Date:

S.N	Name	Village	Designation	Contact number	Signature	
201	Sandip R. [illegible]	Eklera	Farmer	9978841121	[illegible]	M
202	Kaushal Patel	Khajurdi	Farmer	9033123360	K Patel	M
203	Chintan. N. Patel.	Khajurdi	farmer.	99799-17999	C. N. Patel	M
204	Suresh. P. Patel	Khajurdi	farmer	8141333782	[illegible]	M.
205	Jatin. P. Patel	[illegible]	Farmer	9311105534	Patel. J. P	M
206	Kamlesh D. Patel	Ambach	farmer	9426080463	K Patel	M.

Annexure-B

Brief Issues/concern raised during the Environment Information Disclosure & Public Consultation

Valsad (Gujarat)-30/05/2018	○ Affected Tree count is incorrect it will be approximate 6 lac, please check the exact figure.	The tree count incorporated in the report is based on the LIDAR data for the land falling under the RoW and not for the entire district. The physical counting is underway, and the result shall be updated in the Final S-EIA Report.
	○ Every farmer does not read the news paper. How they were informed?	The notice for the Public Consultation was published in the local news paper in local language (Gujarati). Further to give more publicity and awareness, every Panchayat was informed individually with a copy of the Summary of the Draft S-EIA Report in Gujarati (local language).
	○ Without permission HSR project work has been started since December 2017.	The official permission was taken during the Joint Feasibility Study Stage of the project in 2014-15 and in continuation to that the present study is being undertaken.
	○ For every meeting every farmer and affected people should get the agenda, booklets, pamphlets to all.	The Summary of the Draft S-EIA was made available at the Office of the District Collector and also to all Panchayats. Before start of the Public Consultation it has been distributed to all interested farmers in Gujarati.

Valsad EPC pictures

DNH-Silvasa

ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION PROCEEDING

It is hereby informed that environment information disclosure & public consultation at district level was organized in compliance to the JICA's Guidelines on Environmental and Social Consideration, April 2010 at District Silvasa at Community Hall, NaroliPanchayat, Silvasa on 15th April 2018, 1130 hrs for the proposed Mumbai-Ahmedabad High Speed Railway Project (MAHSR) implemented by National High Speed Rail Corporation Limited (A Joint Venture of Government of India and Participating State Governments).

National High Speed Rail Corporation Limited (NHSRCL) intends to implement the first ever bullet train in India under the Mumbai Ahmedabad High Speed Railway Project (MAHSR).

A notification for Environmental Information Disclosure & Public Consultation was published in the daily news paper Gujarat Samachar on 12-April-2018.

The public consultations were conducted after circulation of the executive summary of the Supplemental Environmental Impact Assessment (S-EIA) report in advance to the affected panchayat. During the public consultations, a detailed presentation was given on findings of S-EIA in local language, so that local public understand about the findings, such as project details, considered impact and its mitigation measures

A copy of the Summary of Draft S-EIA Report was also made available at District Collector Office,Silvasa for inspection to the public during normal office hours till the public consultation is over.

Comments / views of concerned persons having plausible stake in the environmental aspects of the Project were heard during the consultation meeting and they were requested to send their response in writing to the concerned district collectorate.

Smt. Soumya, RDC, Silvasa, supervised and presided over the entire Environmental Information Disclosure & Public Consultation process.

Following officials of District Administration and Project Authority were present in the Environmental Information Disclosure & Public Consultation meeting.

Officials of District Administration & Other Stakeholders

Smt. Soumya, RDC, Silvasa
Sh. T S Sharma, Mamlatdar, Silvasa
Sh N G Gandhi, DDA/SDS, Silvasa
Sh P Dinesh Kannan, DCF(T), Silvasa
Sh Ashwin Parihar, DCF(Wildlife), Silvasa
SmtSweta Sharma, Dr. A P J Abdul Kalam Govt. College, Silvasa
ShDharam Pal Meshram, Dr. A P J Abdul Kalam Govt. College, Silvasa
Dr. B Jha, Dr B B A Govt. Polytechnic, Silvasa
Sh Raman W Kanka, President, District Panchayat, Silvasa
Sh P D Patel, JE, PWD-II, Road, Silvasa
Sh D B Patel, AE-II, PWD-II, Road, Silvasa

<u>Officials of NHSRCL</u>
Mr. A K Gupta, Sr. Manager, CPM Office, Mumbai
Mr. Ingole, Dy. Collector (Retired), CPM Office, Mumbai

Mr A K Gupta, NHSRCL welcomed the dignitaries followed by introductory session by Mr. Pritesh Patel.

Mr Pritesh Patel, representative of M/s GPS Technologies Pvt. Ltd. gave the presentation highlighting project details and the key findings of the S-EIA study.

Upon completion of the presentation, RDC, Silvasa addressed the participants about the project and need of the public consultation and invited the participants to express their views, suggestions and issues related to environment, if any.

The list of the participants (attendance sheet) is attached as Annexure-A.

The issues raised by the participants during the Environmental Information Disclosure & Public Consultation along with the response of the NHSRCL is attached as Annexure-B (in English).

After the discussion session, RDC, Silvasa announced the closure of the Environmental Information Disclosure & Public Consultation.

Dy. Collector informed that the written response to the issues raised by the public shall be communicated by the Office of the District Collector, Silvasa.

Annexure-A

Attendance Sheet

ON ENVIRONMENTAL AND SOCIAL CONSIDERATION, APRIL 2010 AT DISTRICT SILVASA, DNH IN THE COMMUNITY HALL, NAROLI PANCHAYAT, ON 16-APRIL-2018 FROM 1130 HRS FOR THE PROPOSED MUMBAI-AHMEDABAD HIGH SPEED RAILWAY PROJECT (MAHSR) IMPLEMENTED BY NATIONAL HIGH SPEED RAIL CORPORATION LIMITED (NHSRCL).

LIST OF PARTICIPANTS PRESENT DURING THE ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION HELD ON 16-APRIL-2018 AT COMMUNITY HALL, NAROLI PANCHAYAT, SILVASA.

Sr. No.	Name	Address & Mobile No.	Signature
1	KARANBHAI. C. Patel	Kumbharwadi - Narol 9727100389[illegible]	Y Patel.
2	Rithis. m Patel	Kumbharwadi. Narol 7096110 46	Y [illegible]
3	Dorang. N. Rathod	Vad Faliya - 7567675444	[illegible]
4	Narendra Nanu Patel	Kumbharwadi -	NNP
5	Hemantbhai. R. Patel	Kumbharwadi. 9727344110	[illegible]
6.	Nirmal. m. Patel	Narol - Kumbharwadi 9904553062	y NmP
7.	Padmaben. P. Patel	Kumbharwadi. Narol 9998910866	Padma
8	Bhanumati. m. Patel	Kumbharwadi. Narol 971280137	[illegible]
9.	Lataben. N. Patel	Kumbharwadi Naroli	[illegible]
10	Harsinh. M. Solanki	Vad Faliya - Narol 9909135792 (9909135792)	[illegible]
11	Thakor. C. Patel	Vad Faliya Narol 9712276585	[illegible]
12	Arunaben R. Dumaniya	Navafaliya, Munivana M. 8140431139	[illegible]
13	Vijina. N. Patel	Kumbharwad. Narol. 7046019899	[illegible]
14	Namita P. marge	Kumbharwadi Naroli 9574086674	[illegible]
15	Prakash marge	"	" 9825943158	[illegible]
16	Nilesh. P. Solanki	Nava Faliya - Koshiwad (9315825)	[illegible]
17	Ashok. P. Solanki	Nava faliya. Narol 9825365027	[illegible]
18	Kamlesh D. Solanki	School falia - 9374833192	[illegible]
19	Mahendrasinh B. Puwar	Mori Faliya 8511108999	[illegible]
20	Dilip G. Parmar	Mori Faliya 9727860660	[illegible]
21	Smt. Pritiben. Nodiya	Sarpanch Narol 9824481685	P. J. Doda
22	Digishaben. H. Patel	BTS Panchayat Member	J. H. Patel
23	H. M. Chavda	C. E. O (DNH) 8487819999	[illegible]

Sr. No.	Name	Address & Mobile No.	Signature
24	T.S Sharma	Mamlatdar 9824598721	
25	N.G. Gandhi	DDA / SDSLO 9979374700	
26	P. D. Patil	J.E. PWD II (Road)	
27	D. B. Patel	A.E.II (PWD-II) Road	
28	Raman D. Konkna	(DP) President	
29	R. DINESH KANNAN	DCF (Territorial), Forest	
30	Ashum Parihar	DCF (Wildlife), Forest dept.	
31	Shweta Sharma	Dr. APJ AK Govt College	
32	Dharmpal Meshram	Dr. APJ Abdul Kalam Govt College	
33	Dr. B. Jha	Dr. BBA Govt. Polytechnic Karad	
34	Ramesh Patel	Kumbharwadi - Naroli	
35	Mayuruba Patel	9712443415	
36	M.B. Solanki	Naru Faliya	
37	R. M. Solanki	Naru Faliya 9924445010	
34	E. J. Gabriel	Lord Acapola [illegible]	
35	Kishor Bhanushi	Durga S. No. 25 Vapi	9374991671
36	Akash A Bhanushali	Durga S.No.25 Vapi	
37	Milan Solanki	Naru Faliya 9726[illegible]	
38	Bhagwansingh Solanki	Naru Faliya 9726104117	
39	Virendra Narain	Kumbharwadi 9869090901	
40	Rakesh. a. S[illegible]	Naru Faliya 9913602900	
41	Khalpabhai Rohit	Naru Faliya 9537921787	
42	Alkesh Rathod	Naru Faliya 7698547600	
43	Chauhan N.L.	Silvassa 9732559000	
44	Nailah Parmar	Hotel Plaza Kumbharwadi	93770090 41
45	R. P. Sinha	Bhilad 9234[illegible]	
46			
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48			
49			
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Annexure-B

Brief Issues/concern raised during the Environment Information Disclosure & Public Consultation

Silvasa (DNH)-16/04/2018	○ As an example of a recent project, NHAI stated that there will be a service road along NH and the villagers will be able to use the road. However, no road has been constructed.	For the MAHSR project the total width to be acquired is 17.5 metres, which includes the elevated viaduct structure of 13.5m width and a maintenance road (4m wide). The maintenance road will be necessary for the HSR and will be constructed along with the track. Since the maintenance road planned along the alignment will not be fenced near the villages / habitation, it will allow free movement of people and livestock across the alignment.
	○ Will there be any local employment generation	Various job opportunities shall be created during the construction, operation & maintenance of the MAHSR project. During the construction phase, locals shall be preferred depending their skill and qualifications as per prevailing law of land. New stations will also open new market and entrepreneurship opportunities for the local population. NHSRCL will provide skill training for employment or self-employment. NHSRCL will provide skill training for employment or self-employment.
	○ What will happen, if the onboard passengers use toilets? It may pose sanitation issue to the habitants located on either side of the MAHSR track.	The Shinkansen E5 series being used for MAHSR does not use conventional railway toilet system. The HSR will be a zero-discharge train and its toilet facilities will operate similar to those in commercial aircrafts.

DNH-Silvasa EPC pictures

Office of the District Collector, Palghar
Chintupada Rd, Udhyog Nagar, Palghar, Maharashtra 401404

ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION PROCEEDING

It is hereby informed that environment information disclosure & public consultation at district level was organized in compliance to the JICA's Guidelines on Environmental and Social Consideration, April 2010 in the campus of Shri. S T Kadam Medium Vidyalaya, Jivan Vikas Shikshan Sanstha, Boisar, Palghar on 2nd June 2018, 1000 hrs for the proposed Mumbai-Ahmedabad High Speed Railway Project (MAHSR) implemented by National High Speed Rail Corporation Limited (A Joint Venture of Government of India and Participating State Governments).

National High Speed Rail Corporation Limited (NHSRCL) intends to implement the first ever bullet train in India under the Mumbai Ahmedabad High Speed Railway Project (MAHSR).

A notification for Environmental Information Disclosure & Public Consultation was published in the daily news paper on 30-May-2018, 31-May-2018 and 01-June-2018 in Lokmat, Samarthan, Rajtantra news paper.

A copy of the Summary of Draft S-EIA Report was made available at District Collector Office, Palghar and also in each Panchayat for inspection to the public during normal office hours till the public consultation is over.

Individual notification was also circulated to each panchayat informing about the scheduled Environmental Public Consultation.

Comments / views of concerned persons having plausible stake in the environmental aspects of the Project were heard during the consultation meeting and they were requested to send their response in writing to the concerned district collectorate.

Shri. Dr. PrashantNarnaware, IAS, District Collector, Palghar, supervised and presided over the entire Environmental Information Disclosure & Public Consultation process.

Following officials of District Administration and Project Authority were present in the Environmental Information Disclosure & Public Consultation meeting.

<u>Officials of District Administration</u>

DrPrashantNarnaware, IAS, District Collector, Palghar
Sh Pandurang Magdum, Dy. Collector, Land Revenue Department, Palghar

<u>Officials of NHSRCL</u>

Mr. U.P. Singh, CPM, Mumbai
Mr. PankajUke, GM-Operations, CPM's office, Mumbai
Mr. A.K Gupta Sr. Manager, Mumbai
Mr. Ingole, Dy. Collector (Retired), CPM Office, Mumbai
Mr. RP Singh, Project Manager, Civil

The list of the participants (attendance sheet) is attached as Annexure-A.

Smt. Deepa Rajendra Shinde welcomed the dignitaries and respected citizen of Plaghar district present in the Public Consultation. Smt. Shinde then started the presentation detailing the various components of the project and the findings of the S-EIA study.

During the presentation, some of the stakeholder present in the audience started raising concerns of inadequate advance notice. It was clarified by the officials of JICC / NHSRCL Mumbai that notices were sent to Panchayats informing about the meeting. It was also informed that the full S-EIA report will be made available on the NHSRCL website.

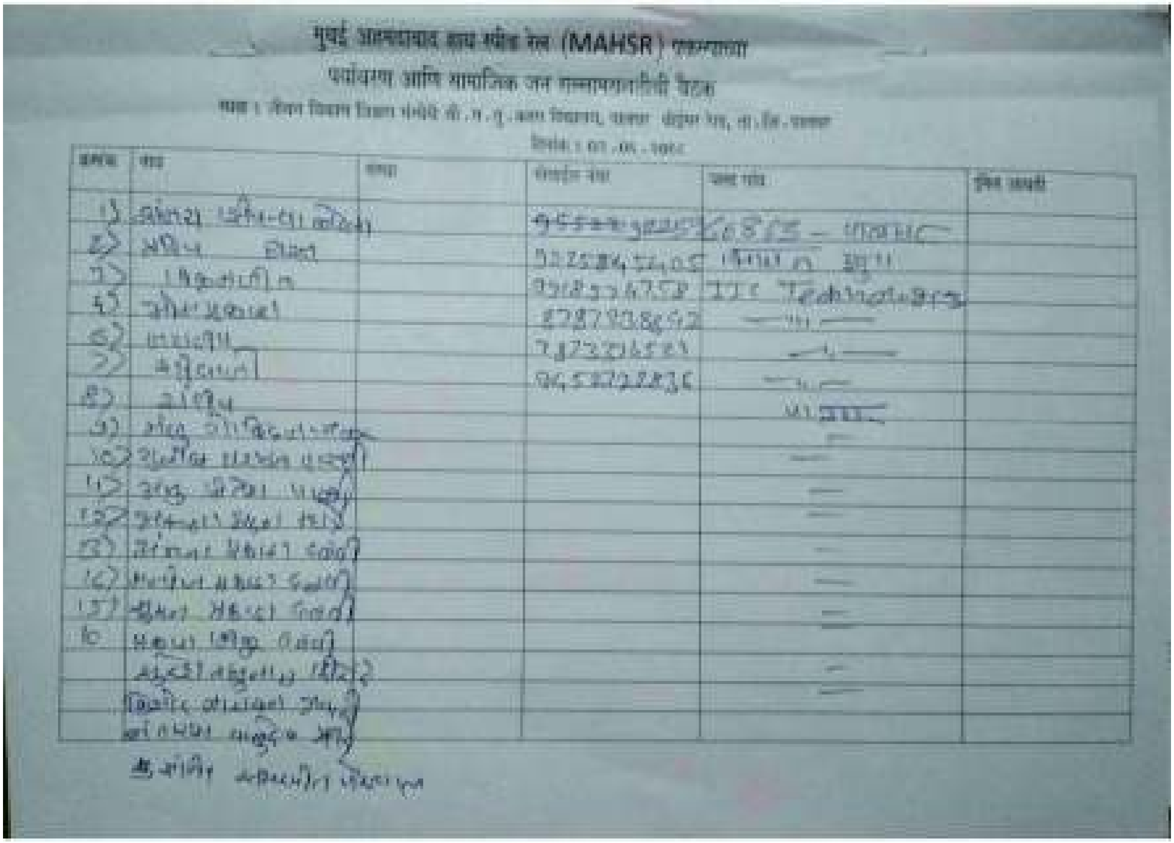
Others stakeholder also raised their concerns about the advance disclosure of the EIA related documents in Marathi language. JICC person clarified that the report being technical is in English. However, the executive summary is already available in Marathi.

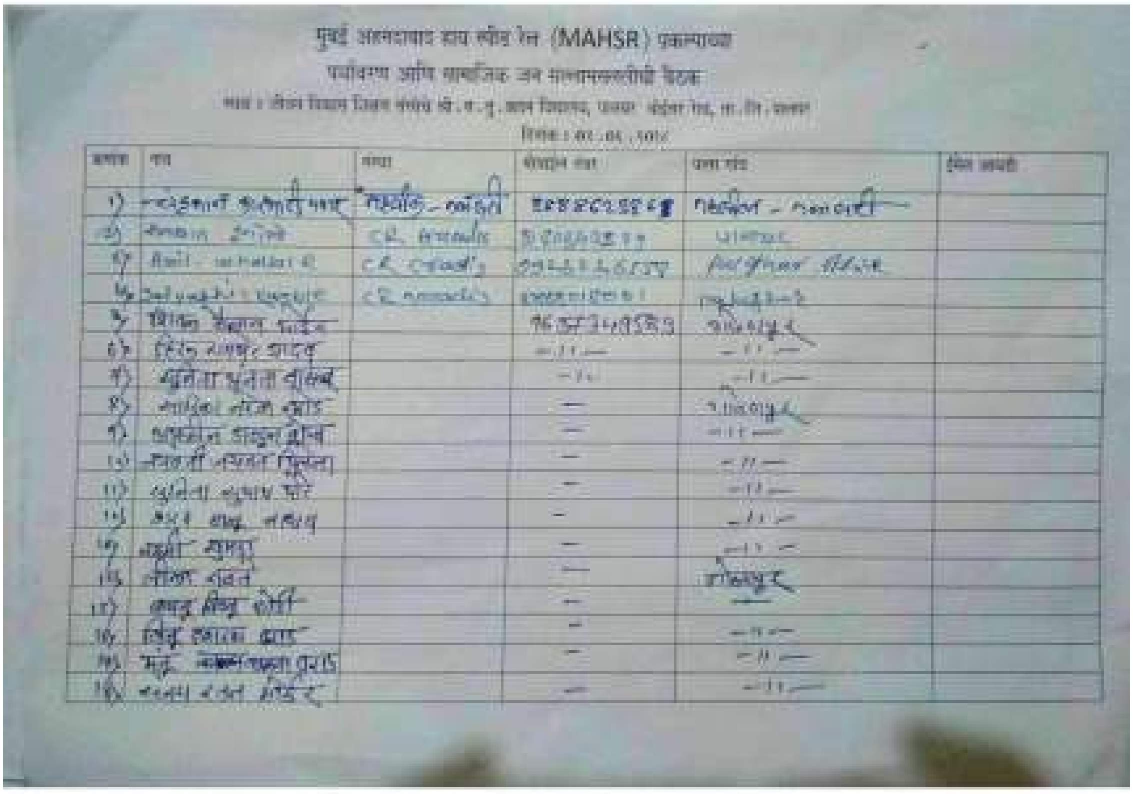
After hearing the concern of the participants, Hon'ble District Collector, while in his concluding remark on Environmental and Social Public Consultation District, thanked people for participating in the consultation and suggested that, if required, project authority may continue information dissemination in the village panchayat in coming days. He also assured the audience that their concerns will be communicated to the Central Government as well as NHSRCL HQ.

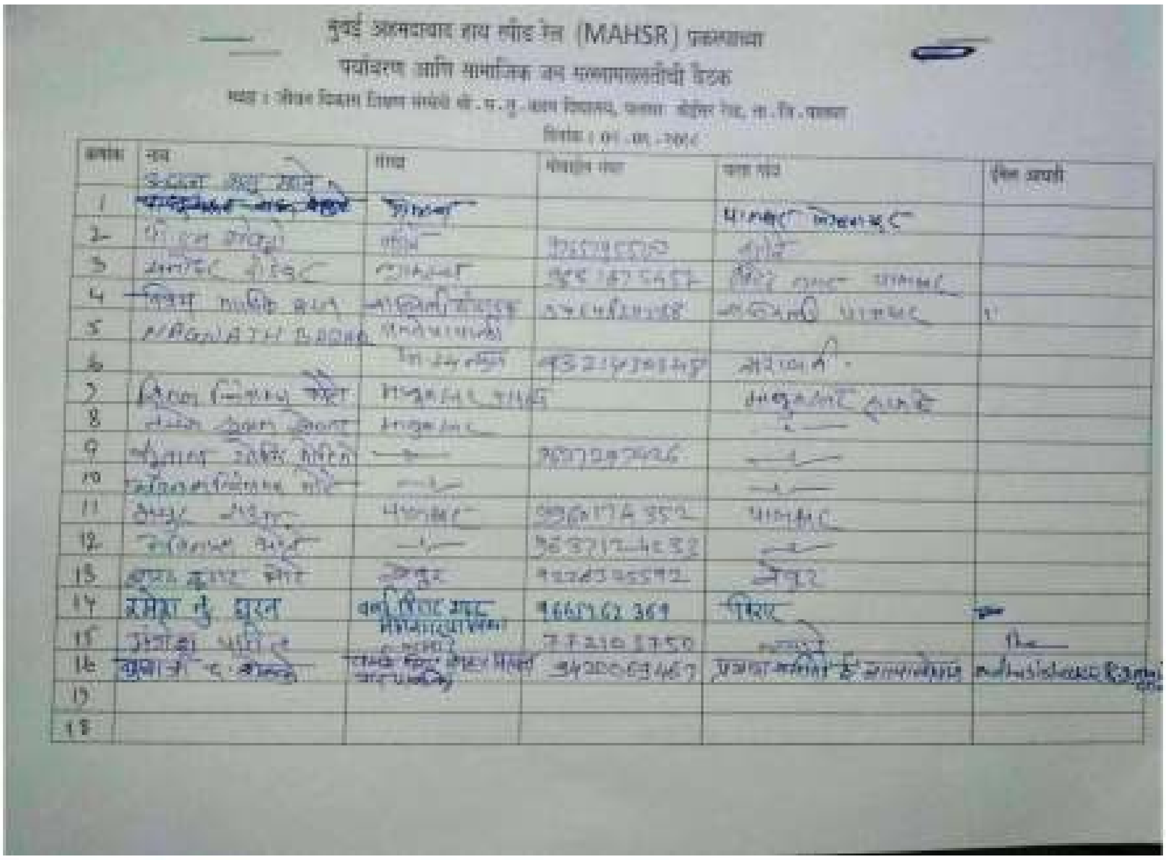
The issues raised during the proceeding of the Environmental Public Consultation and response of the NHSRCL is attached as Annexure-B.

Annexure-A

Attendance Sheet



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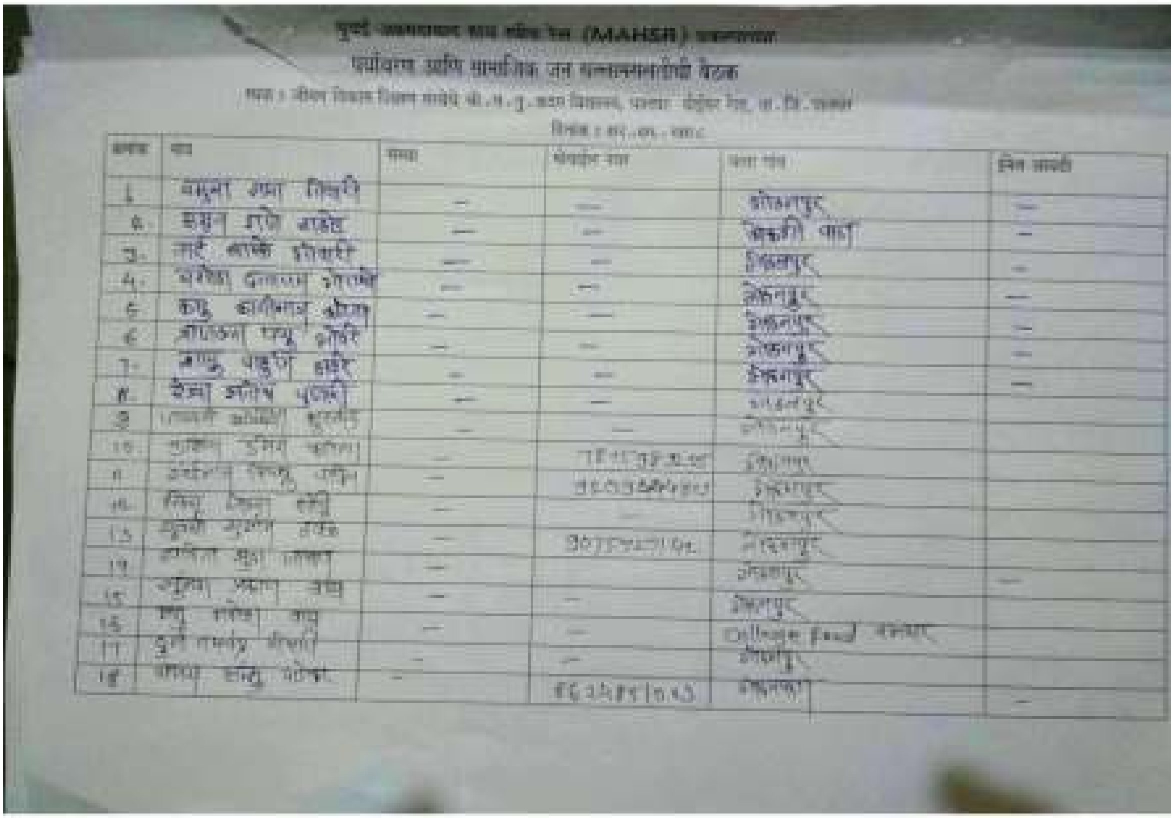
पर्यावरण आणि सामाजिक जन सल्लामसलतीची बैठक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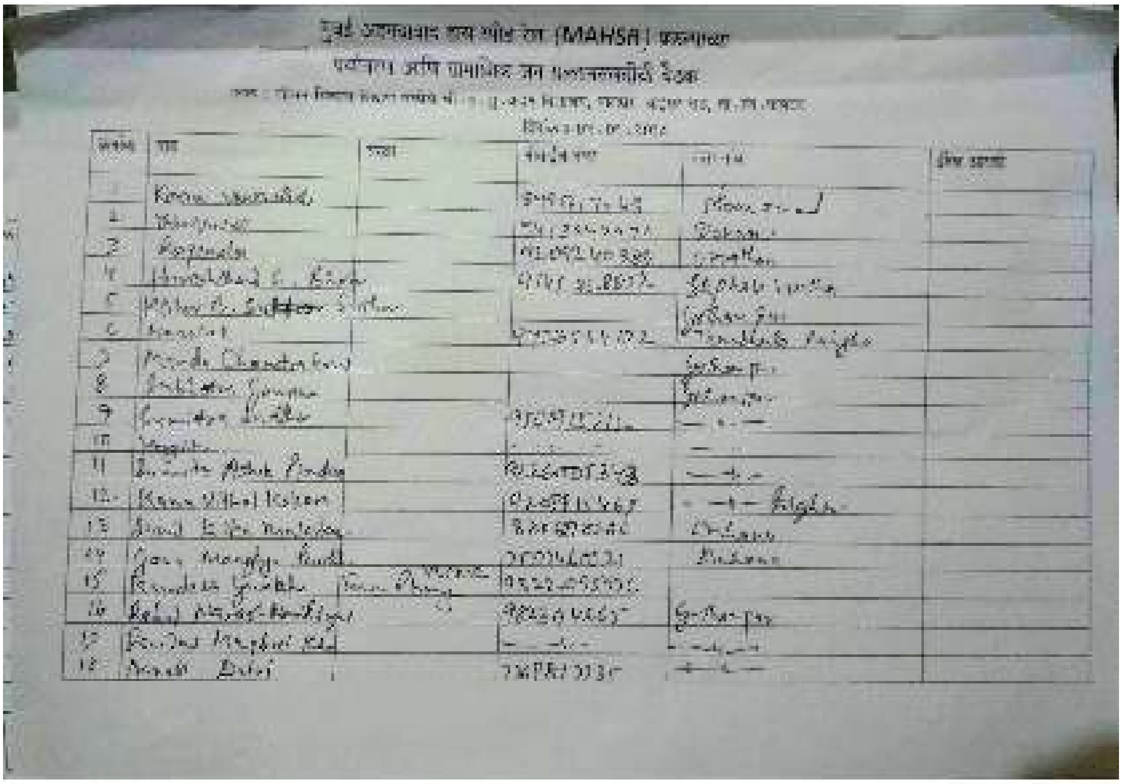
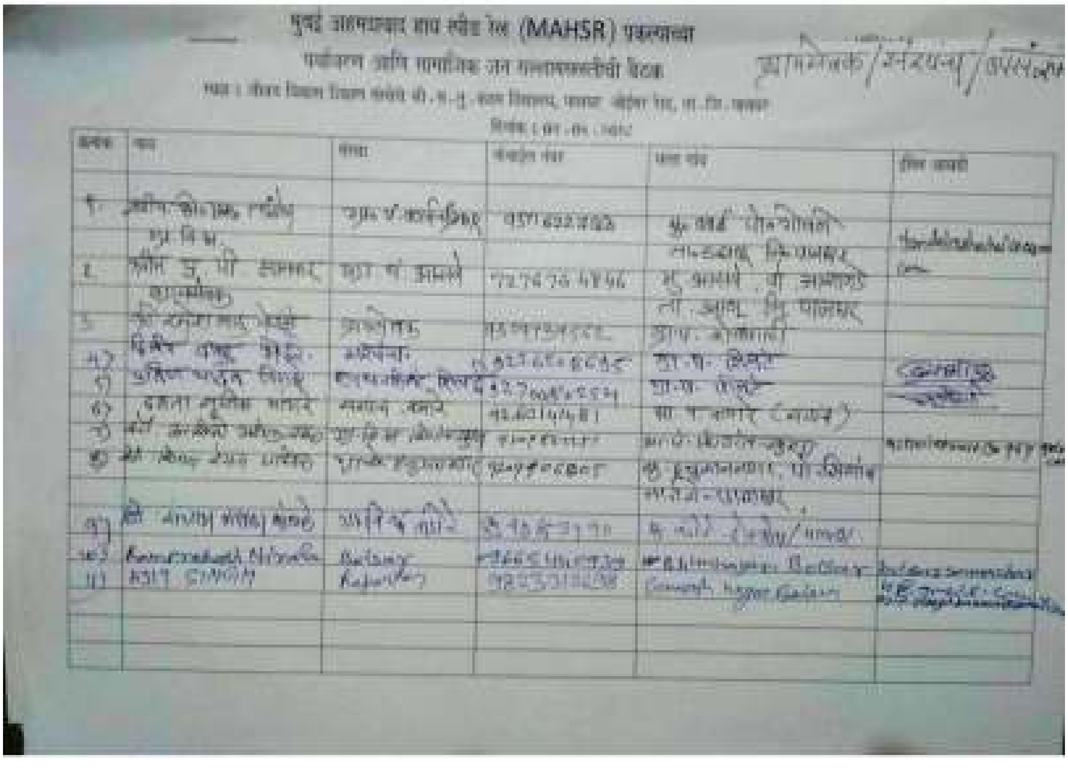

(MAHSR)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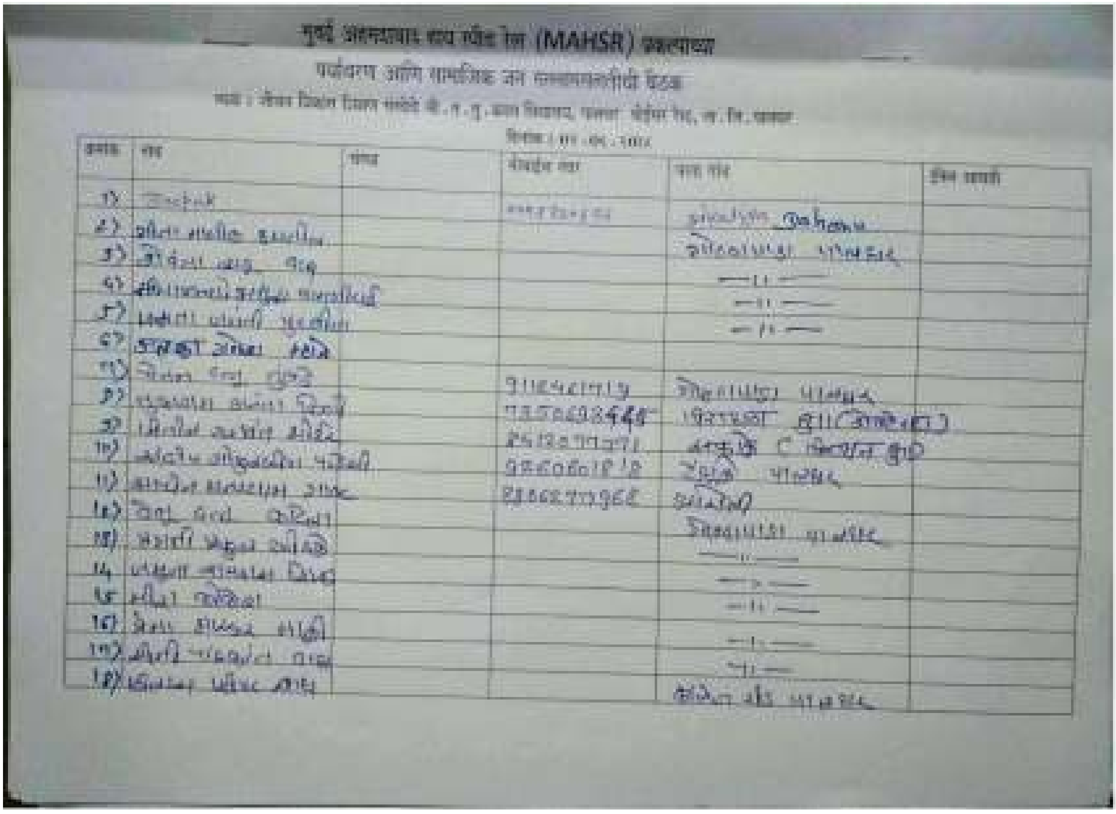
पर्यावरण आणि सामाजिक जन सल्लामसलतीची बैठक



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पर्यावरण आणि सामाजिक जन सल्लामसलतीची बैठक

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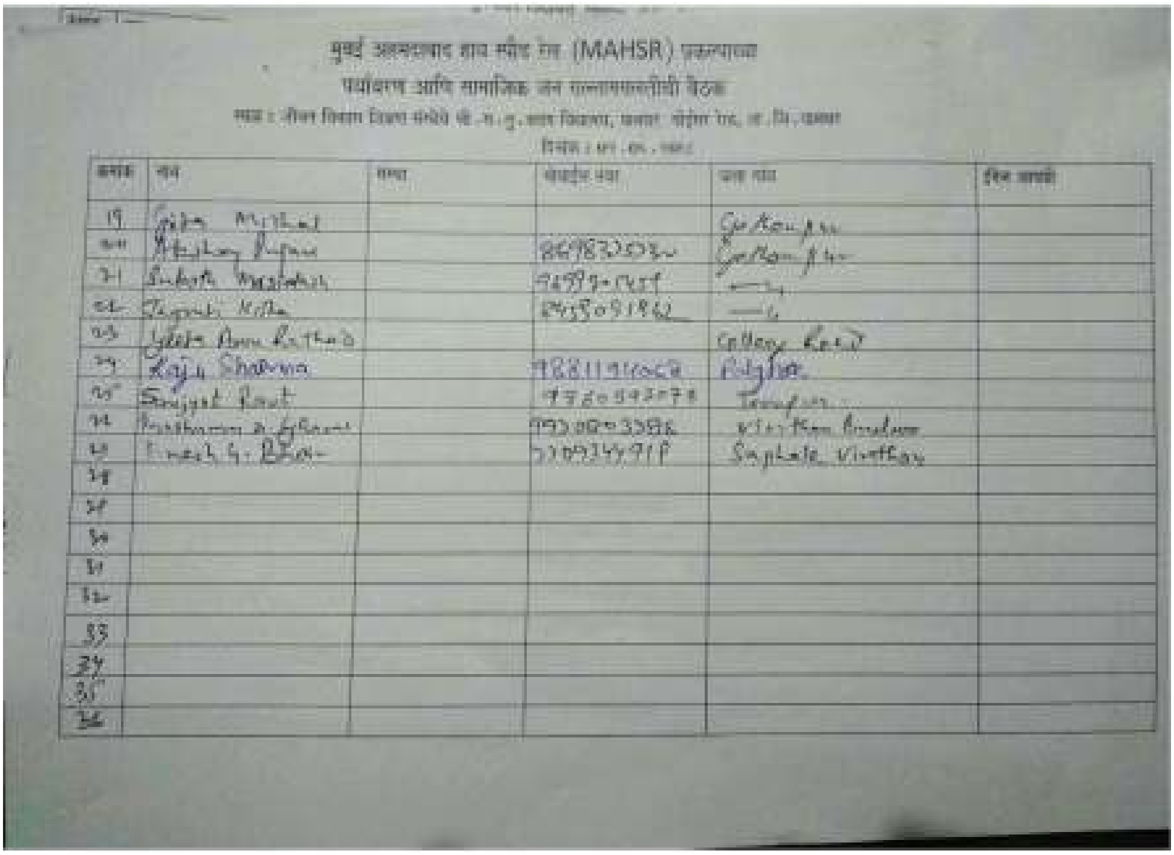

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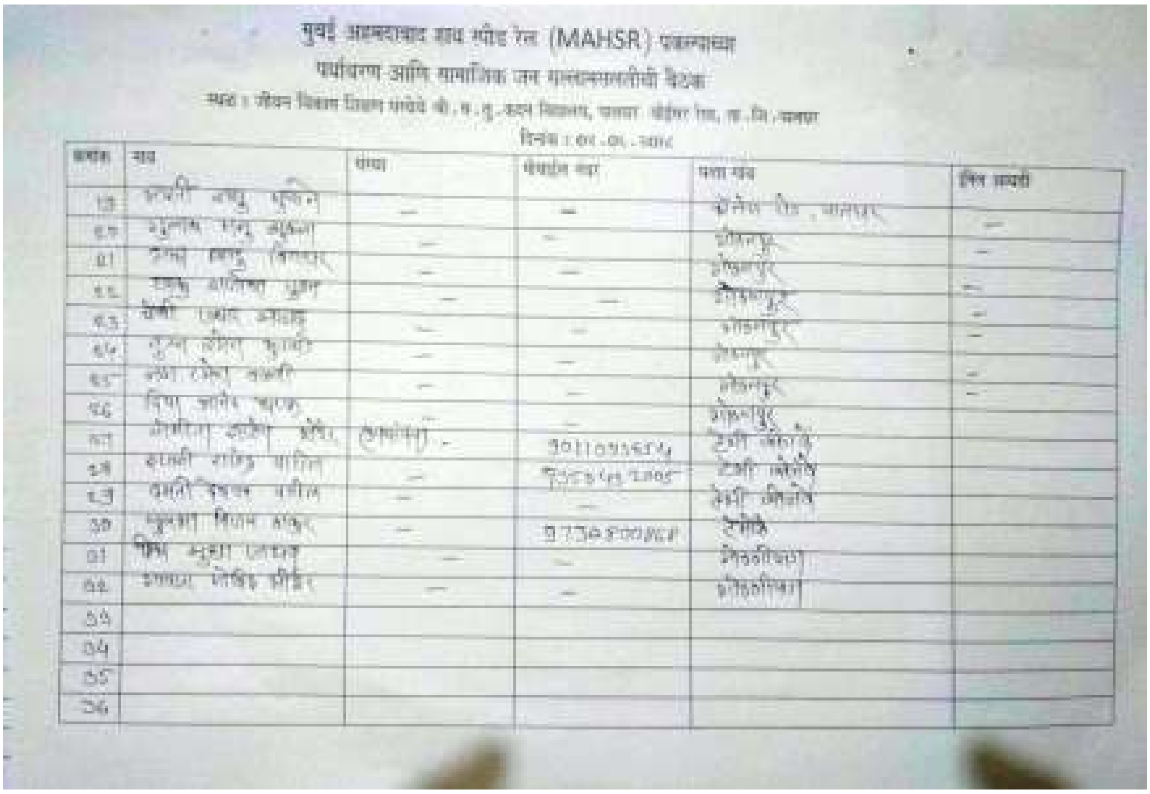
पर्यावरण आणि सामाजिक जन सल्लामसलतीची बैठक

क्रमांक	नाव	संस्था	मोबाईल नंबर	गाव नाव	ईमेल आयडी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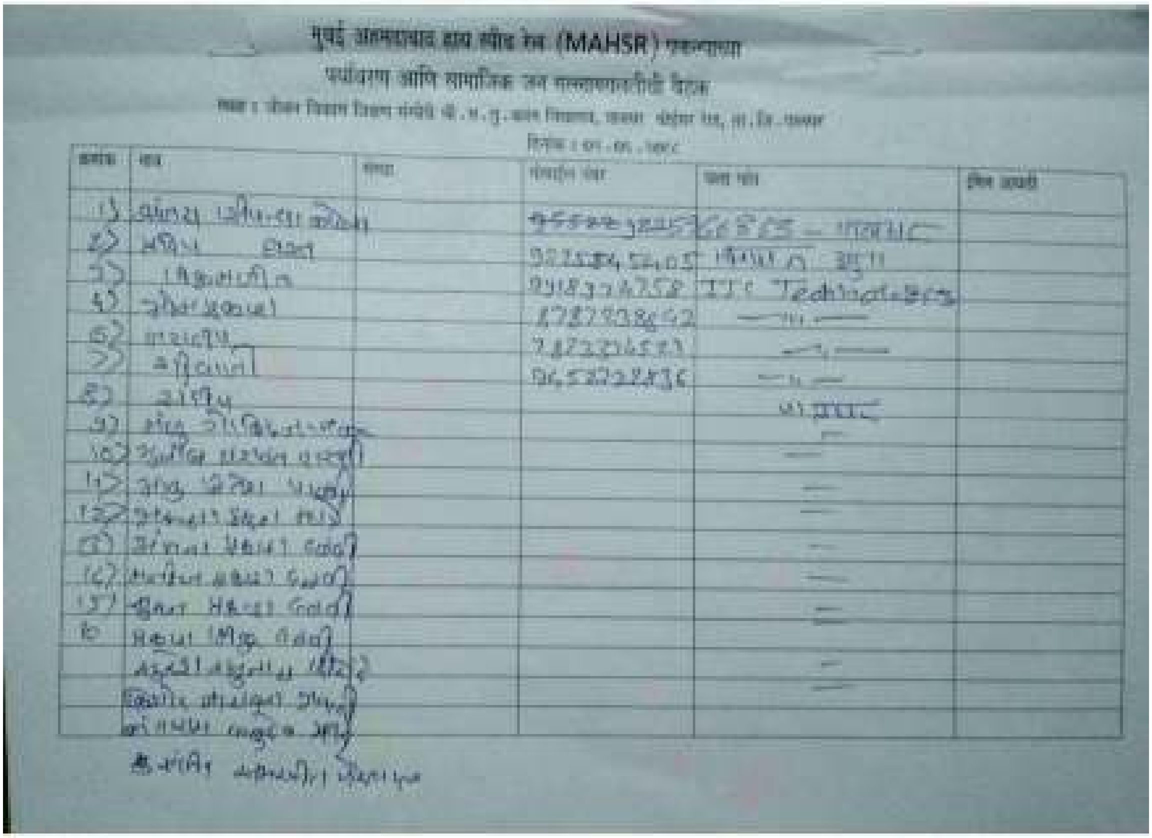
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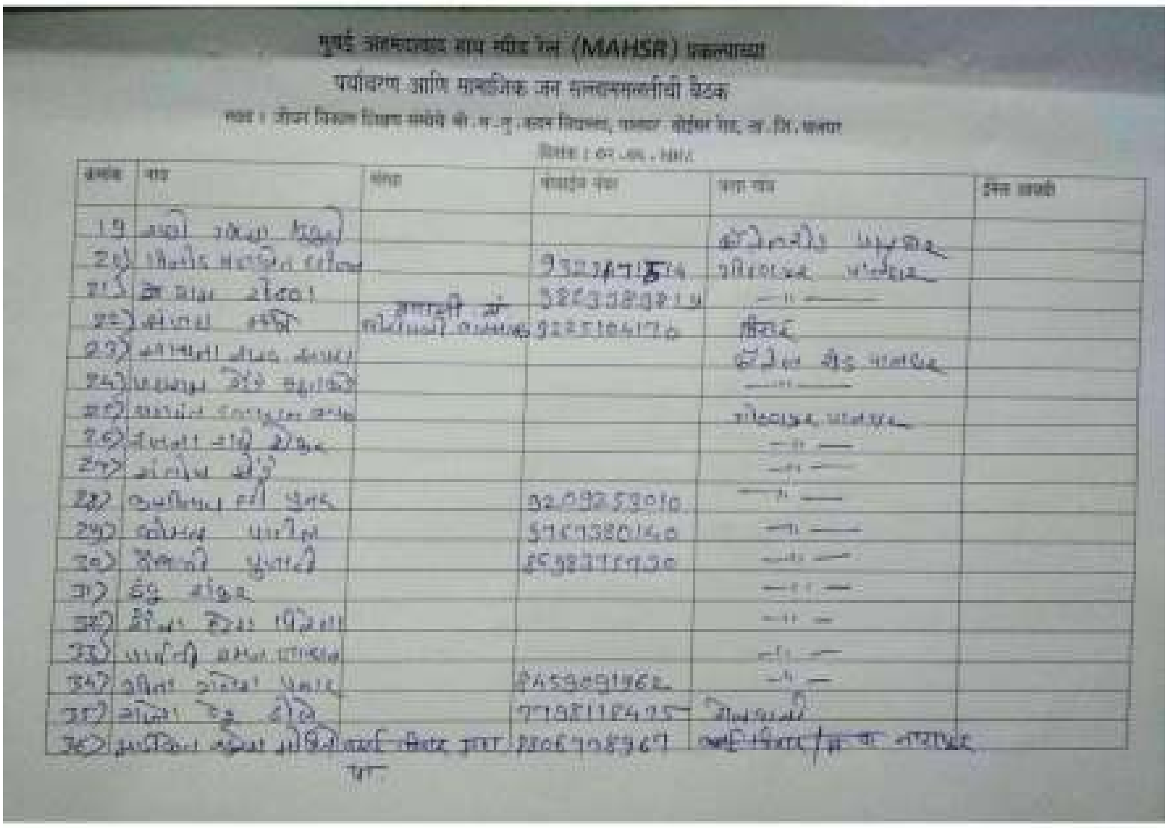
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पर्यावरण आणि सामाजिक जन सल्लामसलतीची बैठक
क्रमांक
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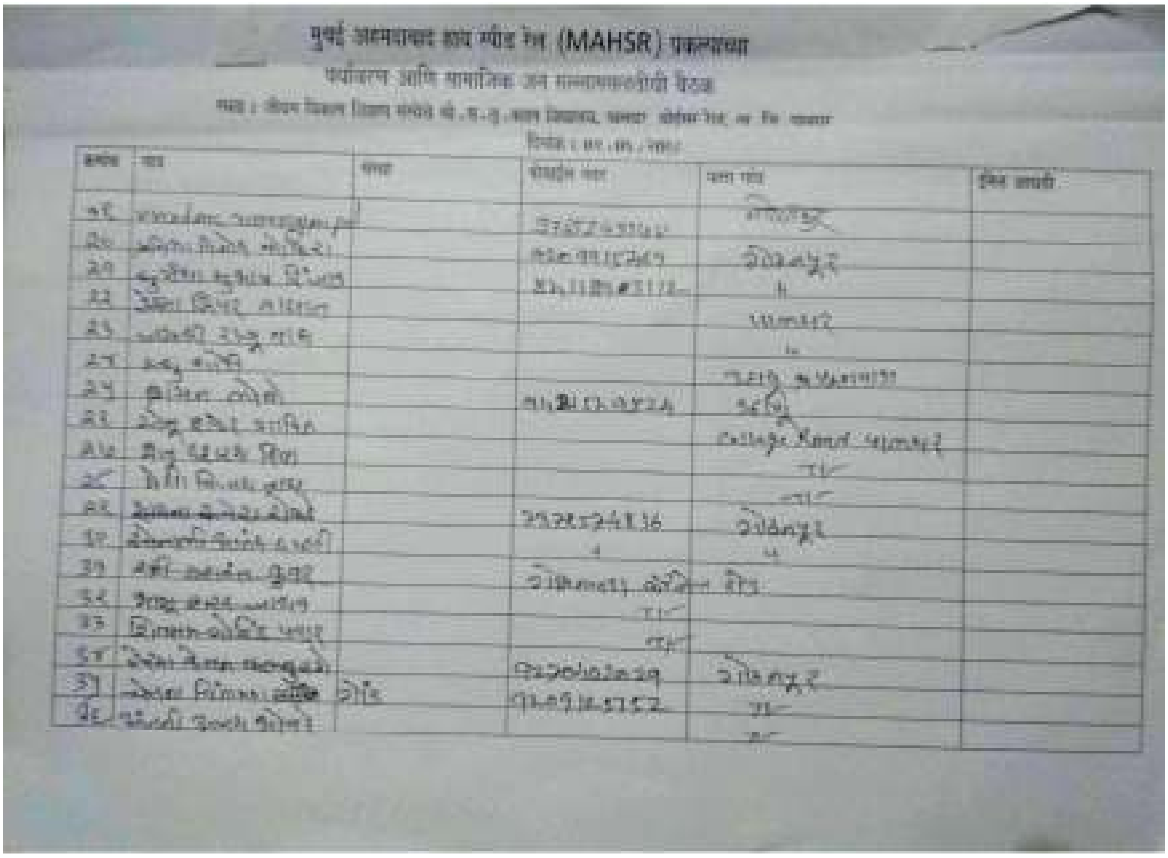
संस्था
मोबाईल नंबर
पत्ता गाव
ईमेल आयडी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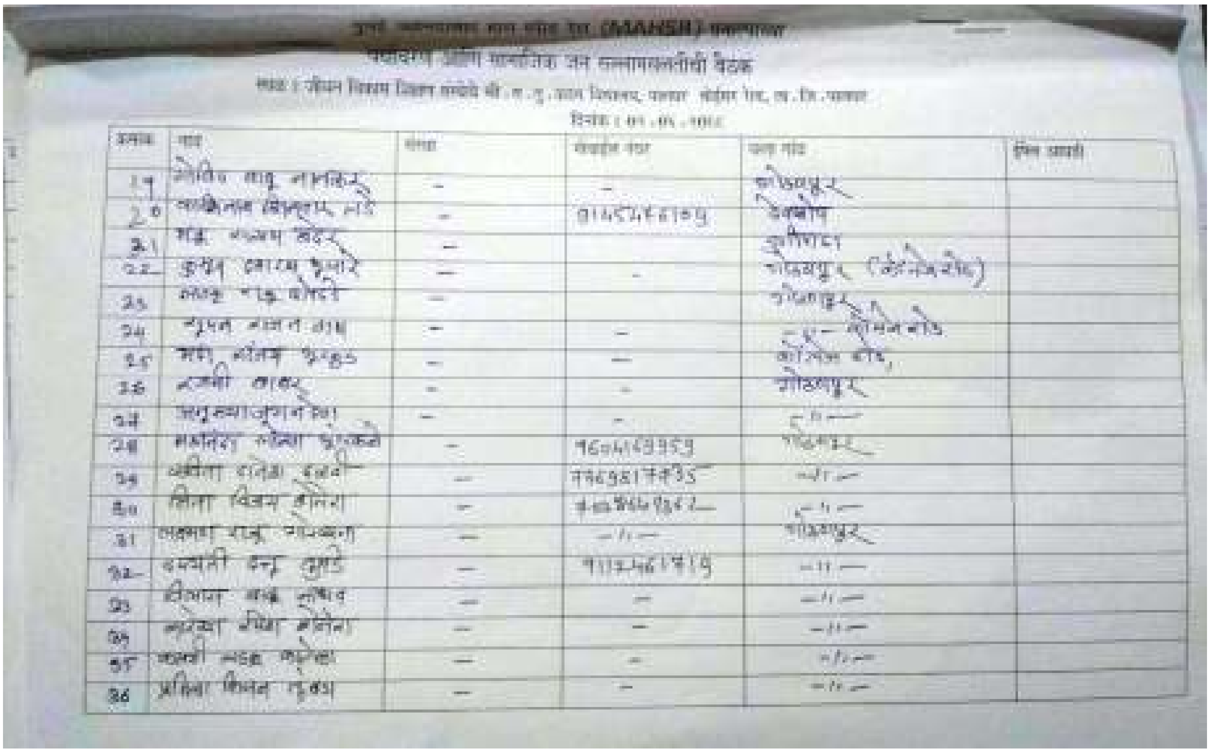
पर्यावरण आणि सामाजिक जन सल्लामसलतीची बैठक
क्रमांक
नाव
संस्था
मोबाईल नंबर
पत्ता गाव
ईमेल आयडी



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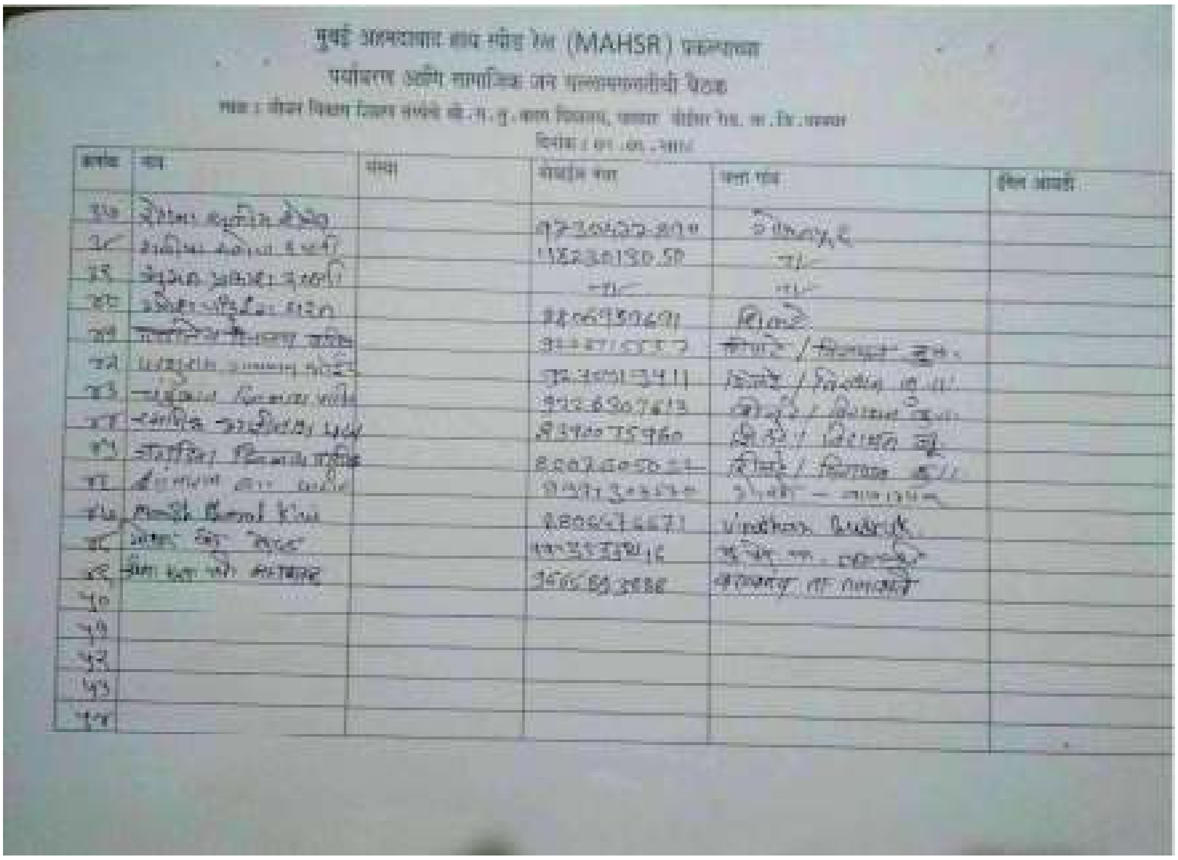

अनुक्रमांक	नाव	संस्था	मोबाईल नंबर	पत्ता गाव	ईमेल आयडी
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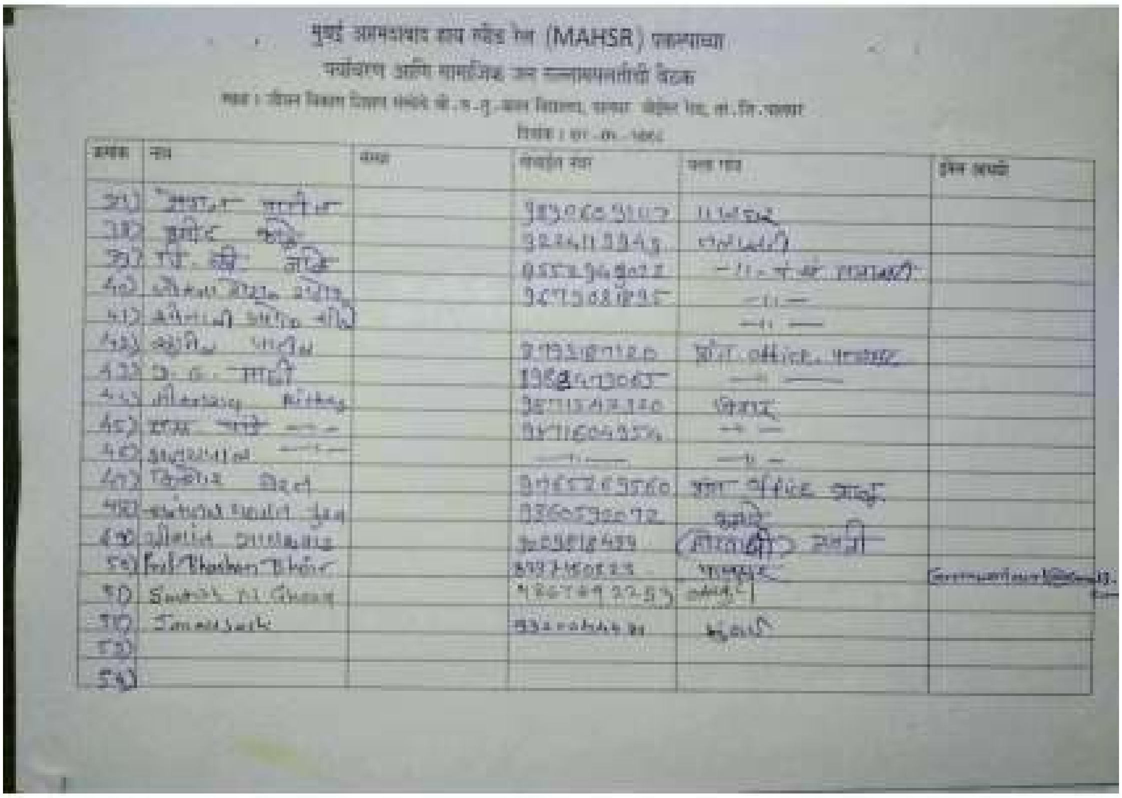
५४					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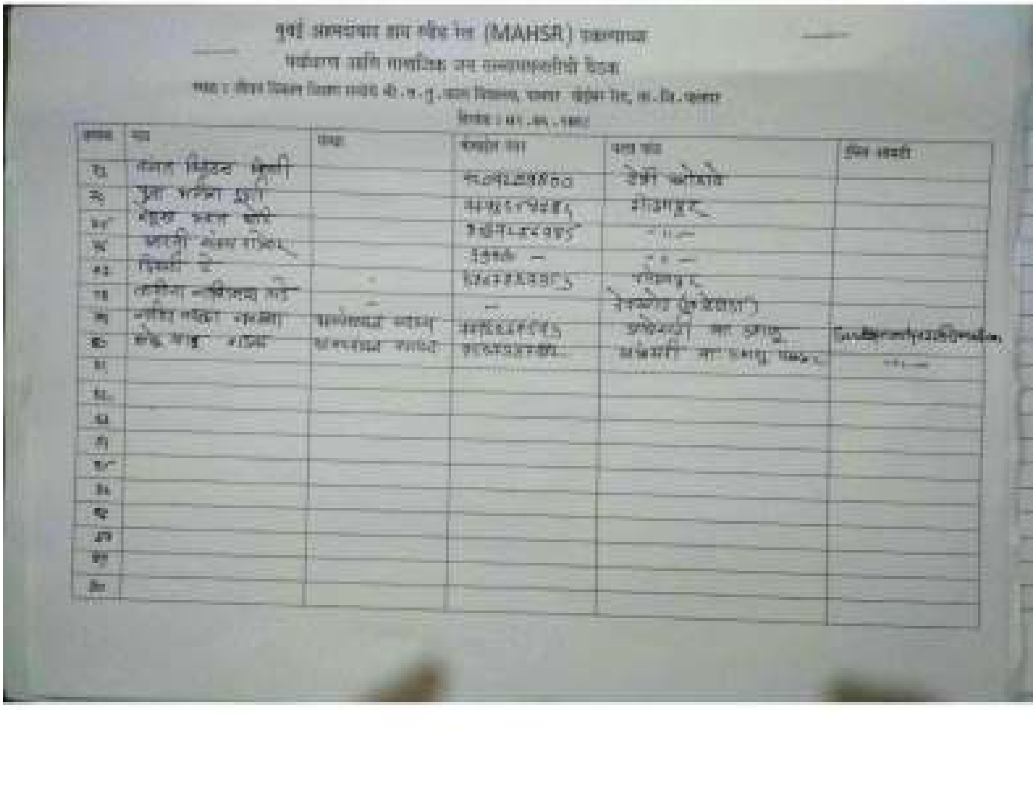
पर्यावरण आणि सामाजिक जन सल्लामसलतीची बैठक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पर्यावरण आणि सामाजिक जन सल्लामसलतीची बैठक

मुंबई अहमदाबाद हाय स्पीड रेल (MAHSR) प्रकल्पाच्या

पर्यावरण आणि सामाजिक जन सल्लामसलतीची बैठक

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दिनांक : [illegible]

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५४	[illegible]	-	-	-	

मुंबई अहमदाबाद हाय स्पीड रेल (MAHSR) प्रकल्पाच्या

पर्यावरण आणि सामाजिक जन सल्लामसलतीची बैठक

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दिनांक : [illegible]

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५९	[illegible]		-	-॥-	
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७२	[illegible]	-	9970693525	-॥-	

Annexure-B

Issues raised during the Environmental Information Disclosure and Public Consultation

Palghar (Maharashtra) -02/06/2018	○ NHSRCL promised to disclose the information and distribute Summary of S-EIA in advance. But no such documents were made available to the public. The local tribal people have lost today's wages due to this meeting.	The project authority clarified that adequate advance notifications were published in the local news paper and also it was individually sent to each affected Panchayats. The disclosure document i.e. the Summary of the Draft S-EIA Report (English and Marathi) was also made available at the Office of the District Collector and every Panchayat.
	○ People representative demanded to give complete project information in local languages (Marathi) to all persons and suggest the conduct of the Public hearing meeting only after giving proper and complete information to all the people.	Adequate and complete project information is disclosed in the Summary of Draft S-EIA Report. The suggestions and concern of the public shall be incorporated in the S-EIA report and uploaded on the NHSRCL website in public domain. The revised and updated Summary (in English and local language) shall be made available in the public domain. EIA being a continuous process, it can be further updated based on the suggestions/ observations received from the stakeholders.
	○ A cumulative EIA study should be taken up for the entire Palghar District because a number of government projects are planned in/through Palghar district	This is the policy matter related to the Government decision.
	○ People demanded the EIA report in Marathi language.	As per the E&S guidelines of JICA, only Executive Summary of the S-EIA Report in local language shall be uploaded on the website. The S-EIA Report, in English, shall be available in NHSRCL offices for review.
	○ There are total 73 gram panchayats in Palghar district. Executive summary of EIA should be given to all gram panchayats.	The project authority confirmed that the Summary of the Draft S-EIA Report was made available to each Panchayat in Palghar District.
	○ The people suggested the	The present Mumbai-Ahmedabad High

	proposed budget of the bullet train should be used for strengthening and upgrading the existing Indian Railway System instead of constructing the bullet train	Speed Railway Project has been sanctioned for implementation as per the finding of the "INDIAN RAILWAY VISION 2020". The modernisation and augmentation of the existing railway system is underway. It will be start of new era in the public transport. Every Indian should be proud of having Bullet Train in the country.
	○ The people demanded to cancel the public consultation	The DC assured the public that their concern/suggestions shall be addressed satisfactorily within the E&S framework of JICA.

Palghar EPC pictures

Office of the District Collector, Thane
Court Naka, Thane (West), PIN:400 601

ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION PROCEEDING

It is hereby informed that environment information disclosure & public consultation at district level was organized in compliance to the JICA's Guidelines on Environmental and Social Consideration, April 2010 at Rame Ganesh Gadkari Rangyatan, Thane (W) on 29th May 2018, 1100 HRS for the proposed Mumbai-Ahmedabad High Speed Railway Project (MAHSR) implemented by National High Speed Rail Corporation Limited (A Joint Venture of Government of India and Participating State Governments).

National High Speed Rail Corporation Limited (NHSRCL) intends to implement the first ever bullet train in India under the Mumbai Ahmedabad High Speed Railway Project (MAHSR).

A notification for Environmental Information Disclosure & Public Consultation was published in the daily news paper Maharashtra Times on 14-May-2018 and repeated on 21-May-2018 in Lokmat Times.

A copy of the Summary of Draft S-EIA Report was made available at District Collector Office, Thane for inspection to the public during normal office hours till the public consultation is over.

Comments / views of concerned persons having plausible stake in the environmental aspects of the Project were heard during the consultation meeting and they were requested to send their response in writing to the Office of District Collector, Thane.

Dr Shivaji Patil, Resident Deputy Collector, Thane supervised and presided over the entire Environmental Information Disclosure & Public Consultation process.

Following officials of District Administration and Project Authority were present in the Environmental Information Disclosure & Public Consultation meeting.

Officials of District Administration & Other Stakeholders
Dr Shivaji Patil, Resident Deputy Collector, Thane
Sh Pardeshi Sudam, SDO, Thane
Dr Santosh Thite, SDO, Bhiwandi

Officials of NHSRCL
Mr. U. P Singh, CPM, Mumbai
Mr. A K Gupta, Project Manager (Mech)
Mr. R P Singh, Project Manager (Civil)
Mr. Manoj Gupta
Mr. Ashok Mali,
Dr Ramesh Salunke

Sh R P Singh, Project Manager, NHSRCL welcomed the dignitaries and introduced the officials of NHSRCL, JICC and GPS.

Ms. Deepa Rajendra Shinde, representative of M/s GPS Technologies Pvt. Ltd. gave the presentation highlighting project details and the key findings of the S-EIA study.

Upon completion of the presentation, RDC, Thane, addressed the participants about the project and need of the public consultation and invited the participants to express their views, suggestions and issues related to environment, if any.

The issues raised by the participants during the Environmental Information Disclosure & Public Consultation along with the response of the NHSRCL is attached as Annexure-A.

After the discussion session, RDC, Thane announced the closure of the Environmental Information Disclosure & Public Consultation.

Dy. Collector informed that the written response to the issues raised by the public/stakeholders shall be communicated by the Office of the District Collector, Thane and shall be made available in public domain.

Annexure-A

Brief Issues/concern raised during the Environment Information Disclosure & Public Consultation

Thane (Maharashtra) -29/05/2018	○ ZSI did not take any field visit and the impact on the entomology has not been studied	Mr. Rahul Datar, JICC responded and confirmed that the ZSI started the field study from June 2017 and continued till February 2018. The outcome of the study has been incorporated in the S-EIA report.
	○ Whether endangered species have been identified or not?	Detailed biodiversity study has been conducted by the expert and the finding has been incorporated in the S-EIA Report comprising listing of encountered flora and fauna as per IUCN list.
	○ Impact on the river width due to constriction of bridge and danger of flood due to obstruction in water flow	100 years data of water flow and flood including the HFL have been taken into account for development of design of the bridge.
	○ As per the figure brought out in the Executive Summary about 10% of the mangrove area shall be cleared	Mangrove cutting permission shall be obtained from the Bombay High Court. As per the directive of the Forest Department, Mangrove Cell of Thane and Mangrove Conservation Unit, Mumbai, the compensatory afforestation shall be undertaken at the identified land allocated by the District Collector.
	○ Impact on the Flamingo and migratory bird at Thane Creek	During the study period spanning from June 2017 to February 2018, ZSI team did not observe any impact on the flamingo population due to existing traffic movement across the Vashi bridge. However, detailed monitoring schedule has been planned during construction and operation phase of MAHSR project. The counter measures and conservation management plan have been detailed in the "Study on Faunal Components and Management and Conservation plan for Thane Creek Flamingo Sanctuary" prepared by Zoological Survey of India, MoEFCC, Government of India, Kolkata. After the review of the monitoring result, if any adverse impact is observed, the mitigation measures shall be revisited and strengthened suitably.
	○ Impact on wildlife habitat and wildlife corridor as	The MAHSR alignment passes through ESZ of TWLS and SGNP and does not

	the project alignment passing through the ESZ of SGNP and TWLS. There is leopard migratory route.	intersect the Core Zone in the form of Viaduct and also through the Core Zone and ESZ of Thane Creek Flamingo Sanctuary in a tunnel. No physical disturbance is anticipated to this wildlife habitat. The proposal for permission from the Standing Committee of NBWL has been submitted for TCFS, TWLS and SGNP. The proposed MAHSR alignment passes through the ESZ of SGNP and TWLS through viaduct and wildlife movement would not be affected.
	o What will be the effect on the aquifer and ground water due to tunnel?	During the hydro-geological study, drilling was done up to 70 m below the bed of the creek, aquifer was not encountered. The basaltic rock in solid form was recovered during the drilling, continuously up to 70 m. Therefore, no any adverse impact is envisaged on the aquifer and ground water body.
	o What is the protection plan for the water bodies (pond & lake)?	Adjustment of span shall be done during the construction phase to save the water bodies.
	o What is the Solid Waste Management?	Every effort shall be made to reuse the construction debris to the extent possible. If it is inevitable, the solid waste shall be handled as per C & D Rule 2016 and SWM Rules 2016.
	o Local employment	The priority shall be given to the local people depending on the skill and capability of the person. Detailed skill development and livelihood programme has been framed in the SIA.
	o Whether traffic planning has been done for proposed HSR station?	Most of the HSR stations have been planned in the outskirts of the city areas close to the existing roads, which will not pose any load on the existing infrastructure of the local bodies. The access road shall be part of the RoW envisaged for the MAHSR Project. However, local bye laws and guidelines suggested in the Development Plan of the city shall be followed.
	o Impact on flamingo due to construction induced vibration	The MAHSR alignment passes through the Thane Creek Flamingo Sanctuary in a tunnel 30 m below the bed of the creek. A scientific study has been carried out by the Japanese Expert team to study the impact of vibration due to construction of tunnel and it has been concluded that the

		construction induced vibration is unlikely to propagate up to the creek surface. Therefore, no adverse impact on the flamingo sanctuary is envisaged.

Thane EPC pictures

Office of the District Collector, Mumbai Suburban
10th Floor, Administrative Building, Near Chetna College, Government Colony, Bandra East, Mumbai, Maharashtra 400051

ENVIRONMENT INFORMATION DISCLOSURE & PUBLIC CONSULTATION PROCEEDING

It is hereby informed that environment information disclosure & public consultation at district level was organized in compliance to the JICA's Guidelines on Environmental and Social Consideration, April 2010 at Conference Hall, Office of the District Collector, Mumbai Suburban District, 10th Floor, Administrative Building, Near Chetna College, Government Colony, Bandra (E)on 30th May 2018, 1600hrs for the proposed Mumbai-Ahmedabad High Speed Railway Project (MAHSR) implemented by National High Speed Rail Corporation Limited (A Joint Venture of Government of India and Participating State Governments).

National High Speed Rail Corporation Limited (NHSRCL) intends to implement the first ever bullet train in India under the Mumbai Ahmedabad High Speed Railway Project (MAHSR).

A notification for Environmental Information Disclosure &Public Consultation was published in the daily news papersMaharashtra Timesand Lokmaton 21-May-2018.

A copy of the Summary of Draft S-EIA Report was made available at the Office of the District Collector, Mumbai Suburban for inspection to the public during normal office hours till the public consultation is over.

Comments / views of concerned persons having plausible stake in the environmental aspects of the Project were heard during the consultation meeting and they were requested tosend their response in writing to the Office of the District Collector.

Sh. RajendraBorkar, Resident Deputy Collector, Mumbai Suburban supervised and presidedover the entire Environmental Information Disclosure & Public Consultation process.

Following officials of District Administration and Project Authority were present in the Environmental Information Disclosure & Public Consultation meeting.

Officials of District Administration& Other Stakeholders
Sh. RajendraBorkar, Resident Deputy Collector, Mumbai Suburban
ShVishwasGujar, SDO, Mumbai Suburban
ShLad Madhukar, Representative, MPCB, Chembur
Sh. Surya Kant Jadhav, Office of Tehsildar, Mumbai Suburban
Sh. Arvind Kshirsagar, City Survey Office, Ghatkopar

Officials of NHSRCL
Mr. U. P Singh, CPM, Mumbai
MrA K Gupta, Project Manager (Mech)
Mr. R P Singh, Project Manager (Civil)
MrManoj Gupta
Mr. Ashok Mali,
Dr Ramesh Salunke

Sh R P Singh, CPM/NHSRCL Mumbai welcomed the dignitaries and introduced the official of NHSRCL, JICC and GPSTPL to the participants.

Ms. Deepa Rajendra Shinde, representative of M/s GPS Technologies Pvt. Ltd. gave the presentation highlighting project details and the key findings of the S-EIA study.

Upon completion of the presentation, RDC, Mumbai Suburban addressed the participants about the project and need of the public consultation and invited the participants to express their views, suggestions and issues related to environment, if any.

The list of the participants (attendance sheet) is attached as Annexure-A.

The issues raised by the participants during the Environmental Information Disclosure & Public Consultation along with the response of the NHSRCL is attached as Annexure-B.

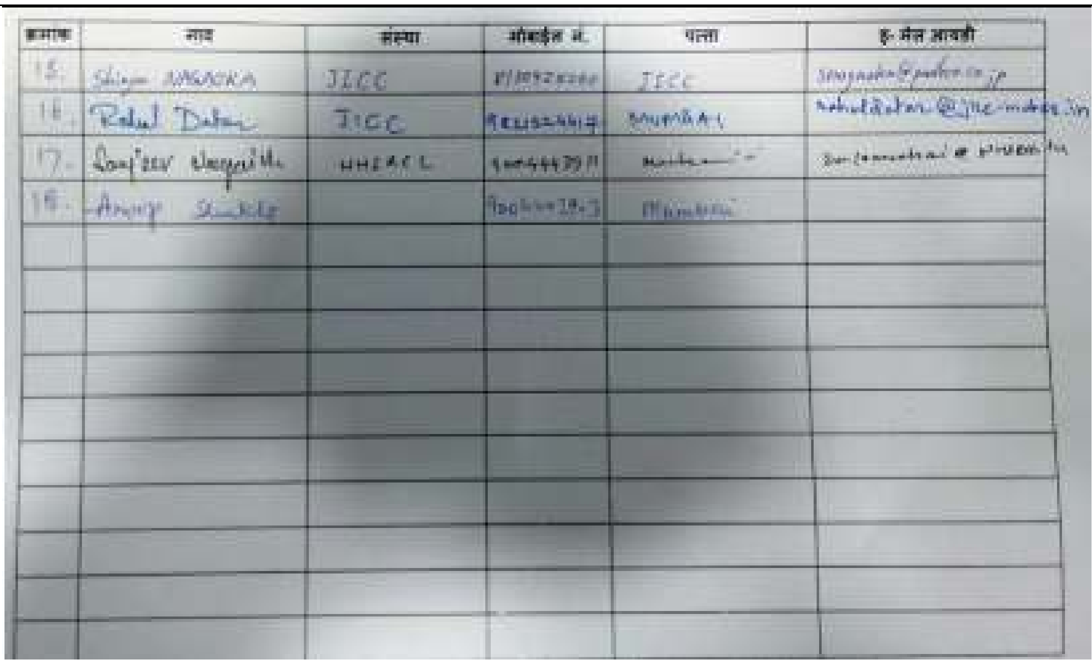
After the discussion session, RDC, Mumbai Suburban announced the closure of the Environmental Information Disclosure & Public Consultation.

RDC informed that the written response to the issues raised by the public shall be communicated by the Office of the District Collector, Mumbai Suburban and also shall be uploaded on the website of NHSRCL-www.nhsrcl.in.

Annexure-A

Attendance Sheet

क्रमांक	नाव	संस्था	मोबाईल नं.	पत्ता	ई-मेल आयडी
1	[illegible]		[illegible]	[illegible]	
2	[illegible]	NHSRCL	[illegible]	NHSRCL [illegible]	[illegible]
3	[illegible]	[illegible]			[illegible]
4	[illegible]	[illegible]	[illegible]	NHSRCL	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	NHSRCL	[illegible]	NHSRCL	[illegible]
8	[illegible]	NHSRCL	[illegible]	NHSRCL	
9	Ashok [illegible]		[illegible]	Dahisar	[illegible]
10	Arvind Kshirsagar	City Survey office [illegible]	[illegible]	[illegible]	[illegible]@gmail.com
11	[illegible]	NHSRCL, Mumbai	[illegible]	NHSRCL, Mumbai	[illegible]
12	DR. [illegible]	MSI	[illegible]	Thane (W)	[illegible]
13	Dr [illegible]	MSI	[illegible]	Goa	[illegible]
14	V.K. Singh	[illegible]	[illegible]	[illegible]	[illegible]



क्रमांक	नाव	संस्था	मोबाईल नं.	पत्ता	ई-मेल आयडी
15.	Shigeo NAGAOKA	JICC	[illegible]	JICC	[illegible]
16.	Rahul Dalan	JICC	[illegible]	MUMBAI	[illegible]
17.	Sanjeev Nagpal [illegible]	NHSRCL	[illegible]	[illegible]	[illegible]
18.	Anup [illegible]		[illegible]	Mumbai	

Annexure-B

Brief Issues/concern raised during the Environment Information Disclosure & Public Consultation

Mumbai Suburban (Maharashtra) -30/05/2018	o Whether waste disposal site has been identified?	The construction waste during the tunneling shall be reused for other construction activities / ballast in metro rail construction, DFCC and service roads. The unused waste shall be disposed off at the identified and approved site in consultation with the local municipal authorities.
	o Identification of compensatory afforestation and survival rate.	The land for the compensatory afforestation shall be identified and allocated by the concerned District Collector and the afforestation shall be undertaken in coordination with the Forest Department. The effort shall be made for transplantation in the vicinity at the available land. Scientific methods shall be adopted to achieve optimal survival rate.
	o Waste water discharge	Every effort shall be made to recycle and reuse of the waste water after proper treatment depending upon the quality of the treated water.
	o Is there ventilation shaft in Mangrove area?	No. The shaft has been provided on the private land and there is no mangrove area involved there as per MSI studies as well as Godrej officials.
	o Why is not EIA shared with the public till date? There is lack of information in the executive summary	The Environmental Information Disclosure and Public Consultation has been completed in various districts. The suggestions and concerns of the public shall be incorporated in the S-EIA report and uploaded on the NHSRCL website in public domain. The revised and updated Summary (in English and local language) shall be made available in the public domain. EIA being a continuous process, it will be further updated based on the suggestions/ observations received from the stakeholders.
	o Is there planning of underground reclamation	Reclamation has not been envisaged in the detailed design engineering.
	o If the alignment is	This aspect has been taken care in the

	going through tunnel in Mumbai section, then how will NHSRCL take care of flood as Mumbai gets flooded at the time of monsoon season	design of the tunnel.
	o Does the NHSRCL alignment coincide with the Mumbai metro alignment?	The MAHSR alignment does not coincide with the Mumbai Metro alignment.
	o What will be the effect on the aquifer and ground water due to tunnel?	During the hydro-geological study, drilling was done up to 70m below the bed of the creek, aquifer was not encountered. The basaltic rock in solid form is recovered during the drilling continuously up to 70 m. Therefore, no any adverse impact is anticipated on the aquifer and ground water body.
	o What will be the impact on mangroves due to underground tunnel?	The tunnel shall be 30 m below the bed of the creek. No any adverse impact mangrove is envisaged. Further, the roots of the mangrove are limited to 3 m only.

The Resident District Collector assured the participants that the written objection received shall be responded by the NHSRCL within a week time.

Mumbai Suburban EPC pictures