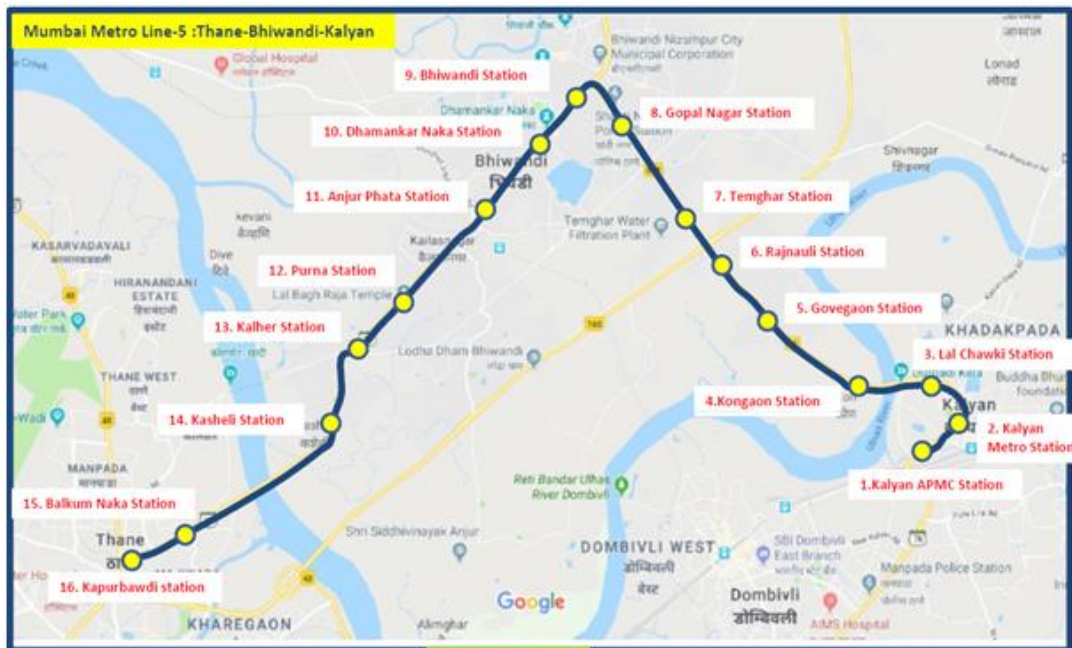


# Mumbai Metropolitan Region Development Authority

## Mumbai Metro Line-5 Phase-I (Thane – Bhiwandi)



## Environmental Impact Assessment Draft Report

11 September 2023

Prepared by

Metro Project Implementation Unit, MMRDA, MUMBAI  
For the  
Asian Infrastructure Investment Bank

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**ABBREVIATIONS**

AIIB	Asian Infrastructure Investment Bank
AFC	Automatic Fare Collection System
AGT	Automated Guideway Transit
AMSL	Above Mean Sea Level
AON	All Or Nothing Assignment
ASS	Auxiliary sub stations
ATO	Automatic Train Operation
ATP	Automatic Train Protection
ATS	Automatic Train Supervision
BGL	Below Ground Level
BIS	Bureau of Indian Standards
BOD	Biochemical Oxygen Demand
BOT	Build Operate & Transfer
BRT	Bus Rapid Transit
CBI	Computer Based Interlocking
CPCB	Central Pollution Control Board
CRZ	Coastal Regulation Zone
CTS	Comprehensive Transportation Study
CWLW	Chief Wild Life Warden
CWR	Continuous Welded Rails
DMRC	Delhi Metro Rail Corporation
DPR	Detail Project Report
DPR	Detailed Project Report
DTO	Driverless Train Operation
EC	Environmental Clearance
EHV	Extra High Voltage
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EPA	Environment Protection Act
ESZ	Eco-Sensitive Zone
ETP	Effluent Treatment Plant
FGD	Focus Group Discussion
FIRR	Financial Internal Rate of Return
IMD	Indian Meteorological Department
LWR	Long Welded Rails
MCZMA	Maharashtra Coastal Zone Management Authority
MIDC	Maharashtra Industrial Development Corporation
MMC	Multi Modal Corridor
MMR	Mumbai Metropolitan Region
MMRDA	Mumbai Metropolitan Region Development Authority
MMMOCL	Maha Mumbai Metro Operation Corporation Limited

MoEF&CC	Ministry of Environment, Forest and Climate Change
MoUD	Ministry of Urban Development
MPCB	Maharashtra Pollution control board
MRTS	Mass Rapid Transit System
MSETCL	Maharashtra State Electricity Transmission company Limited
MSL	Mean Sea Level
MRV	Medium Rail Vehicles
MSRTC	Maharashtra State Road Transport Corporation
MVA	Motor Vehicle Act
NAAQS	National Ambient Air Quality Standards
NBWL	National Board for Wild Life
NDZ	No Development Zone
NMS	Network Management System
NOx	Oxides of Nitrogen
O&M	Operation & Maintenance
OCC	Operation Control Centre
OPC	Overhead Protection Cable
PCU	Passenger Car Unit (PCU)
PHPD	Peak Hour Peak Direction
PM10	Particulate Matter (10 Micron)
RET	Rare Endangered Threatened
RPM	Respirable Particulate Matter
RCC	Reinforced Cement Concrete
RSS	Receiving Sub Station
SAR	Sodium Adsorption Ratio
SCADA	Supervisory Control and Data Acquisition
SEIAA	State Environment Impact Assessment Authority
SGNP	Sanjay Gandhi National Park
SO2	Sulphur di Oxide
SPM	Suspended Particulate Matter
SPV	Special Purpose Vehicle
STO	Semi-Automatic Train Operation
STP	Sewage Treatment Plant
TBK	Thane Bhiwandi Kalyan
TCFS	Thane Creek Flamingo Sanctuary
TMC	Thane Municipal Corporation
TMT	Thane Municipal Transport
ULB	Urban Local Bodies

## EXECUTIVE SUMMARY

i. Mumbai Metropolitan Region (MMR) spread over 6,328 sq. km and comprises of Mumbai city district, Mumbai suburban district, parts of Thane district (Thane, Bhiwandi, Kalyan and Ulhasnagar tehsils, Vasai tehsil), and parts of Raigad district (Uran tehsil, Panvel, Karjat, Khalapur, Pen and Alibaug tehsil). The entire area is overseen by the Mumbai Metropolitan Region Development Authority (MMRDA). MMR is being supported by the public transportation system, but the existing system is running at more than its saturated capacity. Also, the entire region is affected due to high traffic congestion, in spite of the usage of the public transportation system by majority of the population (88%). MMRDA has carried out travel demand estimation for Thane (North), Bhiwandi, Kalyan sub region which is the busiest routes in MMR as per the Comprehensive Transportation Study (CTS) conducted for MMR. D'Appolonia S.p.A. and TATA Consulting Engineers Limited has carried out the investigation and studies for Thane-Bhiwandi-Kalyan Metro Rail Project (Mumbai Metro Line-5) and submitted a Detailed Project Report (DPR) during September, 2016 along with Environment Impact Assessment (EIA) study. MMRDA is the Executing agency and Maha Mumbai Metro Operation Corporation Limited (MMMOCL) will operate the Metro Rail.

ii. As the project is funded by Asian Infrastructure Investment Bank (AIIB), MMRDA got the EIA report of Thane-Bhiwandi-Kalyan Metro Rail Project updated as per the requirements of AIIB, for Phase I of the Metro Line-5 project, i.e., Thane (Kapurbawadi) to Bhiwandi (Dhamankar Naka). As per the Environmental and Social Framework (ESF) of the AIIB, this project has been categorized as “A” and accordingly, it mandates a full assessment of environmental and social impacts, and the preparation of the Environmental Impact Assessment (EIA) including Environmental management Plan (EMP) and Social Impact Assessment including Resettlement Action Plan. The key national and state acts, and regulations applicable for this project are as follows:

- Environmental Impact Assessment Notification and Amendments
- Coastal Regulation Zone Notification and Amendments
- Notification on use of fly ash (subsequent amendments)
- Forest (Conservation) Act
- Maharashtra Tree Cutting Acts in Urban and Rural Areas
- Wildlife (Protection) Act
- Water (Prevention and Control of Pollution) Act (and subsequent amendments)
- Air (Prevention and Control of Pollution) Act (and subsequent amendments)
- Noise Pollution (Regulation and Control) rules
- Hazardous Waste (Management & Transboundary Movement) Rules and subsequent amendments
- The municipal solid waste management rules and subsequent amendments
- Environmental Clearance (EC) under EIA notification (and subsequent amendments) for new quarry areas
- Central Motor Vehicle Act and Central Motor Vehicle Rules
- The Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act
- The Right to Fair Compensation and Transparency in Land Acquisition Rehabilitation and Resettlement Act, 2013 (Act 30 of 2013) (LARR)

iii. This project does not warrant Environmental Clearance (EC) as per the EIA notification 2006 as the railway projects are not listed in the schedule of the said notification. Other clearance required for the project includes (i) Permission for cutting Mangroves from Bombay High Court, (ii) Forest clearance for clearing mangrove area of 0.6983 ha (reserved forest area) (iii) Coastal regulation zone (CRZ) clearance from Maharashtra State Coastal Zone Management Authority, (iv) Permission for felling of trees from the Forest Department and Tree Authorities of concerned Municipal Corporations. Other project related clearances to be

obtained by the Contractor are detailed in this EIA report. The proposed project is not impacting any National Park/ Wildlife sanctuary area or their ESZ. Sanjay Gandhi National Park (SGNP) and Thane Creek Flamingo Sanctuary are located at distance of more than 3.4 km and 5.2 km respectively from the alignment, and the alignment is outside the protected area and ESZ of these areas. Thus, there is no impact envisaged on SGNP and Thane Creek Flamingo Sanctuary due to proposed project or project related construction and operation activities.

iv. Proposed project alignment falls in the coastal plains of western part of Thane District of Maharashtra and have elevation varying from 0-21 m above MSL (lowest near Ulhas River and highest near Kapurbawadi). Project alignment traverses through the western part of the district and thus experience tropical climate. The coastal area of Thane district, have average daily maximum temperature of 32.9 °C during summer and during winter average mean daily minimum temperature of 16.8 °C. During the monsoon (June – September), the relative humidity varies from 76.60% to 91.10%. Between November to January i.e. during winter, the relative humidity varies from 47.68% to 77.23%. Owing to the proximity of the sea the district is on the whole very humid nearly all the year round. The average annual rainfall in the district is 2293.4 mm. Windspeed varies from 9.2-18 mph and dominant wind direction is W and NW. The project area falls under the Zone III (moderate intensity zone) for seismic activity and hence no major risks are anticipated to the proposed project infrastructure. Project alignment lies within the coastal area of the district and major soil type of area is fine deep soils which are poorly drained.

v. As per the land use study carried out for the 100 m radius area around alignment, 75.9% area is under settlements followed by agriculture (12.95%), vegetation (5.05%), water body (3.2%) and mangroves (2.9%). Ambient air quality study of the project area, conducted during Oct 2022, reveals levels of PM10 and PM2.5 that exceed the National Ambient Air Quality Standards (NAAQS). The data is verified with the regular monitoring conducted by MPCB at Balkum and Prematai hall, Bhiwandi and the primary data is found to resonate with the secondary data monitored by MPCB. High levels of PM10 and PM2.5 are due to heavy movement of the vehicles on Thane-Bhiwandi Road. Other key noxious parameters (SO<sub>2</sub>, NO<sub>x</sub> & CO) are well within the NAAQS limits. Ambient noise level data is collected during Oct 2022 and is found to be within the permissible limits except for one location. Noise data is being collected by MPCB in Thane District on annual basis and during Ganesh festival in the Thane district. Noise levels recorded during the festival are higher than the prescribed standards under Noise Rules 2000. Also, Leq. level of noise at all the monitoring locations, monitored by MPCB are compared with the noise standards for the commercial land use, i.e. 65 dB(A) during day time and 55 dB(A) during night time and are found to be higher than the prescribed standards both during day and night time.

vi. Surface water quality data is monitored for Kasheli Creek in up-stream & down-stream during October 2022. Monitored Results are compared with the designated best use water quality criteria defined by CPCB (IS 2296-1982) is found that the water bodies quality is well within the prescribed limits of the concentration of various parameters defined for Class C. Surface water quality study is also conducted by MPCB between 2019-2021. Closest waterbodies to project site which are being monitored by MPCB are Rabodi Nallah and Ulhas River near Reti Bunder, Mumbra Reti Bander and Kolshet Reti Bunder. As per the results of the monitoring, it is found that all the water bodies have high BOD levels than prescribed for Class A to D water bodies, thus these water bodies can be classified as Class E water bodies. Ground water quality of project area was monitored at 5 locations during Oct 2022 and is found that the water quality of all the samples is well within the prescribed limit of IS 10500: 2012: Drinking Water.

vii. No cultural or religious property is affected due to the project. There are no national or state protected cultural and religious properties falling within the RoW. The project infrastructure (stations, entry and exit points) locations are planned avoiding impacts on local places of workshop along the alignment (at Balkum Station). Owing to the urban settings, flora in the



project area is limited to avenue plantation, except the mangroves area at depot site at Kasheli and stream crossing at Ch 4600-4700. Planted species of trees include *Pongamia Pinnata* and *Azadirachta Indica* majorly. A total of 708 trees fall within the alignment, out of which 495 will be transplanted, 166 will be cut, and 47 will be trimmed. A site at Kasheli is identified for development of depot. In addition, approximately 50-60 trees exist at depot site which may need to be removed.

viii. Proposed alignment is affecting 0.6983 ha forest land which constitute 0.3771 ha Reserve Forest land and 0.3212 ha unnotified Mangrove Forest land at Kasheli, Taluka Bhiwandi. However, forest land exists in the proposed Kasheli Depot and forest clearance is in process to be obtained. Mangroves exist along the small stream at Chainage 4600-4700 of the alignment. The area of Mangroves and the creek falls under CRZ as per CRZ Notification, 2011 and the CRZ clearance has been obtained for the project for viaduct portion. The CRZ clearance for the spur line, approach road to Kasheli depot & EHV tower foundation structure is under process. The main species of mangroves found are *Avicennia marina* and *Sonneratia apetala*. Other associate mangrove species present in the study area are *Salvadora persica*, *Derris heterophylla*, *Sesuvium portulacastrum* etc. No wildlife is found in the project area due to the urban settings. Project alignment traverses through Ulhas River at two locations (north and south Kasheli Creeks) for a total length of about 500 m. Common phytoplanktons found in the Ulhas River are *Rhizosolenia species* & *Skeletonema species* and common zooplanktons found are *Calanus* spp., *Eucalanus elongates*, *Pseudocalanus elongates*, *Phialidium*, *Candacia* spp., *Comb jelly*, *Hemimysis*, *Shrimps*, *Sirellas* spp., *Oithionas* spp., *Nereis* spp., *Sagitta*, *Zoea*, and Other larval forms.

ix. Ecologically protected areas in the 10 km radius area of the project alignment are Sanjay Gandhi National Park (approximately 3.4 km, West of alignment) and Thane Flamingo Sanctuary (approximately 5.2 Km, South of alignment), but none of these will be impacted due to the project and its associate activities. Also, project alignment is outside the notified core and ESZ of these areas. No RET species or Schedule I species as per the Wildlife Protection Act 1972 is found within Project corridor. Entire project alignment lies in Thane District, which is well developed and heavily populated with total population of 18,41,488.

x. As part of the project preparation work, public consultation (2020 and 2021) was conducted for the project at 3 locations (i. on 16/01/2020 at Balkum, ii. on 30/06/2021 at Balkum iii. On 17.06.2021 at Kasheli), the project interventions were detailed to the public/ local communities and feedback/ views from them have been obtained. Accordingly, suitable replies were given to the queries raised by the stakeholders. The suggestions and feedback shared by the public/ community during consultations were accepted and incorporated in EMP. The Grievance Redressal Mechanism proposed in this EIA deal with workers grievances and community grievances on issues related to wages, working conditions, worker accommodation, health and safety issues of workers and community, conflicts among workers and with community, community complaints, disruption of utilities, construction related inconveniences, etc.

xi. Mostly impacts are anticipated during construction and various impacts have been listed. The impacts during construction phase vary from low to high significance. But these impacts are short term and are restricted only to the construction zone and can be reduced significantly by adopting suggested engineering, design and good construction practices/measures accompanied by site-specific mitigation measures. However, some impacts due to project planning and location like: tree cutting, vegetation removal, removal of mangrove patch and impacts on micro climate etc., are long term and irreversible and cannot be mitigated, but the impacts can be reduced to an acceptable level by adopting the suggested mitigation measures like transplantation & compensatory plantation, reducing no of trees to be cut with proper planning & joint inspections, , implementation of Environment Management Plan (EMP) etc. The EMP recommends to avoid, minimize and mitigate environmental impacts anticipated during project implementation at various stages namely Pre-construction, Construction and Operation

**& Maintenance.**

xii. Air quality along the alignment and at casting yards/batching plants will be adversely impacted temporarily during construction activities. The Environment Management Plan (EMP) has detailed mitigation measures for these, viz., Casting yards/ batching plants at least 1 km in the downwind direction from the human settlements, Vehicles delivering sand and fine aggregates to be covered, Water to be sprayed on earthworks, temporary haulage, and detour roads regularly, etc. During the operation stage, the air quality in the project area shall improve due to shift of ridership from road to metro which is cleaner mode of transportation as compared to road transport. The noise impacts due to the project will be of significance in both the construction as well as the operation stages. The settlements/ communities abutting project alignment and construction establishments will be adversely affected by an increase in noise level due to operating equipment and construction activities, viz., at Kapurbawadi, the viaduct is 3 m away the edge of residential structures; after conducting a noise study, proper mitigation measures will be taken up. All mitigation measures such as the use of enclosures, walls, installation of mufflers around noisy equipment; substituting quieter equipment or construction methods; timing of noisier construction and demolition activities; providing Personnel Protective Equipment (PPE) to the workers; locating construction establishments away from sensitive receptors, etc. are proposed. Noise due to metro operation will be controlled by provision of noise barriers along the corridor if passing through sensitive and residential areas. The generated construction waste (such as removed concrete, wood, trees and plants, packaging materials, empty containers, and other similar items) and hazardous wastes (including oils, lubricants etc.), will be managed through reuse, recycling, and disposal (at designated/approved disposal areas). With the help of Urban Local bodies (ULB's), the construction and solid waste shall be managed.

xiii. Occupational health and safety impacts can arise from construction, operation and maintenance works. Exposure to the work-related chemical, physical, biological and social hazard is typically intermittent and of short duration but is likely to reoccur. Potential impacts are negative and long-term but reversible by mitigation measures. Overall, the contractor should comply with IFC EHS General Guidelines in terms of Occupational Health and Safety risks. Manpower will be required during the 30 months construction phase. This can help to generate contractual employment and an increase in local revenue. The Contractor shall employ the local labour force to the extent possible.

xiv. The EMP given in the bid document will be implemented by the Contractor (the contractor will have Environmental and Safety personnel) during construction. Contractor shall make sure that all the project related permissions/consents including the No Objection Certificate (NOC) / Permissions from the competent authority will be obtained before contractors' mobilization. He/she will be responsible for conducting the environmental monitoring (as per the environmental monitoring plan) and the preparation and submission of the report monthly to the General Consultants and the Metro PIU who would be responsible for the implementation of the EMP. The contractor needs to be trained on environmental issues specific to Metro Rail projects. Suitable training programs shall be conducted for the workers and staff by the contractor. The training program consists of several training modules specific to target groups. The training would cover basic principles of environmental assessment and mitigation plans; implementation techniques; monitoring and management methods and reporting tools. The environmental management budget has been worked out for the effective implementation of the EMP for a sum of INR 6.80 Crores, which covers various environmental mitigation measures, monitoring of environmental attributes during all the phases of the project. Overall, the major environmental impacts associated with the project are limited to the construction phase and can be mitigated to an acceptable level by implementation of EMP and by best engineering practices. Project benefits far outweigh negative impacts.

## CHAPTER 1.INTRODUCTION

### 1.1. Project Rationale

1. Mumbai Metropolitan Region (MMR) spread over 6,328sq. km and comprises of Mumbai city district, Mumbai suburban district, parts of Thane district (Thane, Bhiwandi, Kalyan and Ulhasnagar tehsils, Vasai tehsil), and parts of Raigad district (Uran tehsil, Panvel, Karjat, Khalapur, Pen and Alibaug tehsil). The entire area is overseen by the Mumbai Metropolitan Region Development Authority (MMRDA), a Maharashtra State Government organization in charge of town planning, development, transportation and housing in the region.

2. Though Mumbai Suburban Railway system has been supporting the emerging public transport needs, trains are overcrowded during peak hours, with trains of capacity 1,700 passengers, actually carrying around 4,500 passengers at peak hours. With immensely increasing population of MMR, problem of traffic congestion in the area is also rising even though 88% of its commuters travel by public transport.

3. With rapid strides in economic development particularly in urban areas, the need for rationalizing and upgrading the transport system and infrastructure is imperative. In wake of this, MMRDA has appointed D'Appolonia S.p.A. and TATA Consulting Engineers Limited to carryout travel demand estimation for Thane (North), Bhiwandi, Kalyan sub region and to prepare Techno-Economic Feasibility and Detailed Project Report (DPR) for appropriate Metro Rail Transit system for the Thane-Bhiwandi-Kalyan sub region which is one of the busiest route in MMR as identified in the Comprehensive Transportation Study (CTS) for MMR. D'Appolonia S.p.A. and TATA Consulting Engineers Limited has carried out the investigation and studies for Thane-Bhiwandi-Kalyan Metro Rail Project and submitted a Detailed Project Report (DPR) in September, 2016 along with the environment impact assessment study.

4. As the project is funded by Asian Infrastructure Investment Bank (AIIB), MMRDA has appointed EQMS to update the EIA report of Thane-Bhiwandi-Kalyan Metro Rail Project carried out during DPR stage as per the requirements of the funding agency of the project and carrying out the remaining required studies for Phase I of the Metro Line-05 project, i.e. Metro line-05 from Thane to Bhiwandi.

5. Executing agency of the proposed project is MMRDA and the project will be operated by Maha Mumbai Metro Operation Corporation Limited (MMMOCL).

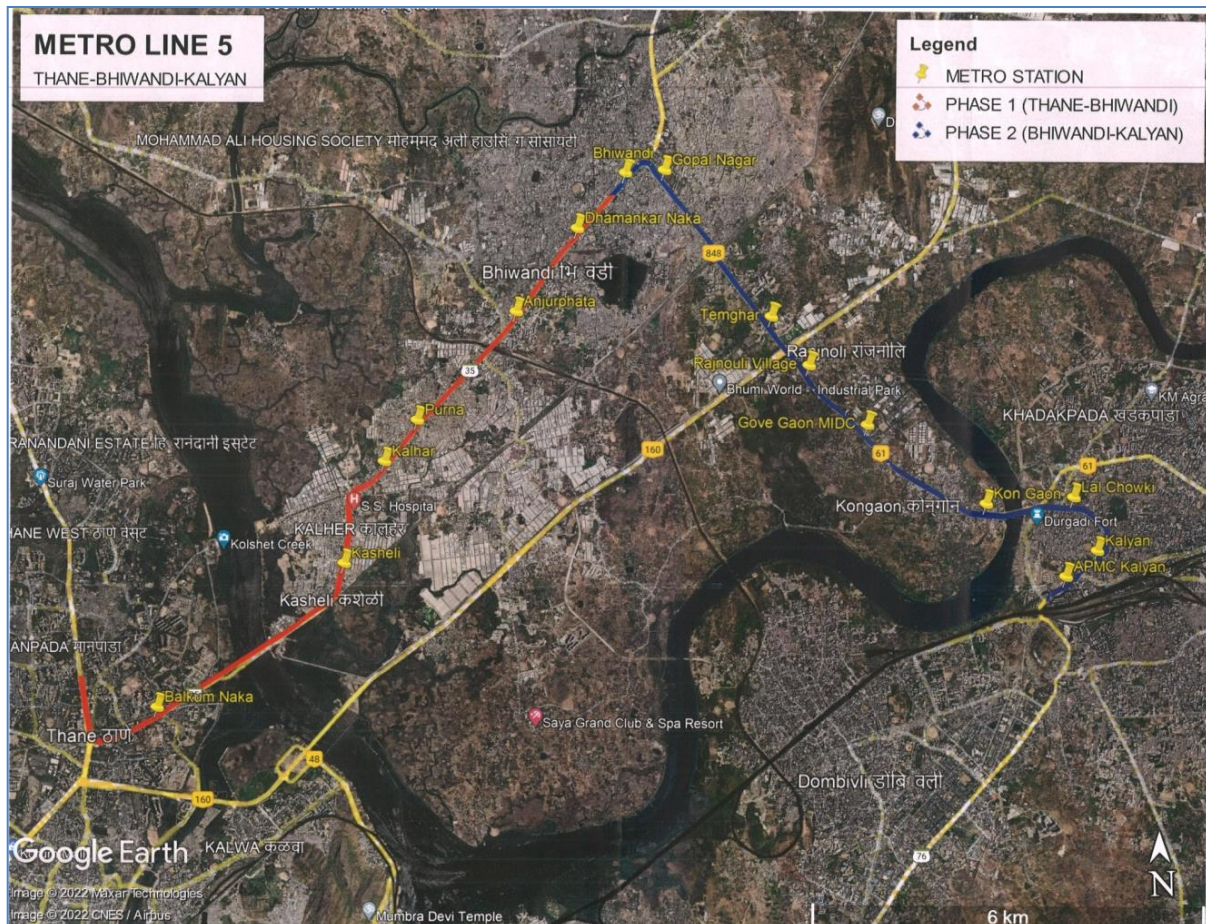
### 1.2. Objectives of the Project

6. Thane and Kalyan are major trip generating locations in Mumbai Metropolitan Region (MMR). Considerable population of working class is living in Thane and Kalyan. Bhiwandi is a hub for warehouses and small industries, which leads into major trip attraction zone. Though in terms of time-based mobility and accessibility, there is lack of connectivity between them. Secondly, besides having railway stations at Thane and Kalyan, most of the time suburban trains have passenger volume which is far more than the crush load and hence causes high level of discomfort to the commuters. In light of above, it is necessary to review the status of public transportation in Thane, Bhiwandi and Kalyan.

7. The key objective of the project is to address the rapidly increasing traffic demand in the MMR by developing efficient public transportation system, i.e. proposed Metro Line-05 between Thane and Kalyan. The Project is expected to improve the public transportation facility between the connected areas by reducing the traffic congestion; catering the projected traffic demand in the area and decongesting the already saturated Mumbai Suburban Railway system by shifting the ridership to proposed metro route.

### 1.3. Project Status

8. Detailed Project Report (DPR) study has been conducted for the entire alignment Metro Line-05. Based on the ground survey, availability of land, environmental sensitivities etc. finetuning is done to the alignment and location of stations and the depot and now alignment between Thane and Bhiwandi measuring approx. 11.88 km has been fixed out of total alignment of approx. 24.9 km between Thane and Bhiwandi. At present alignment between Thane and Bhiwandi of Metro Line-05 is being implemented as phase-I. Proposed project alignment of Metro Line-05 is presented in **Figure 1.1**.



**Figure 1.1 : Proposed Metro 5 alignment (Phase I & II)**

9. At present Phase I of the Metro Line-5 of viaduct length is approximately 11.88 km and comprising of 6 stations will be implemented. Phase -I of Metro Line-05 is being developed with the financial aid of AIIB. This EIA report is prepared as per the prevailing policies of the AIIB.

### 1.4. Purpose of Environmental Impact Assessment (EIA)

10. Proposed project is spread over large spatial extent, i.e., approx. 11.88 km length, traverse through heavily populated areas between Thane and Bhiwandi, traverse through coastal regulated zone (CRZ) and mangroves, involves tree cutting and involves resettlement and rehabilitation of people and thus the impacts are anticipated to be significant which mandates preparation of the Environmental Impact Assessment (EIA) Report including Environmental Management Plan (EMP) as per AIIBs' ESF. In accordance with the AIIB's Environmental and Social Framework (ESF), proposed project has been assigned as a category "A" project.

11. Accordingly, detailed assessments of the environmental impacts have been carried out

following a suitable methodology. In this EIA, the environmental impacts due to the project, concerning construction-related environmental impacts, infringements with natural habitats and places of cultural heritage in the context of ‘chance-find’, are covered. The findings of EIA will guide the effective development of the specific EMP and appropriately facilitate the implementation of environmental safeguard measures. The specific objectives of EIA are given under:

#### **1.4.1. The objective of the EIA**

12. As per the requirement of the AIB’s ESF, the EIA has been performed for the Phase I of proposed Metro 5-line project with the following objectives:

- To collect the baseline data on the physical, biological and socio-economic conditions of the project area using primary as well as secondary sources.
- To conduct stakeholder consultation to understand their concern and suggestion for the project to enhance its environmental and social acceptability
- To prepare detailed legal framework applicable to the proposed project as per National legislation and requirement of AIBs’ ESF
- To carry out the environmental assessment for the project and design the implementable, cost effective and time bound measures elimination or reduction of the identified potential environmental impacts of the project to acceptable levels
- To prepare the specific EMP which will include the institutional responsibilities and methods of monitoring the mitigation measures and monitoring procedures.
- To prepare an indicative cost estimate and timeframe for implementation of EMP.

#### **1.5. The methodology for conducting EIA study**

13. Various steps involved in conducting the EIA study for the project are given below

##### **Task 1: Screening:**

14. It is a process of analyzing the project w.r.t environmental and social risks and to assess whether EIA study is required or not. EIA Notification, 2006 in India mandates the polluting projects as mentioned in schedule of the notification to undertake EIA study and obtain prior environmental clearance. However, railway projects are not included in schedule of the notification, thus the notification is not applicable for the project and environmental clearance is not required. However, other acts including Forest (Conservation) Act 1980 and CRZ Notification 2011 are applicable on project as the alignment traverses through the Mangroves (reserved forest) and costal regulation zone and thus detailed EIA study is required to be carried out for the project.

15. Also, the project is obtaining financial aid from AIB and is required to follow the AIBs’ ESF, 2019 requirements. ESF classifies all developmental projects under four categories based on the magnitude and significance of associated environmental and social risks, i.e. A, B, C & F1.

##### **Task 2: Scoping:**

16. MMRDA has defined the terms of reference for conducting the EIA study for the project. Terms of reference has provided scope for conducting the EIA study. EIA study has been carried out as per the terms of references provided by MMRDA, guidelines of MoEF&CC for conducting EIA study for linear projects (highways) and AIB’s ESF, 2019.

##### **Task 3 Field Reconnaissance Survey and Review of Earlier Studies**

17. The field reconnaissance survey has been carried out to understand the environmental and social setting of the project area; identify the existing pollution sources in project area which can enhance the impact of project cumulatively; and to identify the environmental and social sensitive features along the alignments which can get impacted due to project implementation and operation.



**Task 4: Review and Assessment of Applicable Environmental Regulations**

18. A detailed analysis of various acts/ rules/ regulations and guidelines applicable to the proposed metro line 5 project vis-à-vis centre (GoI), state (GoM) statutory requirements and AIIB's ESF were reviewed and referred to for assessing current environmental impacts that are likely to emanate. Based on this analysis, an environmental impact assessment is conducted, and an environment management plan is prepared for the project.

**Task 5: Delineation of Study Area for Assessment**

19. Study area of the project has been delineated considering the nature and the area of the development. Nature of the project is linear, and the development is confined within the project RoW. Project RoW in case of metro project is highly variable depending on the location. Thus, study area of the project is divided into two zones, i.e. core zone and the buffer zone.

20. **Core Zone:** Core zone is defined as the area where the project development works are proposed to be undertaken and will include the following areas

- Project RoW (metro corridor): Approx. 90% of the alignment is proposed on the median of the existing road where the width of approx. 8-9 m will be required for construction purpose and during operation phase project RoW will be approx. 2-2.5 m which will be confined to the median of the road only. However, in the stretches away from the road, project RoW is considered to be 10.550 m wide (Twin U-girder of 5.25 m each) and for station width of the box is 21 m and for entry-exit 6 m on either side
- Location of casting yard, site office or any other temporary facility to be set up for project construction
- Depot, operation control centre and receiving sub-station.

21. **Buffer Zone:** Buffer zone considered for assessment of the impact due to metro project includes following

- Area of 100 m width on either side of the alignment/corridor and other temporary facilities as the impacts are localized and impact is not anticipated beyond 100 m width
- Area of 500 m radius around station and depot locations. Area of 500 m is considered as project RoW is twice that of the ROW in viaduct area and also during operation phase impact on air quality and noise level are anticipated near the station and depot area
- 10 km radius area around alignment/stations/depot/project facilities for assessment of the impact on Notified environment protected areas like national parks, wildlife sanctuaries, Migratory wildlife/bird corridor, Ramsar wetlands etc.

**Task 6: Assessment of Baseline Environmental and Social Conditions**

22. This task comprises a collection of baseline data for physical, biological and socio-economic conditions in study area. The secondary sources<sup>1</sup> of information was utilized for giving a generic snapshot of socio environment features. Also, existing environmental and social quality/features along the proposed project was assessed based on a walk-through survey, public consultations etc.

**Task 7: Stakeholder consultations**

23. Stakeholder consultations has been carried out for the project with the project affected people, local people and the revenue officials to understand their concerns due to project development and suggestions for improvement of the project.

24. Community consultation was held on 16.01.2020 at Balkum site office of Metro Line 5, prior

<sup>1</sup> Secondary source of information for various socio-economic parameters were collected from government departments like Census of India, Department of Industries, Department of Economics and Statistics, Department of Agriculture, Directorate of Settlements and Land Records etc. This helped to understand the socio-economic profile of the project area with respect to indicators like population growth rate, literacy rate, work force participation rate (WFPR) etc. in comparison with the project districts and state.

to start of survey. Project affected people, local people, MMRDA officials, revenue officials, environment & social consultant of the project attended the meeting and addresses all the queries related to the project, survey procedure, possible impact due to project development, compensation to be provided etc and replies were given to the queries of the stakeholders. Community consultation was conducted on 30.06.2021 and 17.06.2021 at Balkum and Kasheli also prior to start of baseline socio-economic survey (BSES) study and details of the importance of BSES were explained to the people in detail and their queries were answered.

**Task 8: Prediction of Environmental Impacts (including social impacts)**

25. Likely impacts that would arise due to the construction of the proposed project were identified for each project activity, through changes in the physical, biological or socio-economic environment. The assessment considered both positive and negative impacts at different stages of project implementation, i.e. pre-construction, construction and operation stages.

**Task 9: Preparation of Environment Management Plan (EMP)**

26. A comprehensive Environmental Management Plan (EMP) was prepared which includes mitigation measures to avoid, reduce, mitigate, or compensate for all the identified negative impacts and enhancement measures for positive impacts, with related institutional arrangement, implementation schedule and cost estimates provided.

**Task 10: Preparation of Environmental Management Budget**

27. Based on the impact assessment of the environmental components, a suitable budget is estimated to compensate for the temporary and permanent impacts that are likely during the project implementation. The budget also includes compensatory afforestation measures for the loss of trees due to project.

**Task 11: Environmental Safeguard Clauses in the Bid Document**

28. Suitable safeguard clauses have been prepared based on the EIA, the prepared clauses shall form part of the bid document either in the General condition or Specific conditions of the contract agreement/ bid document. The prepared EMP shall also be part of the bid document.

## 1.6. Structure of EIA Document

29. EIA report has been structured under various headings/subheadings and titles as depicted in the table below

**Chapter 1- Introduction:** Briefs the Project rationale, Objective of the project, the project status of the project and the purpose of conducting the Environmental Impact Assessment

**Chapter 2- Project Description:** This chapter covers the detailed description of the project, such as, the type of project, need for the project, project location, project alignment, project components, utilities affected due to project, amenities requirement for project, land requirement, implementation schedule and the estimated cost of the project.

**Chapter 3- Legal Policy Framework:** The applicable Government of India and Maharashtra State regulatory requirements for this project has been discussed along with necessary clearance to be obtained by the contractor has been detailed.

**Chapter 4- Description of the Environment:** The environmental baseline condition for various environs namely Physical, Biological and Social conditions has been detailed for the project area

**Chapter 5- Grievance Redress Mechanism:** The GRM proposed for this project along with the roles and responsibilities of the GRM members are discussed in detail.

**Chapter 6- Analysis of Potential Environmental Impact and Mitigation Measure:** Various anticipated impacts during the project implementation have been discussed along with suitable mitigation measures.

**Chapter 7- Stakeholder Consultation and Information Disclosure:** This chapter covers the details and outcome of the stakeholder consultations carried out for the project as per guidelines of Gol and AIIB.

**Chapter 8- Environmental Management Plan (Including Capacity Building and EMP Budget):** For the identified Environmental Impacts, suitable management/ mitigation measures have been provided to minimize the impacts with roles and responsibilities for implementing the same. Various training modules for environmental awareness and EMP implementation has been discussed. A suitable budget provision has been estimated based on the prepared EMP.

**Chapter 9 – Conclusion and Recommendations:** Based on the conducted environmental assessment and its finding, a suitable conclusion chapter along with recommendations has been detailed.



## Chapter 2. Project Description

### 2.1. Introduction

30. This chapter details the project description for proposed project. The description includes the project location, surroundings, project components, analysis of alternatives, land requirement and implementation schedule.

### 2.2. Project Alignment and Location

31. Phase I of Metro Line-05 starts from the Kapurbawadi station (Ch-0.321454) which will be constructed as part of Metro Line-04 project and ends at Thane (Dhamankar naka at Ch 12.200 km). Start and the end coordinates of the alignment are 19°13'36.39"N, 72°58'37.92"E and 19°17'30.37"N, 73° 3'29.55"E. The alignment starts from planned Kapurbawadi station and runs along Kapurbawadi flyover. Alignment turns East towards Balkum from Kapurbawadi junction along the SH-35 (Bhiwandi Wada Road). Alignment crosses Ulhas River at chainage 3400 to 3900 and runs along the existing bridge. Ulhas River and its' bank falls under CRZ area which will be to some extent disturbed due to project. From the bridge alignment continues to follow Bhiwandi Road and Thane Road before terminating to Dhamankar Naka. Majorly alignment (more than 90%) is within median of the existing roads. Entire project area is urbanized stretch and heavily populated. Land use along the alignment is mix of residential and commercial/industrial and traverses through the areas like Srinagar Colony, Ganesh Bawadi, Jawahar Nagar, Chirak Nagar, Sainath Nagar, Samata Naga, Kapurbawadi, Kolshet industrial area BMC colony, Ashok Nagar, Puranik Villas, Kalher, Nayan Sagar, Kopar, Tadkar wadi, Kailasnagar, Anjurphata, Oswal wadi, Bhiwandi, Narpoli. Google earth imagery of various project alignment sections is presented in **Figure 2.1**.

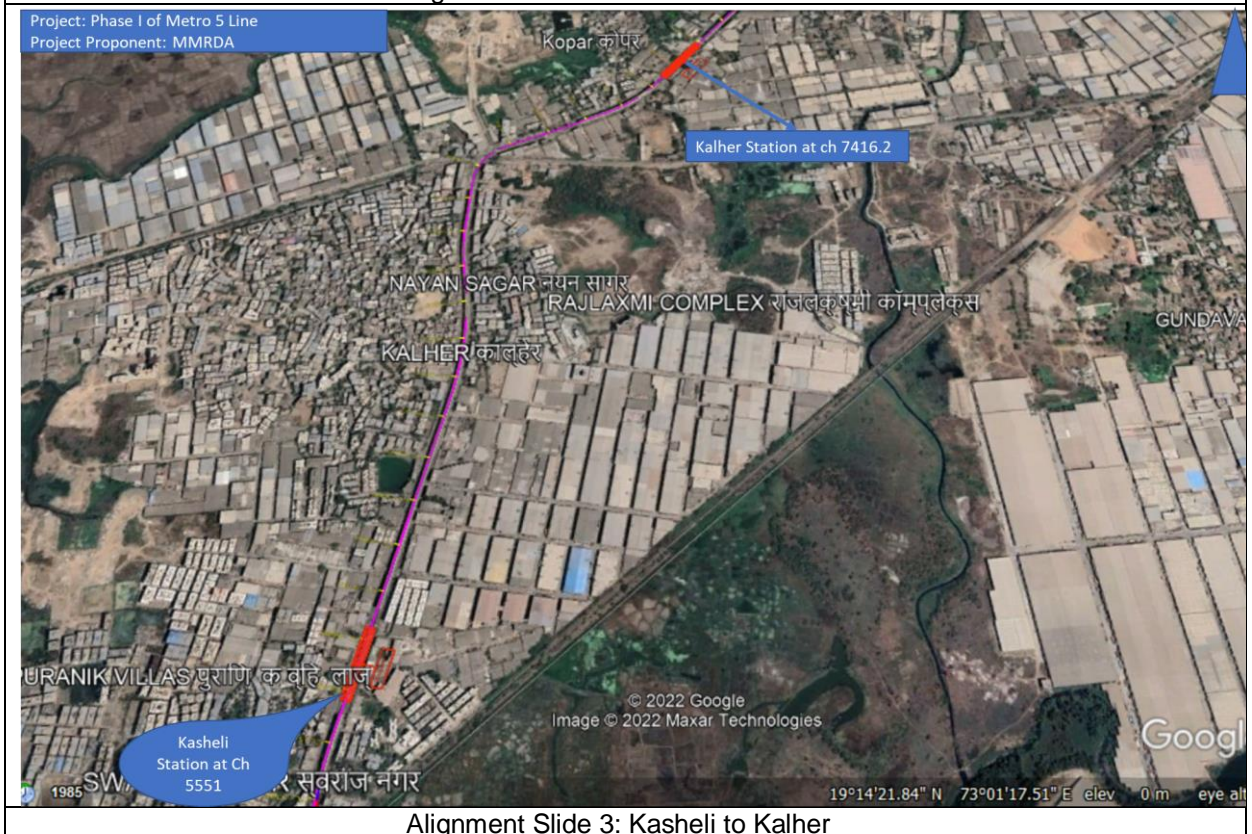




MML5 – Phase 1 (Thane- Kapurbawadi to Bhiwandi- Dhamankar Naka) – Draft EIA



Alignment Slide 2: Balkum to Kasheli

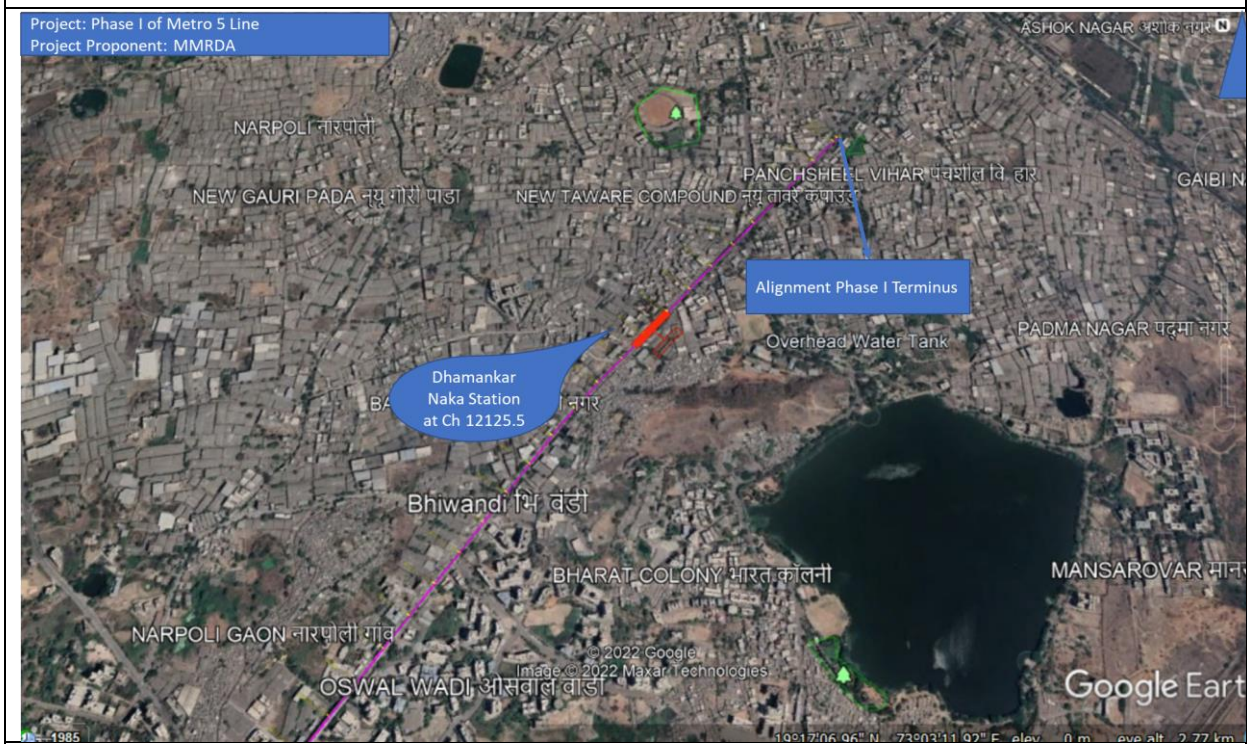


Alignment Slide 3: Kasheli to Kalher





Alignment Slide 4: Kalher to Anjur Phata



Alignment Slide 5: Anjur Phata to Dhamankar Naka

Figure 2.1 : Google Imagery: Phase I Metro Line-5 Project Alignment

### 2.3. Analysis of Alternatives

#### 2.3.1. Alternate Transit System

32. Government of Maharashtra (GoM) and Mumbai Metropolitan Region Development Authority (MMRDA) has completed Comprehensive Transportation Study (CTS) for MMR that has identified transport infrastructure for horizon year 2031 with an intend to improve transport

scenario in the Mumbai Metropolitan Region (MMR). One of the idea of CTS was to implement Thane - Bhiwandi – Kalyan monorail (approx. 25 kms) corridor. MMRDA has carried out Technical Feasibility Study for the same and has found that the CTS data used for the estimating the ridership in this corridor is more than a decade old. As per Feasibility study, Thane (Kapurbawadi) -Bhiwandi- Kalyan Monorail corridor may not turn out to be economically viable on fare box, advertisement, and other revenues.

33. Thus, MMRDA appointed D'Appolonia S.p.A. and TATA Consulting Engineers Limited to carryout fresh travel demand estimation for Thane (North), Bhiwandi, Kalyan sub region and to prepare Techno-Economic Feasibility and Detailed Project Report (DPR) for appropriate MRT system for the Thane-Bhiwandi-Kalyan sub region. As per the study, it was proposed to develop a metro rail system for this corridor in place of mono-rail. Various companies, industries, residential areas and educational institutions are falling along the corridor which will attract large number of commuters for metro. Proposed metro system will also be integrated with the existing Metro line 4 at Kapurbawadi enhancing the utility and efficiency of the public transportation system in MMR.

### **2.3.2. Alternate Gauge System**

34. Mumbai Metro Corridors has been implemented with Standard Gauge (1435 mm). With the objective of uniformity, this corridor is also proposed to be on Standard Gauge (1435mm). Apart from the uniformity feature, the standard gauge for Proposed Metro corridor is highly recommended for the following reasons:

35. The standard gauge is better as it allows a low turning radius as low as of 90 to 140 meters as against 175 meters for broad gauge and this reduces the requirement of land when the Metro has to take a curving turn. Metro alignment is passing through built-up areas for optimal commuter Utilization, and this imposes severe restrictions on the selection of curves. As in most of the cities in India no 'right of way' has been reserved for metro systems, the alignments have to pass through already congested major arterial roads. These roads may have sharp curves and right-angle bends at many sections. In such a situation, adoption of Standard Gauge is advantageous, since it permits adoption of sharper curves compared to Broad Gauge to minimize property acquisition along the alignments.

36. Since all the major Metro systems adopt the standard gauge, quality is ensured because of mass production.

37. The adoption of standard gauge also ensures constant up-gradation to latest technologies in rolling stock, suspension, braking traction and propulsion in future as well, because of the availability of a very large market.

38. In Standard Gauge 1 in 7 and 1 in 9 turnouts, which occupy lesser length, are feasible compared to 1 in 8 ½ and 1 in 12 turn-outs required for Broad Gauge. Length of cross-overs for Standard Gauge is thus lesser than for Broad Gauge. Land requirement for depot where a large number of lines connected together in the shape of ladder is also reduced. Standard Gauge is, therefore, more suited for use in built up environment where land availability is scarce especially in cities like Mumbai.

39. For Standard Gauge, optimized state-of-the-art rolling stock designs are available 'off the-shelf'. This is not so for Broad Gauge where new designs for rolling stock have to be specially developed, which entails extra time and cost.

40. Once technology for Standard Gauge coaches get absorbed and a manufacturing base for them is set up in India, there will be considerable export potential for the coaches, since almost all the countries use Standard Gauge for their metros. This is not so in case of Broad Gauge.

### **2.3.3. Alternate Alignment**

41. Since the corridor length is small (approx.11.88 km) and system is planned for heavily populated urban settings, many alternate alignments were not possible due to availability of limited space. The alignment is proposed so as to minimize the environmental and social disturbance due to the project. The corridor is planned to be majorly on the median of the existing road causing minimum disturbance and land acquisition. At only a few places the alignment diverts from the median but remains along the road. Alternate route/locations considered are discussed below:

#### **Section between Kapurbawadi Station (Ch 0) and Kasheli Toll Naka (Ch 4900)**

42. The alignment at kapurbawadi flyover turns on to the right and then follows the median at Balkum fire station, dokali Naka, then it continues along the median till Balkum Naka and then turn to left and near Maru Aai temple it turns to right, then it continues to shiv temple before kasheli (ulhas river bridge) and turns at left of the ulhas river bridge at chainage 3900, and it crosses the river parallel to kasheli creek bridge, then it continues at left of the carriageway and run parallel (3.65 m gap) to kasheli minor bridge and it continues till kasheli toll Naka at chainage 4900, then gradually turns right at median after kasheli toll Naka. From Kasheli Bridge to Dhokali Naka two alignment options were explored viz. (i) Option-1- Proposed alignment after crossing Kasheli Bridge runs at edge of existing RHS of carriageway till temple. After crossing the temple, the alignment transits through portal system along median of existing carriageway from near temple upto Dhokali Naka and; (ii) Option-2- Proposed alignment after crossing Kasheli Bridge runs at edge of existing RHS carriageway up to Dhokali Naka. Comparing both the options in terms of number of trees required to be cut, Option-1 is better as number of trees required to be cut is less as compared to Option-2. Considering the option 2 for this stretch, number of trees required to be cut were reduced.

### **2.3.4. Alternate locations for Kalher station**

43. Location of Kalher station has now been shifted towards Bhiwandi side by 400 m as the earlier location was crossing the high-speed railway corridor. Construction of station at crossing point is challenging both w.r.t engineering and safety perspective. Thus, considering the both, location of Kalher station is shifted

### **2.3.5. Alternate locations for Depot**

44. Three locations were considered for development of Depot, i.e. at Kon (MIDC); APMC, Kalyan; and at Kasheli. Since the locations at Kon and at Kalyan are falling in the Phase-2 alignment, depot at Kasheli is considered for development at this stage.

### **2.3.6. With and Without Project Scenario**

45. Analysis is carried out to understand the project significance and impact by comparing the “With Project” scenario and “Without Project” scenario. Analysis is carried out w.r.t various parameters which are defined below in **Table 2.1**.

**Table 2.1 : Comparison of the Alternatives for “With and Without Project” Scenario**

<b>Parameters</b>	<b>Alternative 1 (With Phase I of Proposed Metro Corridor)</b>	<b>Alternative 2 (No Project scenario)</b>
<b>Length</b>	Approx. 11.88 km	Road/Rail: Approx. 20 km (No direct connectivity between Thane to Bhiwani by local train)
<b>Structural Features</b>	The entire section of the alignment will be on viaduct/ bridge structure (elevated)	Embankment (on existing rail/ road)
<b>Right of Way</b>	2-2.5 m on road median Max. 12 m if away from road	Road: 30 m – 120 m depending on the number of lanes proposed/required Railway: 60-80 m
<b>Change in Land Use Pattern</b>	Minimal change in land use pattern is envisaged as the alignment is majorly either elevated and running on median of existing roads or along the existing roads	Changes in land use pattern at large scale
<b>Travel Time</b>	15-20 mins approx. Annual time saving cost of passenger travelling by metro is estimated to be INR 36714 Cr and annual time cost saved by road passengers is 1266 Cr.	45-60 mins approx. by road
<b>Travelling Speed</b>	Average speed: 35 kmph Max speed: 80 kmph	The carrying capacity of the existing road is lesser because multiple vehicles/ trains are operated on same road/ railway. Low speed operations are possible leading to continual congestion and traffic jams
<b>Safety</b>	A high safety is kept because of fully dedicated railway Line and high-quality safety infrastructure. Safety features includes: 1. Closed doors 2. Dedicated line 3. Structures are designed to withstand the seismic shocks of more than expected intensity	The safety performance is lower than roads and conventional railway line and due to conventional infrastructure
<b>GHG Emissions</b>	It is estimated that with introduction of proposed metro corridor, it is expected that the emissions from road transportation will be reduced due to decongestion and due to shift of ridership to metro system. Total reduction in GHG emission is estimated to be 1,024.35 kg/1000 liters of fuel used leading to annual saving of INR 1350 Crores	By 2050 a six-fold increase in the CO <sub>2</sub> emission is expected with existing transportation system



Parameters	Alternative 1 (With Phase I of Proposed Metro Corridor)	Alternative 2 (No Project scenario)
<b>Fuel Consumption</b>	It is assumed that construction of metro route will shift the ridership from road to the metro system thereby decongestion the oversaturated road system leading to overall reduction in fuel consumption due to decongestion effect in bus, car, 2 wheelers & 3 wheelers is 0.17687252 l/km thereby leading to annual fuel cost saving by road passenger is of approx. 960 Crore plus there will be saving in fuel for the passenger traveling by metro of amount approx. 11877 Crores	Higher fuel consumption due to increased number of private vehicles plying between the connected cities and high congestion & traffic jams due to increased load of passenger with time.
<b>Accidents</b>	The probability of accidents will be reduced due to the adoption of the high level of safety standards in the project design and minimum interference with the pedestrian, cattle and other transport due to its elevated nature. Annual cost saved due to reduction of accident is 3980 Cr.	Due to an increase in traffic in existing roads/ rail lines, accidents probability will increase
<b>Environmentally Sensitive Areas (NP/ WLS/ Forests/ etc.)</b>	Land requirement for the construction on viaduct and road is very less, i.e. RoW of -10.55 m. Thus, there is a probability of less impact on forest area. No notified environmental protected area like national park/wildlife etc. is getting impacted due to the project	Land requirement for the construction on embankment for road and railway is 9.3 or 7.5 ha/ km respectively which is much larger as compared to metro rail projects. Thus, there is probability of more impact on forest area/ protected area due to large land acquisition in these areas (if any)
<b>Total Evaluation</b>	The proposed metro rail project shall be developed keeping in view high safety and efficiency.	Existing transportation system shall be improved, focus should be on development of reliable, comfortable, faster and efficient public transportation system
	High demand is expected because major stations are in the urban area and linked with the city transport service. Shift of ridership to metro in these areas will improve efficiency of existing transportation system as well	The prevailing transport issues will continue.
	The impact to natural environment is minimal because of low land requirement	The impact to natural environment is comparatively more
	This is the most desirable plan.	This plan is inferior to ALT1

Source: Study team &amp; DPR

## 2.4. Project Components (Interventions)

46. Project involves development of elevated metro rail corridor of 11.88 km, comprising of 6 no of elevated stations, 1 no. of depot, staff quarters, operation control centre, receiving sub-station and allied facilities. Details of the project components is given in sub-sections below. Salient features of the project are given in **Table 2.2** below.

**Table 2.2 : Salient Features of Project (Phase I-Metro Line-05)**

Length-Phase 1	11.88 Km (Elevated)
Stations-Phase 1	6 Nos. (Dhamankar Naka, Anjurphata, Purna, Kalher, Kasheli, Balkum Naka)
Length-Phase 2	13.02 Km
Stations-Phase 2	9 Nos.
Elevated/Underground	Elevated along Kapurbawadi to Bhiwandi.
Depot Location	Kasheli
Interchange stations	Kapurbawadi with Metro Line 4
Traction System	25 KV AC Single Phase Overhead Traction System.
Project Cost (For 24.90 Km length)	Total Cost with Land – 6621.273 Cr. As per DPR, Total Completion Cost including all – Rs. 8415.255 Cr. (incl. Phase-II)
FIRR & EIRR	6.00% & 17.09%
Ridership (Daily Ridership)	2021: 2.29 Lakhs (PHPDT*- 17957) 2031: 3.03 Lakhs (PHPDT*- 26143) PHPDT* – Peak Hour Peak Direction Traffic
Rolling Stock	Width: 3.20m, Height: 3.90m, Length: 21.84m, Axle load: 17 Tonnes Seating Arrangement – Longitudinal Capacity-8 Coach Unit with 6 standees/Sqm-2352
Signalling System	Automatic Train Protection System (ATPS)
Gauge	1435 mm (Standard Gauge)
Design/Operating Speed	Design Speed = 90 Kmph, Operating Speed = 80 Kmph
Viaduct	Twin U Girder except Special Spans
Stations	Spine and Wings at Concourse Level, U Girder, and Inverted U Girder at Platform Level
Components funded by AIIB	<ol style="list-style-type: none"> <li>1. Design, Manufacture, Supply, Installation, Testing, Commissioning of Standard Gauge Metro Rail coaches and training of maintenance staff after commissioning.</li> <li>2. Design, Manufacture, Supply, Installation, Testing and Commissioning of Train Control and Signalling, Telecommunication.</li> <li>3. Design, Manufacture, Supply, Installation, Testing and Commissioning of Platform Screen Door System.</li> <li>4. Design, Manufacture, Supply, Installation, Testing and Commissioning of E&amp;M, Fire Detection and Fire Suppression Systems including DG sets for Elevated stations as well as Kasheli car shed</li> <li>5. Design, detailed Engineering, Supply, Installation, Testing and Commissioning of 220kv/33KV Receiving cum Auxiliary Main Substation, 220kv/25KV single phase AC Traction Substation,</li> </ol>



	<p>OHE, Traction as well as Auxiliary SCADA, 33KV cables &amp; ASS for line 5 including ASS &amp; OHE in Kasheli Car Shed</p> <p>6. Design, Manufacture, Supply, Installation, Testing, Commissioning including Maintenance of Escalators &amp; Lifts of 6 Elevated Stations.</p> <p>7. Design, Manufacture, Supply, Installation, Testing and Commissioning of Automatic Fare Collection (AFC) systems for 6 Elevated Stations and AFC OCC, AFC Software Testing, and development Centre (SDC).</p> <p>8. Manufacture, Supply, Installation, Testing, Commissioning of M&amp;P for Kasheli Depot including training to maintenance staff of car shed</p>
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### 2.4.2. Viaduct and Piers

47. The superstructure of a large part of the viaduct comprises of simply supported spans. However, at major crossing over or along existing bridge, special steel or continuous unit will be provided. Normally the Box Girder having a soffit width of about 4.0 m (approx.) accommodates the two tracks situated at 4.2m centre to centre (c/c). The Box Girder superstructure for almost all the simply supported standard spans will be constructed by precast prestressed segmental construction with epoxy bonded joints.

48. The standard spans c/c of piers of simply supported spans constructed by precast segmental construction technique has been proposed as 28.0m. The usual segments shall be 3.0m in length except the Diaphragm segments, which shall be 2.0m each. The other spans (c/c of pier) comprise of 11.950 to 29.05 m, which shall be made by removing/ adding usual segments of 3.0 m each from the centre of the span.

49. The viaduct superstructure will be supported on single cast-in-place RC pier. The shape of the pier follows the flow of forces. For the standard spans, the pier gradually widens at the top to support the bearing under the box webs. At this preliminary design stage, the size of pier is found to be limited to 1.8m to 2.0 m diameter of circular shape for most of its height so that it occupies the minimum space at ground level where the alignment often follows the central verge of existing roads. To prevent the direct collision of vehicle to pier, a Jersey Shaped crash barrier of 1.0 m height above existing road level has been provided all around the pier. A gap of 25 mm has also been provided in between the crash barrier and outer face of pier. The shape of upper part of pier has been so dimensioned that a required ground clearance of 5.5 m is always available on roadside beyond vertical plane drawn on outer face of crash barrier. An outward slope of 1:200 will be provided at pier top for the drainage due to spilling of rainwater, if any.

50. Substratum consists of top 1 meter as filled up soil followed by sand, silty sand, silty sand mixed with gravel up to 30-meter depth. Pile foundations have been recommended for the foundations as per the stratum encountered. Hence, pile foundations with varying pile depths depending on soil characteristic have to be provided on a case-by-case basis.

### 2.4.3. Stations

51. It is proposed to construct the elevated stations with elevated concourse over the road at most of the locations to minimize land acquisition. Total 6 no of elevated stations are proposed in Phase I of proposed Metro Line-05 and the details are provided in Table 2.3.

52. The station is generally located on the road median on central piers as far as possible and have two side platforms. Total length of the station is 145 m. All the stations are two-level stations. Staircases /Escalators are proposed from either side of the road along the sidewalks in the open

spaces available near the stations keeping the acquisition of private property to the minimum. Passenger facilities like ticketing, information etc. as well as operational areas are provided at the on-course level. Typically, the concourse is divided into public and non-public zones. The non-public zone or the restricted zone contains station operational areas such as Station Control Room, Station Master's Office, Waiting Room, Meeting Room, UPS & Battery Room, Signalling Room, Train Crew Room & Supervisor's Office, Security Room, Station Storeroom, Staff Toilets, etc. The public zone is further divided into paid and unpaid areas. Auxiliary Service station is provided on the ground nearby as per availability of land. Since the stations are in the middle of the road, minimum vertical clearance of 5.5 m has been provided under the concourse. Platforms are at a level of about 13.5 m from the road.

**Table 2.3 : Proposed Stations**

S. No.	Name of Station	Start Chainage	Approx. Distance from previous station (c/c)-km
1.	Balkum	1766.850	1.767
2.	Kasheli	5551.704	3.785
3.	Kalher	7416.328	1.865
4.	Purna	8250.753	0.834
5.	Anjur Phata	10527.568	2.277
6.	Dhamankar Naka	12125.569	1.598

Note: Kapurbawadi station will be constructed as part of Metro line-04 and is not considered under this project

#### **2.4.4. Gauge**

53. Mumbai Metro Corridors has been implemented with Standard Gauge (1435 mm). With the objective of uniformity, this corridor is also proposed to be on Standard Gauge (1435mm).

#### **2.4.5. Track Structure**

54. Two types of track structures are proposed for Metro system. The normal ballasted track is suitable for At-Grade (surface) portion of Main Lines and in Depot (except inside the Workshops, inspection lines and washing plant lines). The ballast-less track is recommended on Viaducts. Only in case of the depot normal ballasted track is proposed for adoption. From considerations of maintainability, riding comfort and also to contain vibrations and noise levels, the complete track is proposed to be joint-less and for this purpose even the turnouts will have to be incorporated in Long Welded Rails (LWR) /Continuous Welded Rails (CWR). The track will be laid with 1 in 20 canted rails and the wheel profile of Rolling Stock should be compatible with the rail cant and rail profile.

#### **2.4.6. Rail Section**

55. Keeping in view the proposed axle load and the practices followed abroad, it is proposed to adopt UIC-60 (60 kg. /m) rail section. Since on main lines sharp curves and steep gradients would be present, the grade of rail on main lines should be 1080 Head Hardened as per IRST- 12-96. As these rails are not manufactured in India at present, these have to be imported. For the Depot lines, the grade of rails should be 880, which can be manufactured in India.

#### **2.4.7. Turnouts**

56. From considerations of maintainability and riding comfort, it is proposed to lay the turnouts also with 1 in 20 cant. Further, it is proposed to adopt the following two types of turnouts:

- i. On main lines, 1 in 9 type turnouts with a lead radius of 300 metres and permissible speed on divergent track as 40 km/h
- ii. On Depot lines, 1 in 7 type turnouts with a lead radius of 140 metres and permissible

speed on divergent track as 25 km/h

#### 2.4.8. Rolling Stock

57. Medium Rail Vehicles (MRV) with 2.9 m maximum width and longitudinal seat arrangement, conceptually the crush capacity of 43 seated, 204 standing, a total of 247 passengers for a Driving Trailer Car, and 50 seated, 220 standing, a total of 270 for a Trailer/ Motor Car is envisaged. Proposed train composition is 6-car Train: DTC+TC+MC+MC+TC+DTC. Height of the coach is 3.9 m and width of the coach is 2.9 m. Dimension of coach is given below in Table 2.4. Seating capacity of DTC is 282 (seating – 42; standing – 240) and of TC/MC is 298 (seating – 50 ; standing – 248). Maximum design speed is 95 kmph and maximum operating speed is 85 kmph.

**Table 2.4 : Coach Dimension**

Particulars	Length (m)	Width (m)	Height (m)
Driving Trailer Car (DTC)	21.64	2.9	3.9
Trailer Car (TC)/Motor Car (MC)	21.34	2.9	3.9

58. Trains composed of 6 cars with a service frequency of 12 trains per hour (i.e. headway 5 minutes) are proposed to be provided and details are provided in **Table 2.5**.

**Table 2.5 : Rake Requirement**

Particulars	Year 2031
Cars/trains	6
Peak Headway (Minutes)	3
Train capacity (6 cars)	1756 (seating – 284; standing – 1472)
Max. PHPDT Demand	29906
PHPDT Capacity Available	35120 36000* (@ 8 persons per square meter of standee area is assumed)
No of trains required	38

#### 2.4.9. Depot

59. Depot location is finalized at Kasheli for Phase-I. Detail of depot location is given below in **Table 2.6**. Layout of the Kasheli depot is given in **Figure 2.2**. Photographs of the Kasheli depot site is given in **Figure 2.3**. Proposed Kasheli depot site is low-lying area. Proposed depot site thus needs to be treated and filled prior undertaking depot construction works by 2-3 m. There is one existing nalla (water body) across the width of depot land in spiral shape (non-CRZ area) which is proposed to be diverted straight across by constructing RCC drain. Google earth imagery showing the depot site is given in **Figure 2.4**.

One elevated spur line (exit) to depot, approach road to the depot site and foundation structure for 220 kV EHV tower (Power supply to RSS at Depot will be derived from existing EHV tower of MSETCL tower falls in the CRZ area and thus permission under the CRZ Notification 2011 shall be required for this area.

One Elevated exit Spur Line (approx. 217 m length) having 09 no. of spans with typical span of 28m will be constructed in CRZ- III with pile foundation & central single pier.

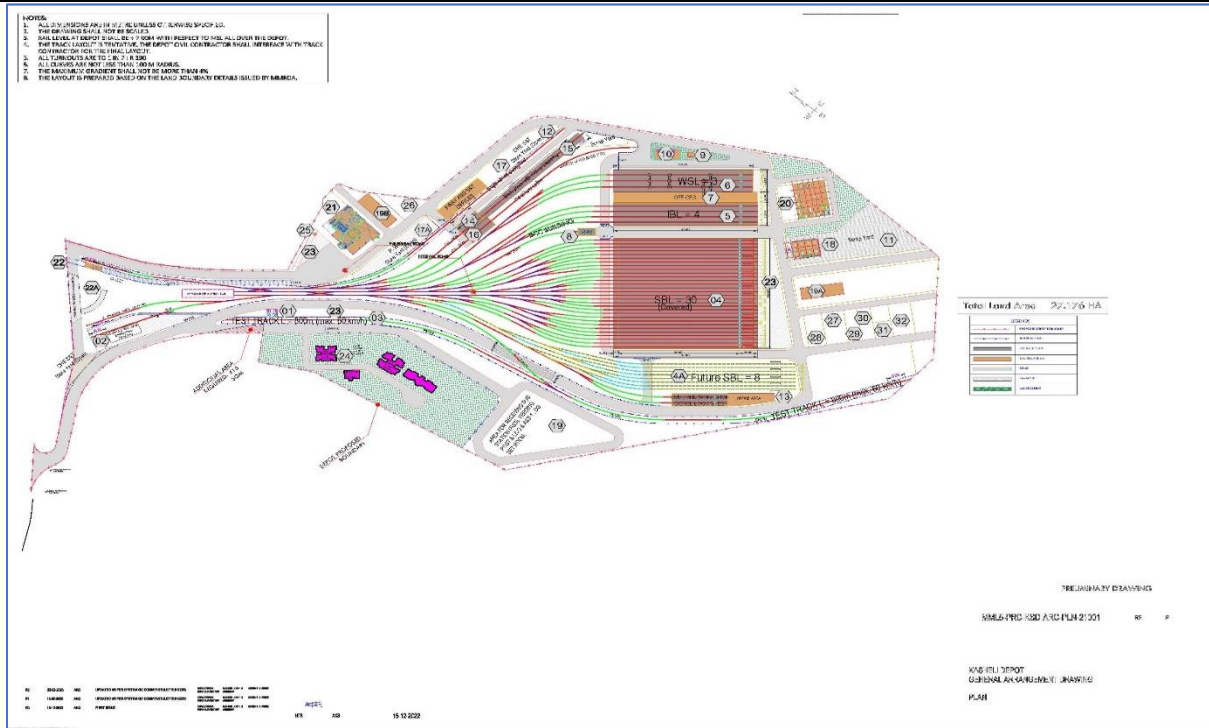
Total length of approach road to depot in CRZ area is 185m. Portion of approach road Bridge in CRZ- IA area (135m) will be constructed on stilts (as per the CRZ notification,2011) while remaining portion i.e., 50m in CRZ-III will be constructed on embankment (elevated ramp).

The power supply from MSETCL to Depot is through an existing EHV line of MSETCL. The

connection involves 4 foundation structures for installation of 220 KV EHV towers for power supply transmission line of 543 m to traction for Metro Line-5. Out of 4 foundation structures, 2 of the Foundation structure (2 nos. 8m X 8m) are in CRZ.

**Table 2.6 : Land Requirement for Depot**

S. No.	Location	Land Area (Ha)	Ownership	Remarks
1.	Kasheli	27.134 Ha	Government. - (0.23 Ha) & Private - (26.904 Ha)	Land For Depot for ML-5 (Phase -1)



**Figure 2.2 : Layout of Kasheli Depot**



**Figure 2.3 : General View of Land from Kasheli Road**

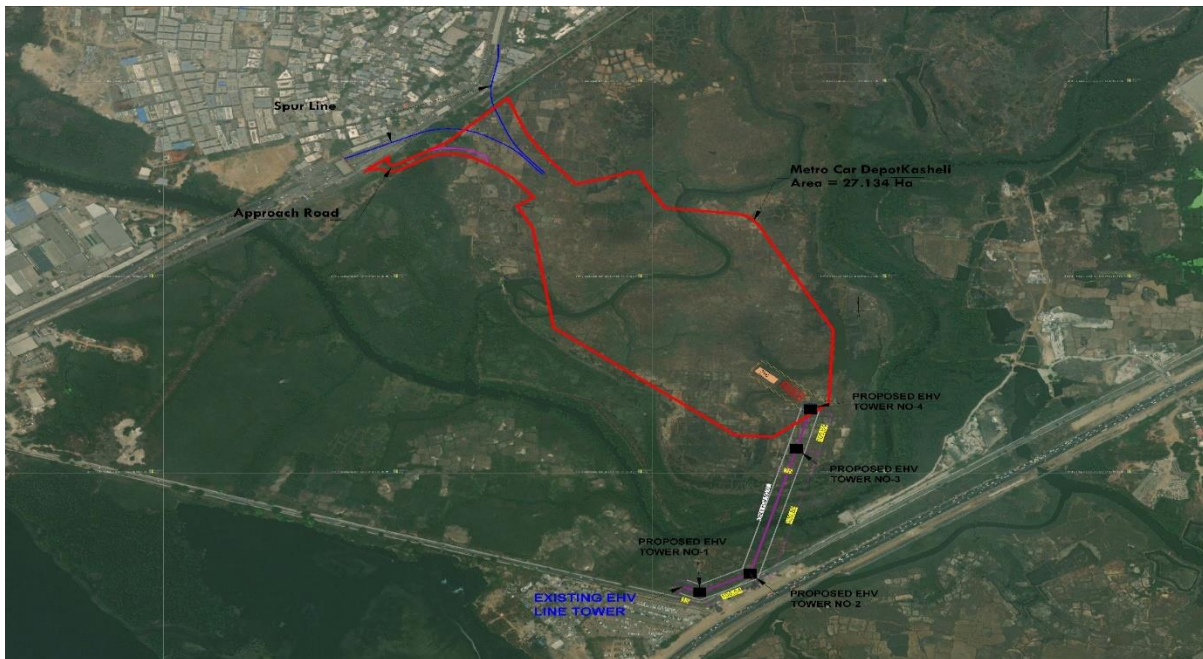


Figure 2.4 : Google Earth Imagery of Kasheli Depot and EHV Tower

## 2.5. Estimated Ridership

60. As per the traffic and ridership estimation study, estimated ridership data for 2021 and 2031 horizon is given below in **Table 2.7**.

**Table 2.7 : Estimated Ridership Data Between Thane and Kalyan (Metro Line-05)**

S. No.	Horizon	Maximum PHPD	Daily Ridership	Average Trip Length
1.	Horizon 2021	17957	229394	10.48
2.	Horizon 2031	26143	302558	11.16

61. As per the study, proposed project will be a valuable alternative to local trains (i.e. Central Railway) for connecting Thane to Kalyan, whose train connection at the moment has an extremely high ridership. Many usual commuters would prefer the new MRTS, since it would give the possibility to reach their destinations in less time and with a high level of service quality. Approximate Modal shift from other modes to Metro are as follows

- Two wheeler :11%
- Car/Taxi : 13%
- Auto :21%
- Bus: 31%

## 2.6. Construction Methods

62. Construction of the project will involve various steps and are defined below:

### 2.6.1. Utility diversion

63. All utilities falling within excavation area will be diverted away in advance to avoid damage to such utilities during the excavation/ construction phase. The cross utilities, however, has to be kept supported. Pressurised water pipelines crossing the proposed cut area will be provided with valves on both sides of the cut so that the cut area can be isolated in case of any leakage to the pipeline to avoid flooding of the cut/damage to the works.



### 2.6.2. Demolition Works

64. Structures which are falling within the RoW shall be removed/demolished. Approx. 313 structures falls within RoW of the Phase I alignment from Kapurbawadi to Dhamankar Naka out of which residential structures are 56 and commercial are 257. No community or CPR is being affected due to the project. Structures shall be removed only after paying the decided compensation to the owners and obtaining the consent. Any damage, if occurred in nearby areas or properties during demolition works shall be repaired and restored to its original condition.

### 2.6.3. Site Clearing and Vegetation Removal

65. Clearing and grubbing will be carried out before commencement of construction works. Project RoW have approx. 708 trees out of which 495 will be transplanted, 47 will be trimmed and 166 will be cut. Other than this, approx. 50-60 trees exists at depot site which may need to be removed from the site. For each tree cut/transplanted, compensatory afforestation works will be carried out as per guideline of concerned Tree Authority under Maharashtra (Urban Areas) Protection and Preservation of Trees Act, 1975 and its amendments and The Maharashtra Felling of Trees (Regulation) Act 1964.

### 2.6.4. Construction Works

66. **Pre-Cast Construction:** For the elevated sections It is recommended to have pre-cast segmental construction for super structure for the viaduct. For stations also the superstructure is generally of pre-cast members.

67. **Casting of Segments:** For viaducts segmental pre-cast construction requires a casting yard<sup>2</sup>. The casting yards will have facilities for casting beds, curing and stacking areas, batching plant with storage facilities for aggregates and cement, site testing laboratories, reinforcement steel yard, fabrication yard, etc.

68. **Launching Scheme:** Launching girder is specially designed for launching of segments. Initially, the launching girder is erected on pier head at one end of the work. The segments are lifted in sequence as shown in the figures and dry matched while hanging from the launching girder. After dry matching, the segments are glued with epoxy and pre-stressed from one end. The girder is lowered on the temporary / permanent bearings after pre- stressing. The launching girder then moves over the launched span to next span and the sequences continue.

69. **Construction of Stations:** It is proposed to construct the elevated stations with elevated concourse over the road at most of the locations to minimize land acquisition. To keep the rail level low, it is proposed not to take viaduct through the stations. Sub-structure for the station portion will also be similar to that of viaduct and will be carried out in the same manner. However, there will be single viaduct column in the station area, which will be located on the median and supporting the concourse girders by a cantilever arm so as to eliminate the columns on right of way. Super-structure will consist of precast segmental box Girders for supporting the track structure and I Girder / Double T Girders for supporting the platform and concourse areas. A pre-cast or cast in situ prestressed cross girder will be required over the middle piers for supporting platform structure. Box shaped in situ prestressed cantilever cross girders are planned for supporting the concourse girders and escalators at mezzanine level. All the members will be pre-cast in a casting yards and launched at site through cranes.

70. **RoW Required for Construction:** As most of the construction is to be carried out on the middle of the road, central two lanes including median will be required for construction activities.

<sup>2</sup> Already existing at Ovali (Bhiwandi) and Dapode (Bhiwandi). Consent to establish and operate is obtained for operating batching plant at both the sites and are valid till date.

During piling and open foundation work, a width of about 9 m will be required for construction and the same will be barricaded. Two lanes shall be provided for traffic on either sides during construction by widening of roads, if necessary. In certain cases, one way traffic may be resorted to.

71. **Restoration:** After the completion of project construction works, project RoW will be made free of all kind of waste, debris, machinery etc. Temporary acquired areas will be restored to its original condition and handed over to the owning agency/authority/individuals.

## 2.7. Amenities

### 2.7.1. Land Requirement

72. Proposed Mumbai Metro Line 5 project shall require land for different purposes. Land is generally required for (i) Viaduct, construction of stations and allied services, (ii) Approach Road to Depot, (iii) Construction of Depot including laying of stabling lines, (iv) Workshops, washing lines, administrative buildings and (v) Water, Sewage & Effluent treatment systems in addition to storage facilities. Additionally, land is also required for Traction Sub Station (TSS). Details of land required for various purposes is given in **Table 2.8**.

**Table 2.8 : Permanent and Temporary land Requirement for Metro Line-05 Project**

Sr.No	Component	Location	Govt. Land (sqm)	Private Land (sqm)	Total (sqm)
Permanent Land Requirement					
1	Entry/ Exit structure of stations	Balkum Naka		193.522	4,439
2		Kasheli		0.000	
3		Kalher		115.866	
4		Purna		203.097	
5		Anjurphata		1,954.211	
6		Dhamankar Naka		1,972.787	
7	Viaduct	Kapurbawdi, Thane		797.11	9,447
8		Furniture Market, Kasheli	7,781.10		
9		MCGM & other Land, Thane	836.40		
10		Chhatrapati Shivaji Maharaj Krida Sankul, Kasheli	32.33		
11	Depot	Kasheli		2,05,900	2,05,900
12	Operation Control Center (OCC)	Kasheli		3,000	3,000
13	Staff Quarters	Kasheli		10,000	10,000
14	Receiving Sub Station	Near Balkum Fire Station	4,000		4,000
	Total Permanent		12650	224137	2,36,786
Temporary Land Requirement					
1	Temporary Office/ Site Office	Balkum Naka	1,500		1,500
2	Segment Casting Yard	Dapode	60,000		60,000
	Total Temporary		61,500		61,500
	<b>Grand Total</b>		<b>74150</b>	<b>224137</b>	<b>2,98,286</b>

**2.7.2. Water Requirement****2.7.2.1 Construction Phase**

73. Water will be required during construction phase for construction works, mixing of concrete, curing works, washing & cleaning and domestic usage of construction workers. Water requirement for concrete mixing and curing purpose is given in **Table 2.9**. As per the BOQ available for other metro project, it is estimated that approx. 15 cum of concrete is required for construction of 1 m of the elevated metro corridor (11.01 km) and 30 cum for stations 870 m length, thus concrete required for construction of proposed corridor is approx. 1,91,250 cum.

**Table 2.9 : Water Requirement for Construction & Sprinkling Purpose**

Purpose	Thumb Rule	Water Requirement-KL
Concrete Mixing	0.17KL/cum	32,512.5
Curing	0.3 KL/cum	57375
Total		89887.5
Losses @10%		8988.75
Total water required for concrete mixing and curing	98,876.25 KL 98.87625 ML	
Water Sprinkling @ approx. 1 liter/sq m/day (9 m width for 11.88 km = 1,06,920 sq m) (considering approx. 30 months of construction and 24 months of dry months for sprinkling)	76982 KL  76.98 ML	
Total		1,75,858.65 KL, 175.85 ML/195.39 KLD

74. It is estimated that approx. 1000 labour/staff will be contracted for undertaking the construction works. Domestic water requirement for the labour is estimated @ 80 LPCD and is equal to 80 KLD. For construction period of 30 months, water requirement for domestic purpose is estimated to be 72,000 KL (72 ML).

75. Source of water supply during construction phase can be either tanker supply or the ground water supply. Permission shall be obtained from the CGWA/State Water resources Board/Municipal Corporation as required prior extraction of ground water.

76. Wastewater will also be generated during construction phase at site as site run-off. The site run-off shall be collected using temporary storm water drain into sedimentation tank and the same shall be re-used at site for sprinkling/curing purpose. Wastewater will also be generated from kitchen, bathrooms and toilets area at labour camps and site. Wastewater generation is estimated @ approx. 60 LPCD and comes to be 60 KLD. This wastewater can either be stored in septic tanks and the septage on regular basis shall be disposed off to the STP of municipal corporation for disposal. Otherwise, a STP can also be provided for treatment of sewage up to tertiary level and the treated water can be re-used at site for the sprinkling purpose.

**2.7.2.2 Operation Phase**

77. Water will be required during operation phase at stations for cleaning/washing/drinking purpose and at depot for cleaning/washing/drinking purpose and for washing of rolling stock. Water requirement estimations is provided in **Table 2.10**. Rain water harvesting will be carried out to harvest the storm water and recharge the ground water.

**Table 2.10 : Water Requirement: Operation Phase**



S. No.	Purpose	Water Requirement (per day)
1.	Stations/Depot: Drinking purpose (Considering total 100 staff (2 shifts) @ each station & depot (6+1 =7), thus 700 staff at 6 stations & 1 depot-water requirement @45 LPCD)	31.5 KLD
2.	Stations: Cleaning & Washing (@ 1 KLD/station)	6 KLD
3.	Depot: Cleaning, Washing & Misc. (@ 5 KLD/station)	5 KLD
4.	Depot: Rolling stock washing (@ 500 liter/car for 6 cars) and no of trains to be washed per day is 10 Nos.	<b>30 KLD</b>
5.	Total	<b>72.5 KLD</b> <b>~ 73 KLD</b>

78. Wastewater will be generated at both stations and depot during operation phase. Wastewater at stations will be collected in septic tanks which will be emptied on regular basis through authorized vendors and septage will be disposed off to the nearby common STP of TMC. At depot, for management of sewage and effluent from washing will be treated in the effluent treatment plant (ETP). Effluent from ETP will be treated up to tertiary level and will be re-used within the site for gardening/flushing purpose by provision of dual plumbing system.

### 2.7.3. Power Requirement

79. Electricity/power is required for operation of Metro system for various activities such as running of trains, station services which include lighting, lift operation, escalators, signalling & telecom processes, firefighting activities, workshops/depots and other maintenance infrastructure. Total traction power requirement for Metro Line-05 is estimated to be 8.6 MW in 2021 and 13.8 MW in 2031. Total Auxiliary power requirement for Metro Line-05 is estimated to be 5.4 MW in 2021 and 7.8 MW in 2031. Source of supply will be the State power grid. In order to ensure a reliable Power Supply, a separate dedicated Receiving Sub Station is planned for the corridor and the depot. At 220 kV from MSETCL network by drawing power through LILo arrangement from MSETCL 220 kV double circuit Temghar – Colorchem transmission line

80. The 220 kV power supply will be stepped down to 33 kV level at the RSS's of metro authority being constructed in Depot area. The 33 kV power will be distributed along the alignment through 33 kV Ring main cable network for feeding auxiliary loads of stations & depot. These cables will be laid in dedicated ducts/cable brackets along the viaduct. For traction supply 220 kV power will be stepped down to 25kV & will be taken to viaduct through cables of suitable size to feed power to Line 5 for traction purposes.

81. In case of total grid failure, all trains may come to a halt, but station lighting, fire and hydraulics & other essential services can be catered to by standby DG sets. However, no train services can be run with power supply received from DG Sets. Therefore, while the proposed scheme is expected to ensure adequate reliability, it would cater to emergency situations as well, except for the train running.

### 2.7.4. Man-power

82. It is estimated that approx. 1000 labour and staff (technical included) may be employed during construction phase of the Metro Phase I project and approx. 350 staff will be required during operation phase of the Metro Phase I project.

## 2.8. Utilities

83. The proposed alignment is passing along through the major arterial roads which are serving commercial and residential areas. A large number of surface and sub-surface utility services e.g. sewers, water mains, storm water drains, telephone cables, electric poles, traffic signals etc. exist along the proposed alignment. Utilities (existing & proposed) are getting impacted at 4 locations, i.e. existing water mains line at Ch 2.5 km, proposed water mains line between Ch 1.4 km to 2.5 km, existing water mains line at Ch 7.4 km and MGL steel pipe line (proposed & existing) at Ch 1.7 km.

## 2.9. Casting Yard and Site Office

84. Casting yard shall be established at a distance of minimum 500 m from the settlement area. Private agricultural land, forest areas, sensitive habitats etc shall be avoided for establishment of casting yard. Distance of minimum 500 m should also be maintained from water bodies as feasible. If any existing casting yard is available in area, then possibility of using that shall be explored. Consent to establish and operate shall be obtained from SPCB for establishment of batching plant, STP etc as applicable in casting yard/labour colony prior start of any operations in casting yard. Labour colonies shall be located within the casting yards preferably. Labour colonies as established for the project are listed in **Table 2.11** below:

**Table 2.11 : Details of Labour Camps**

Sl. No.	Camp Location	No. of Workers (Residing in camps)	Facilities
1	Sanjivani Complex, Kalher	400	Accommodations with proper sanitation and kitchen facility , Medical assistance by regular doctor's visits and First Aid facility provided, with Firefighting arrangement and regular pest control(mosquito, rodents etc.).
2	Dapode Casting Yard	150	
3	Ovali Casting Yard	50	

## 2.10. Project Cost

85. Cost estimates are available for entire metro 5-line project. Cost estimates for the project as provided in DPR (March 2016) is presented in **Table 2.12**.

**Table 2.12 : Summary: Project Completion Cost (Phase I +II)**

S. No.	Items	Cost (In Crores)
1	Total civil cost (excluding taxes)	3,212.34
2	Total systems cost (excluding taxes)	2,946.56
3	Total taxes including escalation (Central)	908.42
4	Total taxes including escalation (State)	751.09
5	Total Design Charges	431.13
6	Total land cost	146.93
7	IDC	20.00
8	<b>Project completion cost</b>	<b>8,416.51</b>
9	<b>Total Escalation Cost</b>	<b>1,774.28</b>

## 2.11. Project Implementation Schedule

86. Project implementation may require time of approx. 30 months from commencement.

## CHAPTER 3. LEGAL POLICY FRAMEWORK

### 3.1. Introduction

87. The Constitution of India clearly mandates the duty of the state to ‘protect and improve the environment and to safeguard the forests and wildlife of the country’. It imposes a duty on every citizen ‘to protect and improve the natural environment including forests, lakes, rivers, and wildlife’. Reference to the environment has also been made in the Directive Principles of State Policy as well as the Fundamental Rights. The Department of Environment was established in India in 1980 to ensure a healthy environment for the country. This later became the Ministry of Environment and Forests in 1985, now named as Ministry of Environment, Forest and Climate Change (MoEF&CC).

88. The constitutional provisions are backed by a number of laws – acts, rules, and notifications. The EPA (Environment Protection Act), 1986 came into force soon after the Bhopal Gas Tragedy and is considered an umbrella legislation as it fills many gaps in the existing laws. Thereafter a large number of laws came into existence as the problems began arising. The sincere implementation of these laws ensures that the development is sustainable as well as protects human health and property in the long term. The Ministry of Environment, Forest and Climate Change (MoEF&CC), the Central and State Pollution Control Boards / UT Pollution Control Committees represent the principal administrative and regulatory bodies responsible for the preservation and conservation of the environment as the country undergoes massive social, economic and infrastructural transformation and thereby ensuring environmentally sustainable development in the country.

89. In India, various Environmental Acts, Rules and Notifications have been introduced to ensure that developmental projects are planned and executed on the principles of sustainable development. The objective of these regulations is that the project should not lead to major ecological or other losses while accruing project benefits. The applications of various regulations/law to the design (project preparation stage), construction (implementation stage) and post project stage (operational phase) of the project are described in detail, in this Chapter.

### 3.2. National Institutional Settings of Environmental Regulations in India

90. The notification of the Government of India in the erstwhile Ministry of Environment and Forests vide number S.O. 1533 (E) dated the 14th September, 2006 (hereinafter referred to as ‘EIA Notification, 2006’), the Central Government imposed certain conditions and thresholds on the undertaking of some projects or expansion or modernization of such existing projects entailing capacity addition, in any part of India listed in Schedule to the EIA Notification, 2006 unless Prior Environment Clearance has been accorded by the Ministry of Environment, Forest and Climate Change (MoEF&CC) or the State Level Environment Impact Assessment Authority (SEIAA) or accordance with the procedure specified in the EIA Notification, 2006 and subsequent amendments.

91. Since Railway projects are not included in the Schedule of the EIA Notification, 2006, prior environmental clearance is not required for the proposed Phase I of Metro Line-5 project.

### 3.3. National and State Rules and Regulations

92. As a part of the environmental impact assessment of the proposed project, applicable laws, regulations, and policies have been reviewed and provided in subsequent sections.

#### 3.3.1. National Environment Policy, 2006

93. The National Environment Policy is a response to our national commitment to a clean

environment, mandated in the Constitution in Articles 48 A and 51 A (g), and strengthened by judicial interpretation of Article 21. It is recognized that maintaining a healthy environment is not the state's responsibility alone, but also that of every citizen. A spirit of partnership should thus be realized throughout the spectrum of environmental management in the country. The National Environment Policy is intended to be a guide to action: in regulatory reform, programmes and projects for environmental conservation; and review and enactment of legislation, by agencies of the Central, State, and Local Governments. The dominant theme of this policy is that while conservation of environmental resources is necessary to secure livelihoods and well-being of all, the most secure basis for conservation is to ensure that people dependent on particular resources obtain better livelihoods from the element of conservation, than from degradation of the resource. The policy also seeks to stimulate partnerships of different stakeholders, i.e. public agencies, local communities, academic and scientific institutions, the investment community, and international development partners, in harnessing their respective resources and strengths for environmental management.

### **3.3.2. The Environment (Protection) Act, 1986**

94. The Environment (Protection) Act, 1986 is widely regarded as a comprehensive or umbrella legislation for environment in its entirety. The responsibility for implementation of the provisions of the EPA has to a large extent been entrusted to the regulatory agencies created under the Air and Water Acts. Department of Environment (DoE) was created in 1981 in the Central Government to act as a nodal agency for environmental protection and development in a coordinated manner. The principal environmental Regulatory Agency in India is the Ministry of Environment Forests & Climate Change (MoEF&CC) of the Government of India. MoEF&CC formulates environmental policies and accords environment clearances for the large projects (sector-wise listing has been done by MoEF&CC for e.g. Area development, Highways, Petrochemicals, etc.). State Department of Forest & Environment and Pollution Control Boards/ Committees are enforcing authorities at the State level to resolve environmental issues arising due to infrastructure projects. The provisions of this act are applicable to the project.

### **3.3.3. Environmental Impact Assessment Notification, 2006 and its Amendments**

95. The Ministry of Environment and Forests (now known as Ministry of Environment, Forest and Climate Change) has issued Environmental Impact Assessment notification on 14<sup>th</sup> September 2006, as a major tool for minimizing the adverse impact of rapid industrialization on environment. As per this notification, all projects and activities are broadly categorized into two categories - Category 'A' and Category 'B' based on the spatial extent of potential impacts and potential impacts on human health and natural and manmade resources. All projects or activities included as Category 'A' in the Schedule shall require prior environmental clearance from the Central Government in the Ministry of Environment, Forest and Climate Change (MoEF&CC) on the recommendations of an Expert Appraisal Committee (EAC) constituted by the Central Government for the purposes of this notification. All projects or activities included as Category 'B' in the Schedule will require prior environmental clearance from the State/Union territory Environment Impact Assessment Authority (SEIAA). The railway sector or metro rail projects are not included in the schedule list of EIA notification, 2006 hence the proposed project does not require to apply for Environment Clearance. However, project activities like establishing Ready Mix Concrete plants, tree cutting, mining (for establishment of new quarries), forest clearance, for activities in coastal regulation zone, for working navigational channels, etc. require permissions/ clearances from respective authorities.

### **3.3.4. CRZ Notification 2011**

96. Ministry of Environment and Forest has issued a Coastal Zone Regulation Notification in 1991 to regulate the activities in coastal area and to protect its pristine and fragile environment. The 1991 notification was superseded by a new notification in 2011 and now new CRZ notification

2019 is applicable for areas wherein Coastal Zone Management Plan (CZMP) 2019 is approved. However, for Thane district CZMP 2019 is under draft stage and thus CRZ Notification 2011 is applicable for this project. The CRZ notification has demarcated the coastal zone where the development is prohibited without obtaining permissions from State coastal zone management authorities and national coastal zone management authorities as applicable. The notification broadly classifies CRZ into 4 zones and further sub-zones depending on type of the area. Proposed phase I of Metro Line-05 project also traverses through the CRZ area at two locations, i.e. at Ulhas River crossing at Kasheli and some portion of proposed Kasheli depot is falling under CRZ. A new metro bridge is proposed to be constructed at Kasheli along the existing Kasheli bridge. At this location, approx. 824 m of alignment passes through CRZ I area, 356 m is passing through Mangroves and its buffer zone, thus total length in CRZ I area is 1180 m. Another 1450 m of alignment passes through CRZ III area and 680 m passes across river. Total no of piers in CRZ is 132 out of which 14 are in the river. The CRZ clearance is already obtained for this location.

97. A portion of spur line, approach road to Kasheli depot and foundation structure of EHV tower falls in CRZ area. It is likely that CRZ I A and CRZ III area will be impacted. CRZ clearance shall be obtained for the same. Detail of CRZ are given below. Map showing CRZ area demarcation is attached as **Appendix 3.1**.

<b>CRZ AFFECTED AREA OF APPROACH ROAD, SPUR LINE AND EHV TOWERS (AS PER APPROVED CZMP,2011)</b>						
Sr. No.	CRZ Details	Description				Area Sq.m
		Length (m)	No. of Foundations and Size		Area Sq.m	
			Nos.	Length (m.)		Width (m.)
<b>1</b>	<b>CRZ III (NDZ)</b>					
i	Spur Line (480 m. total length)	216.30	10	5	5	250
ii	Approach Road / Bridge (total length of ramp portion is 50 m.)	50	-	50	16	800
iii	EHV Towers		2	8	8	128
<b>Total CRZ III (NDZ) Area</b>						<b>1178</b>
<b>2</b>	<b>CRZ-IA (50 m. Mangrove Buffer zone)</b>					
i	Approach Road / Bridge on stilt	135	10	Varies between 16m to 64m	4.3	1096
<b>Total CRZ-IA (50 m. Mangrove Buffer zone) Area</b>						<b>1096</b>
<b>Total CRZ affected area for the project under consideration</b>						<b>2274</b>

### 3.3.5. *Permission from Bombay High Court*

98. Mangroves patches at any location are declared as Reserved Forest by Bombay high Court and clearing of the Mangroves is prohibited without permission of MCZMA, Forest department and Bombay high Court. Thus, permission shall be obtained from the court prior cutting of Mangroves. While permission from MCZMA is obtained for the alignment, the permissions from Forest Department and High Court are in process.

### 3.3.6. *The Forest Conservation Act, 1980 along with the Forest Conservation Rules, 2003*

99. The Act prohibits the State Government or any other authority, without the prior approval of the Central Government, to de-reserve the Reserved Forests or permit use of any forest land or

any portion thereof for non-forest purpose. It further prohibits without the prior approval of the Central Government, to assign by lease or otherwise, any forest land or portion thereof to any private entity not owned, managed or controlled by the Government and further than no forest land or portion thereof may be cleared of naturally grown trees including for afforestation. The forest clearance is applicable for the project, if forest land needs to be diverted for the project. Further, if any activity is taken up in forest area, which do not require forest land diversion, then permission from the concerned DFO need to be taken. Project does not traverse through any notified forest area except the mangroves near the Ulhas River which are declared as reserved forest by Bombay High Court. Mangroves of area of approx. 0.6983 Ha. will be impacted due to the project. The forest clearance will be required for diversion of this mangrove for project development purpose. However, the project is elevated and the area will be required maximum for the pier construction. Due to elevated nature of project, mangroves are likely to grow back in the area after commencement of construction works.

### **3.3.7. *The Wildlife (Protection) Act, 1972***

100. The Act provides for Preservation and Conservation of wildlife, birds, plants and environment in biodiversity rich areas by notifying them as Protected Areas (PA) either as Wildlife Sanctuaries (WLS) or National Parks (NP) or Conservation Reserves (CR) or Community Reserves (CoR). The State Government and the Central Government, both have the powers to notify WLS & NP. The Act provides for constitution of National and State Board of Wildlife with the Prime Minister of India and Chief Ministers of States as their respective Chairpersons. For activities within a conservation reserve, a recommendation from the Standing Committee of National Board for Wild Life (NBWL) would be required after obtaining the permission from the Chief Wild Life Warden (CWLW) with the approval of the State Government (in consultation with SBWL). The Supreme Court vide order dated 13.11.2000 in Centre for Environment Law, WWF-1 v. Union of India, WP(C) 337/1995 has prohibited the de-reservation/ de-notification of WLS & NP without the approval of the Supreme Court. The proposed project does not pass through any protected area like WLS, NP, etc. or its ESZ, thus act is not applicable for the project and wildlife clearance is not required for the project.

### **3.3.8. *Maharashtra Felling of Trees (Regulation) Act, 1964,***

101. The Act provides for regulating in non-urban areas, the felling of certain tree species for the purpose of their preservation and protection of soil from erosion. The Act prohibits the felling of trees (currently 16 species) specified in the Schedule to the Act without the prior permission of the Tree Officer and provides for penalty and procedure for penalty along with conditions of compensatory plantation.

### **3.3.9. *The Maharashtra (Urban Areas) Protection and Preservation of Trees Act,1975 (As amended)***

102. The Act provides for protection and preservation of trees in urban areas, by regulating felling of trees and through planting of adequate number of new trees. It is applicable to any urban area or part thereof as specified by the State Government in the Official Gazette. The Act prohibits felling of any tree except with the prior permission of the Tree Officer after applying in writing to the Tree Authority and the authority may impose conditions with regards to compensatory plantation. There may also be a Tree Cess levied by the urban local authorities in some of the urban areas. Total 708 nos. of trees fall within the Phase I alignment for which permission is required from Thane Municipal Corporation, DCF, Thane and Bhiwandi Nizampur Municipal Corporation prior cutting of trees. Applications has been submitted to the respective authorities and is at different stages of approval. Out of 708 trees, 495 trees should be transplanted, 166 will be cut and 47 will be trimmed. Other than this, approx. 50-60 trees exist at depot site which may need to be removed from the site.

**3.3.10. The Water (Prevention & Control of Pollution) Act, 1974 amended in 1988**

103. The Water (Prevention and Control of Pollution) Act, 1974 resulted in the establishment of the Central and State Pollution Control Boards whose responsibilities include managing water quality and effluent standards, monitoring water quality, prosecuting offenders and issuing licenses for construction and operation of certain facilities. The consent to establish and consent to operate from State Pollution Control Board/ Pollution Control Committee are required by user agency under this act.

**3.3.11. The Air (Prevention & Control of Pollution) Act 1981 as amended in 1987**

104. The Act provides for preservation of air quality and control and abatement of air pollution, constitution of Boards, functions and powers of the boards, for setting of standards of air quality and standards for emissions of air pollutants into the atmosphere from industrial plants and automobiles, penalties for violation and process for appeals, etc,. It is mandatory to obtain prior consent of the State Pollution Control Board before establishing or operating any industrial plant in an Air Pollution Control Area. CPCB has issued directions for harmonization of classification of industrial sectors under red/ orange/ green/ white categories vide Notification dated 7th March, 2016, and additional guidelines vide notification dated 12.01.2021 and notification dated 30.04.2021. As per these guidelines, activities requiring consents to establish and operate from SPCB are:

- Setting up of batching plant
- Construction and operation of stations
- Establishment of depot
- Operation of stone crushers
- Construction of Buildings, etc.

**3.3.12. The Noise Pollution (Regulation and Control) Rules, 2000 and its Amendment in Rules (Noise Amendment rules 2010)**

105. The Union Government has laid down statutory norms to regulate and control noise levels to prevent their adverse effects on human health and the psychological wellbeing of the people. The rules titled Noise Pollution (Regulation and Control) Rules, 2000 have come into force at February 14, 2000. Under the new regulation, different areas and zones are to be identified as industrial, commercial, and residential or silence areas and anyone exceeding the specified noise level would be liable for action. Noise standards as per the rules for different land use is provided in **Table 3.1**.

**Table 3.1 : Ambient Air Quality Standards WRT Noise (Noise Rules, 2000)**

Area Code	Category of Area/Zone	Limits in dB(A) Leq*: Day Time	Limits in dB(A) Leq*: Night Time
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential area	55	45
D	Silence Zone	50	40

Note:

1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night-time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is defined as an area comprising not less than 100 meters around hospitals, educational institutions and courts. The silence zones are zones, which are declared as such by the competent authority.
4. Mixed categories of areas may be declared as one of the four-abovementioned categories by the competent authority.

\*dB (A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

A “decibel” is a unit in which noise is measured.

“A” in dB (A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.

Leq: It is an energy mean of the noise level over a specified period.

**Source: Noise Pollution (Regulation and Control) Rules, 2000**

106. In view of various difficulties being faced by the society due to noise pollution, the Central Government amended the Noise Pollution (Regulation and Control) Rules, 2000, and came out with The Noise Pollution (Regulation and Control) (Amendment) Rules, 2010. Through this amendment, stress has been laid on making the night time less noisy and peaceful. Restrictions have been imposed on use of horns, sound emitting construction equipment and bursting of fire crackers during night time. Community loud speaker now include not just 'Public Address System' but also any 'Sound Producing Instruments'.

107. As per Noise Pollution (Regulation and Control) Rules, 2000, under the title Noise from construction and civil engineering works, noise from construction sites is generally far worse than noise originating from factories. There are two main reasons for this. One is that wherever construction takes place like erection of roads, bridges and buildings noise emissions levels are higher. The other is that civil engineering equipment is inherently noisy. The worst of these pieces of equipment, from the noise generation point of view, are given in **Table 3.2**.

**Table 3.2 : Noise Limit for Automobiles at Manufacturing Stage**

S. No.	Categories of Vehicles	Limits in dB(A)
1	Motorcycle, scooters and three-wheelers	80
2	Passenger cars	82
3	Passenger or commercial vehicles of up to 4 MT	85
4	Passenger or commercial vehicles of above 4 MT and up to 12 MT	89
5	Passenger or commercial vehicles exceeding 12 MT	91

108. In the era of fast urbanization of buildings and roads, the demolition and the repair activities along with the huge machines used for the purposes create a great deal of noise to the annoyance of the people living near the sites of construction. Hence such works are also a potential source of noise pollution. Precautions in Construction Activities. -

- Acoustic barriers should be placed near construction sites.
- The maximum noise levels near the construction site should be limited to 75 dB (A) in industrial areas and to 65 dB (A) in other areas.
- There should be fencing around the construction site to prevent people coming near the site.
- Materials need to be stockpiled and unused equipment to be placed between noisy operating equipments and other areas.
- Constructing temporary earth bunds around the site using soil, etc., which normally is hauled away from the construction site.

### **3.3.13. The Motor Vehicles Act 1988 and its Amendment 2019**

109. In 1988, amendment of the Indian Motor Vehicle Act empowered the State Transport Authority to enforce standards for vehicular pollution prevention and control. The authority also checks emission standards of registered vehicles, collects road taxes, and issues licenses. In August 1997, the “Pollution Under Control” (PUC) programme was launched in an attempt to crackdown on the amount of vehicular emissions in the state. The MV Act was recently amended in August 2019. This new act has increased fines for many offences to check the road accidents



and improve the road safety in the country.

### **3.3.14. Movement of Hazardous Chemicals**

110. Movement of hazardous chemicals by road is governed by the Central Motor Vehicle Rules, 1989 (rules 129 through 137). Besides regulations and precautions to be taken while transporting such goods, the rules stipulate availability of a Transport Emergency (TREM) Card with the driver of the carrier which shall provide information on hazardous nature of the chemical carried and also precautions required to handle emergencies such as spillage and fire. These rules are not fully applicable to the proposed project as it involves oil, grease, paint, admixtures, etc. only to be used in different applications during construction. The contractor must be aware of these rules and must follow accordingly.

### **3.3.15. The Ancient Monuments and Archaeological Sites and Remains Act, 2010**

111. This Act provides for the preservation of ancient and historical monuments and archaeological sites and remains of national importance and for the regulation of archaeological excavations and for the protection of sculptures, carvings and other like objects. According to this Act, areas within the radii of 100m from the “Protected Monument” are designated as “Prohibited Areas” and from there 200m is designated as “Controlled /Regulated Areas”. No development activity (including building, mining, excavating, blasting) is permitted in the “prohibited areas”. Development activities likely to damage the protected monument are not permitted in the “controlled/regulated areas” without prior permission from the Archaeological Survey of India (ASI) if the site/ remains/ monuments are protected by ASI or the State Directorate of Archaeology. No Ancient Monuments and Archaeological sites found within 300m of the proposed project corridor. Hence the provisions of this Act are not be applicable for this Project. However, this act may be applicable due to any chance finding of artefacts during construction phase, if any.

### **3.3.16. Disposal of Fly Ash Notification 2009 and amended on 25th January 2016**

112. The main objective of the Fly Ash Notification is to conserve the topsoil, protect the environment and prevent the dumping and disposal of fly ash discharged from coal-based power plants. The fly ash notification makes essential the use of fly ash in road construction activities. As per the amendment of the Notification dated 25th January 2016, “No agency, person or organization shall, within a radius of 300 km of a thermal power plant undertake construction or approve design for construction of roads or flyover embankments with topsoil; The guidelines or specifications issued by the Indian Road Congress (IRC) as contained in IRC specification No. SP: 58 of 2001 as amended from time to time regarding use of fly ash shall be followed and any deviation from this direction can only be agreed to on technical reasons if the same is approved by Chief Engineer (Design) or Engineer-in-Chief of the concerned agency or organization or on production of a certificate of ‘fly ash not available’ from the Thermal Power Plant(s)”. The amendment further states “The cost of transportation of ash for road construction projects within a radius of 100 km from a coal or lignite based thermal power plant shall be borne by the thermal power plant and the cost of transportation beyond the radius of 100 km and up to 300 km shall be shared equally between the user and the thermal power plant”. The time period to comply with the provisions of the amendment by all concerned authorities was 31st December 2017. It is proposed to use fly-ash for the construction purpose of the proposed metro project.

### **3.3.17. Electricity Act 2003 (amendments 2004 and 2007)**

113. An Act to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity and generally for taking measures conducive to development of electricity industry, promoting competition therein, protecting interest of consumers and supply of electricity to all areas, rationalization of electricity tariff, ensuring transparent policies regarding subsidies,

promotion of efficient and environmentally benign policies, constitution of Central Electricity Authority, Regulatory Commissions and establishment of Appellate Tribunal and for matters connected therewith or incidental thereto. Permission shall be required under the act for installation of DG sets, installation of sub-stations for sourcing the power

114. As the Mumbai Metro Line 5 will be operated using electricity and this involves working with electricity, setting up transformers, switch gears units, Ring Main Units (RMU), UPS for power backup, etc. the following regulation is applicable:

Central Electricity Authority (CEA) is the technical agency making regulations consistent with the Electricity Act, 2003 under section 177 and carrying out the provisions of the Act. The following relevant regulations, which deal with health and safety requirements, are notified and published in the official gazette of the Government of India and available on the website of CEA:

- (i) Central Electricity Authority (Safety Requirements for Operation, Construction and Maintenance of Electric Plants and Electrical Lines) Regulations 2011
- (ii) CEA (Installation and Operation of Meters) Regulations, 2006
- (iii) CEA (Grid Standards for Operation & Maintenance of Distribution Lines) Regulations, 2010
- (iv) CEA (amendment to the regulations on “Installation & Operation of Meters”) Regulations, 2010
- (v) CEA (Measures Relating to Safety & Electric Supply) Regulations, 2010
- (vi) CEA (Technical Standards for Construction of Electric Plants and Electric Lines) Regulations, 2010
- (vii) CEA (Safety Requirements for Construction, Operation and Maintenance of Electrical Plant and Electrical Lines) Regulations, 2011
- (viii) CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) – Regulations 2010
- (ix) CEA (Technical Standards for Connectivity to the Grid) (Amendment) Regulations 2010

### 3.3.18. Other Legislations

115. In addition to the above discussed major environmental regulations there are many other legislations relevant to the proposed project which are listed below in **Table 3.3** and Relevance, applicability and responsible agencies of all these has been discussed in the **Table 3.4** and **Table 3.5**

**Table 3.3 : Other Legislations**

<ul style="list-style-type: none"> <li>• Workmen Compensation Act, 1923,</li> <li>• The Public Liability Insurance Act, 1991,</li> <li>• The Explosives Act (&amp; Rules), 1884 (revised in 1983),</li> <li>• Contract Labour (Regulation &amp; Abolition) Act, 1970,</li> <li>• Minimum Wages Act, 1948,</li> <li>• Payment of Wages Act, 1936,</li> <li>• Equal Remuneration Act, 1979,</li> <li>• Child Labour (Prohibition &amp; Regulation) Act, 1986,</li> <li>• The Building &amp; Other Construction Workers (Regulation of Employment &amp; Conditions of Service) Act, 1996</li> <li>• Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 as amended,</li> <li>• The Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989,</li> </ul>	<ul style="list-style-type: none"> <li>• E-Waste (Management) Rules, 2016,</li> <li>• Building and Other Construction Workers (Regulation of Employment and Conditions of Services) Act and Rules,</li> <li>• The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation, and Resettlement Act, 2013 etc.</li> <li>• Biomedical Waste Management Rules 2016 and amendments</li> <li>• Batteries (Management &amp; Handling) Amendment Rules, 2010</li> <li>• Minor Mineral and concession Rules, 1960</li> <li>• The Mining Act, 1952</li> <li>• Petroleum and its amended rules, 2019</li> <li>• The Chemical Accidents (Emergency Planning, Preparedness, And Response) Rules, 1996</li> </ul>
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<ul style="list-style-type: none"><li>• Solid Waste Management Rules, 2016,</li><li>• Construction and Demolition Waste Management Rules, 2016,</li><li>• Mines &amp; Minerals (Regulation and Development) Act 1957 and amendments,</li></ul>	<ul style="list-style-type: none"><li>• Permission for water extraction from CGWA under section 3 of Environment (Protection) Act, 1996</li><li>• The Scheduled Tribes and Other Traditional</li><li>• Forest Dwellers Act, 2006</li></ul>
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Table 3.4 : Applicable Environmental legislations

S. No	Act/ Rules/ Standards	Applicable Y/N				Purpose and Reason of Applicability	Concerned Authority	Responsibility for obtaining permission	Implementation	Supervision-Construction Phase
		PC	C	P O	O					
1.	Environmental (Protection) Act, 1986	Y	Y	Y	Y	The rules will be applicable for the project both during construction and operation phase as it is likely to impact the various components of environment	MoEF&CC Gol, Forests & Env. Dept., GoM, CPCB, MPCB	Permission is not required under this rule but the rule should be followed	Contractor: construction phase and MMRDA: Operation Phase	MMRDA, Supervision Consultant
2.	Environmental Impact Assessment (EIA) Notification, 2006	N*	N	N	N	The railway projects are not included in the Schedule of the Notification thus the project does not attract the conditions of EIA Notification 2006 and its further amendments; hence Environmental Clearance will not be applicable for the project. *However, Environmental Clearance may be applicable for establishing new quarries	MoEF&CC	Contractor: construction phase and MMRDA: Operation Phase	Contractor: construction phase and MMRDA: Operation Phase	MMRDA, Supervision Consultant
3.	Forest (Conservation) Act, 1980	Y	Y	N	Y	Applicable as the project would require clearing of mangrove area of 0.6983 Ha. , forest clearance will be required for the project. Also, permission from High Court of Bombay will be required for cutting of Mangroves	MoEF&CC, Forest Deptt. Govt of Maharashtra, Bombay High court	MMRDA	MMRDA, Forest Department, Contractor to follow the conditions of the permission	MMRDA, Supervision Consultant
4.	Wildlife Protection Act, (1972 and 1993)	N	N	N	N	Not applicable as the project alignment does not impact any notified area under the act. Project alignment is at more than 3.0 km distance from the Sanjay Gandhi National park (SGNP) and Thane Creek Flamingo sanctuary (TCFS). Also, the alignment does not affect the declared ESZ of the SGNP and TCFS. No impacts due to the proposed project are envisaged on the SGNP and TCFS as project	MoEF&CC	MMRDA	MMRDA, Forest Department, Wildlife Department, Contractor to follow the conditions of the permission	MMRDA, Supervision Consultant

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						alignment is located outside declared protected area and ESZ of these areas.				
5.	Water (Prevention and Control of Pollution) Act 1974	Y	Y	Y	Y	This act will be applicable and CTE is required to be obtained before construction or establishments of concrete batching plant, stone crusher, construction yard, workers' camp and stations, etc, and CTO is required to be obtained before operation of concrete batching plant, stone crusher, construction yard, workers' camp, depot and stations.	MPCB	Contractor	Contractor: construction phase and MMRDA: Operation Phase	MMRDA, Supervision Consultant
6.	Air (Prevention and Control of Pollution) Act 1981 as amended in 1987	Y	Y	Y	Y	This act will be applicable and CTE is required to be obtained before construction or establishments of concrete batching plant, stone crusher, construction yard, workers' camp and stations, etc, and CTO is required to be obtained before operation of concrete batching plant, stone crusher, construction yard, workers' camp, depot and stations.	MPCB	Contractor	Contractor: construction phase and MMRDA: Operation Phase	MMRDA, Supervision Consultant
7.	Noise Pollution (Regulation and Control) rules 2000 and its amendment 2010	N	Y	N	Y	These rules will apply to the project during the construction and operation phase. During the construction phase noise producing heavy construction equipment will be used and during the operation phase, the movement of the train and use of public address system at the stations may produce noise.	MPCB	Permission is not required under this rule but the rule should be followed	Contractor: construction phase and MMRDA: Operation Phase	MMRDA, Supervision Consultant
8.	Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010	N	Y	N	N	No ancient monuments and archaeological sites within 300m of the alignment. However, these rules will be applicable only for a chance finding of artifacts/ structures during excavation during the construction phase as there are.	Archaeological Dept. Gol, Dept. of Archaeology GoM, National Monuments Authority, New Delhi	MMRDA	MMRDA, Contractor to follow the conditions of the permission. Contractor will take permission in case of chance finding of any such item/structure during construction	MMRDA, Supervision Consultant

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9.	Notification for use of fly ash, 2016	Y	Y	N	N	This law is applicable as there is the existence of coal- based thermal power plants within 300 km from the project alignment.	MoEF&CC	Contractor	Contractor	MMRDA/ PMU
10.	The Explosives Act (& Rules), 1884	Y	Y	Y	Y	Applicable if any explosive will be stored and transported for the project	Chief Controller of Explosives	Contractor	Contractor	MMRDA, Supervision Consultant
11.	Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016	Y	Y	Y	Y	This rule is applicable as the project will involve the generation, storage, and disposal of hazardous waste like used oil, waste oil, greased cotton, empty paint, and oil barrels, empty containers of hazardous waste, etc.	MPCB	Contractor: construction phase and MMMOCL: Operation Phase	Contractor: construction phase and MMMOCL: Operation Phase	MMRDA, Supervision Consultant
12.	The Manufacture, Storage and import of Hazardous Chemicals Rules, 1989 as amended	N	Y	Y	Y	These rules may be applicable if there is the storage of any hazardous chemicals equal to or more than threshold quantities as per Schedules of the Act.	Authorities as Described in Schedule - 5 of the Rules (MoEF&CC, CPCB, CCE, DC, CIM)	Contractor: construction phase and MMMOCL: Operation Phase	Contractor: construction phase and MMMOCL: Operation Phase	MMRDA, Supervision Consultant
13.	Solid Waste Management Rules, 2016	Y	Y	Y	Y	This rule is applicable as the project will involve the generation, storage, and disposal of municipal solid waste.	Local Bodies	Contractor: construction phase and MMMOCL: Operation Phase	Contractor: construction phase and MMMOCL: Operation Phase	MMRDA, Supervision Consultant
14.	Biomedical Waste Management Rules	Y	Y	Y	Y	This rule will be applicable as first aid centers will be established for the project both during construction and operation phase.	MPCB	Contractor: construction phase	Contractor: construction phase	MMRDA, Supervision Consultant

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	2016 and amendments, 2016							and MMOCL: Operation Phase	and MMOCL: Operation Phase	
15	Construction and Demolition Waste Management Rules, 2016	Y	Y	N	N	This rule will be applicable during the construction stage only as the project may involve demolition of the various structures like buildings, roads, etc. as required for clearing the RoW for the project.	Local Bodies	Contractor	Contractor	MMRDA, Supervision Consultant
16	Batteries (Management & Handling) Amendment Rules, 2010	N	Y	N	Y	This rule may be applicable if the project involves the handling, storage, and disposal of lead-acid batteries. Consumers and bulk consumers (100 or more lead-acid batteries in a year) will follow the rules and bulk consumers will file the return annually.	MPCB	Contractor: construction phase and MMOCL: Operation Phase	Contractor: construction phase and MMOCL: Operation Phase	MMRDA, Supervision Consultant
17	E-Waste (Management) Rules, 2016	N	Y	N	Y	This rule will be applicable as it is likely that e-waste like computers, laptops, printers, etc. waste may be generated both during the construction and operation phase.	MPCB	Contractor: construction phase and MMOCL: Operation Phase	Contractor: construction phase and MMOCL: Operation Phase	MMRDA, Supervision Consultant
18	Motor Vehicles Act, And its amendment 2019	Y	Y	N	N	This rule will be applicable for all transportation vehicles, construction machinery and other vehicles.	Motor Vehicle Department	Contractor: construction phase and MMOCL: Operation Phase	Contractor: construction phase and MMOCL: Operation Phase	MMRDA, Supervision Consultant
19	Minor Mineral and concession Rules, 1960	Y	Y	N	N	This rule will be applicable if sand/ earth/ aggregates or any other minor mineral will be extracted for the project. It is not likely that there may be a requirement for the establishment of a new quarry and borrow areas for this project & material may be procured from licensed vendor preferably. However it will be applicable if any new borrow area or quarry is established	District Collector	Contractor	Contractor	MMRDA, Supervision Consultant

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20	The Mining Act, 1952	Y	Y	N	N	This rule will be applicable if sand/ earth/ aggregates or any other minor mineral will be extracted for the project. It is likely that there may be a requirement for the establishment of a new quarry and borrow areas for the project.	Department of Mining, GoM	Contractor	Contractor	MMRDA, Supervision Consultant
21	Mines & Minerals (Regulation and Development) Act 1957 and amendments,	Y	Y	N	N	This rule will be applicable if sand/ earth/ aggregates or any other minor mineral will be extracted for the project. It is not likely that there may be a requirement for the establishment of a new quarry and borrow areas for this project & material may be procured from licensed vendor preferably. However it will be applicable if any new borrow area or quarry is established	Department of Mining, GoM	Contractor	Contractor	MMRDA, Supervision Consultant
22	Petroleum and its amended rules, 2019	N	Y	N	Y	This rule will be applicable as the project may involve storage and handling of petroleum products equal to more than threshold quantities specified in the rule and permission from PESO may be required.	Petroleum and Explosives Safety Organization (PESO)	Contractor: construction phase and MMMOCL: Operation Phase	Contractor: construction phase and MMMOCL: Operation Phase	MMRDA, Supervision Consultant
23	The Building and Other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996	N	Y	N	N	This rule is applicable as the project involves the hiring of labour for the construction.	Labor Department/State Govt	Contractor	Contractor	MMRDA, Supervision Consultant
24	The Maharashtra Building and Other Construction Workers (Regulation	N	Y	N	N	This rule is applicable as the project involves the hiring of labour for the construction.	Labour Department/State Govt.	Contractor	Contractor	MMRDA, Supervision Consultant



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	of Employment and Conditions of Services) Rules, 2007									
25	Contract Labour (Regulation and Abolition) Act, 1970	Y	Y	Y	Y	This law is applicable as the project involves hiring of contractual labour.	Ministry of Labor & Employment	Contractor	Contractor	MMRDA, Supervision Consultant
26	National Forest Policy (Revised), 1988	Y	Y	Y	Y	This policy is applicable as the project involves diversion of forest land.	MoEF&CC and Forest Department, GoM	MMRDA	MMRDA and Contractor	MMRDA, Supervision Consultant
27	The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013	Y	N	N	N	This act will be applicable as there will be the acquisition of land for the project.	Revenue Dept., State Govt.	MMRDA	MMRDA, District Authorities	MMRDA
28	Forest Conservation Rules (2003) and Guidelines issued to date by the State Govt.  Maharashtra	Y	Y	N	N	Project may impact approx. 708 trees in RoW out of which 495 will be transplanted, 166 will be cut and 47 will be trimmed. Other than this, approx. 50-60 trees exist at depot site which may need to be removed from the site. Permission will be required from Tree officer of the concerned local authority/Forest Department	Tree Officer/Local Designated District Authority/Tree Authority	MMRDA for project RoW/alignment and ancillary facilities Contractor: Planned facilities by contractor	MMRDA for project RoW/alignment and ancillary facilities Contractor: Planned facilities required for project	MMRDA, Supervision Consultant

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	a Felling of Trees (regulation) Act, 1964  The Maharashtra (Urban Areas) Protection and Preservation Act, 1975,							required for project construction	construction. forest department	
29	Guidelines to regulate and control ground water extraction in India, 2020	N	Y	N	Y	This act will be applicable if ground water extraction is required for the project.	Central Ground Water Authority	Contractor: construction phase and MMRDA: Operation Phase	Contractor: construction phase and MMRDA: Operation Phase	MMRDA, Supervision Consultant
30	CRZ Notification 2011	Y	N	N	N	Applicable as the project alignment passes through the Coastal Regulation Zone as per the notification and requires to obtain CRZ clearance (Kasheli bridge site and spur line & approach road to Kasheli depot site)	MCZMA, MoEF&C, SEIAA	MMRDA	MMRDA (Contractor to follow condition of the clearance obtained)	MMRDA, Supervision Consultant
31	Workmen Compensation Act, 1923	N	Y	N	N	This Act provides for payment of compensation to workmen (or their dependents) in case of personal injury caused by accident or certain occupational diseases arising out of and in the course of employment and resulting in disablement or death.	Ministry of Labour & Employment	Contractor	Contractor	MMRDA, Supervision Consultant
32	Minimum Wages Act, 1948	N	Y	N	N	The provision of the Minimum Wages Act, 1948 applies to every employer that employs more than 1000 employees in a state.	Ministry of Labour & Employment	Contractor	Contractor	MMRDA, Supervision Consultant
33	Payment of Wages Act, 1936	N	Y	N	N	This Act applies to all persons employed, whether directly or through contractors, in a factory or certain specified industrial or other establishments.	Ministry of Labour & Employment	Contractor	Contractor	MMRDA, Supervision Consultant

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34	Equal Remuneration Act, 1979	N	Y	N	Y	The Act is a Central Legislation and applies to the whole of India. The objective of the Act is to provide for protection against discrimination of women workers on the ground of sex, about the payment of equal remuneration in the matter of employment.	Ministry of Labour & Employment	Contractor	Contractor	MMRDA, Supervision Consultant
35	Child Labor (Prohibition & Regulation) Act, 1986	N	Y	N	Y	Aims to eradicate any kind of child abuse in the form of employment and prohibit the engagement of children in any kind of hazardous employment, who have not completed 14 years of age.	Ministry of Labour & Employment	Contractor	Contractor	MMRDA, Supervision Consultant
36	The Scheduled Tribes and Other Traditional Forest Dwellers Act 2006	Y	N	N	N	This act is applicable as the project traverses through the scheduled areas	Concerned District Collector and DCF/DFO.	MMRDA	MMRDA (Contractor to follow the conditions of act and the approvals as obtained by MMRDA)	MMRDA
37	The National Waterways Act, 2016	Y	N	N	N	Permission will be required if the alignment traverses through any declared national waterway by IWAI	Inland Waterways Authority of India	Contractor	Contractor	MMRDA, General Consultants
38	Indian Electricity Act, 2003, 2004 and 2007	Y	Y	Y	Y	This Act consolidates the laws relating to generation, transmission, distribution, trading and use of electricity and generally for taking measures conducive to development of electricity industry, promoting competition therein, protecting interest of consumers and supply of electricity to all areas, rationalization of electricity tariff, ensuring transparent policies regarding subsidies, promotion of efficient and environmentally benign policies, constitution of Central Electricity Authority, Regulatory Commissions and establishment of Appellate Tribunal and for matters connected therewith or incidental thereto. The act details the functions of various agencies involved in power sector,	Central Electricity Authority	Contractor-Construction Phase MMRDA-Operation Phase	Contractor-Construction Phase MMRDA-Operation Phase	MMRDA, General Consultants

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				<p>powers of inspectors for safety in operations, dispute resolution, etc.                  Requirements under the act shall be followed for taking required permission for installing DG sets and establishment of sub-stations for sourcing the power.                  The following CEA regulations provide for safety requirements and guidance including preparation of Safety Manuals, Safety Officers, Reporting on accidents, Emergency Management Plans, etc.                  Central Electricity Authority (Safety Requirements for Operation, Construction and Maintenance of Electric Plants and Electrical Lines) Regulations 2011                  CEA (Installation and Operation of Meters) Regulations, 2006                  CEA (Grid Standards for Operation &amp; Maintenance of Distribution Lines) Regulations, 2010                  CEA (amendment to the regulations on “Installation &amp; Operation of Meters”) Regulations, 2010                  CEA (Measures Relating to Safety &amp; Electric Supply) Regulations, 2010                  CEA (Technical Standards for Construction of Electric Plants and Electric Lines) Regulations, 2010                  CEA (Safety Requirements for Construction, Operation and Maintenance of Electrical Plant and Electrical Lines) Regulations, 2011                  CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) – Regulations 2010                  CEA (Technical Standards for Connectivity to the Grid) (Amendment) Regulations 2010</p>				
<p>*Supervision during operation phase may be carried out by MMMOCL only or through an appointed agency.</p>								

**Table 3.5 : Permission Required for Phase I Metro Line-05 project**

<b>S. No.</b>	<b>Permission and Concerned Legislation</b>	<b>Authority Concerned</b>	<b>Responsibility of Obtaining</b>	<b>Responsibility of Implementation</b>
1	Forest Clearance under Forest (Conservation) Act, 1980	State Forest Department, MoEF&CC	MMRDA for diversion of forest land within RoW and spur line & approach road to depot site	Contractor & MMRDA
2	Tree Cutting permission as per Forest Conservation Act (1980), Forest Conservation Rules (2003) and Guidelines issued to date by the State Govt. Maharashtra Felling of Trees (regulation) Act, 1964, The Maharashtra (Urban Areas) Protection and Preservation Act, 1975	Tree Officer/Local Designated By Respective District Authorities/ Forest Department	MMRDA for RoW and ancillary facilities, Contractor for Planned facilities by contractor required for project construction (in consultation with forest department)	MMRDA, Contractor, Forest Department
3	CRZ Clearance under CRZ Notification 2011	MCZMA, MOEFCC	MMRDA	Contractor & MMRDA
4	Mangrove Felling as per the directives of the Hon'ble Bombay High Court	The Bombay High Court	MMRDA	Contractor & MMRDA
5	Permission for groundwater extraction in view of Guidelines to control and regulate ground water extraction in India' vide notification number 3289(E) dated 24th September, 2020 by the Ministry of Jal Shakti (Department Of Water Resources, River Development and Ganga Rejuvenation), Central Ground Water Authority-Construction Phase	CGWA	Contractor	Contractor
6	Permission for groundwater extraction in view of Guidelines to control and regulate ground water extraction in India' vide notification number 3289(E) dated 24th September, 2020 by the Ministry of Jal Shakti (Department Of Water Resources, River Development and Ganga	CGWA	MMMOCL	MMMOCL

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	Rejuvenation), Central Ground Water Authority-Operation Phase			
7	Environment Clearance for Stone Quarries under EIA Notification, 2006 and as amended	SEAC/SEIAA/ MoEF&CC	Contractor	Contractor
8	Permission for Withdrawal of water from Surface Water bodies	Irrigation Department, Govt. of Maharashtra	Contractor	Contractor
9	Traffic Diversion, Movement of transportation vehicles as per CMVR, 2020	Transport Department, Govt. of Maharashtra	Contractor	Contractor
10	Consent to Establish and Consent to Operate from Batching Plant, Depot, Stations, Quarries, Stone Crushers, etc. under Air Act 1981 and Water Act 1974	MPCB	Contractor	Contractor
11	Authorization for handling, storage, and disposal of hazardous waste under Hazardous and other waste (Management and Transboundary movement, 2016) and agreement with the authorized vendor	MPCB	Contractor	Contractor
12	Authorization for handling, storage, and disposal of municipal waste under Solid Waste Management Rules, 2016 and other waste including bio-medical waste, e-waste, plastic waste, battery waste as applicable	MPCB/Local Bodies	Contractor	Contractor
13	Authorization for handling, storage, and disposal of construction & demolition waste under C&D Waste Management Rules, 2016	MPCB/Local District authorities	Contractor	Contractor
14	Storage of petroleum products under the Petroleum Rules, 2002 as amended	Department of the ministry of petroleum and natural gas	Contractor	Contractor
15	Registration of Workers under CLA, 1970	Labour & Employment Department, GoM	Contractor	Contractor
16	Storage of petroleum products under the Petroleum Rules, 2002 as amended	Department of the Ministry of Petroleum and Natural Gas	Contractor	Contractor
17	Pollution Under Control	Transport Department	Contractor	Contractor



	Certificate			
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### 3.4. International Treaties in Relevance with the Project

116. The international policies and treaties binding on Government of India that are relevant to the proposed project have been identified and provided below.

#### 3.4.1. Ramsar Convention on Wetlands, 1971

117. The Convention on Wetlands (Ramsar, 1971) is an intergovernmental treaty whose mission is “the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world”. The Convention on Wetlands is an intergovernmental treaty adopted on 2 February 1971 in the Iranian city of Ramsar, on the southern shore of the Caspian Sea. Thus, though the name of the Convention is written “Convention on Wetlands (Ramsar, Iran, 1971)”, it has come to be known popularly as the “Ramsar Convention”. Ramsar is the first of the modern multilateral environmental agreements on the conservation and sustainable use of natural resources, and compared with more recent ones, its provisions are relatively straightforward. It is unusual in establishing commitments at site level as well as at the level of national policy. The proposed project alignment does not pass through the any notified Ramsar site.

#### 3.4.2. Convention on Biological Diversity, 1992

118. The Convention on Biological Diversity (CBD), known informally as the Biodiversity Convention, is a multilateral treaty. The convention has three main goals: the conservation of biological diversity (or biodiversity); the sustainable use of its components; and the fair and equitable sharing of benefits arising from genetic resources. Its objective is to develop national strategies for the conservation and sustainable use of biological diversity, and it is often seen as the key document regarding sustainable development. The convention was opened for signature at the Earth Summit in Rio de Janeiro on 3-14<sup>th</sup> June, 1992 and entered into force on 29 December 1993. The United States is the only UN member state which has not ratified the convention. It has two supplementary agreements, the Cartagena Protocol and Nagoya Protocol. The Cartagena Protocol on Biosafety to the Convention on Biological Diversity is an international treaty governing the movements of living modified organisms (LMOs) resulting from modern biotechnology from one country to another. It was adopted on 29 January 2000 as a supplementary agreement to the CBD and entered into force on 11 September 2003.

119. As per IUCN status of conservation, two species are critically endangered Aythya baeri (Baer's pochard) and Vanellus gregarious (Sociable lapwing), one species Neophron percnopterus (Egyptian Vulture) is under endangered category, two species as near threatened Limosa limosa (Black Tailed Godwit) and Numenius arquata (Eurasian curlew) whereas three species Aythya farina (Common Pochard), Gallinago nemoricola (Wood Snipe), Saxicola insignis (Hodgson's Bushchat) are under vulnerable category. Convention on Biological Diversity, 1992 is applicable for the conservation of the above-mentioned species. This convention is not applicable as the project will not impact the above-mentioned species.

#### 3.4.3. Convention on the Conservation of Migratory Species of Wild Animals, 1979

120. The Convention on the Conservation of Migratory Species of Wild Animals, also known as the Convention on Migratory Species (CMS) or the Bonn Convention, is an international agreement that aims to conserve migratory species throughout their ranges. The Agreement was signed under the auspices of the United Nations Environment Programme and is concerned with conservation of wildlife and habitats on a global scale. The CMS Family covers a great diversity of migratory species. The proposed does not impact habitat of any migratory species of wild

animal or birds.

#### **3.4.4. Kyoto Protocol, 1997**

121. The Kyoto Protocol was an international treaty which extended the 1992 United Nations Framework Convention on Climate Change (UNFCCC) that commits state parties to reduce greenhouse gas emissions, based on the scientific consensus that (part one) global warming is occurring and (part two) that human-made CO<sub>2</sub> emissions are driving it. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. There were 192 parties (Canada withdrew from the protocol, effective December 2012) to the Protocol in 2020. The Kyoto Protocol implemented the objective of the UNFCCC to reduce the onset of global warming by reducing greenhouse gas concentrations in the atmosphere to "a level that would prevent dangerous anthropogenic interference with the climate system" (Article 2).

122. The Kyoto Protocol applied to the seven greenhouse gases listed in Annex A: carbon dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF<sub>6</sub>), Nitrogen trifluoride (NF<sub>3</sub>). Nitrogen trifluoride was added for the second compliance period during the Doha Round. The operation of proposed metro rail project is likely to result in reduced emission of CO<sub>2</sub> and which further result in reduced impact of greenhouse gas.

#### **3.4.5. Vienna Convention for the Protection of the Ozone Layer**

123. The Vienna Convention for the Protection of the Ozone Layer is a multilateral environmental agreement signed in 1985 that provided frameworks for international reductions in the production of chlorofluorocarbons due to their contribution to the destruction of the ozone layer, resulting in an increased threat of skin cancer. During the 1970s, research indicated that man-made chlorofluorocarbons (CFCs) reduce and convert ozone molecules in the atmosphere. CFCs are stable molecules composed of carbon, fluorine, and chlorine that were used prominently in products such as refrigerators. The threats associated with reduced ozone pushed the issue to the forefront of global climate issues and gained promotion through organizations such as the World Meteorological Organization and the United Nations. The Vienna Convention was agreed upon at the Vienna Conference of 1985 and entered into force in 1988. The Vienna Convention provided the framework necessary to create regulatory measures in the form of the Montreal Protocol. The operation of proposed metro rail project will result in less emission of CO<sub>2</sub> and which further result in less impact of greenhouse gas.

#### **3.4.6. Montreal Protocol on Substances that Deplete the Ozone Layer**

124. The international treaty called The Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol) is gradually eliminating the production and consumption of ozone depleting substances to limit their damage to the earth's ozone layer. The Montreal Protocol is signed by 197 countries – the first treaty in the history of the United Nations to achieve universal ratification – and is considered by many the most successful environmental global action. The United States signed the Montreal Protocol in 1987 and has been a leader in guiding the successes of the treaty. Over the past 30 years, EPA has been a proud contributor to the broad coalition that developed and implemented flexible, innovative, and effective approaches to protect the stratospheric ozone layer. In 1995, the United Nations named September 16 the International Day for the Protection of the Ozone Layer, also known as World ozone day. The operation of proposed metro rail project will result in less emission of CO<sub>2</sub> and which further result in less impact of greenhouse gas.

#### **3.4.7. The Kigali Agreement amendment, 2016**

125. The Kigali Amendment to the Montreal Protocol is an international agreement to gradually

reduce the consumption and production of hydrofluorocarbons (HFCs). It is a legally binding agreement designed to create rights and obligations in international law. The Montreal Protocol was originally created to preserve and restore the ozone layer, and it worked. The Protocol was an agreement between participating countries to phase out certain ozone depleting gases. HFCs were used to replace the substances banned in that agreement because they have zero impact on the ozone. However, HFCs are powerful greenhouse gases that contribute to climate change, so this amendment adds HFCs to the list of chemicals that countries promise to phase down. NO HFCs will be used for the project. The operation of proposed metro rail project will also result in lesser emission of CO<sub>2</sub> when compared to road/air which will further reduce the impact of greenhouse gas.

126. Summary of the international treaties/convention/declaration on environment are given below in **Table 3.6**.

**Table 3.6 : International Treaties/ Conventions/ Declarations on Environment**

<b>Sl. No</b>	<b>International Treaties/ Conventions/ Declarations</b>	<b>Description</b>
1.	United Nations Conference on the Human Environment - Stockholm 1972	To coordinate global efforts to promote sustainability and safeguard the natural environment
2.	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1975	Its aim is to ensure that international trade in specimen of wild animals and plants does not threaten their survival
3.	Ramsar Convention, 1971, 1975	The Convention on Wetlands is the intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources
4.	The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes, 1989	The Convention aims to protect human health and the environment against the adverse effects resulting from the generation, transboundary movements and management of hazardous wastes and other wastes
5.	United Nations Conference on Environment and Development (UNCED), 1992, 2002	The conference had three objectives (Agenda – 21, Rio Declaration and Millennium Development Goals), to secure renewed political commitment for sustainable development, to assess the progress and implementation gaps in meeting previous commitments, and to address new and emerging challenges
6.	Framework Convention on Climate Change (FCCC), 1992 Kyoto Protocol, 1997	It operationalizes the United Nations Framework Convention on Climate Change by committing industrialized countries to limit and reduce greenhouse gas (GHG) emissions in accordance with agreed individual targets
7.	The Vienna Convention, 1985 Montreal Protocol on Ozone depleting substances, 1992	It sets binding progressive phase out obligations for developed and developing countries for all the major ozone depleting substances, including chlorofluorocarbons (CFCs), halons and less damaging transitional chemicals such as hydrochlorofluorocarbons (HCFCs)

8.	Convention on Biological Diversity, 1992 Cartagena Protocol on Biosafety, Ratified on 17 <sup>th</sup> January, 2003	It is an international treaty governing the movement of living modified organism (LMO) resulting from modern biotechnology from one country to another
9.	Convention to Combat Desertification, 1996	It is the only binding international agreement linking environment and development to sustainable soil management
10.	Rotterdam Convention on Prior Informed Consent Procedure for certain Hazardous Chemicals in International Trade, 2002	It is a multilateral treaty to promote shared responsibilities in relation to importation of hazardous chemicals
11.	International Convention on Hazardous Materials	Stockholm Convention on Persistent Organic Pollutants (POPs) ensures the environmentally sound management and the disposal of POPs including polychlorinated biphenyls (PCBs). India has started using PCB free equipment, but existing equipment contaminated and cross contaminated with PCBs are also present. The convention gives governments until 2025 to phase out “in-place equipment” such as electrical transformers containing PCBs, as long as the equipment is maintained in a way that prevents leaks. It grants them another three years to destroy the recovered PCBs. The recovered PCBs must be treated and eliminated by 2028. If the MML5 is using any transformers (new or old), these need to comply with this. However, PCBs is not being used in the traction & auxillary transformers of MMRDA and Transformer oil as per IS 12463 has been used in transformers
12.	International Convention on Atmospheric Emissions	UNFCCC (United Nations Framework Convention on Climate Change) is to stabilize GHG emissions <sup>3</sup> in the atmosphere at a level low enough to prevent dangerous anthropogenic interference with the climate system. The SF6 is a potent GHG used in switchgear/ RMUs. These components will be used for the MML5. This needs to be properly mitigated. Following measures may be adopted for controlling SF6 leakages and its impacts on environment: <ul style="list-style-type: none"> <li>• Promotion of the sealed pressure system concept, where possible, mainly for Medium Voltage application.</li> <li>• Use of hermetically sealed/ tight welded enclosures or certified quality casting, as appropriate.</li> <li>• Reduction of the quantity of SF6 gas per unit.</li> </ul>

<sup>3</sup> The six greenhouse gases that form part of the Kyoto Protocol to the United Nations Framework Convention on Climate Change include carbon dioxide (CO<sub>2</sub>); methane (CH<sub>4</sub>); nitrous oxide (N<sub>2</sub>O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulfur hexafluoride (SF<sub>6</sub>).

		<ul style="list-style-type: none"> <li>• Use of static and dynamic sealing high quality materials.</li> <li>• Use of dynamic sealing redundant systems.</li> <li>• Provision of means designed for a proper recovery operations</li> <li>• Looking for options for recovery of SF6 from rejected electrical equipment</li> </ul> <p>The Gas Insulated switchboards and Circuit breakers are equipped with SF6 gas density monitor for each breaker and busbar chamber. A SF6 density monitor is a device that measures the density of SF6 in a gas-insulated switchgear (GIS) or other electrical equipment. The monitor typically consists of a pressure sensor and a temperature sensor, which are used to measure the pressure and temperature of the SF6 gas. In case of any leakage in the chamber an audible alarm will be generated by density monitor in switchboard and similarly an alarm will appear in SCADA workstation in Operations Control Centre (OCC).</p>
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### 3.5. AIIB Policy

127. AIIB recognizes that environmental and social sustainability is a fundamental aspect of achieving development outcomes consistent with its mandate to support infrastructure development and interconnectivity.

- AIIB screens and categorizes each proposed project based on their environmental and social risks and impacts
- Identifies actions to avoid, minimize, mitigate and/or offset impacts
- Includes provisions for disclosure of information and public consultation
- Every project should have Grievance Redress Mechanism (GRM) accessible to the general public/ community

128. The Environmental and Social Framework, 2016 and its amendment 2019 of AIIB, includes an Environmental and Social Policy (ESP) and Environmental and Social Standards (ESSs). The key objectives of the ESF are

- Ensure the environmental and social soundness and sustainability of each project
- Support integration of environmental and social aspects of projects into the decision-making process by all parties
- The Environment and Social Framework applies to all projects

129. The EIA study is being carried out in accordance to the AIIB's ESP which sets forth mandatory environmental and social requirements for each Project and ESSs which set out more detailed mandatory environmental and social requirements relating to the following<sup>4</sup>

- ESS 1: Environmental and Social Assessment and Management
- ESS 2: Involuntary Resettlement
- ESS 3: Indigenous Peoples

<sup>4</sup> <https://www.aiib.org/en/policies-strategies/download/environment-framework/Final-ESF-Mar-14-2019-Final-P.pdf>

130. Based on the proposed alignment and reconnaissance survey outcome, the ESS I and ESS 2 are applicable for this project.

131. **ESS 1 (Environmental and Social Assessment and Management)**. Aims to ensure the environmental and social soundness and sustainability of projects and to support the integration of environmental and social considerations into the Project decision-making process and implementation. ESS 1 is applicable if the Project is likely to have adverse environmental risks and impacts or social risks and impacts (or both). The scope of the environmental and social assessment and management measures are proportional to the risks and impacts of the Project. ESS 1 provides for both quality environmental and social assessment and management of risks and impacts through effective mitigation and monitoring measures during the course of Project implementation. The ESS 1 defines the detailed requirements of the environmental and social assessment to be carried out for any project to be financed by the AIIB.

132. **ESS 2 (Involuntary Resettlement)**. Is applicable if the Project's screening process reveals that the Project would involve Involuntary Resettlement (including Involuntary Resettlement of the recent past or foreseeable future that is directly linked to the Project). Involuntary Resettlement covers physical displacement (relocation, loss of residential land or loss of shelter) and economic displacement (loss of land or access to land and natural resources; loss of assets or access to assets, income sources or means of livelihood) as a result of: (a) involuntary acquisition of land; or (b) involuntary restrictions on land use or on access to legally designated parks and protected areas. It covers such displacement whether such losses and involuntary restrictions are full or partial, permanent or temporary. The ESS 2 defined detailed requirements of resettlement planning of the projects involving involuntary resettlement.

133. Hence, the EIA study has been carried out to meet the requirements in AIIB's ESP and ESS 1. MMRDA has engaged a Social Consultant to identify important social aspects such as places of worship, other community assets, socio-economic set up, related to land acquisition and resettlement. The Social Consultant has prepared a Social Impact Assessment and a Resettlement Action Plan (RAP) in accordance with AIIB's ESP and ESS 2.

134. **ESS 3 (Indigenous Peoples)**. It is applicable to the project involving the impact on indigenous people. This ESS is not applicable on the project as the project will not impact indigenous people.

### **3.6. EHS Guidelines of World Bank/IFC**

135. The World Bank's Environment Health Safety General Guidelines (2007) and Environment Health Safety Guidelines for Railway (2007) shall be followed for the project in addition to the Regulations of GoI, AIIB policy & guidelines and the mentioned international treaties/convention to ensure the management of environment, health and safety.

### **3.7. SHE Policy and Safety Manuals of MMRDA**

136. MMRDA has well established SHE policy and SHE Manual for management of safety, health and environment at all its projects. These SHE Policy and Manuals are made part of the contract documents volume 2, conditions of contracts on Safety, Health and environment of the contract agreement to ensure its compliance. Maha Mumbai Metro Operation Corporation Limited (MMMOCL) is sister concern of MMRDA. MMOCL has manuals on safety, accidents and disaster management to be used for its operations.

137. MMOCL, that will be operating the Maha Mumbai Metro will strive to achieve 'Zero Unsafe Incidents' by inculcating Positive Safety Culture, implementing a robust Safety Management System and continual improvement in all Safety related functions. The Safety Objectives are a) Zero Unsafe incidents in Metro Rail premises, b) Inculcating a Positive Safety Culture at all levels,



c) Identifying and managing risks in a proactive manner, d) Developing and maintaining skills, e) Proactive reporting of all unsafe incidents or near-misses, and f) Use of prescribed Personal Protective Equipment (PPE)

138. MMMOCL has a Safety Manual that describes the safety arrangements used by MMMOCL, and all associated contractors / sub-contractors who shall be a part of the Operational, Maintenance or any supporting activities over Mumbai Metro Rail. The Safety Manual is a compendium of plans, principles and procedures approved and applicable in MMMOCL. As such, the provisions contained in the manual are in conformity with the Metro Railway General Rules & other documents of MMMOCL. However, whenever there is a conflict in the instructions in this manual and any of the provisions, first the Metro Railway General Rules will apply, then the Safety Manual, then the Safety Management System and then all other plans & procedures. MMMOCL Safety Management System (SMS) is a robust system with adherence to all the provisions of: a) Metro Railways (Operation and Maintenance) Act, 2002; b) Metro Railways General Rules, 2020; c) Metro Railways (Notice of Accidents & Inquiries) Rules, 2014; d) The Electricity Act, 2003; e) All other Acts and applicable Rules.

139. MMMOCL has a Safety Management System (SMS) that provides the means of communicating and fostering a positive safety culture and establishes a mechanism of continuously improving safety management processes and safety performance. This also establishes the principles of Organization and Management of safety for the operations & maintenance activities performed by MMMOCL. The overall aim of this Safety Management System is to provide safe metro rail operations and a safe, secure and healthy work environment in MMMOCL. The SMS is the predominant means by which MMMOCL ensures safety during Operations & Maintenance and complies with the requirements of the Metro Railways (Operation and Maintenance) Act, 2002, and supporting regulations for rail based mass transit systems in India. The SMS covers; a) Measures to manage risks; b) Emergency management plan; c) Rules applying to Metro Railway employees (Chapter-II of MRGR 2020); d) Interface Coordination; e) Security Management; f) Management of Contractors; g) Providing an Annual Safety Report, along with other regular reports including incident/ accident reporting and investigations as prescribed in Accident Manual.

140. The MMMOCL's Accident Manual is a document providing general rules and procedures of incident and accident management in line with railway systems. It specifies the broad details of the action to be taken by various officials after an incident/accident has taken place in Metro Railway premises. This document is applicable to all the employees of MMMOCL and its contractors/subcontractors. These rules apply throughout the Metro Railway to all lines opened for carriage of passengers. This manual complies with a) The Metro Railway (Operation and Maintenance) Act, 2002/2009, b) The Metro Railways General Rules, 2020, c) The Opening of Metro Railway for Public Carriage of Passengers Rules, 2013, d) The Metro Railway (Notices of Accidents and Inquiries) Rules, 2014, e) Metro Railways (Procedure of Claims) Rules, 2017, f) Criminal Procedure Code, 1973, and g) Disaster Management Manual

141. The MMMOCL's Disaster Management Plan provides with a plan outline that identifies and mitigates the risks of disaster and consequent hazards including disruption of services. The purpose of this Plan is to establish procedures to respond to those states of emergency that may cause any harm to human beings, infrastructure and/ or impact on the operation of Metro Lines. This Plan establishes and communicates systems with stakeholders that allow MMMOCL to prevent, prepare, respond and recover from disasters thereby restricting / minimizing the injuries/ loss of human life, assets, and service.

### **3.8. Conclusion**

142. Proposed project does not attract requirements of prior Environmental Clearance (EC) as per EIA Notification, 2006 and as amended till date wherein the Railway sector/metro rail projects

are not included in the Schedule list of development activities which requires EC. However, permits/clearance like forest clearance, CRZ clearance, tree felling permission etc. shall be required for the proposed project. The alignment is passing through the Mangroves area thus permission will be required from forest Department and High Court of Bombay for diversion of the mangrove area for construction of project. The alignment impacts the CRZ at two locations, i.e. at spur line & approach road to Kasheli depot site and at crossing point of Ulhas River (Kasheli bridge) for which CRZ clearance is required for the project<sup>5</sup>. Other requirements (Environmental, Occupational Health & Safety as well as Labour laws), based on various Central and State level regulations, will apply on the proposed project during the construction and operational phases.

143. Project will receive funding from AIB, thus the AIBs' Environmental and Social Framework (ESF) will be applicable on the project. Proposed project is spread over large spatial extent, i.e. approx. 11.88 km length, traverse through heavily populated areas between Thane and Bhiwandi, traverse through coastal regulated zone (CRZ) and mangroves, involves tree cutting and involves resettlement and rehabilitation of people and thus the impacts are anticipated to be significant which mandates preparation of the Environmental Impact Assessment (EIA) Report including Environmental Management Plan (EMP) as per AIBs' ESF. In accordance to the AIB's Environmental and Social Framework (ESF), proposed project has been assigned as a category "A" project and thus it mandates preparation of the Environmental Impact Assessment (EIA) Report including Environmental Management Plan (EMP) as per AIBs' ESF.

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<sup>5</sup> CRZ clearance for Kasheli bridge has been obtained

## CHAPTER 4. DESCRIPTION OF THE ENVIRONMENT

### 4.1. Introduction

144. This chapter presents the information on the existing scenarios/statuses of the environmental attributed in and near to the project corridor. Collection of baseline data on bio-physical, socio-economic aspects of the project area is a very important step for environmental assessment studies as it helps to: understand the existing baseline scenario/condition of the various environmental parameters which helps in evaluation of significance of the impact due to the proposed project on the various environmental components; and record the baseline scenario so as the impact due to project during & post-implementation can be carried out. The data/features documented here have been collected through published data sources, field visits, interaction with local stakeholders and primary & secondary baseline environmental monitoring studies. The field visits include an inspection of sensitive locations, consultations with the locals/communities, recording the visual observations and collection of primary data on air quality, noise level, water quality and soil quality. Secondary information was collected from the various stakeholders, government agencies, literature and publications (including web based information). Based on the secondary information, the data gap has been identified and it is fulfilled by collecting primary information, which includes baseline environmental monitoring for key environs and conducting FGD's, public consultation, etc. This chapter comprises of the following:

- Physical environmental components such as meteorology, geology, topography, soil characteristics, air quality, noise quality, surface, and sub-surface water quality, etc;
- Ecological environmental components such as terrestrial flora, fauna, and aquatic biodiversity; and
- The socio-cultural and economic environment in terms of demography, land use, etc.

### 4.2. Study Area

145. The study area for the proposed EIA study is divided into two zones as follows. Map of project alignment and surroundings within 5 km radius is presented in **Figure 4.1**.

146. **Core Zone:** Core zone is defined as the area where the project development works are proposed to be undertaken and will include the following areas

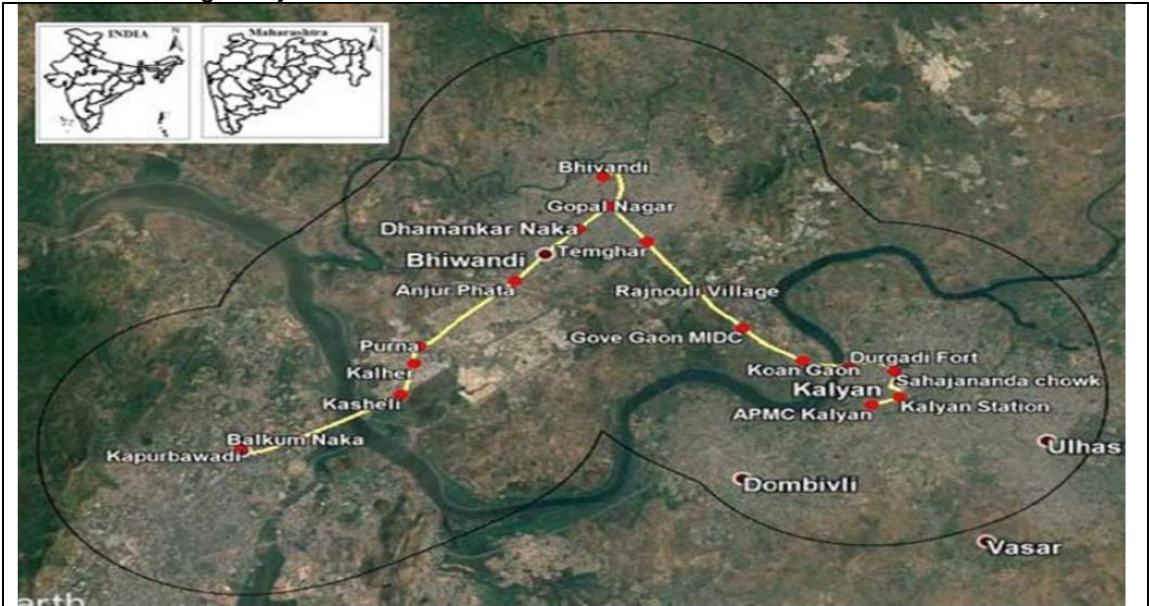
- Project RoW (metro corridor): Approx. 90% of the alignment is proposed on the median of the existing road where the width of approx. 8-9 m will be required for construction purpose and during operation phase project RoW will be approx. 2-2.5 m which will be confined to the median of the road only. However, in the stretches away from the road, project RoW is considered to be 10.550 m wide (Twin U-girder of 5.25 m each) and for station width of the box is 21 m and for entry-exit 6 m on either side
- Location of casting yard, site office or any other temporary facility to be set up for project construction
- Depot, operation control centre and receiving sub-station

147. **Buffer Zone:** Buffer zone considered for assessment of the impact due to metro project includes following

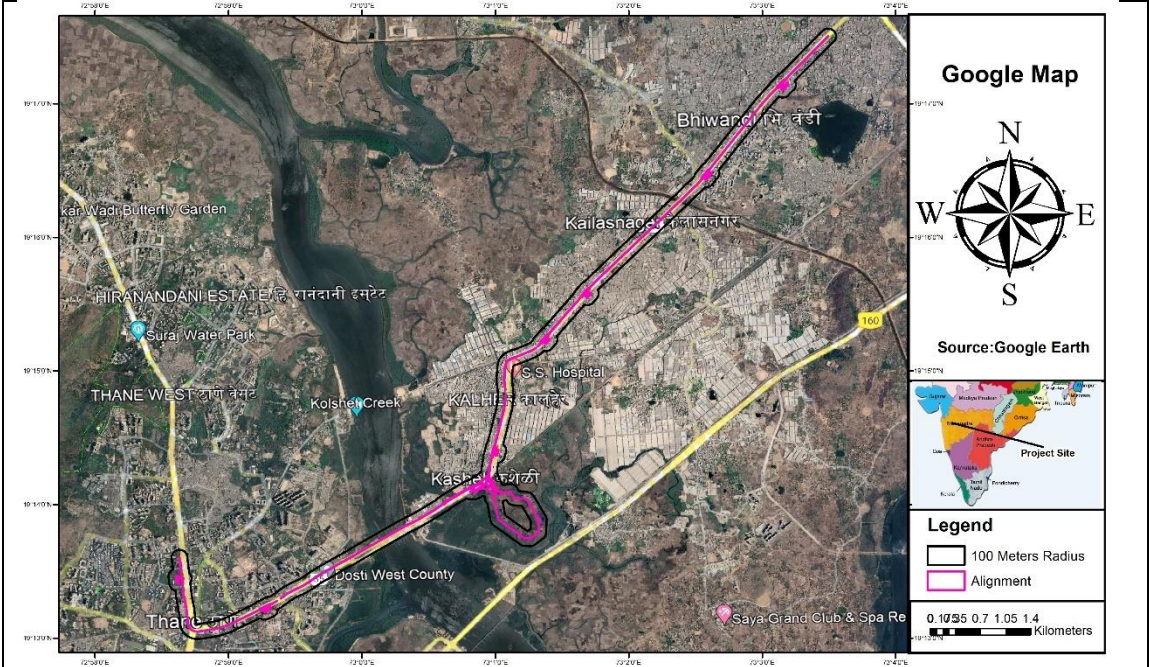
- Area of 100 m width on either side of the alignment/corridor and other temporary facilities as the impacts are localized and impact is not anticipated beyond 100 m width
- Area of 500 m radius around station and depot locations. Area of 500 m is considered as project RoW is twice that of the ROW in viaduct area and also during operation phase impact on air quality and noise level are anticipated near the station and depot area
- 10 km radius area around alignment/stations/depot/project facilities for assessment of the impact on Notified environment protected areas like national parks, wildlife

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sanctuaries, Migratory wildlife/bird corridor, Ramsar wetlands etc.

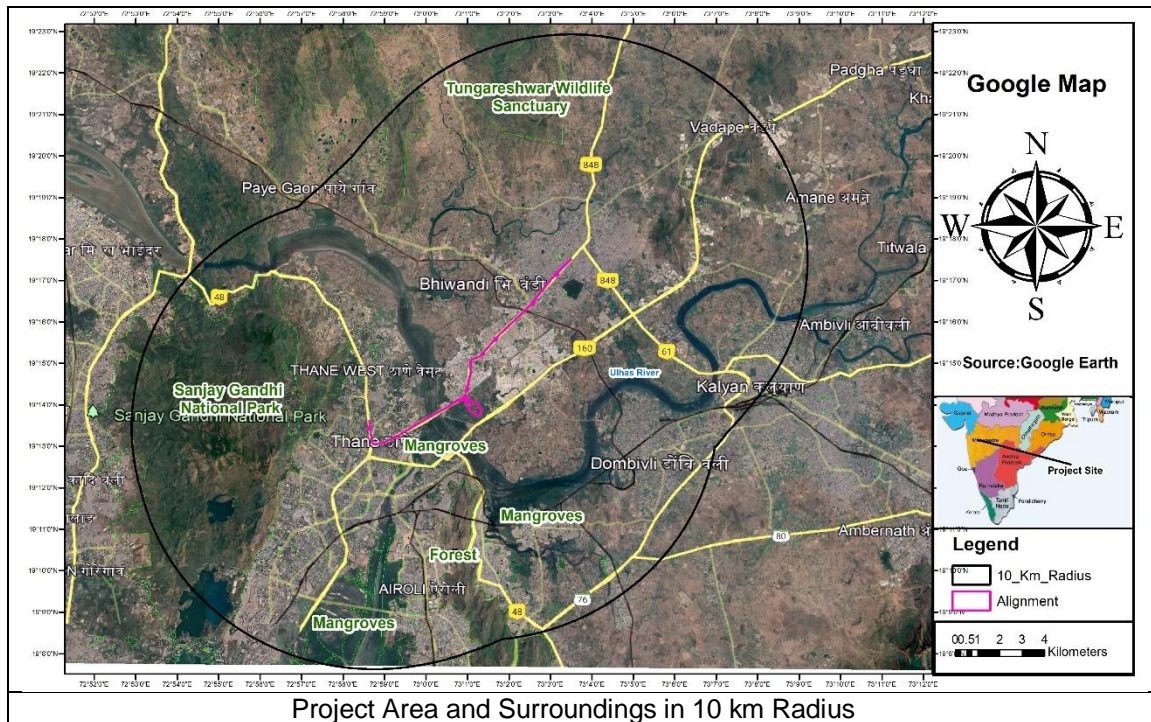


Project Alignment (Metro Line-05 Phase I +II) and Surroundings within 5 km Radius



Project Area and Surroundings in 100 m Radius





**Figure 4.1 : Project Alignment Area and Surroundings**

**4.3. Study Period**

148. The study period considered for primary baseline data collection is post-monsoon season i.e. Oct, 2022. Summary of baseline data collected during the study period is presented in Table 4.1. Project traverses through the Thane and Bhiwandi regions and regular monitoring of all environmental aspects is being undertaken by the Maharashtra Pollution control Board. Thus, the secondary information on the environmental profile of the districts have also been taken for discussion.

**Table 4.1 : Summary of Primary Baseline Data**

Component	Parameters	No. of Sampling Locations	Frequency
Ambient Air Quality	PM <sub>10</sub> PM <sub>2.5</sub> SO <sub>2</sub> NO <sub>2</sub> CO	6	Twice a week (24 hrs continuous) during October, 2022
Noise	Leq day and Leq night	6	Once during October 2022 (24 hrs continuous)
Water Quality (Surface & Drinking Water Sample)	pH, Colour, Odour, Turbidity, TDS, Conductivity, Hardness as CaCO <sub>3</sub> , Nitrate as NO <sub>3</sub> <sup>-</sup> , Chloride as Cl <sup>-</sup> , Sulphate as SO <sub>4</sub> <sup>-</sup> , Calcium as Ca <sup>++</sup> , Magnesium as Mg <sup>++</sup> , Iron as Fe <sup>+++</sup> , Fluoride as F <sup>-</sup> , Cyanide as CN <sup>-</sup> , Arsenic as As <sup>-</sup> , Mercury as Hg <sup>++</sup> , Lead as Pb <sup>++</sup> , Chromium as Cr <sup>+6</sup> , Copper, Total Coliform, Alkalinity (as CaCO <sub>3</sub> ), Sodium (as Na <sup>+</sup> ), Potassium (as K <sup>+</sup> ), Dissolved Oxygen, BOD, COD	Drinking Water-5 (RO) Surface Water-2	Once during October, 2022

Soil	Texture, Sand, Silt Clay, pH (10% Slurry), Conductivity, Organic Matter, Bulk density, Porosity, S.A. R, Bicarbonates, Calcium as Ca <sup>++</sup> , Magnesium as Mg <sup>++</sup> , Sodium as Na <sup>+</sup> , Potassium as K <sup>+</sup> , Phosphorus as P, Chloride as Cl <sup>-</sup> , Zinc as Zn <sup>++</sup> , Copper as Cu, Iron as Fe, Nitrogen, Organic Carbon, Sulphate as SO <sub>4</sub> <sup>-</sup> , Sulphur as S, Fluoride as F <sup>-</sup> , Selenium as Se, Manganese as Mn <sup>++</sup> , Chromium as Cr <sup>+6</sup> , Nickel as Ni, CEC	6	Once during October, 2022
Ecology	Aquatic		Once in a season
	Terrestrial		Once in a season

#### 4.4. Physical Environment

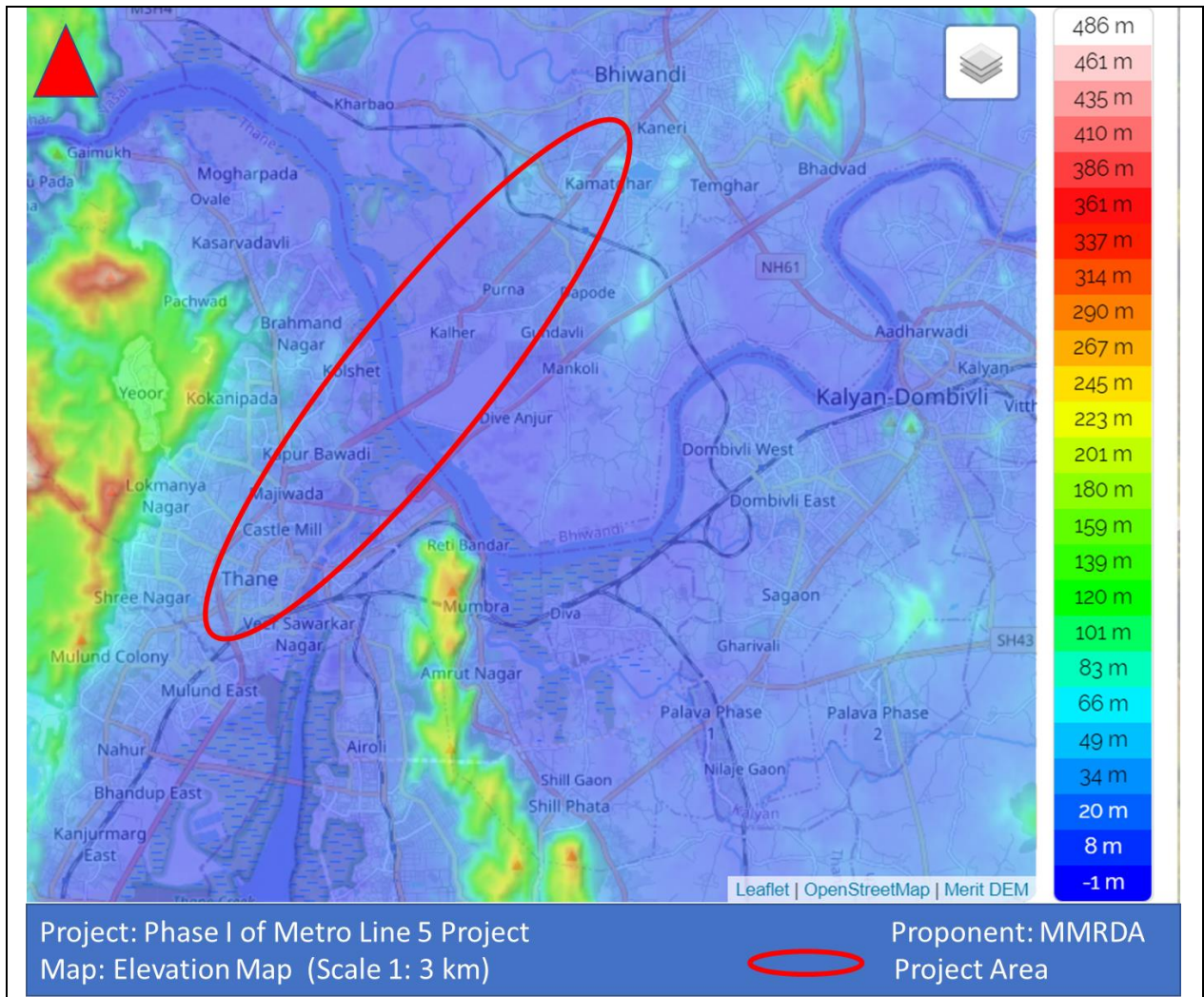
##### 4.4.1. Physiography and Topography

149. Proposed project alignment falls in the Thane District of Maharashtra. Thane is the northern most district of Konkan region of Maharashtra. It is second most populated district and one of the few industrially developed districts of the State. Thane district is situated between western ghat on eastern side and Arabian Sea coast on western side. On the northern side, it is bounded by forest area of Gujarat and on the southern side it is bounded by Bombay City. The district lies between north latitude 18°25" and 20°12" and east longitude 72°27" and 73° 29". The area, of Thane district is 9337 sq.km and occupies 1.37% of the total area of Maharashtra State. It extends for about 140 km from north to south and 101km from east to west. District head quarter is located at Thane town which is taluka headquarters also

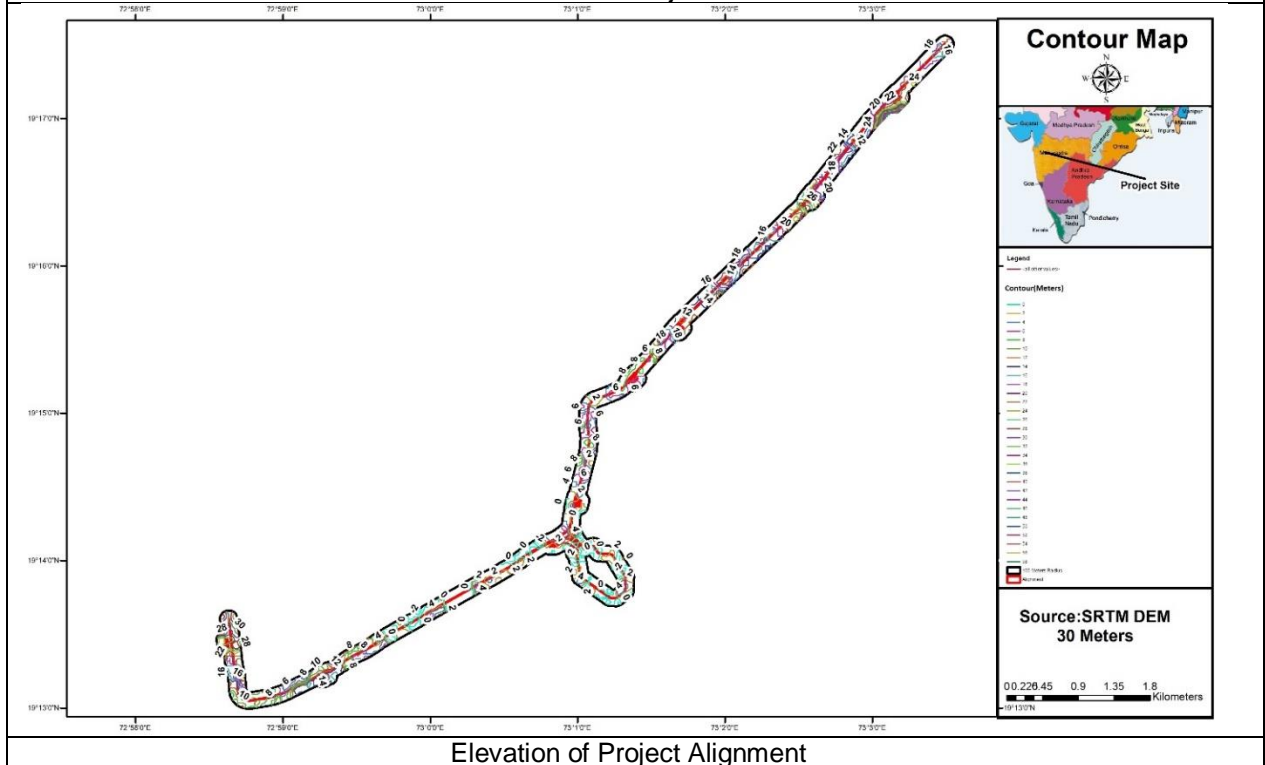
150. The Thane district forms part of western slope of Sahayadri hill range. This hill range passes through the eastern part of the district. Major part of the district constitutes rugged and uneven topography, characterized by high hills and steep valleys. Physiographically, district can be divided into two broad divisions-Undulating Hilly Tract and Coastal Plain in western part

151. Project alignment falls in the western part of the district, i.e. coastal plains and have elevation varying from 0-21 m amsl. Lowest elevation level are found near the Ulhas River (approx. 0 m amsl) and highest near Kapurbawadi (Approx 21 m amsl)

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Elevation in Project Area





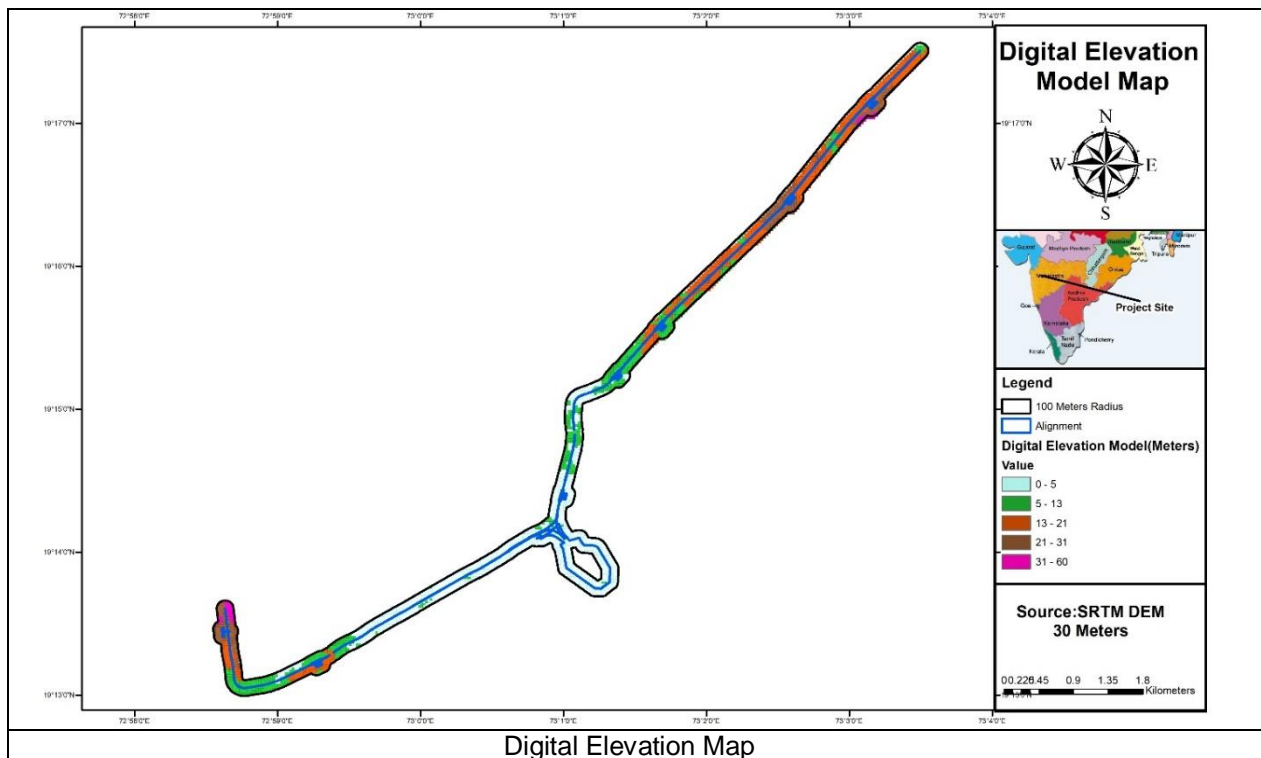


Figure 4.2: Project Area elevation Map<sup>6</sup>

#### 4.4.2. Meteorology

152. Meteorology is an important parameter in environmental impact assessment exercise. It is responsible for the movement of air and air pollutants. Meteorological data has been collected from Indian Meteorological Department (IMD) for the project area.

153. **Climate:** There are two distinct climates in the district, one on the western coastal plains and the other on the eastern slopes of Sahyadri. The climate on the western coastal plains of Thane is tropical, very humid and warm. The climate on the plains at the foot of the slopes (Kalyan, Bhiwandi, Vada, Ulhasnagar, Ambernath and Talasari talukas) and on the eastern slopes of Sahyadri (Murbad, Shahapur, Jawhar Vikramgad and Mokhada talukas) is comparatively less humid. The temperature variation is more in the eastern part of the district comparing to the western coastal areas. The district has four seasons. Winter is from December to February, followed by summer from March to June. The southwest monsoon season is from June to September. October and November months constitute the post-monsoon season, which is hot and humid in the coastal areas. Project alignment traverses through the western part of the district and thus experience tropical climate.

154. **Temperature:** In the coastal area of Thane district, the average daily maximum temperature in summer is 32.9 °C and in winter average mean daily minimum temperature is 16.8 °C.

155. **Relative Humidity:** In the monsoon (June – September), the relative humidity varies from 76.60% to 91.10%. Between November to January i.e. during winter, the relative humidity varies from 47.68% to 77.23%. Owing to the proximity of the sea the district is on the whole very humid nearly all the year round.

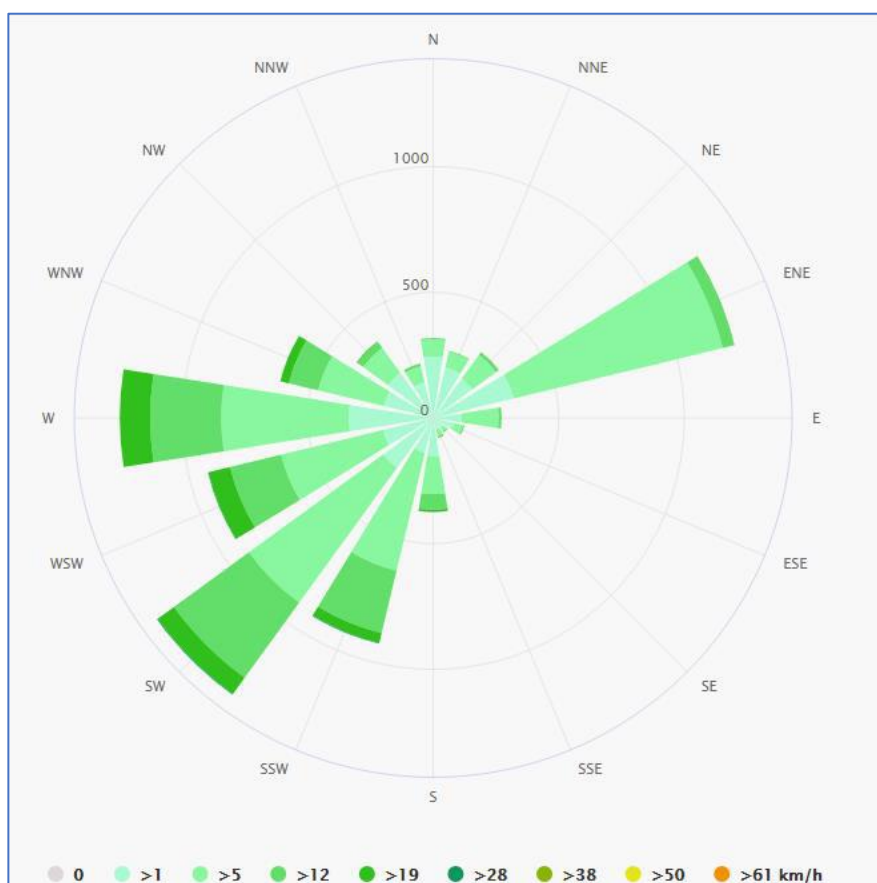
<sup>6</sup> Source: <https://en-ca.topographic-map.com/maps/l6i1/Thane/>

156. **Rainfall:** The average annual rainfall in the district is 2293.4 mm. The rainfall in the district increases from the coastal areas to the interior. The rainfall during the southwest monsoon season, June to September, constitutes about 94% of the annual rainfall. July is the wettest month with a rainfall of about 40% of the annual total. The variation in the annual rainfall from year to year in the district is not large.

157. Mumbai is nearest IMD station to Thane, micro-meteorology of Mumbai is presented in **Table 4.2**. Windrose diagram for Thane district is presented in **figure 4.3** representing that dominant wind direction throughout the year is SW (maximum times flow from SW direction) followed by ENE and West direction.

**Table 4.2 : Micro-meteorology of Mumbai (Santa Cruz)**

Month	Temperature, °C			Humidity, %			Pressure, hPa		Wind Speed, mph	Predominant Wind Direction	Rainfall mm
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg		
January	13.2	35.1	24.9	49	70	62	16.6	17.9	11.4	NW	0.3
February	36.4	14.3	25.3	47	68	62	17.6	18.1	10.9	NW	0.4
March	38	17.5	27.1	51	69	63	21.4	22.2	10.5	NW	0
April	37.6	21.1	28.9	59	69	66	26.4	26.7	9.9	NW	0.1
May	36.1	24.4	30.5	65	70	68	29.9	30.3	11.2	NW	11.3
June	34.9	23.2	29.3	74	79	77	31.8	31.8	15.3	W	493.1
July	32.2	23.4	27.8	81	85	85	31.7	31.7	18.0	W	840.7
August	31.5	23.5	27.4	81	86	84	30.7	31	16.3	W	585.2
September	33.1	23.0	27.8	76	85	80	30.2	30.5	11.6	W	341.4
October	36.3	20.3	28.9	63	74	72	27	27.4	9.2	NW	89.3
November	35.8	17.6	28.4	54	63	65	20.8	22.6	10.2	NW	9.9
December	35.1	4.5	26.5	51	65	63	7.3	19.6	11.0	NW	1.6



**Figure 4.2 : Windrose Diagram of Thane District**

### **Climate Change:**

158. 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. According to 2009 data, India is the world's third biggest emitter of CO<sub>2</sub> after China and the United States – pushing Russia into fourth place. 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. 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.

159. Mumbai and surrounding coastal districts have 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 due to changing climatic pattern. 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 diarrhoea cases and cholera outbreaks, as the cholera bacterium survives longer in saline water. Mumbai and surrounding coastal districts are densely populated cities, are particularly vulnerable to the impacts of sea-level rise, tropical cyclones, and riverine flooding.

160. As per the Climate & Air Pollution Risks and Vulnerability Assessment of Mumbai city prepared under Climate Action plan for Mumbai, Mumbai is the most populous city in India and, globally, the 7th largest in terms of population, projected to be the 6th largest by 2030. According to the 2011 Census, population density in these two districts exceeds 20,000 persons/km<sup>2</sup>, whereas the national average is 382 persons/km<sup>2</sup> and the state average is 365 persons/km<sup>2</sup> (TERI, 2014, p. 40). According to the Slum Rehabilitation Authority (SRA), around 55% of Mumbai's population lives in slums and about 65% are employed in the informal sector (Bhowmik, 2010). This makes the impact and experience of climate risks highly varied across the city and across different socio-economic groups.

161. Mumbai faces two major climate challenges – urban flooding and increasing heat. Being a coastal city, Mumbai experiences high levels of humidity and resulting humid heat. Coastal risks due to storm surge, coastal inundation and sea intrusion are also exacerbated during the monsoon months. Demographic diversity impacts sensitivity to climate risks, adding a layer of complexity to understanding differential vulnerabilities and resilience capacities. According to the Maharashtra State Adaptation Action Plan on Climate Change (SAPCC) 2014 (TERI, 2014), which provides state, regional and city level climate vulnerability context, 40% of Maharashtra's geographic area is drought prone and 7% is flood prone, with deficient rainfall reported once every five years. The state experienced severe and successive droughts in 1970-1974 and 2000-2004. Severe drought conditions occur once every eight to nine years. Mumbai city in particular, due to its geographical condition, is susceptible to heavy rainfall and prone to flooding almost annually. The fact that Mumbai was created by reclaiming land between seven separate islands is one of the primary reasons for its flooding. The Mean Sea Level (MSL) of Mumbai is very close to the Indian MSL at 0.01m. The average high tide level is 2.5m, the annual highest peak tide level being 2.75m. The average low tide level is -2m (i.e., two meters below the MSL). Between 2004 and 2007, Mumbai experienced flooding annually, incurring heavy losses and damages (Kuruppu, Bee, & Schaer, 2018). During July 2005, the city witnessed the worst flooding in its history (Gupta, 2007) that claimed over 900 lives and resulted in losses of over INR450 crore (TERI, 2014, p. 42).

162. The low-lying areas of the island city have a history of flooding five to six times a year, generally for a few hours when high intensity rainfall is coupled with high tides. Areas are just 2.25m to 3m above MSL, which are similar to flood levels in the creeks. In areas such as Saat Rasta, Lower Parel, and Grant Road, the land level is below the high tide level. Large areas along the coast including Juhu Aerodrome and Khar are at 3m, making them vulnerable to submergence. Only low tide phases (about 10 to 12 hours in a day, when water recedes below MSL) provide relief during storm events by draining out accumulated surface water. Anthropogenic activities have not factored in the city's estuary nature, landscape ecology and diverse demography, exacerbating the problem. These activities include unsustainable use of resources, reclamation of low-lying areas, poor condition and capacity of drainage system, development of eco-sensitive zones such as wetland and mangrove areas leading to a loss of holding ponds and biodiversity, incorrectly designed levels of outfalls, development patterns increasing run-off coefficient, to name a few. This is evident in the fact that while the Mumbai Metropolitan Region (MMR) increased in area from 149km<sup>2</sup> in 1971 to 1,000km<sup>2</sup> by 2010 with an expansion in the area under industry from 45km<sup>2</sup> to 140km<sup>2</sup>, its forest area declined from 1,045km<sup>2</sup> to 879km<sup>2</sup> and area under agriculture reduced from 2,098km<sup>2</sup> to 1,381km<sup>2</sup> (TERI, 2014).

163. Another major risk is urban heat. Mumbai experiences high temperatures not only during summer but also in the post monsoon months when humidity levels increase heat stress. Low-income households and informal settlements are at a higher risk (Mehrotra, Bardhan, & Ramamritham, 2018) given the limited access to water and sanitation services and nature of their living environment (metal roofs and tarpaulin roofs exacerbate heat risks). Heat stress also impacts productivity and thereby livelihoods and the economy. According to National Oceanic and Atmospheric Administration (NOAA) projections, 60% of Mumbai's year will comprise high heat days by 2040, where temperatures can exceed 32°C. Mumbai is vulnerable to climate change induced hazards including sea level rise, heavy rainfall, storm surge and tropical cyclones. It is also susceptible to landslides as a result of heavy rain that causes many fatalities and physical damage every monsoon. By 2030, at the state level, relatively increased rainfall intensity is projected for Northern Maharashtra as compared to baseline rainfall for the other parts of the state. Research Climate Central shows a large part of Mumbai is at risk of being submerged by 2050 (Kulp & Strauss, 2019). With a business-as usual scenario and no corrective action initiated to address the impending climate risks, Mumbai's total losses for a 100-year return period event is projected to be greater than factor 3 by the 2080s. The contribution of indirect losses to total losses would increase from 14% in the present-day situation to 18% in the 2080s (Hallegatte, et al., 2010, p. 34). Also, by 2080, the likelihood of urban floods such as the July 2005 event is more than double (Ranger, et al., 2010).

164. Project site lies in MMR and thus is vulnerable to above defined climatic risks. Mumbai in recent past has been experiencing the floods due to heavy rains as discussed above as well. Torrential rainfall leading to floods also happens also due to cyclones in the Arabian Sea. Mumbai ranks fifth among the world's cities which are prone to flooding, recording annual losses amounting to USD 284 million. Floods are severe and lead to inundation of the most of the city leading to disruption of the day-to-day activity and cause loss of property and life. Thus, it is mandatory to the study the HFL in the area prior designing the infrastructure. As per the data available with MMB, HFL in the project area is 500 mm (0.5 m) BGL (or 1.2 m AMSL) and existing ground level is 1.7 m AMSL. Project area is about 500 mm above the HFL and has not been inundated in past due to floods in Kasheli creek. Proposed project is elevated thus most of the structure is above HFL and significant impact on project infrastructure due to floods is not anticipated. Height of the viaduct for the proposed project varies between 8.7 m to 23.7 m thus impact of inundation of viaduct due to floods is not anticipated. Also the entry and exit of the proposed stations is designed above HFL. All stations are elevated thus risks of inundation is minimal.

165. The Mumbai Climate Action Plan 2022 (MCAP) advocates an approach for moving towards low-carbon transport in Mumbai, based on an assessment of the gaps and barriers in the transport sector. The MCAP has identified a four-pronged approach with aligned actions for reducing emissions from the transport sector. The approach also includes improved accessibility of public transport, improved multimodal integration and zero-carbon freight and passenger modes, with a focus on inclusivity. The approach includes a) promoting zero emission fuels as well as fuel efficiency improvements, b) adopting transport demand management to discourage private vehicle usage and shifting towards low-carbon modes, c) integrating across multiple transport modes and improved last-mile access, and d) optimizing the existing transport capacities through intelligent transport systems. The MML5 fits into this approach and contributes to carbon emission reduction.

#### **4.4.3. Seismicity**

166. In the seismic zone map of India prepared by Bureau of Indian Standards (BIS code: IS 1893: Part-1:2002). The seismic zoning map of India divides India into 5 seismic zones (Zone 1, 2, 3, 4 and 5). According to the present zoning map, Zone 5 expects the highest level of seismicity whereas Zone 2 is associated with the lowest level of seismicity. Thane district falls in Zone 3 (ref



western part of the district, i.e. coastal plain area of the district.

#### 4.4.5. Soil Types

170. Most of the soils in the district can be considered as being derived from trap (Basaltic) rocks. The soil has been classified into three broad categories based on the characteristics and relationship with topographic set up. (1) Soil of Coastal Lands with Residual Hills – These soils are slightly deep, poorly drained, fine soils on gentle sloping land and very fine soil on sloping land. (2) Lighter Coloured soils – These soils are occurring on the undulating, elongated hills and intervening valleys. These are medium to deep greyish in colour, poor in fertility, clayey to loamy in nature, shallow in depth and coarse in texture. These soils are known as Varkas and are suitable for rice. These soils occur on the eastern part of the district. (3) Black Coloured Soil- These soils occur on plains in the middle and eastern part of the district along the valleys. Project alignment lies within the coastal area of the district and major soil type of area is fine deep soils which are poorly drained. Soil quality of the project area is monitored at 6 locations and the data is presented in **Table 4.3**. As per the data it is concluded that soil in area is loamy to sandy clay loam.

**Table 4.3 : Soil Quality data in project Corridor (Oct, 2022)**

S. No.	Parameter	Unit	Near Balkum Metro Station	Kasheli Near Crick	Near Anjurphata Metro Station	Dhamankar Naka	Casti ng Yard Dapode	Kope r Metro Station Near Kahl er
1	Texture	-	Loam	Sand y Loam	Sandy Clay Loam	Sandy Loam	Sand y Loam	Sand y Clay Loam
2	Sand	%	48.6	56.2	60.8	53.5	63.2	50.9
	Silt	%	36.5	27.3	18.8	29.1	22.0	27.8
	Clay	%	14.9	16.5	20.4	17.4	14.8	21.3
3	Water Holding Capacity	%	25.6	31.8	34.5	28.6	30.4	32.4
4	Porosity	%	48.3	45.9	42.8	46.3	42.9	45.1
5	Bulk Density	gm/cc	1.26	1.37	1.43	1.38	1.47	1.41
6	pH (1:2.5)	-	7.49	7.28	7.62	7.56	7.35	7.69
7	Electrical Conductivity (1:2)	µS/cm	216	342	295	269	326	285
8	Cation Exchange Capacity	meq/100 gm	10.2	11.88	14.2	11.8	13.4	12.4
9	Exchangeable Sodium	mg/kg	186	296	256	214	318	258
10	Exchangeable Calcium	mg/kg	1340	1634	1871	1290	1538	1482
11	Exchangeable Magnesium	mg/kg	275	325	310	338	412	262
12	Sodium Absorption Ratio	mg/kg	1.21	1.75	1.44	1.37	1.85	1.62
13	Organic Carbon	%	0.46	0.61	0.74	0.58	0.66	0.54



14	Manganese	mg/kg	2.1	2.8	3.1	1.7	2.8	1.5
15	Zinc	mg/kg	9.6	11.3	15.2	7.2	10.3	6.9
16	Iron	mg/kg	23.1	20.8	31.7	16.4	26.8	17.3
17	Copper	mg/kg	0.96	1.35	1.02	0.74	1.12	0.82
<b>Available Nutrients</b>								
18	Nitrogen as N	kg/ha	179	268	314	182	295	274
19	Phosphorus(Olsen's ) as P	kg/ha	13.2	15.5	17.1	14.9	16.4	15.1
20	Potassium as K	kg/ha	156	217	239	168	226	205

171. Analysis of soil quality on basis of the data collected is presented below:

172. **Physical properties:** Texturally the soils of study area are observed as loamy to Sandy Clay Loam Soils. The Bulk Density (BD) of the soils was found in the 1.26-1.47 gm/cc. Water Holding Capacity (WHC) of study area soils was observed between 25.6 and 34.5%.

173. **Chemical properties:** The soil pH was found as within range of 7.28 to 7.69, thereby indicating the soil is neutral in nature. The organic carbon content in sampled soil was observed as 0.46-0.74% thereby implying that soils are sufficient in organic content.

174. **Macronutrients:** Available nitrogen content was observed in the surface soil between 179-295 kg/ha, thereby indicating that soil is low in available nitrogen content. Available phosphorus content was observed as 13.2 to 17.1 kg/ha, thereby indicating that soil is low-medium in available phosphorus. Available potassium content in the sampled soil was also observed as 156-239 kg/ha, thereby is indicating that the soil is low to medium in potassium content.

175. **Micronutrients:** The available manganese content in sampled surface soil was recorded between 1.5-3.1 mg/kg, as the critical limit of available manganese is 2.0-mg/kg.

#### 4.4.6. Hydrogeology

176. Deccan trap Basalt of Upper Cretaceous to Lower Eocene age is the major rock type covering about 80% of the district, coastal alluvium is other formation occurring only in western end of the district. Ground water in Deccan Traps mostly occurs in the weathered and fractured parts down to 10-15m depth. At places potential zones are encountered at deeper levels in the form of fractures and inter-flow zones which are generally confined down to 60-80m in the district. The weathered portions of both vesicular and massive units have better porosity and permeability. Intensity of weathering is less in hilly region as seen in the eastern part of the district while it is higher in plain area. The yield of dug wells tapping phreatic aquifer ranges between 18 to 152 cum/day, which have 5-12m depth range.

177. Alluvium is developed in the western part of the area along the coast and river courses and are lacustrine in nature. Along the coast, alluvium consists of clayey and mud deposits. The quality of water is slightly brackish and pumping from this formation has to be restricted to prevent ingress of seawater. The alluvium constitutes the potential aquifer in the area. The yield of dug wells ranges between 122 to 252 cum/day, which have 8-16 m depth range. The bore wells are generally drilled down to 20 to 30m tapping weathered and fracture/vesicular zones, these wells have a discharge of 4 to 6lps. Project area lies in the coastal plains of Thane district and underlain by alluvium formation.

178. The pre-monsoon depth to water level ranges from 0.50 to 14.60 m BGL. The depth to water level ranging between 2 to 5 m BGL and 5 to 10 m BGL are observed in major part of the

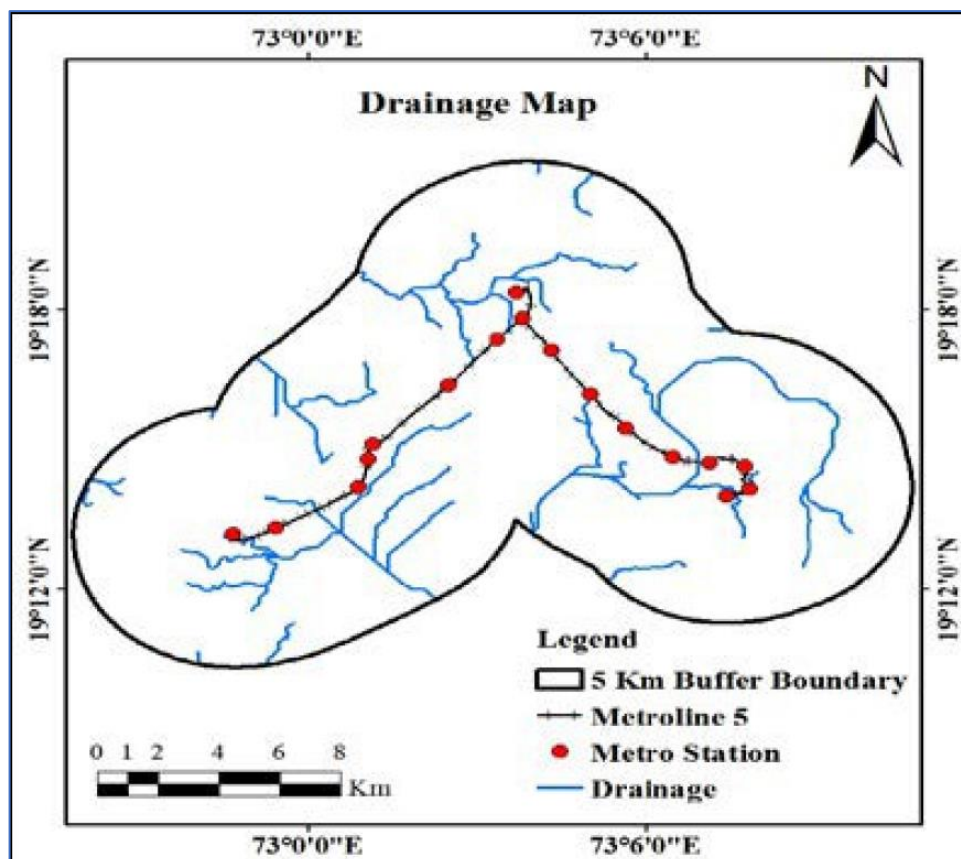
district. The post monsoon water level ranges from 1.20 to 6.90 m BGL. The water levels of 2-5 m BGL are observed in major part of the district. Less than 2 m BGL water level is observed in the eastern part of the district and water level of more than 5 m BGL occurs as isolated patches in the central and northern part of the district. In project area, water level varies between 5 to 10 m BGL during pre-monsoon and 2-5m BGL during post-monsoon.

179. Overall ground water development in the district is very low and accounts to 1.28% for the district. Entire district is categorized as safe category. Project alignment falls in Thane and Bhiwandi block of the district where stage of ground water development is 6.88% and 21.07% respectively. Area majorly depends on MIDC water supply for meeting domestic water needs.

#### 4.4.7. Drainage

180. The district has major drainage systems namely the Tributaries Ulhas River. Drainage Map 5 Km on Either Side of Metro Corridors is presented in **Figure 4.4**. Thane creek is 26 km long and it is connected to the Mumbai harbour on its south, joins by a minor connection with the Ulhas River on its north near Thane city. The creek is narrow & shallow at the riverine end due to the presence of the geomorphic head and broader & deeper towards the sea. The creek is tidally influenced with dominance of neritic waters and negligible freshwater flow except during the monsoon. The substratum of the creek in the mid-stream is made up of consolidated and unconsolidated boulders intermingled with loose rocks and rarely with sand and gravel. Extensive mudflats are formed along the banks of the creek, which are characterized by the growth of mangroves. The presence of mangroves along both the banks has made Thane creek a highly productive ecosystem.

181. Main rivers flowing through the district is the Ulhas River. The Ulhas originates from the north of Tungarli near Lonavala, flows for a short distance before descending near Bor ghat, and meets the sea at Vasai Creek. The Ulhas River is 135 km long. The river has many tributaries; the two most important of them (within the boundaries of this district) are the Barvi and the Bhatsa.



**Figure 4.4 : Drainage Map of Study Area (5 km radius area)****4.4.8. Land Use**

182. Land use patterns are important aspect in EIA study as it describes its use such as agriculture, settlement, forest, vegetation, etc. For the study area Land use – Land cover of 5 km on either side from proposed centreline of Metro Corridor has been derived from latest satellite imagery. The satellite image used in the current study includes LISS-IV data of Resourcesat-2 having Row 059 and Path 095. The entire data is in Universal Transverse Mercator projection system with spheroid and datum as WGS84 and Zone as 43 North.

183. Land use detail of Thane district as per Thane District Report is discussed below, however primary study on land use of the corridor has also been conducting using the satellite imagery data and software. The land use map was prepared using on-screen visual interpretation technique using ERDAS Imagine and Arc GIS software. The classification data of the corridor is also given in 4.4 and land use map for 5 km radius and 100 m radius is shown in **Figure 4.5 and 4.6.**

**Land Use of Thane District**

Land Use Class	Area-Ha
Geographical area	934
Cultivable area	356
Forest Area	330
Non-agricultural Land	90
Permanent pastures	46
Cultivable Wasteland	21
Land under Misc. tree crops and groves	24
Barren and uncultivated land	39
Current fallows	17
Other fallows	11

**Table 4.4 : Land Use of Study Area**

5 Km Radius Area		
Land Use Class	Area-Ha	Area Percentage (%)
Open land	171.298	32.01
Built-up	328.077	61.31
Mangrove	11.604	2.17
Vegetation	10.087	1.88
Water Body	14.077	2.63
Grand Total	535.144	100.0
100 m Radius Area		
Agricultural land	43.0	12.95
Water body	10.6	3.2
Settlement	252	75.9
Mangroves	9.5	2.9
Vegetation	17	5.05
Total	332.1	100

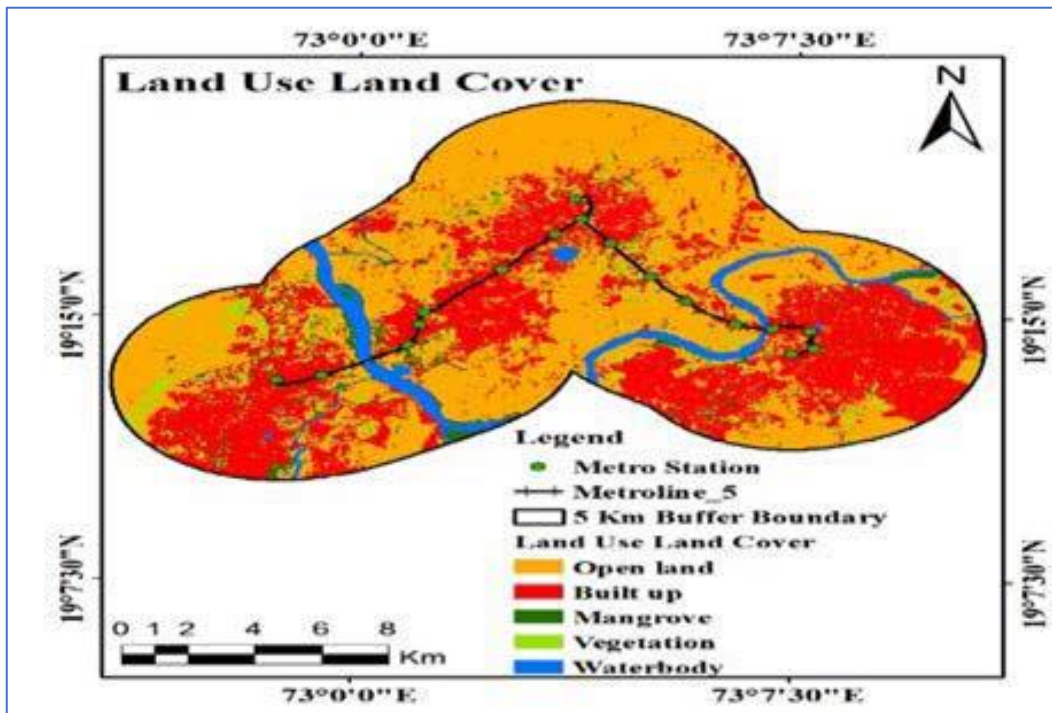


Figure 4.5 : Land Use Map of Study Area (5 km radius)

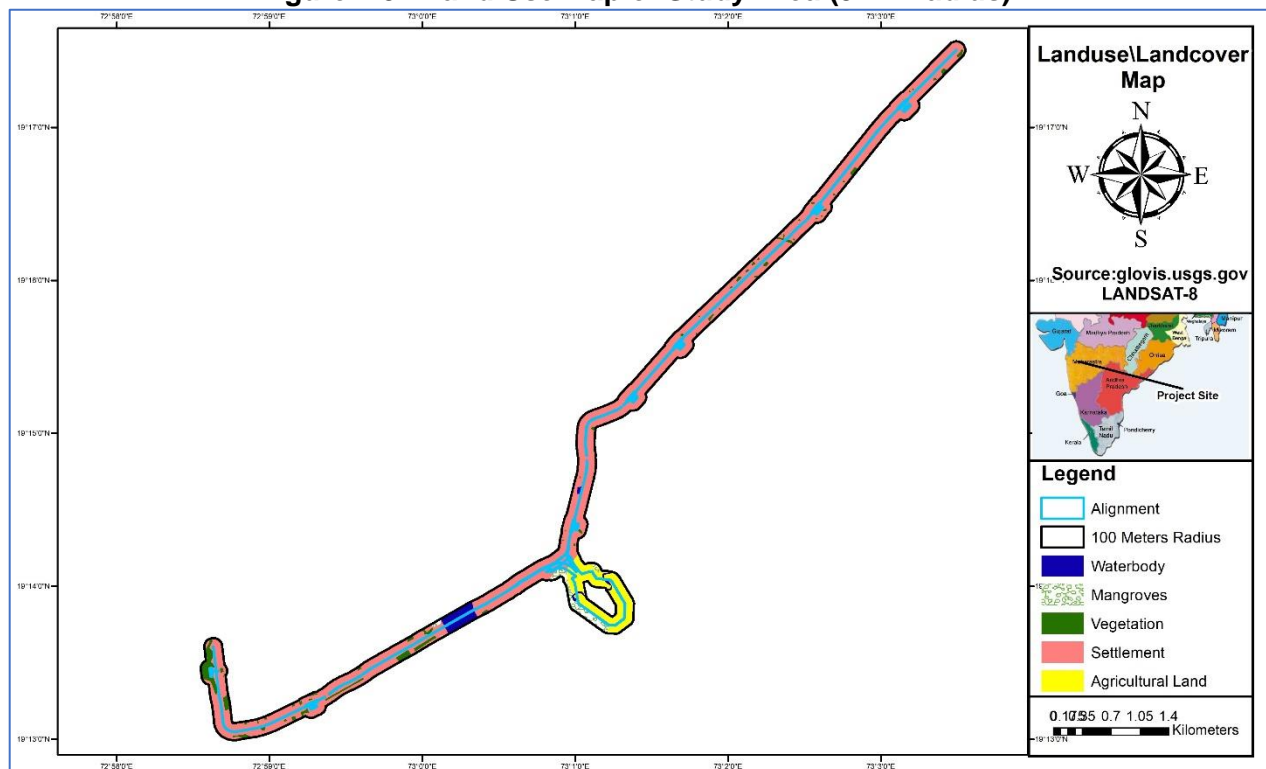


Figure 4.6 : Land Use Map of Study Area (100 m radius)

#### 4.4.9. Ambient Air Quality

184. All air pollutants emitted by point and non-point sources are transported, dispersed or concentrated by meteorological and topographical conditions. The meteorological parameters regulate the transport and diffusion of pollutants into the atmosphere. Primary data on air quality is collected for 6 locations and is presented in **Table 4.5** below. The secondary Ambient Air Quality data in terms of Respirable Particulate Matter (PM10), Sulphur di oxide (SO2), Oxides of

Nitrogen (NO<sub>x</sub>), has been collected from MPCB (Maharashtra Pollution control board) for major locations (Thane and Bhiwandi) along the Project corridor and average of the data from Jan 2018 to July, 2022 is also presented below.

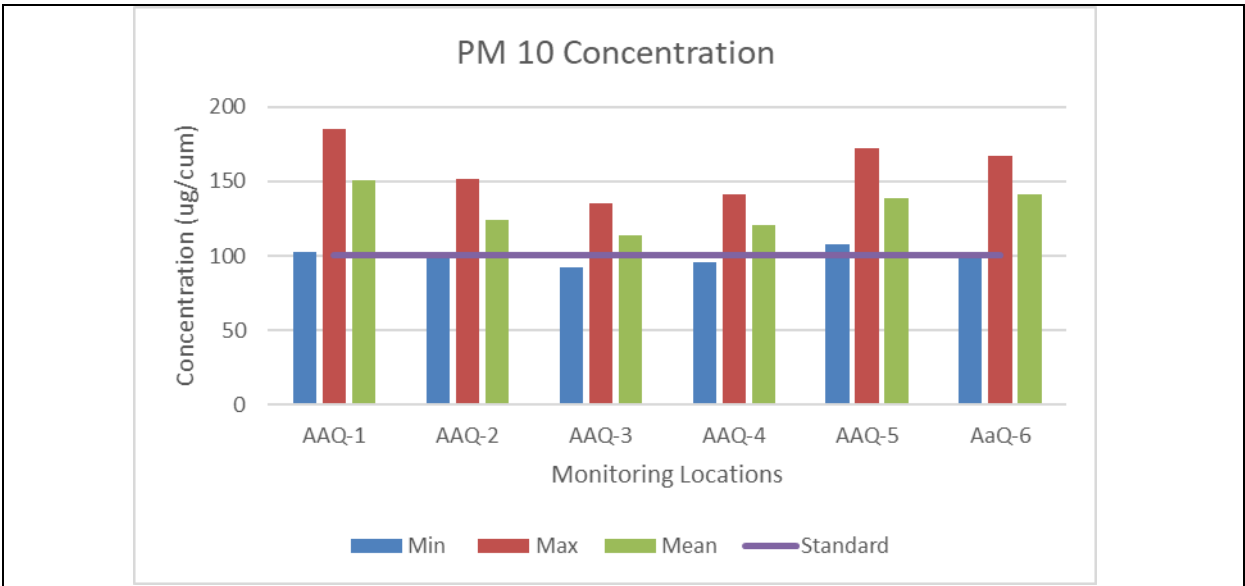
**Table 4.5 : Primary Ambient Air Quality Data (Oct 2022)**

Location		PM10 (µg/m <sup>3</sup> )	PM2.5 (µg/m <sup>3</sup> )	SO <sub>2</sub> (µg/m <sup>3</sup> )	NO <sub>x</sub> (µg/m <sup>3</sup> )
Balkum Metro Station-AAQ 1	Min	103	50.0	11.2	22.3
	Max	185	71.0	18.9	36.5
	Mean	151	60.7	15.0	29.9
Near Kasheli Creek-AAQ2	Min	98	45.0	10.3	19.8
	Max	152	64.0	15.2	31.4
	Avg.	124	55.3	13.3	26.2
Anjarphata Metro Station-AAQ 3	Min	92	44.0	9.2	17.8
	Max	135	62.0	14.4	27.8
	Avg.	114	52.6	10.9	21.6
Dhamkar Naka- AAQ 4	Min	96	42.0	10.2	17.6
	Max	141	70.0	16.8	29.4
	Avg.	120.5	55.6	13.82	24.49
Casting Yard dapode-AAQ 5	Min	108	52.0	9.6	21.6
	Max	172	71.0	16.8	34.5
	Avg.	139	59.0	14.25	28.67
Kopar Metro Station Near kalher	Min	103	51.0	10.2	22.3
	Max	167	68.0	22.73	42.1
	Avg.	141	59.7	16.046	31.673
Standard-NAAQS		100	60	80	80

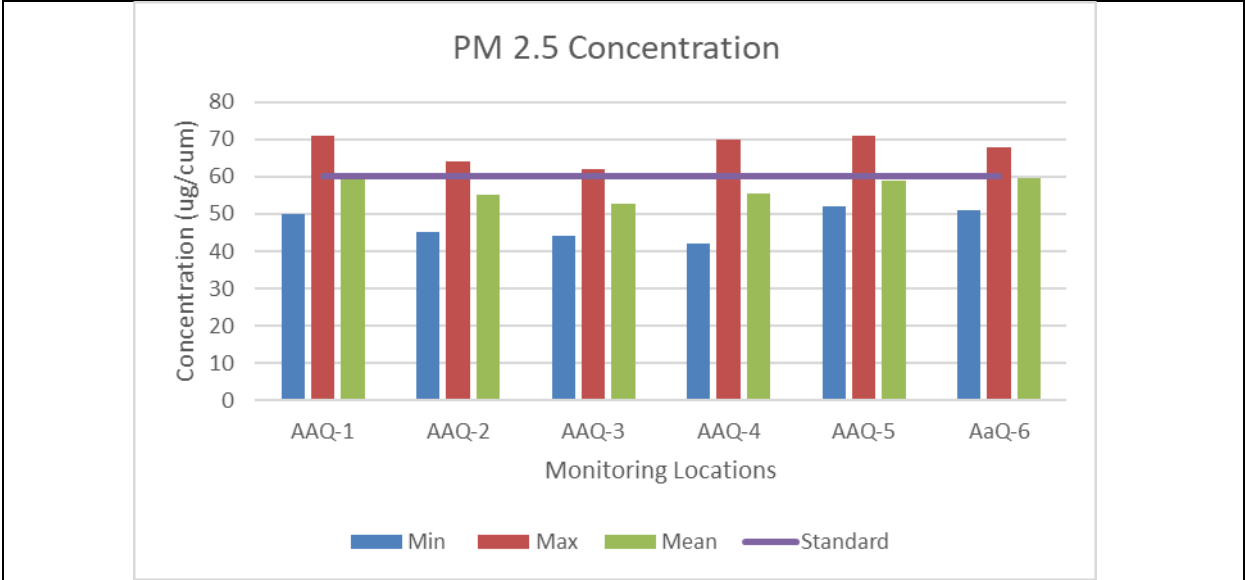
**Secondary Ambient Air Quality Data (Jan 2018 to July, 2022) (MPCB)**

Pollutant/Parameter	SO <sub>2</sub>	NO <sub>2</sub>	RSPM
Balkum, Thane (µg/cum) (1.0 km from alignment, W)			
Min	9	14	31
Max	53	91	244
Average	18.93	33.82	97.39
Premataihall, Bhiwandi (µg/cum) (500 m from alignment in East direction)			
Min	11	16	7
Max	53	66	83
Average	30.10	40.84	59.68
Standards NAAQS 2009	80	80	100

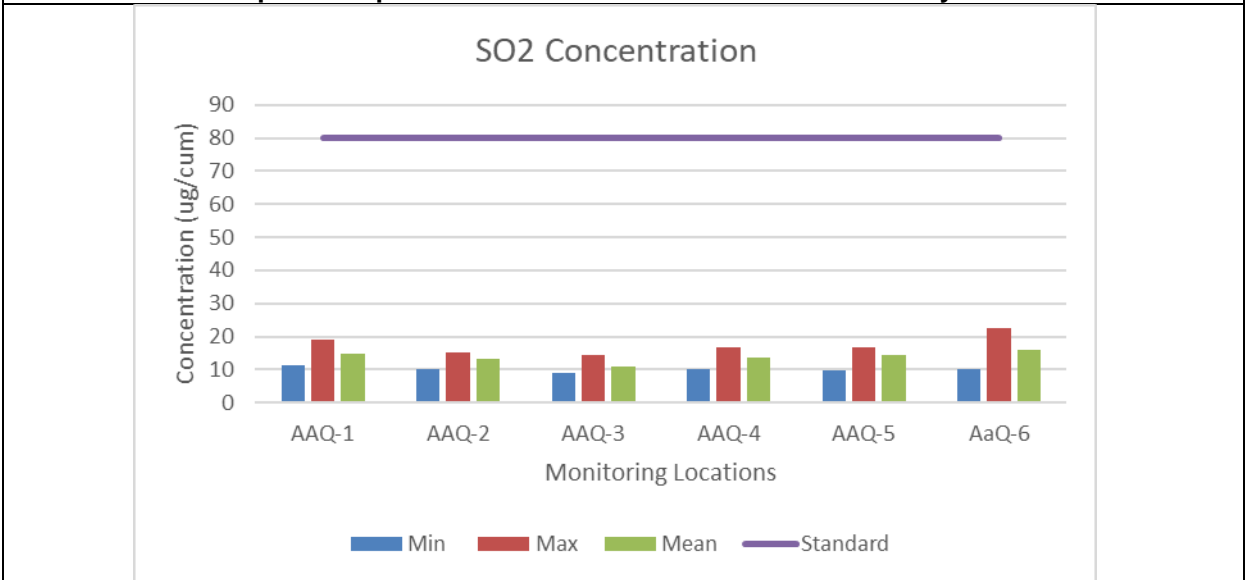
185. From the analysis, it is evident that the concentration of PM10 and PM2.5 exceeds the NAAQS standard at all the locations whereas other pollutants, i.e. SO<sub>2</sub> & NO<sub>2</sub> are well within the prescribed limits of NAAQS 2009. Same is being depicted from the secondary data presented above for Thane. This may be due to heavy movement of the vehicles on Thane-Bhiwandi Road.



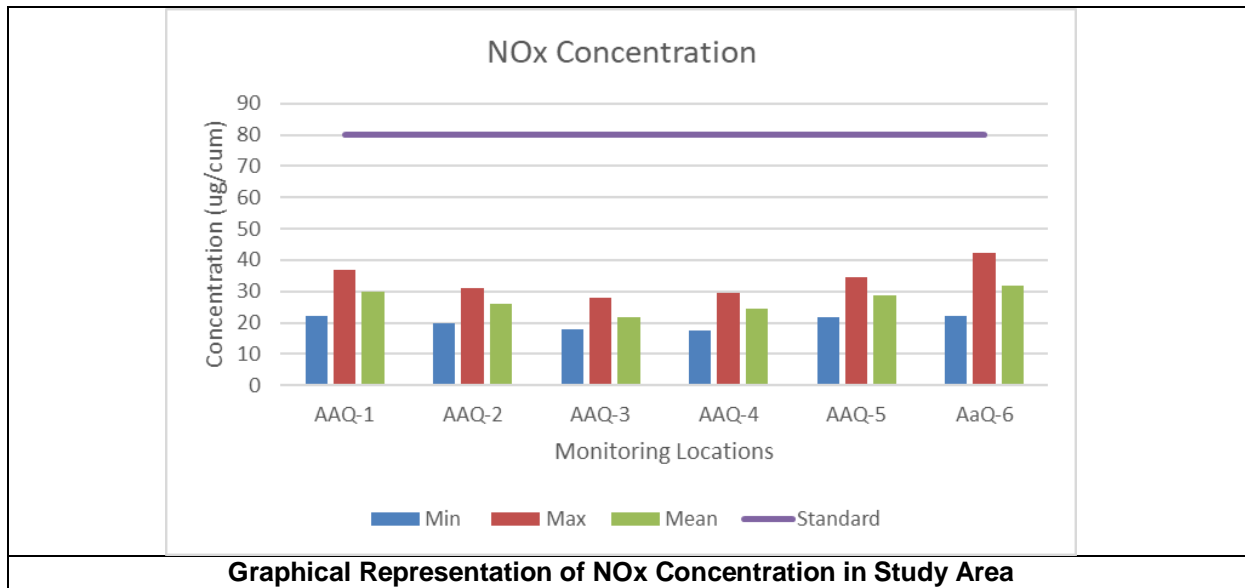
**Graphical Representation of PM10 Concentration in Study Area**



**Graphical Representation of PM2.5 Concentration in Study Area**



**Graphical Representation of SO2 Concentration in Study Area**



#### 4.4.10. Noise levels

186. Primary noise level data is collected at 6 locations during Oct, 2022 in project corridor and the data is presented in **Table 4.6**. Land use of all the monitored location is commercial and industrial. Ambient noise levels data is being collected by MPCB in Thane District on annual basis and during Ganesh festivals which is also referred and is presented below. Graphical representation of the data collected is provided in **Figure 4.7** respectively. Noise level recorded during the festival are higher than the prescribed standards under Noise Rules 2000. Noise standards as per Noise Rules 2000 are presented in **Table 4.7**.  $L_{eq}$  level of noise monitored at all these locations are compared with the noise standards for the commercial and industrial land use, i.e. 65 dB(A) & 75 dB(A) during day time and 55 dB(A) & 70 dB(A) during night time and are found to be within the prescribed standards both during day and night time except for NQ-6 during the day time which slightly increases the prescribed standards. However, the data recorded by MPCB shows that the noise level are on the higher side both during day and night time when compared with the noise level for commercial land use.

**Table 4.6 : Primary data on Noise Level in Project corridor**

Location	Land Use		Day Time dB(A)	Standard- Day Time dB(A)	Night Time dB(A)	Standard- night Time dB(A)
(CA-11 Tata) Kolshet-1 -NQ 1	Commercial	Lmax (day)	68.9	65	54.7	55
		Lmin (day)	56.1		50.3	
		Leq (day)	65.1		53.0	
(CA-08 Reliance) Casting Yard-2-NQ2	Industrial	Lmax (day)	63.8	75	44.1	70
		Lmin (day)	49.5		39.2	
		Leq (day)	59.1		42.3	
(CA-54 J- Kumar) Near Gaimukh-4- NQ 3	Commercial	Lmax (day)	63.5	65	49.9	55
		Lmin (day)	50.4		38.8	
		Leq (day)	57.8		46.4	
Casting Yard	Industrial	Lmax (day)	65.7	75	48.9	70

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Dapode-NQ 4		Lmin (day)	52.3		42.9	
		Leq (day)	62.1		46.6	
Kopar Metro Station Near Kalher-NQ 5	Commercial	Lmax (day)	57.2	65	43.9	55
		Lmin (day)	44.5		37.9	
		Leq (day)	53.7		41.6	
Kopar Metro Station Near Kalher	Commercial	Lmax (day)	66.6	65	52.5	55
		Lmin (day)	53.9		48.6	
		Leq (day)	63.0		50.2	

Table 4.7 : Ambient Air Quality Data WRT Noise in Thane District (2019 &amp; 2021)

Location	Date	Day Time (6AM-10PM) values in dB(A)					
		Leq	Lmax	Lmin	L10	L50	L90
Main Road-Gaondevi Mandir	22.12.2019	69.0	74.2	65.4	71.0	67.6	66.0
	21.02.2021	72.6	55.6	79.6	77.7	68.1	59.9
	22.02.2021	76.9	57.6	80.8	79.9	76.6	60.6
Tembhi Naka	22.12.2019	69.0	74.2	65.4	71.0	67.6	66.0
	21.02.2021	73.8	58.2	76.6	76.0	73.5	69.1
	22.02.2021	73.4	56.3	78.1	77.7	71.3	60.9
Ghokhale Road	22.12.2019	67.5	70.9	62.1	70.3	66.9	63.8
	21.02.2021	70.9	65.1	76.0	72.8	70.4	66.5
	22.02.2021	71.2	61.4	73.8	73.3	71.0	66.4
Pokharan	22.12.2019	70.0	76.9	57.1	73.3	67.4	64.7
	21.02.2021	75.1	57.7	82.4	77.5	73.6	64.4
	22.02.2021	66.6	58.1	72.2	70.2	65.4	59.9
Wagle Estate	22.12.2019	62.8	70.6	54.4	66.8	56.3	54.9
	21.02.2021	69.4	59.5	75.8	71.2	68.0	64.5
	22.02.2021	76.5	53.4	83.3	81.7	66.1	58.4
Location	Date	Night Time (10PM-6AM) values in dB(A)					
		Leq	Lmax	Lmin	L10	L50	L90
Main Road-Gaondevi Mandir	22.12.2019	53.3	60.4	43.4	55.8	47.0	44.0
	21.02.2021	58.3	49.5	62.3	61.5	57.2	52.0
	22.02.2021	74.0	68.4	78.2	77.6	71.2	69.2
Tembhi Naka	22.12.2019	59.1	62.6	54.7	61.1	58.8	55.1
	21.02.2021	62.7	59.5	64.3	64.2	63.1	60.0
	22.02.2021	69.9	64.2	74.3	73.0	68.5	64.9
Ghokhale Road	22.12.2019	60.6	65.7	45.7	64.4	58.4	48.2
	21.02.2021	60.6	51.9	64.6	63.8	59.7	53.4
	22.02.2021	67.1	62.4	69.8	69.6	66.1	63.1
Pokharan	22.12.2019	66.5	71.2	49.3	70.8	61.3	52.3
	21.02.2021	57.2	52.0	60.7	59.7	56.6	52.9
	22.02.2021	67.6	62.7	71.4	70.3	66.4	63.2
Wagle Estate	22.12.2019	64.1	72.1	45.1	64.5	58.3	52.5
	21.02.2021	62.9	51.3	68.6	67.0	57.9	52.0
	22.02.2021	69.4	66.2	72.5	71.0	68.6	67.4
Ambient Air Quality Data WRT Noise in Thane District (During Ganesh festival 2020)							
Year 2019	2-Sept-19	3-Sept-19	6-Sept-19	8-Sept-19	12-Sept-19		



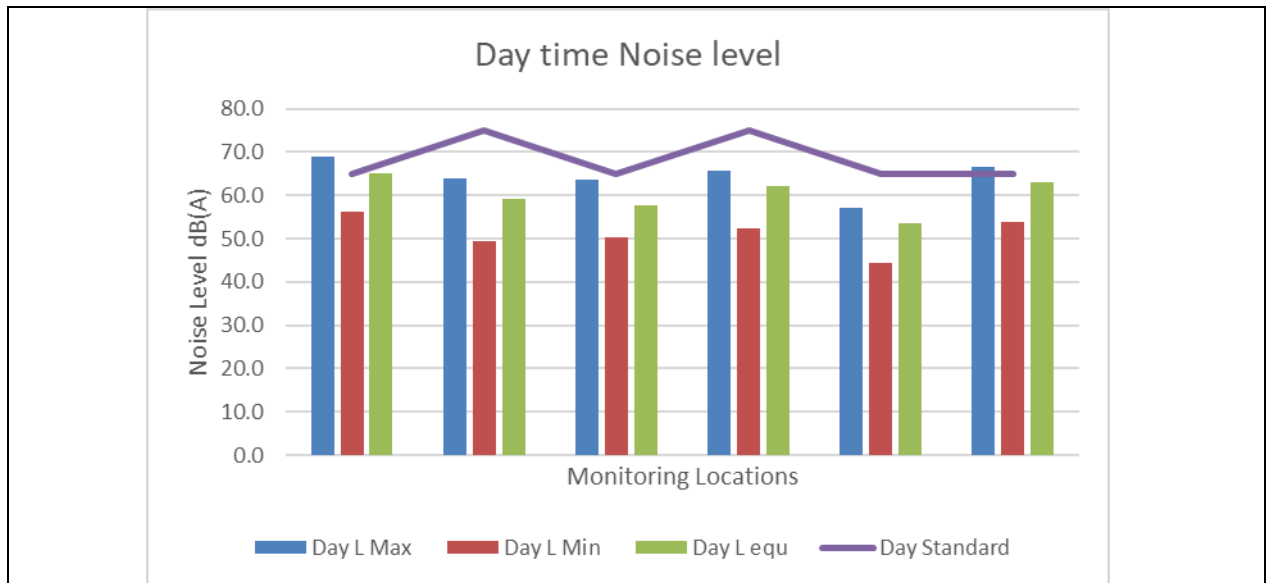
	<b>(L<sub>eq</sub>) dB(A)</b>				
<b>Gokhale Road</b>	70.6	75.6	77.7	75.5	76.3
<b>Jambli Naka</b>	70.8	86.2	74.4	80.8	82.6
<b>Gaondevi Mandir</b>	75.4	89.6	74.3	75.9	80.0
<b>Pokhran Road-</b>	65.5	90.5	84.9	74.9	78.1
<b>Wagle Estate</b>	75.0	74.2	62.4	74.4	75.0
<b>Court Naka</b>	66.2	70.8	61.3	71.9	62.1
<b>Mental Hospital</b>	67.2	74.7	71.5	70.7	62.1
<b>Bedekar Hospital</b>	53.9	74.0	93.7	67.5	71.6
<b>Kalwa</b>	70.6	75.6	77.7	75.5	76.3
<b>Year 2020</b>	<b>22-Aug-20</b>	<b>23-Aug-20</b>	<b>26-Aug-20</b>	<b>28-Aug-20</b>	<b>1-Sept-20</b>
	<b>(L<sub>eq</sub>) dB(A)</b>				
<b>Gokhale Road</b>	65.3	63.8	60.0	72.7	73.9
<b>Jambli Naka</b>	65.5	71.8	70.1	72.7	73.6
<b>Gaondevi Mandir</b>	65.4	67.4	69.2	71.9	71.3
<b>Wagle Estate</b>	55.7	67.9	71.1	69.5	70.6
<b>Court Naka</b>	57.8	66.1	72.0	70.1	69.5
<b>Mental Hospital</b>	55.3	58.2	68.7	68.5	58.7
<b>Bedekar Hospital</b>	65.8	74.0	68.2	68.4	68.5
<b>Kalwa</b>	61.4	66.9	72.5	62.4	67.2

**Table 4.8 : Noise Standards 2000**

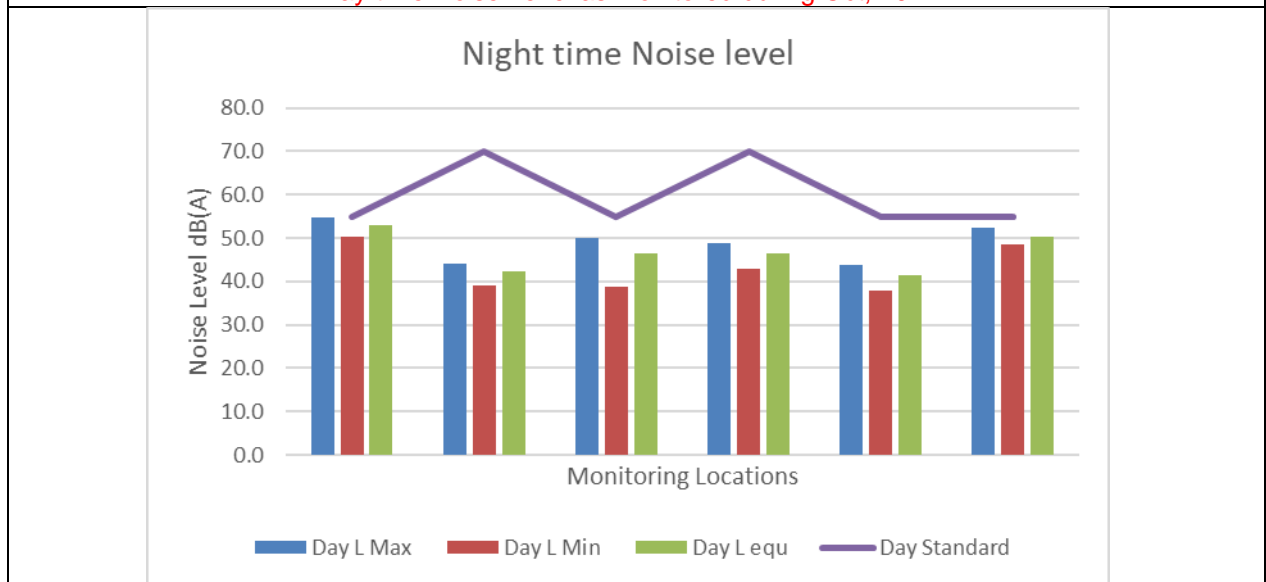
<b>Area Code</b>	<b>Category of Area/Zone</b>	<b>Limits in dB(A) Leq*</b>	
		<b>Day Time</b>	<b>Night Time</b>
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

**Note:**

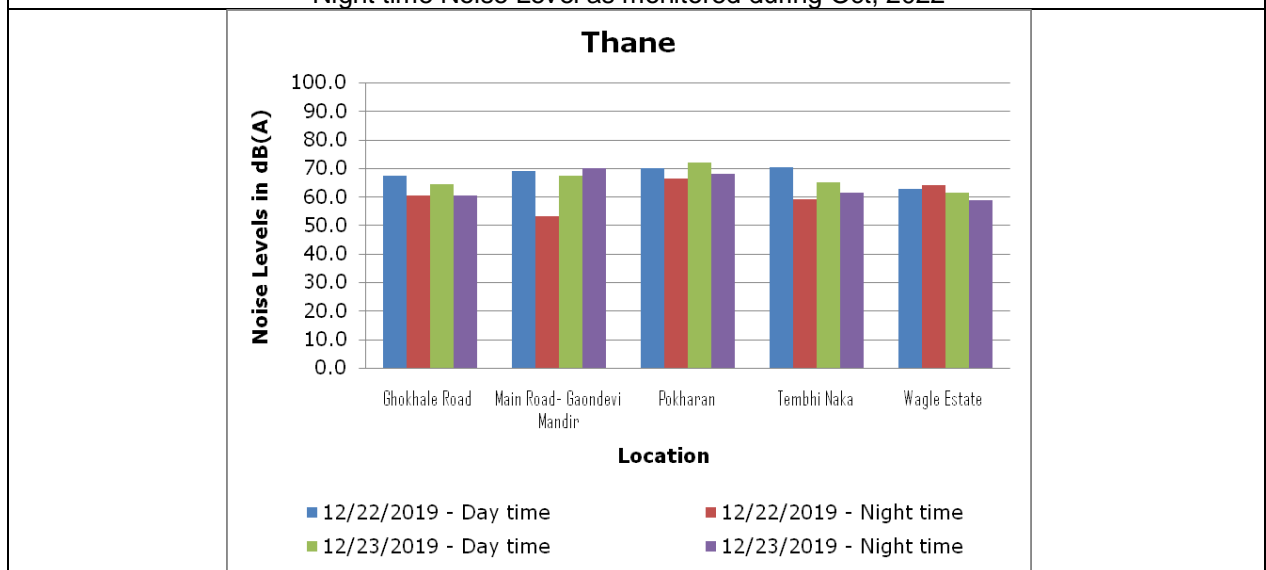
1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
  2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
  3. Silence zone is defined as an area comprising not less than 100 meters around hospitals, educational institutions and courts. The silence zones are zones, which are declared as such by the competent authority.
  4. Mixed categories of areas may be declared as one of the four-abovementioned categories by the competent authority.
- \*dB (A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.  
A “decibel” is a unit in which noise is measured.  
“A” in dB (A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.  
Leq: It is an energy mean of the noise level over a specified period.



Day time Noise Level as monitored during Oct, 2022

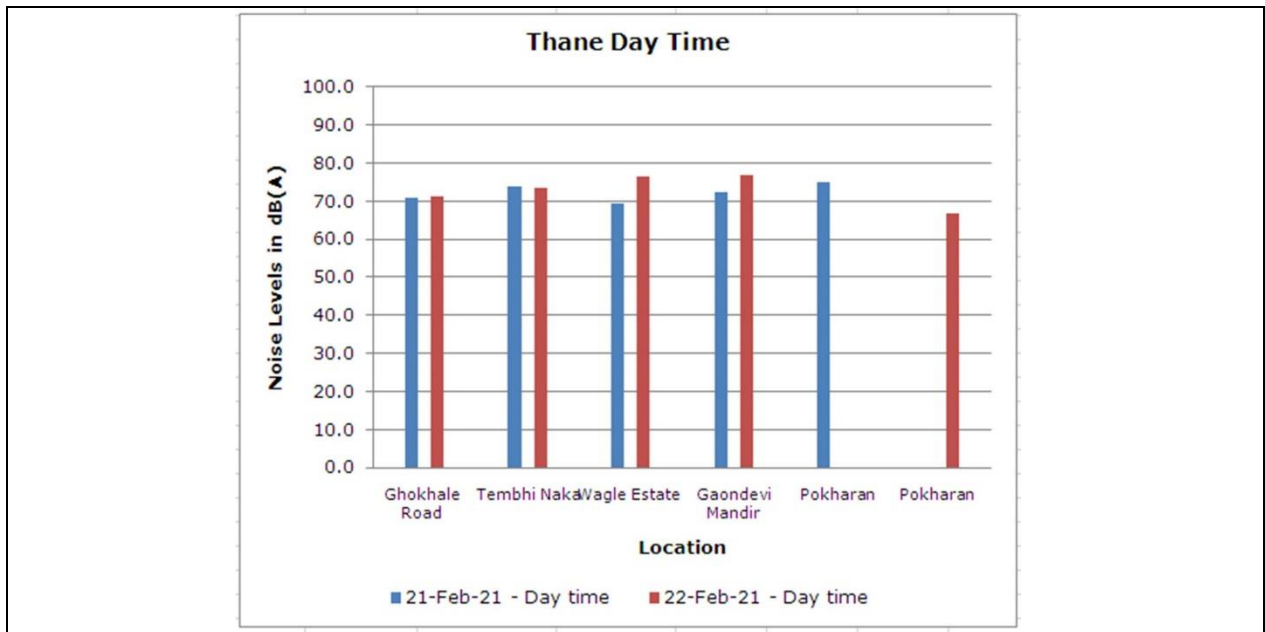


Night time Noise Level as monitored during Oct, 2022

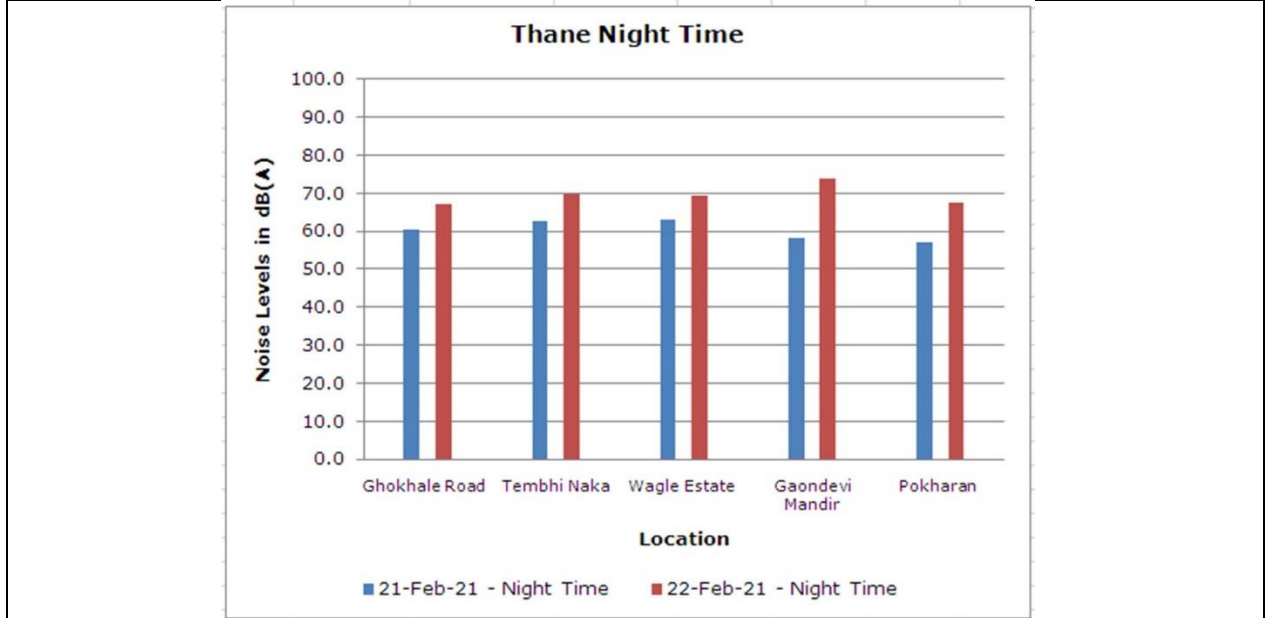


Noise Level in Thane District During Day & Night Time (Dec 2019)-MPCB

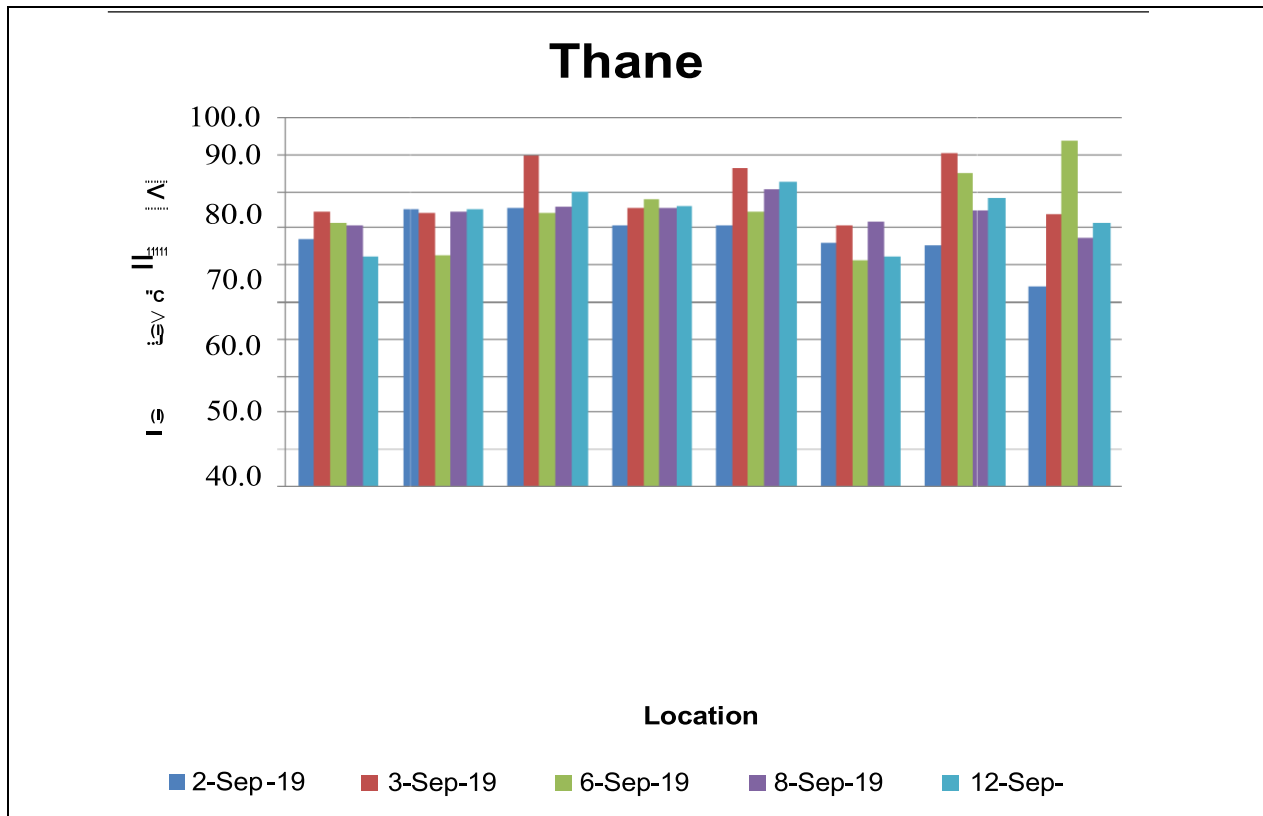
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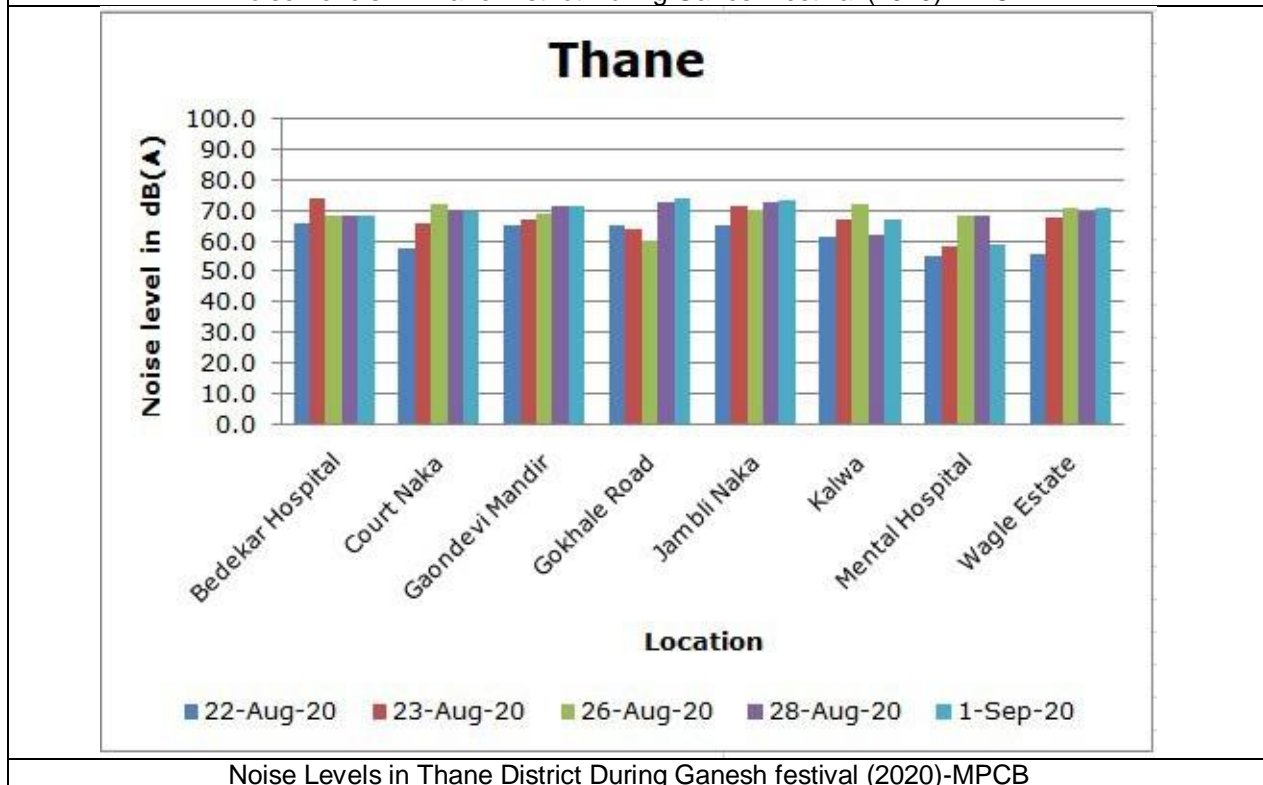
Noise Level in Thane District During Day Time (Feb 2020)-MPCB



Noise Level in Thane District During Night Time (Feb 2020)-MPCB



Noise Levels in Thane District During Ganesh festival (2019)-MPCB



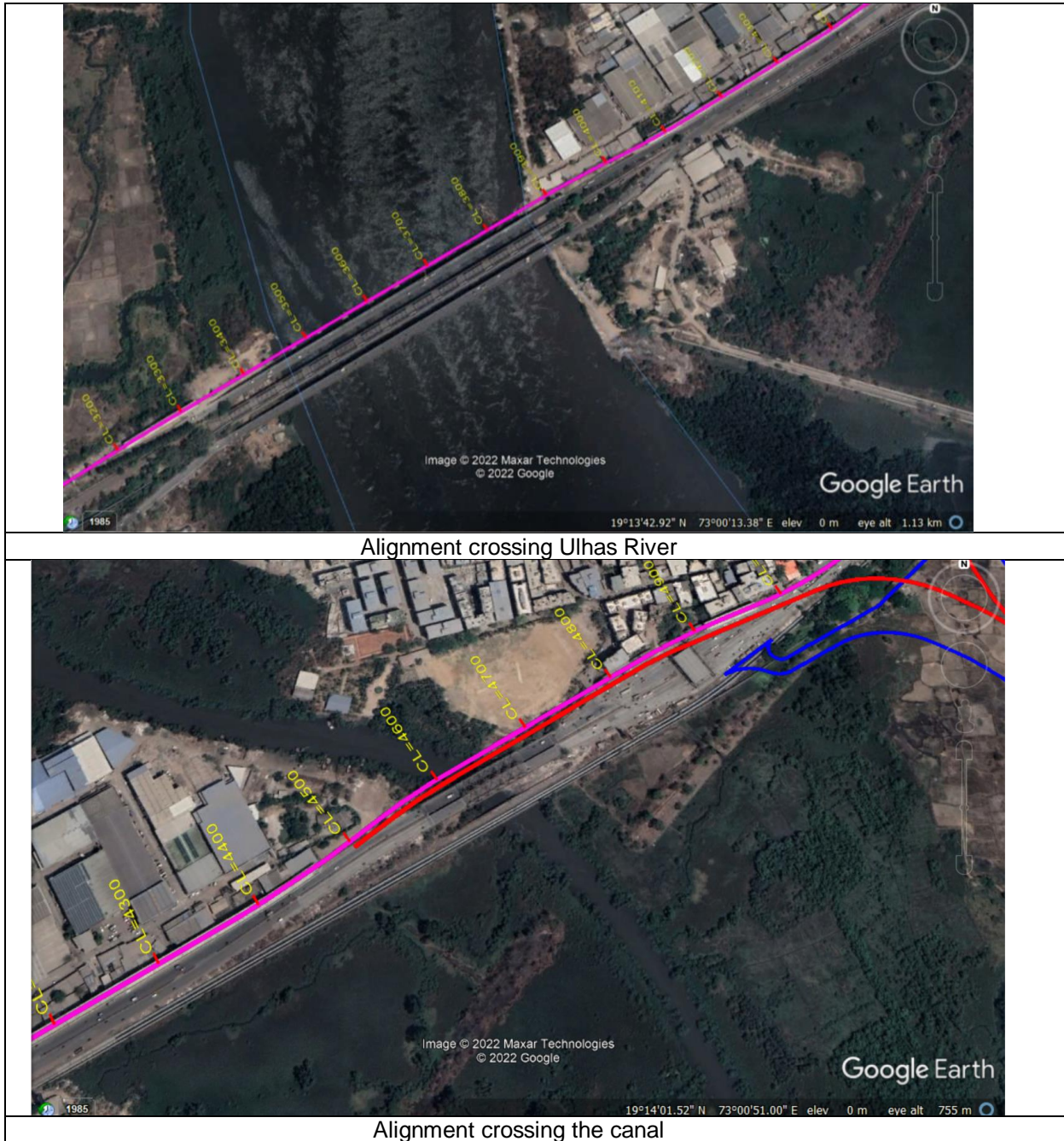
Noise Levels in Thane District During Ganesh festival (2020)-MPCB

Figure 4.7 : Noise Levels in Thane District (2020)

**4.4.11. Surface Water Resources and Quality**

187. Thane District has vast natural water resources in the form of perennial rivers which are the major source of drinking water supply. Primary sources of water in Thane district is from the river

Ulhas and lakes. Ulhas River is 135 km long and originates from the north of Tungarli near Lonavala, flows for a short distance before descending near Bhor ghat. It meets the sea at Vasai creek. The river has many tributaries; two important ones (within the boundaries of this District) are Barvi and Bhatsa. Phase I project alignment intersects two surface water bodies, i.e. Ulhas River and a small stream/canal after Ulhas river at approx. Chainages 3490 and Chainage 4600 near Kasheli as depicted in figure 4.9. It is proposed that approx. 13 piers will be installed in and near Ulhas river & canal at Kasheli.



**Figure 4.8 : Surface water Bodies Intersected by Project Alignment (Phase-I of ML 5)**

188. Surface water quality data is monitored for Kasheli Creek in up-stream & down-stream during Oct, 2022 and is presented in **Table 4.9**. Surface water quality data of the several water bodies is being collected by MPCB annually and the data collected for year 2019-2021 is presented in **Table 4.10** below for water bodies falling in and close to project area. Monitored Results are compared with the Designated best use water quality criteria defined by CPCB (IS 2296-1982) as provided below and is found that the water bodies quality is well within the



prescribed limits of the concentration of various parameters defined for Class C. However as per MPCB, water of monitored water body have high BOD levels than prescribed for Class A to D water bodies, thus these water bodies can be classified as Class E water bodies.

**Table 4.9 : Surface Water Quality Data (Oct 2022)**

S. No	Parameters	Unit	Kasheli Near Creek Up - Stream -(SW)- 1	Kasheli Near Creek Down - Stream -(SW)- 2
1	pH value	-	6.67	6.87
2	Color	Hazen	<5	<5
3	Turbidity	NTU	<1	<1
4	Total Dissolved Solids	mg/l	368	222
5	Total Alkalinity as CaCO <sub>3</sub>	mg/l	82	76
6	Total Hardness (as CaCO <sub>3</sub> )	mg/l	120	98
7	Calcium (as Ca)	mg/l	26	23
8	Magnesium (as Mg <sup>2+</sup> )	mg/l	13.4	9.9
9	Chlorides (as Cl)	mg/l	136	55
10	Fluoride (as F)	mg/l	0.3	0.05
11	Sulphate (as SO <sub>4</sub> )	mg/l	21	24
12	Iron (as Fe)	mg/l	0.1	0.12
13	Nitrate(as NO <sub>3</sub> )	mg/l	4.8	5.1
14	Copper (as Cu)	mg/l	<0.05	<0.05
15	Boron (as B)	mg/l	<0.1	<0.1
16	Manganese(as Mn)	mg/l	<0.05	<0.05
17	Phenolic Compounds (as C <sub>6</sub> H <sub>5</sub> OH)	mg/l	<0.001	<0.001
18	Sulphide (as H <sub>2</sub> S)	mg/l	<0.05	<0.05
19	Zinc (as Zn)	mg/l	0.2	0.23
20	Cadmium (as Cd)	mg/l	<0.003	<0.003
21	Cyanide (as CN)	mg/l	<0.05	<0.05
22	Lead (as Pb)	mg/l	<0.01	<0.01
23	Mercury (as Hg)	mg/l	<0.001	<0.001
24	Total Arsenic (as As)	mg/l	<0.01	<0.01
25	Total Chromium (as Cr)	mg/l	<0.05	<0.05
26	Oil & Grease	mg/l	<1	<1
27	Dissolved Oxygen	mg/l	7.3	7.1
28	Chemical Oxygen Demand	mg/l	12	16
29	Bio- Chemical Oxygen Demand	mg/l	2.2	2.5
30	Total Coliform	MPN/100ml	1.6 x 10 <sup>3</sup>	1.8 x 10 <sup>3</sup>

Table 4.10 : Surface Water Quality of Water Bodies In are Around Project Area

Year	pH			Dissolved Oxygen (mg/l)			B.O.D. (mg/l)			C.O.D. (mg/l)			Nitrate (mg/l)			Fecal Coliform (MPN/100 ml)		
	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG
<b>Rabodi Nalla</b>																		
2019	6.7	7.4	7.05	3	5.7	2.52	5	210	51	20	532	129.45	0.3	17	2.92	220	1600	1140.91
2020	6.7	7.8	7.16	3.4	7	3.46	4	110	24.08	16	296	75	0.2	3.8	1.38	240	2400	1102.5
2021	6.8	7.4	7.07	0.3 (BDL)	2.2	0.41	55	170	83.67	124	316	180.67	0.3	3.71	1.36	6.8	920	315.98
<b>Ulhas River Near Reti Bunder</b>																		
2019	6.5	7.6	7.18	3.3	7	5.05	4	16	8.25	12	256	86	0.3	3.2	1.69	1.8	110	40.98
2020	6.8	7.5	7.11	1.1	7	4.71	3	22	9.02	20	176	64	0.1	7.1	2.73	17	110	44.83
2021	6.9	7.5	7.21	2.7	6.9	4.82	3.4	28	8.93	12	184	79.67	0.3(BDL)	5.6	1.77	13	170	58.08
<b>Ulhas River at Mumbra Reti Bunder</b>																		
2019	6.3	7.9	7.26	3.5	5.6	4.77	5	14	8.42	16	172	74	0.7	7.4	3.03	21	170	59.08
2020	7.1	7.8	7.34	4	7.2	5.33	3	15	7.75	16	140	64.33	0.2	4.6	1.65	17	140	55.42
2021	7	7.5	7.34	3.7	7.3	4.9	3.6	15	9.08	16	184	99	0.3 (BDL)	7.6	1.79	4.5	170	73.04
<b>Ulhas River at Kolshet Reti Bunder</b>																		
2019	6.5	8	7.33	3.5	5.8	4.72	5	14	8.67	20	140	73.67	0.7	6.6	2.86	17	84	43.25
2020	7.2	7.7	7.43	3.5	7.3	5.43	3	22.00	8.8	16	160	66.67	0.1	5.5	1.72	22	110	46.75
2021	7.2	7.6	7.42	3.4	7.3	4.87	3.6	15	9.47	16	200	105.67	0.3 (BDL)	6.1	1.77	4.5	240	94.46

**Designated Best Use Water Quality Criteria (CPCB)**

Designated-Best-Use	Class of water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	Total Coliforms Organism MPN/100ml shall be 50 or less pH between 6.5 and 8.5 Dissolved Oxygen 6mg/l or more Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organised)	B	Total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	D	pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more Free

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		Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	pH between 6.0 to 8.5 Electrical Conductivity at 25°C micro mhos/cm Max.2250 Sodium absorption Ratio Max. 26 Boron Max. 2mg/l



#### 4.4.12. Ground Water Quality

189. Alignment traverses through various area of mixed, residential and industrial land use. Majorly MIDC supply water is being used in the project area to meet domestic needs but ground water is also being used for domestic purposes in the growing residential areas of Thane. Further, the ground water is also used for the industrial purposes in these areas. The cities are located in coastal areas and the uncontrolled exploitation of the ground water resources can cause the seawater intrusion.

190. To understand the ground water quality of project area, a study carried out in 2019, i.e. "Assessment of groundwater quality using GIS in Thane Municipal Corporation, Maharashtra, India by Sitaram Shinde<sup>1</sup> · Pandurang P. Choudhari, Bhushan Popatkar and Namit Choudhari is referred. As per study, 25 samples were collected from Thane district in February, 2019. Project area specific locations are selected from the study and the ground water quality data of those locations is presented in **Table 4.11**.

**Table 4.11 : Ground Water Quality Result (Feb, 2019)**

S. No.	Location	pH	EC $\mu$ S/cm	TH mg/l	Ca <sup>2+</sup> mg/l	Mg <sup>2+</sup> mg/l	K <sup>+</sup> mg/l	Cl <sup>-</sup> mg/l	Li <sup>+</sup> mg/l
1	Uthalsar	6.64	610	212	172	40	4.5	58.44	0.0
2	Rutu Park	8.58	1152	32	12	20	5.0	204.54	0.1
3	Vasant Vihar	7.03	103	48	32	16	0.6	58.44	0.0
4	Chitalsar	6.37	860	372	248	124	0.7	146.1	0.2
5	Dongripada	6.73	549	232	140	92	0.2	58.44	0.2
6	Kolshet	6.91	800	116	64	52	3.6	116.88	0.3
7	Mumbra	6.71	836	284	176	108	2.3	146.1	0.3

191. pH value ranges in the study area between 6.64 to 8.58 which indicated the neutral nature of water. The lowest pH (6.37) found at Chitalsar and the highest pH (8.58) recorded at Rutu Park. Electrical conductivity ranges from 103 to 1152  $\mu$ S/cm. Enrichment of salt in groundwater is the major factor behind high EC. Rutu Park area showed high EC due to highly alkaline ground water in the area. This highly alkaline nature is due to effluents from household wastes that directly enter into artificial rills. Furthermore, the effects of saline intrusion in a freshwater aquifer (in the zone surrounding Thane creek), variation in groundwater level/presence of clay and shales also contributes to high EC. The total amount of calcium and magnesium ions concentration in groundwater describes as its total hardness. The TH for the samples ranged from 32 to 372 mg/l. Hardness is found to be higher at Chitalsar. Various minerals like microcline, hornblende, muscovite, silicate, orthoclase, and biotite in igneous and metamorphic rocks are the major sources of K<sup>+</sup> ions in groundwater. It has found that Rutu Park (32) and Vasant Vihar (48) showed a very less TH due to less TDS. Calcium is an important constituent in determining the hardness of underground water. The Ca<sup>2+</sup> concentration ranged between 12 and 248 mg/l. High calcium level recorded at Chitalsar (248 mg/l). Kolshet (64 mg/l) showed lesser Ca<sup>2+</sup> ions as compared to other areas. This may be due to low TH. Magnesium is an important constituent of basalt and its water dissolving capacity is five times more than that of calcium. The hardness of the water depends on the presence of Mg<sup>2+</sup> and Ca<sup>2+</sup> ions and these occur as bicarbonates in the form of sulphate and chloride. Mg<sup>2+</sup> ions fluctuate from 16 to 124 mg/l. Potassium is mainly found in rocks/soils and occur naturally in local groundwater or from manmade sources. K<sup>+</sup> ions in the samples range from 0.2 to 5.0 mg/l. Lowest K<sup>+</sup> ions (0.2 mg/l) is found at Dongripada. K<sup>+</sup> ions occur naturally in groundwater or can arise from construction sites and household wastes. Chloride is an anion having negatively charged species and its presence affects the quality of groundwater. Cl<sup>-</sup> content in the samples fluctuated from 58.44 to 204.54 mg/l. The lowest Cl<sup>-</sup> ions (58.44 mg/l) observed in Uthalsar, Vasant Vihar and Dongripada. Highest concentration of Cl<sup>-</sup> ions is found in Rutu Park which indicated that groundwater in this region is highly polluted. Li<sup>+</sup> ions in groundwater depend on major factors like geology, topology, and hydrology. Li<sup>+</sup> values are varied between 0.0 to 0.2 mg/l. There is no health-based guideline for Li<sup>+</sup> ions. The results

also can be compared with IS 10500: 2012 as provided in Table 4.12 below. As per the comparison, it is found that the pH level is slightly higher at Rutu park than desirable/ permissible limit. Total hardness is also more than the desirable limits but within the permissible limit of 600 mg/l at 4 locations (location 1, 4, 5 & 7) indicating water is hard. Value of calcium ions is also higher than desirable limit of 75 mg/l but within permissible limit of 200 mg/l at all the above locations except at Chatisar where value is 248 mg/l. Value of magnesium ions is higher than desirable limit of 30 mg/l but within permissible limit of 100 mg/l at all the above locations except at Chatisar where value is 124 mg/l and Mumbra where value is 108 mg/l. Value of chloride ion is within the desirable limit of 250 mg/l at all the locations.

**Table 4.12 : Drinking Water Quality Standards**

S.No	Parameter	Unit	Limit (IS-10500:2012)	
			Desirable	Permissible
1	Temperature (°C)	(°C)	-	-
2	pH	-	6.5-8.5	No Relaxation
4	TDS	mg/l	500	2000
5	TSS	Mg/l	-	-
6	Dissolved Oxygen	mg/l		
7	Alkalinity as (CaCO <sub>3</sub> )	mg/l	200	600
8	Total Hardness (as CaCO <sub>3</sub> )	mg/l	200	600
9	BOD (at 27°C 3-Days)	mg/l	-	-
10	COD	mg/l	-	-
11	Nitrate (as NO <sub>3</sub> )	mg/l	45	No Relaxation
12	Chloride (as Cl)	mg/l	250	1000
13	Phosphates	mg/l	-	-
14	Sulphate (as SO <sub>4</sub> )	mg/l	200	400
15	Sodium (as Na)	mg/l	-	-
16	Potassium (as K)	mg/l	-	-
17	Calcium (as CaCO <sub>3</sub> )	mg/l	75	200
18	Magnesium (as CaCO <sub>3</sub> )	mg/l	30	100
19	Silica	mg/l	-	-
20	Oil & Grease	mg/l	-	-
21	Residual Sodium Carbonate	mg/l	-	-
22	Lead (as Pb)	mg/l	0.01	No Relaxation
23	Arsenic (as As)	mg/l	0.01	0.05
24	Mercury (as Hg)	mg/l	0.001	No Relaxation
25	Cadmium (as Cd)	mg/l	0.003	No Relaxation
26	Chromium (as Cr6+)	mg/l	0.05	No Relaxation
27	Total Chromium (as Cr6+)	mg/l	0.05	No Relaxation
28	Copper (as Cu)	mg/l	0.05	1.5
29	Zinc (as Zn)	mg/l	5	15
30	Iron (as Fe)	mg/l	0.3	1
31	Fluoride	mg/l	1	1.5
32	Nitrite	mg/l	-	-
<b>Bacteriological Parameter</b>				

1	Total Coliform	MPN/100ml	Absent	-
2	E.coli	E.coli /100ml	Absent	-

#### 4.4.13. Drinking water Quality

192. Water being used for drinking purpose in the project has also been monitored at 5 locations in project area and is presented in **Table 4.13**. Water quality of all the samples is well within the prescribed limit of IS 10500: 2012

**Table 4.13 : Drinking Water Quality in project Area (Oct 2022)**

S. No	Parameters	Unit	Balkum Metro Station (R.O Water) -1	Anjurphat a Metro Station(R. O Water)- 2	Dhamank ar Naka(R.O Water) -3	Casting Yard Dapode (Ro.Water)-4	Koper Metro Station Near Kalher-5
1	pH value	-	7.37	6.62	6.64	6.58	7.25
2	Color	Haze n	<5	<5	<5	<5	<5
3	Turbidity	NTU	<1	<1	<1	<1	<1
4	Total Dissolved Solids	mg/l	70	36	84	41	62
5	Total Alkalinity as CaCO <sub>3</sub>	mg/l	30	15	28	16	18
6	Total Hardness (as CaCO <sub>3</sub> )	mg/l	56	38	42	28	48
7	Calcium (as Ca)	mg/l	11	5	9	4	10
8	Magnesium (as Mg <sup>2+</sup> )	mg/l	6.9	6.2	4.7	4.4	5.6
9	Chlorides (as Cl)	mg/l	19	8	25	11	20
10	Fluoride (as F )	mg/l	0.08	0.05	0.1	0.4	0.4
11	Sulphate (as SO <sub>4</sub> )	mg/l	2	3	5	2	4
12	Iron (as Fe)	mg/l	0.03	0.01	0.03	0.02	0.09
13	Nitrate(as NO <sub>3</sub> )	mg/l	1.9	1.1	2.1	1.6	2.3
14	Copper (as Cu)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
15	Boron (as B)	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1
16	Manganese(as Mn)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
17	Phenolic Compounds (as C <sub>6</sub> H <sub>5</sub> OH)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
18	Sulphide (as H <sub>2</sub> S)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
19	Zinc (as Zn)	mg/l	0.06	0.02	0.09	0.04	0.08
20	Cadmium (as Cd)	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003
21	Cyanide (as CN )	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
22	Lead (as Pb)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
23	Mercury (as Hg)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
24	Total Arsenic (as As)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
25	Total Chromium (as Cr)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
26	Total Coliform	per 100ml	Absent	Absent	Absent	Absent	Absent
27	E.Coli	E.coli/ 100ml	Absent	Absent	Absent	Absent	Absent

#### 4.4.14. Traffic Data

193. MMRDA has conducted detailed study to understand the traffic volume of the roads in project area. Traffic data assessment is carried out for Thane Bhiwandi Road at Station crossing location and the data is presented in **Table 4.14**.

**Table 4.14 : Daily Traffic Count Survey (Thane to Bhiwandi)**

Location	Car/Jeep / Pvt Van/Taxi	Bus	LMV	LCV	2 & 3 Axle	MAV	Other commercial vehicles	2 wheelers	NMT
Balkum Station	14775	1247	677	2720	1650	107	14293	19429	119
Dhokali Rd Junction	18888	7544	819	9940	18979	766	22587	9634	67
Anjur Phata Road	2542	55	2441	4478	5989	1225	2654	20185	43
Pipeline Road	1082	19	356	775	522	0	1161	3732	34
Kalher Station	8209	443	700	5196	5393	250	10989	20117	94
Purna Station	8343	779	702	5199	5926	250	10746	20135	94

#### 4.5. Biological Environment

194. An ecological study is essential to understand the impact due to project development activities on flora and fauna of the area. The project site is located in city area and no wildlife is envisaged. Ecological studies are one of the important aspects of Environmental Impact Assessment with a view to conserve environmental quality and biodiversity. Ecological systems show complex inter- relationships between biotic and abiotic components including dependence, competition and mutualism. Biotic components comprise of both plant and animal communities, which interact not only within and between themselves but also with the abiotic components viz. physical and chemical components of the environment. To achieve the above objectives a detailed study of the project corridors was undertaken between 500 m and 10 Km of the project boundary. The data pertaining to flora and fauna have been collected based on discussions with concerned forest department officials, local people, published literature, NGOs etc. supported by physical verifications, wherever feasible.

195. **Methodology:** The baseline study for existing ecological environment was carried out for single season. Field sampling efforts covered the proposed project site and its area of influence. One season field survey was conducted for vegetation, and wildlife. In addition, public consultations were also held in the communities around the site. A phased and consultative approach was followed to carry out ecological assessment. Successive phases of the assessment include (i) Secondary data collection through desktop review of available literature and (ii) Onsite data collection for determining vegetation and wildlife in the study area & Reconnaissance survey (iii) Public consultation.

196. **Secondary Data Collection:** An extensive desktop review of available published literature (books, websites, scientific papers, articles etc.) was conducted. The Forest Working Plans of Forest Divisions was also referred for secondary information. Additional information was sourced from the project proponent, governmental institutions and local residents of the survey-area. Literature was sourced from the govt. source like Forest department, MOEF&CC, IUCN and other related departments. Additional data sources include published articles in journals, gazettes, and technical reports, maps, internet, amongst others. The secondary data was appropriately supplemented by a field survey for primary data collection.

197. **Primary Data Collection & Reconnaissance survey:** A rapid field survey was also made to understand the habitat and threatened species existing in the 10 km radius area. The survey was conducted to assess the existing biodiversity and suitable habitat. Interviews were also conducted with the local villagers on the local biodiversity and the important wildlife of the area. Ground surveys were carried out by trekking the study area for identification of important flora and animal groups such as birds, mammals, reptiles, and amphibians and marine flora and fauna

inhabiting the area, along the agriculture fields, creeks, sea, adjoining vegetation areas on the slopes and nallahs. Type of flora and fauna was noted during the transect walk. The various groups of faunal species including mammal, bird, reptile, and amphibian were surveyed using standard methods in all the habitats. Status of floral species was assessed in the representative habitats around the project site. Sampling was done for Phytoplankton, zooplanktons and benthic organism.

198. **Public consultation:** Beside above local people were also consulted during the site survey. Literature review and gathering publicly available data: The literature review encompassed background information on the Flora and fauna of the area including recent environmental studies

199. **Terrestrial Ecology of project site:** Project site lies in the urban and city area and the flora comprise of the planted trees and shrubs. Planted species of trees includes *Pongamia pinnata* and *Azadirachta indica*. Other tree species include *Terminalia catappa*, *Samanea saman*, *Peltophorum pterocarpum*, *Parkia biglandulosa*, *Ficus racemose*, *Cassia Siamea*, *Mangifera indica*, *Leucaena leucocephala*, *Acacia auriculiformis*, *Delonix regia*, *Moringa pubescent*, *Plyalthis longifolia*, *Trema orientalis*, *Ziziphus mauritiana*, *Cocos nucifera*, *Roystonea regia*, *Syzygium cuminii*, *Ficus religiosa*, *Emblica officinalis*, *Salix tetrasperma*, *Mimusops elengi*, *Alstonia scholaris*, *Khaya senegalensis*, *Swetinia macrophylla*, *Ficus bengalensis*, *Holoptela integrifolia*, *Ficus racemose*, *Pithecellobium dulce* etc. No wildlife is found in the project area due to urban land use. Total 708 trees fall within the alignment out of which 495 will be transplanted, 166 will be cut, and 47 will be trimmed. A site at kasheli is identified for development of depot. Approx 50-60 trees exist at depot site which may need to be removed from the site

200. **Terrestrial Fauna at project site:** The proposed alignment is passing through the urban area and being an urban settlement no major wildlife reported from the proposed site except few avifaunal species.

201. **Aquatic Ecology of project site:** Project alignment traverse through Ulhas River. Biodiversity of Ulhas river is presented below

202. **Phytoplankton:** *Rhizosolenia* species & *Skeletonema* species are the most common phytoplankton observed in Ulhas River. Other species found in the river are: *Rhizosoleniasps*, *Skeletonemasps*, *Pleurosigmasps*, *Fragillariasps*, *Ceratulina pelagic*, *Biddulphiasps*, *Coscinodiscus excentricus*, *Licmophorasps*, *Haplophaera Viridis*.

203. **Zooplankton:** The main type of zooplankton species found in the Ulhas River are *Calanus* spp., *Eucalanus elongates*, *Pseudocalanus elongates*, *Phialidium*, *Candacia* spp., Comb jelly, *Hemimysis*, *Shrimps*, *Sirellasps.*, *Oithionasps.*, *Nereissps*, *Sagitta*, *Zoea*, and Other larval forms.

204. **Vegetation in Study Area (10 Km area):** The study area (10 km area) covers the maximum part of coastal area, urban settlement area. Part of the study area is a natural forest area (Sanjay Gandhi National Park).

205. **Vegetation Type in Urban Areas/stretches:** The vegetation in the urban areas is off commonly found tree species which are either planted by the municipality along the roadside. General vegetation in this part of the study area (urban) are *Pongamia pinnata*, *Acacia arabica*, *Albizia lebbek* and *Azadirachta indica*. Other tree species include *Terminalia catappa*, *Samanea saman*, *Peltophorum pterocarpum*, *Parkia biglandulosa*, *Ficus racemose*, *Cassia Siamea*, *Mangifera indica*, *Leucaena leucocephala*, *Acacia auriculiformis*, *Delonix regia*, *Moringa pubescent*, *Plyalthis longifolia*, *Trema orientalis*, *Ziziphus mauritiana*, *Cocos nucifera*, *Roystonea regia*, *Syzygium cuminii*, *Ficus religiosa*, *Emblica officinalis*, *Salix tetrasperma*, *Mimusops elengi*, *Alstonia scholaris*, *Khaya senegalensis*, *Swetinia macrophylla*, *Ficus bengalensis*, *Holoptela integrifolia*, *Ficus racemose*, *Pithecellobium dulce* etc. The list of the Floral species reported from

the study area is presented in Table 4.15

**Table 4.15 :List of Flora in Study Area**

Sl. No.	Common Name	Scientific Name	Family
1	Ain	<i>Terminalia tomentosa</i>	Combretaceae
2	Alu	<i>Meyna laxiflora</i>	Rubiaceae
3	Ashi	<i>Morinda tinctoria</i>	Rubiaceae
4	Amba	<i>Mangifera indica</i>	Anacrdiaceae
5	Amati (Wavding)	<i>Embelica robusta</i>	Primulaceae
6	Apta	<i>Bauhinia racemosa</i>	Fabaceae
7	Asana	<i>Bridelia retusa</i>	Phyllanthaceae
8	Arjunsadada	<i>Terminalia arjuna</i>	Combretaceae
9	Athroon (Kakar-Bhekal)	<i>Flacourtiera montchi</i>	Salicaceae
10	Avali	<i>Emblica officinalis</i>	Phyllanthaceae
11	Babul	<i>Acacia Arabica</i>	Fabaceae
12	Bel	<i>Aegle marmelos</i>	Rutaceae
13	Bakula	<i>Mimusops elengi</i>	Sapotaceae
14	Bava (Bhava)	<i>Cassia fistula</i>	Fabaceae
15	Beheda	<i>Terminalia belerica</i>	Combretaceae
16	Bhendi	<i>Thespesia populnea</i>	Malvaceae
17	Bhokar (Shelute)	<i>Cordia dichotoma</i>	Boraginaceae
18	Bhutkesh (Lawsat)	<i>Mussaenda frondosa</i>	Rubiaceae
19	Bhitia (Alan)	<i>Elaeodendron glaucum</i>	Celastraceae
20	Bibla	<i>Pterocarpus marsupium</i>	Fabaceae
21	Bondara	<i>Lagerstroemia parviflora</i>	Lythraceae
22	Bor	<i>Ziziphus jujube</i>	Rhamnaceae
23	Chambuli	<i>Bauhinia vahlii</i>	Fabaceae
24	Chinch	<i>Tamarindus indica</i>	Fabaceae
25	Dandoshi	<i>Dalbergia lanceolaria</i>	Fabaceae
26	Daiwas (Dahivel)	<i>Cordia macleodii</i>	Boraginaceae
27	Datir	<i>Ficus heterophylla</i>	Moraceae
28	Dhaman	<i>Grewia tiliaefolia</i>	Malvaceae
29	Dhavada	<i>Anogeissus latifolia</i>	Combretaceae
30	Gol	<i>Trema orientalis</i>	Cannabaceae
31	Hed	<i>Adina cordifolia</i>	Rubiaceae
32	Hirda	<i>Terminalia chebula</i>	Combretaceae
33	Humb	<i>Saccopetalum tomentosum</i>	Annonaceae
34	Jambul	<i>Syzygium cuminii</i>	Myrtaceae
35	Kalamb	<i>Stephegyne parvifolia</i>	Rubiaceae
36	Kadvai	<i>Hymenodictyon orixense</i>	Rubiaceae
37	Katekumbhal	<i>Sideroxylon tomentosum</i>	Sapotaceae
38	Kavath	<i>limonia acidissima</i>	Rutaceae
39	Khair	<i>Acacia catechu</i>	Fabaceae
40	Khavas	<i>Sterculia colorata</i>	Malvaceae
41	Kinhai	<i>Albizzia procera</i>	Fabaceae
42	Kirmira	<i>Casearia tomentosa</i>	Salicaceae
43	Semal	<i>Bombax malabaricum</i>	Malvaceae
44	Kakkad	<i>Garuga pinnata</i>	Burseraceae
45	Shemat	<i>Lannea grandis</i>	Anacardiaceae
46	Ranjana	<i>Mimusops hexandra</i>	Sapotaceae
<b>Shrubs</b>			
1	Adulsa	<i>Adhatoda zeylanica</i>	Acanthaceae
2	Dhaiti	<i>Woodfordia floribunda</i>	Lythraceae

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3	Ghaneri	<i>Lantana camara</i>	Verbenaceae
4	Ghaypat	<i>Agave Americana</i>	Asparagaceae
5	Gultata	<i>Lantana alba</i>	Verbenaceae
6	Kaladhotra	<i>Datura fastuosa</i>	Solanaceae
7	Karvandi	<i>Carrissa carandas</i>	Apocynaceae
<b>Herbs</b>			
1	Anantmul (Upalasar)	<i>Hemidesmus indicus</i>	Asclepiadaceae
2	Bhigguli	<i>Indigofera enneaphylla</i>	Fabaceae
3	Burada	<i>Blumea lacera</i>	Asteraceae
4	Chikata	<i>Desmodium palchellum</i>	Fabaceae
5	Dinda	<i>Leea macrophylla</i>	Vitaceae
6	Litchi (Van-bhendi)	<i>Urena lobata</i>	Malvaceae
7	Papadi	<i>Pavetta tomentosa</i>	Rubiaceae
8	Rankel	<i>Musa superb</i>	Musaceae
9	Ranhalad or sholi	<i>Curcuma aromatic</i>	Zingiberaceae
10	Rankanda	<i>Scilla indica</i>	Liliaceae
11	Sarpmukha	<i>Tephrosia purpurea</i>	Fabaceae
12	Sonki	<i>Senecio graham</i>	Asteraceae
13	Tarota or Takala	<i>Cassia tora</i>	Fabaceae
<b>Climbers</b>			
1	Alai/Alsi	<i>Dalbergia volubilis</i>	Fabaceae
2	Bhuikohala	<i>Ipomoea mauritiana</i>	Convolvulaceae
3	Chilhari	<i>Caesalpinia sepiaria</i>	Fabaceae
4	Gunj	<i>Abrus precatorius</i>	Fabaceae
5	Gulvel (Amarvel)	<i>Tinospora cordifolia</i>	Menispermaceae
6	Kanguni	<i>Celastrus paniculata</i>	Celastraceae
7	Kantjaruel	<i>Capparis sepiara</i>	Capparaceae
8	Kuhili	<i>Mucuna pruriens</i>	Fabaceae
9	Ukshi	<i>Calycopteris floribunda</i>	Combretaceae
10	Valbiwala	<i>Milletia recemosa</i>	Fabaceae
<b>Bamboos &amp; Grasses</b>			
1	Manvel	<i>Dendrocalamus strictus</i>	Poaceae
2	Padhai or katas	<i>Bambusa arundianacea</i>	Poaceae
3	Ber	<i>Ischaemum rugosum</i>	Poaceae
4	BhaleKusal	<i>Heteropogon triticus</i>	Poaceae
5	Bhuri	<i>Aristida paniculata</i>	Poaceae
6	Boru	<i>Andropogon sps.</i>	Poaceae
7	Chirika	<i>Eragrostis tremula</i>	Poaceae
8	Ghanya	<i>Bothriochloa pertusa</i>	Poaceae
9	Gondvel	<i>Andropogon pumilis</i>	Poaceae
10	Harali (Durva)	<i>Cynodon dactylon</i>	Poaceae
11	Kunda	<i>Ischaemum pilosum</i>	Poaceae

206. **Mangroves:** Mangrove forests are important ecosystems because they support a diverse community, minimize coastal erosion, and act as sinks for macronutrients, micronutrients, and heavy metals. They look after their young and create some of the most important biomes (Odum 1971). Mangroves can be found in abundance in estuary areas with vast, gently sloping mudflats. They also live in the intertidal zones of shallow bays and creeks, where the environment is favorable for their development. The mangrove plants absorb nutrients from tidal seawater and river water, providing natural nourishment for the species that lives in the mangroves (Odum et al., 1982). The main species of mangroves found are *Avicennia marina* and *Sonneratia apetela*. Proposed project affects 0.6983 ha forest land which constitute of 0.3771 ha Reserve Forest land and 0.3212 ha unnotified Mangrove Forest land at Kasheli, Taluka. Mangrove exists along the small stream at Chainage 4600-4700. The area of Mangroves and the creek falls under CRZ as



per CRZ Notification, 2011 and the CRZ clearance will be required for the project.

207. Other associate mangrove species present in the study area are *Salvadora persica*, *Derris heterophylla*, *Sesuvium portulacastrum* etc. They are present towards the landward side. Some of these species such as *Derris heterophylla* grows as epiphytes on the *Sonneratia 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

208. 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.

209. 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.

210. **Terrestrial Fauna in Study Area (10 km radius):** The study area (10 km area) is located on the western coast near Sanjay Gandhi national park area, which forms part of the Thane Forest Division. The wildlife population in the Thane Forest Division is dwindling due to increased biotic pressure on their habitat. However due to presence of the Sanjay Ghandi National Park which is famous for its avifaunal diversity. The details of terrestrial fauna present within the study area is describes in following heads:

211. **Mammal:** A total of 7 species of mammal were reported in the urban stretch of study area. As per Indian Wildlife (Protection) Act, 1972 (Amendment 2002) none of mammal species belongs to schedule -I species. List of mammals reported in the study area is presented in Table 4.16.

**Table 4.16 :List of Fauna in Study Area (Other than forests & protected areas)**

S. No.	Species Name	Common Name	IWPA, 1972	IUCN, 2016
1	<i>Sus scrota</i>	Bhund/ Wild Pig	Sch-III	LR-lc
2	<i>Vulpus bengalensis</i>	Lonkadi / Fox	Sch-III	LR-lc
3	<i>Felis chaus-</i>	Jungli biladi / Jungle cat	Sch-II	LR-nt
4	<i>Herpestes edwardsii</i>	Noriyo / Mongoose	Sch-IV	LR-lc
5	<i>Hystrix indica</i>	Sahi / Porcupine	Sch-IV	LR-lc
6	<i>Funambulus pennantii</i>	Khiskholi / Five striped Palm Squirrel	Sch-IV	LR-lc
7	<i>Rattus rattus</i>	Undir / Common Indian Rat	Sch-V	LR-lc

Source: Primary and secondary observations

Sch: Schedule, LR Lc: Lower Risk Least Concern, LRnt: Lower Risk Near Threatened

212. **Herpetofauna:** The list of herpetofauna includes 13 species of amphibians and reptiles which are commonly found in the study area (refer Table 4.17). The all-recorded species are categorized as Lower Risk Least Concerned species of IUCN.

**Table 4.17 Herpetofauna species Recorded in 10 km study area**

Sl. No	Species Name	Common name	IWPA, 1972	IUCN, 2016
1	<i>Bufo melanostictus</i>	Common Indian Toad	Sch-IV	Low Risk, Least Concern
2	<i>Euphlyctis cyanophlyctis</i>	Skittering Frog	Sch-IV	Low Risk, Least Concern
3	<i>Tomoptera breviceps</i>	Indian Burrowing Frog	Sch-IV	Low Risk, Least Concern
4	<i>Hemidactylus brookii</i>	Spotted Indian House Gecko	Sch-IV	Low Risk, Least Concern
5	<i>Hemidactylus leschenaultii</i>	Bark Gecko	Sch-IV	Low Risk, Least Concern
6	<i>Calotes versicolor</i>	Indian Garden Lizard	Sch-IV	Low Risk, Least Concern
8	<i>Varanus bengalensis</i>	Monitor lizard	Sch-II	Low Risk, Least Concern
9	<i>Coelognathus helena</i>	Indian Trinket Snake	Sch-IV	Low Risk, Least Concern
10	<i>Ptyas mucosa</i>	Oriental Rat Snake	Sch-IV	Low Risk, Least Concern
11	<i>Xenochrophis piscator</i>	Checked Keelback Snake	Sch-IV	Low Risk, Least Concern
12	<i>Naja naja</i>	Indian Cobra	Sch-IV	Low Risk, Least Concern
13	<i>Daboia russellia</i>	Russel viper	Sch-IV	Low Risk, Least Concern

213. **Avifauna:** Due to presence of water bodies and Sanjay Gandhi national park there is huge diversity of avifaunal species in the study area specially in Sanjay Gandhi national park. As per the secondary sources the park contains approximately 286 species of birds. Bird survey was conducted on the same transects survey. However during study period about 58 species of avifauna was observed (Table 4.18).

**Table 4.18 List of avifauna Recorded in 10 km study area**

Sr. No.	Species	Scientific Name	IUCN, 2016	IWPA, 1972
1	Common Kingfisher	<i>Alcedo atthis</i>	LR1c	Sch-IV
2	House Swift	<i>Apus affinis</i>	LR1c	Sch-IV
3	Chestnut-bellied Sandgrouse	<i>Pterocles exustus</i>	LR1c	Sch-IV
4	Spotted Sandgrouse	<i>Pterocles senegal/us</i>	LR1c	Sch-IV
5	Red-wattled Lapwing	<i>Vanellus indicus</i>	LR1c	Sch-IV
6	Yellow-wattled Lapwing	<i>Vanellus malarbaricus</i>	LR1c	Sch-IV
7	Indian Courser	<i>Cursorius coromandelicus</i>	LR1c	Seh-IV
8	Blue Rock Pigeon	<i>Columba livia</i>	LR1c	Sch-IV
9	Little Grebe	<i>Tachybaptus ruficollis</i>	LR1c	Sch-IV
10	Little Cormorant	<i>Phalacrocorax niger</i>	LR1c	Sch-IV
11	Little Brown Dove	<i>Streptopelia sene.qalensis</i>	LR1c	Sch-IV
12	Red Collared Dove	<i>Streptopelia tranquebarica</i>	LR1c	Sch-IV
13	Eurasian Collared Dove	<i>Streptopelia decaocto</i>	LR1e	Sch-IV
14	Indian Roller	<i>Coracias benghalensis</i>	LR1c	Sch-IV
15	Small Green Bee-eater	<i>Merops orientalis</i>	LR1c	Sch-IV
16	Asian Koel	<i>Eudynamys sc%pacea</i>	LR1c	Sch-IV
17	Greater Coucal	<i>Centropus sinensis</i>	LR1c	Sch-IV

18	Grey Francolin	<i>Fran colinus pondicerianus</i>	LRlc	Sch-IV
19	Pariah Kite	<i>Milvus niigrans</i>		
20	Rosy Starling	<i>Sturnus roseus</i>	LRlc	Sch-IV
21	Common Myna	<i>Acridotheres tristis</i>	LRlc	Sch-IV
22	Bank Myna	<i>Acridotheres ginginianus</i>	LRlc	Sch-IV
23	Red Vented Bulbul	<i>Pycnonotus cafer</i>	LRlc	Sch-IV
24	White-eared Bulbul	<i>Pycnonotus leucotis</i>	LRlc	Sch-IV
25	Ashy Prinia	<i>Prinia socialis</i>	LRlc	Sch-IV
26	Plain Prinia	<i>Prinia inornata</i>	LRlc	Sch-IV
27	Grey-breasted Prinia	<i>Prinia hodgsonii</i>	LRlc	Sch-IV
28	Jungle Prinia	<i>Prinia sylvatica</i>	LRlc	Sch-IV
29	Rufous-fronted Prinia	<i>Prinia buchanani</i>	LRlc	Sch-IV
30	Graceful Prinia	<i>Prinia gracilis</i>	LRlc	Sch-IV
31	Zitting Cisticola	<i>Cisticola juncidis</i>	LRlc	Sch-IV
32	Common Tailorbird	<i>Orthotomus sutorius</i>	LRlc	Sch-IV
33	Jungle Babbler	<i>Turdoides striatus</i>	LRlc	Sch-IV
34	Common Babbler	<i>Turdoides caudates</i>	LRlc	Sch-IV
35	Singing Bushlark	<i>Mirafra cantillans</i>	LRlc	Sch-IV
36	Ashy-crowned Sparrow Lark	<i>Eremopterix grisea</i>	LRlc	Sch-IV
37	Sykes's Lark	<i>Galerida deva</i>	LRlc	Sch-IV
38	Indian Short-Toed Lark, Sand Lark	<i>Calandrella ray tal</i>	LRlc	Sch-IV
39	Crested Lark	<i>Galerida cristata</i>	LRlc	Sch-IV
40	Purple Sunbird	<i>Nectarinia asiatica</i>	LRlc	Sch-IV
41	House Sparrow	<i>Passer domesticus</i>	LRlc	Sch-IV
42	Tawny Pipit	<i>Anthus campestris</i>	LRlc	Sch-IV
43	Paddy field Pipit	<i>Anthus rufulus</i>	LRlc	Sch-IV
44	Baya Weaver	<i>Ploceus philippinus</i>	LRlc	Sch-IV
45	Indian Silver bill	<i>Lonchura malabarica</i>	LRlc	Sch-IV
46	Rose-ringed Parakeet	<i>Psittacula krameri</i>	LRlc	Sch-IV
47	Common Hoopoe	<i>Upupaepops</i>	LRlc	Sch-IV
48	Lesser Whistling-duck	<i>Edndrocygna javanica</i>	LRlc	Sch-IV
49	Comb Duck	<i>Sarkidiornis sylvicola</i>	LRlc	Sch-IV
50	Black-winged Stilt	<i>Himantopus himantopus</i>	LRlc	Sch-IV
51	Little Ringed Plover	<i>Charadrius dubius</i>	LRlc	Sch-IV
52	Cattle Egret	<i>Bubulcus ibis</i>	LRlc	Sch-IV
53	Little Egret	<i>Egretta garzetta</i>	LRlc	Sch-IV
54	Indian Pond Heron	<i>Ardeola wayii</i>	LRlc	Sch-IV
55	Indian Pond Heron	<i>Ardeola wayii</i>	LRlc	Sch-IV
56	Black Ibis	<i>Pseudibis papil/osa</i>	LRlc	Sch-IV
57	Eurasian Spoonbill	<i>Plata lea leucorodia</i>	LRlc	Sch-IV
58	Woolly-necked Stork	<i>Oconia episcopus</i>	LRlc	Sch-IV
59	Greater Falimingo	<i>Phoenicopterus roseus</i>	LRlc	Sch-IV

Source: Primary and secondary observations (Sch: Schedule, LR Lc: Lower Risk Least Concern)

214. **Notified Ecologically Important Areas within 10 km radius:** Sanjay Gandhi National park (3.4 km) and Thane Creek Flamingo Sanctuary (Approx. 5.2 Km, S). However due to large distance from core & ESZ of these zones and confinement of project activities to RoW, there will be no impact on flora & fauna of these zones.

215. **Bio-diversity of Sanjay Gandhi National Park:** Sanjay Gandhi National Park (SGNP) is at approx. 3.4 km from the proposed alignment. Eco-sensitive zone for the SGNP has been notified vide notification S.O.3645(E) dated 05.12.2016. The ESZ varies between 100 m to 4.0 km from the SGNP boundary. Project alignment does not fall within the Protected area or ESZ

of the SGNP and thus does not impact SGNP and its flora or fauna. Map Showing SGNP and the project alignment is given in **Figure 4.9**. There are about 134 trees species, which make up the basis for four major forest types. These are 3B/C1 southern moist teak bearing forest, 3B/C2 southern moist mixed deciduous forest, 4B/TS1 mangrove scrub and 8A/C2 western sub-tropical hill forest. The southern moist mixed deciduous forest is the most prominent in the National Park and covers majority of the area. The forest type 4B/TS1 mangrove scrub is found around Bassein Creek and covers approximately 23 per cent of the National Park, which equals about 2,000 hectares. Mangrove scrub is amongst other reasons, rare and therefore it is vital to preserve this habitat. Having this forest type in the park also increases the faunal diversity significantly, as well as the floral diversity. This area provides a habitat to many species that are found nowhere else in the park. Forest types in SGNP are as provided in **Table 4.15**.

216. The total area of the National Park today is 103.09 km<sup>2</sup> and Mumbai (the second largest metropolis in the world) is the only city that encompasses a National Park. The two lakes that the National Park jealously protects, Vihar and Tulsi are recharged by rainfall. These two lakes have a high hydrological importance as they supply water to Mumbai. The park contains approximately 286 species of birds and a quarter of all bird species found in India are found in the park. The park is home to around 150 butterfly species and it is estimated that there are four times as many moth species found in the park. The dominant vegetation comprising of *Mangifera indica*, *Saraca indica*, *Cassia fistula*, *Delonix regia*, *Peltophorum pterocarpum*, *Borassus flabellifer*, *Madhuca indica* etc

217. SGNP's biodiversity is greatly influenced by elements of the Sahyadri Hills to the east, and over the years, the changes brought about by human impact. The most dominating habitat-type here is the Forest habitat. Of flowering plants alone, an estimated 1300 species exist in SGNP. Much of the forest here conforms to the southern mixed-deciduous forest, dominated by the *Tectona*, *Albizia*, *Terminalia*, *Holarrhena*, *Firmiana*, *Dalbergia*, *Garuga*, *Grewia*, *Adina*, *Ficus*, *Madhuca*, *Caraya*, *Butea* and bamboo compositions. This is most evident in the lowlands and up along the hill slopes.

218. On the upper slopes and in some of the secluded, narrow valleys and stream-beds, there are elements of semi-evergreen, and also some evergreen flora. Bamboo is quite widespread, especially in the lower areas, and the teak – bamboo forest community with its characteristic bird-life and general make-up is easily evident. The Karvi (*Strobilanthes*) is a widespread shrub that constitutes the undergrowth of vast stretches of the forest here; this abundant shrub, while visible all through, even as dry stalks during summer, is most flamboyant when it blooms once after every seven years.

219. Fauna found in SGNP includes spotted Deer, Sambhar, darting Barking Deer, Black-naped Hare, Leopard, Porcupine, Palm civet, striped Hyena, Four-horned Antelope, Mouse Deer, Rhesus Macaque, Bonnet Macaque and Hanuman langur (leaf monkey). The Indian flying fox is the biggest of the 17 bat species found in the park. Other mammals include *Suncus murinus*, *Rousettus leschenaultia*, *Taphozous saccolaimus*, *Rhinolophus rouxii*, *Viverricula indica*, *Lepus nigricollis* and *Funambulus palmarum*.

220. The reptiles include Crocodiles in Tulsi Lake, Monitor Lizards, Pythons, Cobras, Russell's viper, Bamboo-pit Viper and Ceylonese Cat Snake. Spiders like, Giant wood spiders, Signature spiders, Black wood spider etc., exists in project area. The insect includes Silk cotton bugs, Beetles and several kinds of Mantis. The Butterfly includes Blue Mormon, Blue Oak leaf, the bright Jezebels and Large Yellow and White Orange tips, Monarchs, Egg fly, Sailors etc. Amphibians like tree frogs, the bullfrog, common toad and the Jerdon's Narrow-mouthed frog (*Ramanella montana*) have been recorded in the area

221. The avifauna of this area is an attractive wildlife feature. Over 250 bird species, both resident & migrant, belonging to 18 different orders and 47 families have been recorded here.

Migratory ducks, such as, common teal (*Anas crecca*) and the red crested pochard (*Rhodonessa Rufina*) are seen in small numbers in Vihar and Tulsi lakes. Mangrove swamps attract a variety of plovers, sandpipers, gulls and terns. The rose-ringed parakeet (*Psittacula krameri*) and the blossom headed parakeet (*Psittacula roseata*). Mangroves, present in the Park, help in breeding of crustaceans, comprising of barnacles *Balanus* sp., crabs, lobsters, prawns and shrimps, of which crabs are most dominant. Five species of crabs, viz. swimming crabs (*Scylla serrata*, *Varuna litterata*), fiddler crab (*Uca rosea*, *U. vocans*) and *Sesarma* sp. are most common.

222. Aquatic ecology of SGNP: During the monsoons, when deep-sea fishing is suspended, many sea fishes migrate to the shore. Within the park, 25 species of marine fishes exist like *Hilsa ilisha*, *Therapon jarbua*, *Mugil cephalus*, *Harpodon nehereus*, *Scatophagus argus*, *Eleutheronema tetradactylum* etc. Among the marine annelids, two species of Earthworms (*Lumbricidae*) are commonly found. The Molluscs are represented from the orders gastropoda, bivalvia and pulmonata. The common species are *Telescopium telescopium*, *Nerita crepidularia*, *Potamides cingulatus*.

223. Threatened bio-diversity of SGNP: Vegetation species classified as threatened and found in SGNP includes Sita ashok, Kokam and White orchids. Nearly 75 ha patch of *Saraca ashoka*; popularly known as 'Ashok Van' exist near Kanheri caves. Kokam (*Garcinia indica*) is an evergreen species seen mostly at the highest point area. Fruits, having medicinal value for use as antidote of stomach upset, are also preferred by monkeys, langurs and some birds. Two species of white orchids (*Platanthera* sp. and *Habenaria* sp) are found at the highest peak in the month of September.

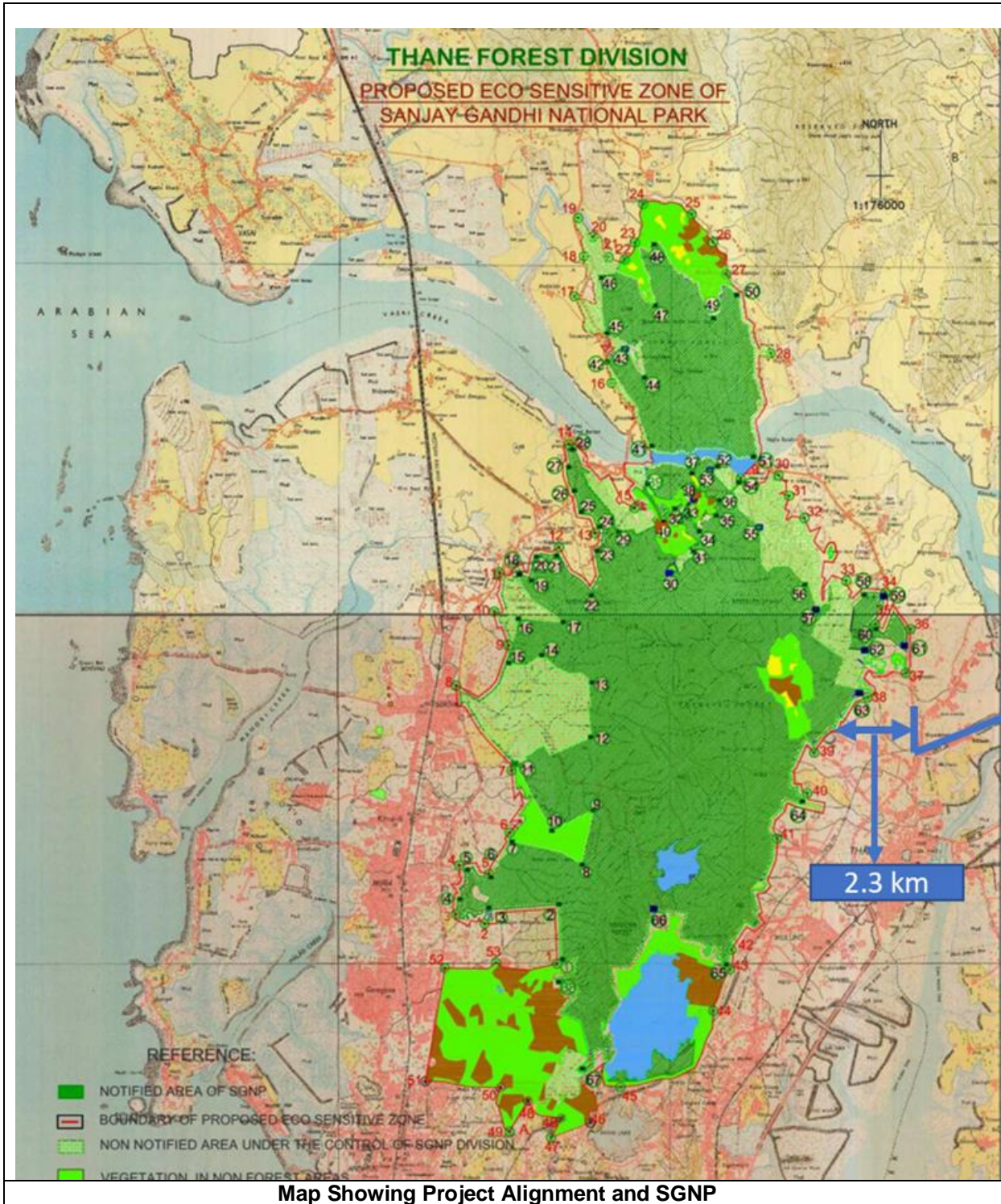
224. Certain fauna in SGNP is enlisted under various Schedules of Wildlife (Protection) Act 1972. While species like Indian peafowl (*Pavo cristatus*), osprey or fish-eating eagle (*Pandion haliaetus*), white-bellied sea eagle (*Haliaeetus leucogaster*), hawks, large falcons and *Haliaeetus leucogaster* are included in Schedule I, *Halcyon pileata*, *Anas crecca* and *Psittacula roseata* are included in Schedule IV of Wildlife (Protection) Act 1972.

**Table 4.19 : Forest Type of SGNP**

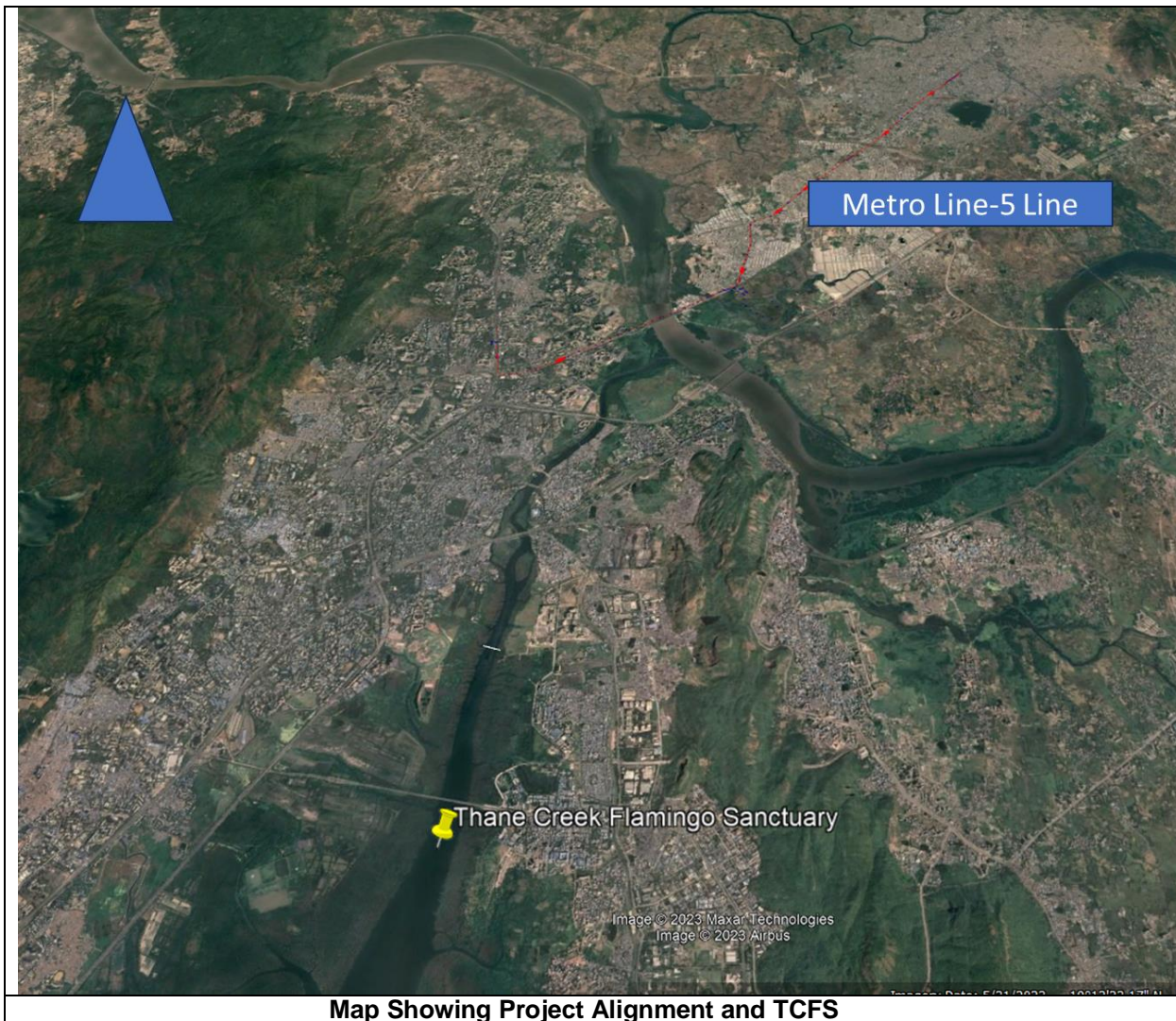
Forest Type	Major Vegetation	
	Scientific Name	Local Name
3B-C1 Southern moist teak bearing forest	<i>Adina cordifolia</i>	Haldu
	<i>Bombax malabaricum</i>	Kate-Saveri
	<i>Garuga pinnata</i>	Kakad
	<i>Lannea grandis</i>	Shemat
	<i>Mangifera indica</i>	Amba
	<i>Mimusops hexandra</i>	Ranjana
	<i>Pterocarpus marsupium</i>	Indian Kino tree
	<i>Schleichera oleosa</i>	Kosumb
	<i>Syzygium cumini</i>	Jambul
	<i>Tectona grandis</i>	Sag
	<i>Bambusa arundinacea</i>	Kalaka Bamboo
3B-C2 Southern moist mixed deciduous forest	<i>Dendrocalamus strictus</i>	Velu Bamboo
	<i>Ixora parviflora</i>	Techi
	<i>Mallotus philippensis</i>	Shendri
	<i>Saraca indica</i>	Ashok
4B-TS1 Mangrove scrubs	<i>Avicennia marina</i>	Grey mangrove
	<i>Pongamia pinnata</i>	Karanj
	<i>Garcinia indica</i>	Kokum
8A-C2 Western sub-	<i>Syzygium cumini</i>	Jambul



tropical hill forest	<i>Murraya paniculata</i>	Kunti
	<i>Ixora parviflora</i>	Techi
	<i>Calophyllum inophyllum</i>	Surangi







**Map Showing Project Alignment and TCFS**

**Figure 4.9 : Map Showing SGNP & its ESZ Boundary & TCFS and Project Alignment**

**225.Yeoor Hill:** Yeoor hill is a part of SGNP. There are 800 plant species, 78 bird species and 12 other animal species are recorded in the forests of Yeoor. (As per ESR). In Yeoor, there are trees like bamboo, boar, mango, *terminalia*, *tomentoso*, red pine, Bauhinia, *Resinosa*, amla, vine, nilgiri, benera, black currant, tamarind, turmeric, lotus, chasheco, hangersten, jackfruit, sandlefruit, seasen, jaan plant, almond and deepal.

**226.Wetland Ecology:** **Wetland present within 10 km radius of project area includes:** Thane Creek Flamingo Sanctuary (Approx. 5.2 Km, S), Thane Creek (800 m, S), Ulhas River (1 Km), Yeoor Lake (3.05 Km, W), Upvan Lake (2.19 Km, W), Jail Lake (2.2 Km, S), Digha Lake (5.00 Km, S), Rewale Lake (0.03 Km, N), Masunda Lake (2.5 Km, S), Kachrali Lake (2.6 Km, SW), Siddheshwar Lake (2.13 Km, SW), Hariyali Lake (3.45 Km, S). Ecology of these wetland systems is discussed in **Table 4.16**.

**227.Important Bird Areas:** Important bird areas existing within 10 km radius of project alignment includes Sanjay Gandhi National Park (3.4 km) and Thane creek Flamingo Sanctuary (9.0 km).

**228.Thane Creek Flamingo Sanctuary:** Thane creek portion is notified as the flamingo sanctuary. Eco-sensitive zone of Thane creek has also been notified vide Notification No. S.O.4293(E) dated 14.10.2021. The Eco-sensitive Zone of the sanctuary is to the extent of 0 (zero) to 3.89 kilometres around the boundary of Thane Creek Flamingo Sanctuary and the area



of the Eco-sensitive Zone is 48.305 square kilometres. Project alignment is approx. 3.0 km from TCFS ESZ boundary and approx. 5.2 km from TCFS boundary in South direction. The project is no where affecting the sanctuary or declared ESZ.

**Table 4.20 : Creek, River & Lake within 10 Km Surroundings of the Project Area**

Sr. No.	Creek- Lakes within 10 Km Vicinity	General Information
1	Thane Creek	1. As per records, Thane creek possesses 19 types of mud burrowing type sea anemones, 8 varieties of polychaetes, 7 kinds of bivalves, the gastropods of 14 types etc. A good variety of birds have been observed and there has been increasing number of Flamingos. There are 11 true mangrove types, dominated by <i>Avicennia marina</i> , 12 varieties of mangroves associates and 5 species of non-mangrove halophytes along the creek. Distance from alignment – 800 m
2	Jail Lake	<b>Trees:</b> <i>Asoka, Gulmohr, Mango, Tamarind, Coconut</i> etc. <b>Shrubs:</b> <i>Ghaneri, Duranta, Jasvand, Kaner, Anar</i> etc. <b>Herbs:</b> <i>Chubukata, Billygoat weed, Ekadandi</i> etc. <b>Water Hyacinth:</b> <i>Eichhornia crassipes</i> etc Distance from alignment – 2.00km
3	Thane Flamingo Sanctuary	Thane Flamingo Sanctuary is located on the western bank of the Thane Creek between Vashi and Airoli bridges that connect Mumbai with Navi Mumbai. It is spread over an area of 1,690 hectares which include 794 hectares of adjacent water body and 896 hectares of mangroves. Shital Pachpande and Dr. Madhuri Pejavar recorded 95 species of bird in Thane Creek. Distance from alignment – 7.4 km.
4	Ulhas River	<b>Phytoplankton:</b> Total 22 genera were recorded from the Ulhas River of which <i>Anabeana</i> sp., <i>Aphanocapsa</i> sp. ( <i>Cyanophyceae</i> ), <i>Ankistrodesmus</i> sp., <i>Closterium</i> sp. ( <i>Chlorophyceae</i> ), <i>Chaetoceros</i> sp., <i>Odontella</i> sp., <i>Navicula</i> sp. ( <i>Bacillariophyceae</i> ) were the dominant phytoplankton. <b>Zooplankton:</b> Altogether 14 genera were found in the Ulhas River of which <i>Copepoda</i> ( <i>Cyclops</i> sp. & <i>Diaptomus</i> sp.) followed by <i>Rotifera</i> ( <i>Euchlanis</i> sp., <i>Mytilina</i> sp. & <i>Keratella</i> sp.) groups dominated all the samples. <b>Fishes:</b> According to local people, common varieties like <i>Tilapia mossambica</i> (Tilapia), <i>Mugil cephalus</i> (Boi), <i>Gonoproktopterus kolus</i> (Kolus), <i>Mystus gulio</i> etc. are available in the Ulhas River.
5	Yeoor Lake	This lake is under Sanjay Gandhi national park and is full of nature, birds, trees and animals. Distance from alignment – 3.0 km Major animals found around the Lake are as follows. <b>Mammals:</b> fruit bats, mongoose, cat, dog etc. <b>Avifauna:</b> blue rock pigeon, Indian myna, house crow, house sparrow, common swallow, Indian black drongo, magpie robin, purple sunbird, redvented bulbul, little cormorant etc. <b>Butterflies:</b> Indian crow, common grass yellow, common wanderer, plain tiger etc.

Sr. No.	Creek- Lakes within 10 Km Vicinity	General Information
6	Upvan Lake	<p>Upvan Lake is located at foothills of Yeoor, in Thane, Maharashtra. It extends over an area of about 6 Ha. Distance from alignment – 2.2 km</p> <p><b>Trees:</b> Australian Babhul, Asoka, Copper pod, Gulmohar, Mango, Jack fruit, Tamarind, Drumstick, Coconut etc.</p> <p><b>Shrubs:</b> Kanher, Anar, Ixora etc.</p> <p><b>Herbs:</b> Kurdu, Ekdandi etc.</p> <p><b>Following phytoplankton diversity was recorded by Sainath Bamane (2013) etal.</b></p> <p>Twenty species from 3 groups. Chlorophyta was represented by 13 species, Bacillariophyta by 5 species and Cyanophyta by 2. The study also showed that the diversity of species from Bacillariophyta was reduced by 54% and that of Cyanophyta by almost 67% from earlier study in 2006. Species from Euglenophyta, Cryptophyta and Dinophyta were not found in later study.</p>

#### 4.6. Socio-Economic Environment

##### 4.6.1. Socio-economic profile of Project Area

229. In order to understand the region better, it is considered appropriate to take up in brief an overview of the demographic and socio-economic characteristics of the Thane-Bhiwandi- region in which the Phase-1 Metro Line-05 project is located.

230. City of Thane, part of Mumbai Metropolitan Region, is one of the major industrial towns. It is one of the fastest growing areas in the region. Increasing industrialization and its proximity to Mumbai led to this fast paced growth. It is bounded by Vasai Creek on the north and east side, while Sanjay Gandhi National Park limits its boundaries on the west side. The city is located on latitude 19.2183°N, and 72.9781°E longitude. Thane is spread over an area of 147 Km<sup>2</sup>. There are a total of 116 wards in Thane city. Large scale developments have also taken place in Kalwa and Mumbra, near to Thane; although much of it is unauthorized. These areas have been experiencing tremendous growth due to their proximity to rail and road corridors. The emergence of these areas as new centres of urban growth has already been recognized in the Draft Development Plan of Thane. The demographic characteristics of Thane city are presented in **Table 4.17**.

**Table 4.21 : Demographic Profile of the Thane City**

<b>Population</b>	18,41,488
<b>Households</b>	4,35,341
<b>Sex Ratio</b>	888 per 1000 males
<b>Literacy Rate</b>	79%
<b>Literacy Rate - Males</b>	82%
<b>Literacy Rate - Females</b>	76%
<b>Population (&gt;6 years of age)</b>	16,31,609
<b>Sex Ratio (&gt;6 years of age)</b>	885 per 1000 males
<b>Main Worker</b>	6,49,128
<b>Main Worker (Male)</b>	5,15,048
<b>Main Worker (Female)</b>	1,34,080
<b>Marginal Worker</b>	50,107
<b>Marginal Worker (Male)</b>	31,138

<b>Marginal Worker (Female)</b>	18,969
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Source: Census of India, 2011

231. The city is well connected by an extensive network of roads and railways. The Central Railway's main north-south corridor passes through the city providing daily commuter services to Mumbai as well as long distance train services. National Highway 3 and State Highway 42 & 35 pass through the city. Thane is accessible by buses of B.E.S.T, T.M.T, NMMT, KDMT, MBMT and MSRTC. Commuters can also avail options of some private, buses, auto-rickshaws and taxis.

232. Bhiwandi, a suburb of Mumbai, is located at latitude 19.2813<sup>0</sup>N and 73.0483<sup>0</sup>E longitude. The Vasai creek - Ulhas River bound the city from the western and southern side. There are many hills which surround the city adding to its scenic beauty. It is connected to Thane and Mumbai via SH35 and NH3. The economy of Bhiwandi-Nizampur is mainly dependent on its power loom industry. It is the second largest power loom centre in the country after Surat city power loom. The bloom of cloth oil and looms attracts a lot of workers from various states to come and find suitable jobs (floating population). It is the richest city in Thane District and also has become city with the highest paid octroi with the largest godown in Asia. The demographic characteristics of thane city are presented in **Table 4.18**.

**Table 4.22 : Demographic Profile of the Bhiwandi City**

<b>Population</b>	12,47,327
<b>Households</b>	3,02,735
<b>Sex Ratio</b>	920 per 1000 males
<b>Literacy Rate</b>	82%
<b>Literacy Rate - Males</b>	85%
<b>Literacy Rate - Females</b>	80%
<b>Population (&gt;6 years of age)</b>	11,26,205
<b>Sex Ratio (&gt;6 years of age)</b>	922 per 1000 males
<b>Main Worker</b>	4,40,991
<b>Main Worker (Male)</b>	3,45,060
<b>Main Worker (Female)</b>	95,931
<b>Marginal Worker</b>	28,315
<b>Marginal Worker (Male)</b>	16,850
<b>Marginal Worker (Female)</b>	11,465

Source: Census of India, 2011

233. At present, there are no intra city bus services within Bhiwandi. Commuters travel within the city via auto rickshaws and taxis apart from private vehicles. TMT, KDMT and MSRTC runs bus services from the city to various other cities in the state as well as neighbouring states. The Bhiwandi Nizampur state transport depot is located on the NH3. Buses run every half hour to nearby depot like Mumbai-Central, Thane, Kalyan, Vasai, Wada and Borivli, Nashik, Shirdi, Aurangabad, Pune etc. The city depends on Mumbai for all flight trips via Chhatrapati Shivaji International Airport, which is at a distance of approximately 40 Km.

234. **Project Affected People:** Total 261 people and 54 PAHs will be affected due to the project. Details is provided in **Table 4.19**. All the individuals in project area belongs to the general category. No SC/ST PAP will be affected due to the project.

**Table 4.23 : Detail of PAPs**

Sr. No	Age / Sex	Male		Female		Row Total		Sex Ratio*
		No.	%	No.	%	No.	%	
1	1 to 14	15	34.09	29	65.90	44	100	1933
			11.71		21.80		16.85	
2	15-30	29	46.03	34	53.96	63	100	1172

			22.65		25.56		24.13	
3	31-60	61	55.96	48	44.03	109	100	786
			47.65		36.09		41.76	
4	Above 60	23	51.11	22	48.88	45	100	956
			17.96		16.54		17.24	
	<b>Total</b>	<b>128</b>	<b>49.04</b>	<b>133</b>	<b>50.95</b>	<b>261</b>	100	1039
	Column %		<b>100</b>		<b>100</b>			

Source: SIA Study Report

235. **Impacted Structures:** Metro 5 project will affect 313 structures. Out of these 56 structures are put to residential use whereas 257 are used as commercial establishments and no community structures are affected in the alignment. The details of types of structures and location and use of these structures currently identified are given in **Table 4.20**.

**Table 4.24 : Types of Structures**

Sr.No.	Type of Structure	Number of Structure	Percentage of Structure
1	Residential	56	17.89
2	Commercial	257	82.10
3	Others	0	0
	<b>Total</b>	<b>313</b>	<b>100.00</b>

Source: SIA Study Report

236. **Culture and Religious Facility:** No cultural or religious property be affected due to the project. Alignment is finetuned in away to protect the cultural and religious property falling with in RoW. Cultural and religious properties along the RoW are given in **Table 4.21**.

**Table 4.25 : Cultural and Religious Properties Along RoW**

Chainage	Location	Temple name	Nearest Pier
1005.305	RHS	Hanuman Temple	P-25
1666.350	LHS	Hanuman Temple	P-49
2319.075	LHS	Devi matha temple	P-68
5044.149	LHS	Hanuman Temple	PP-158
5068.149	LHS	Matha temple	CP-159
5917.772	LHS	Ganesha temple	P-186
9667.202	LHS	Church	P-316
12254.012	LHS	Masjid	P-400

Source: MMRDA

#### 4.6.2. Community Property Resources

237. As pointed out above, no common property resources are affected in the alignment.

## Chapter 5. Grievance Redress Mechanism for Workers and Community<sup>7</sup>

### 5.1. Introduction

238. The main objective of a Grievance Redress Mechanism (GRM) is to assist to resolve complaints and grievances in a timely, effective, and efficient manner that satisfies all parties involved. The project SIA has provided for a GRM for land, livelihoods, etc. related grievances. This GRM is exclusively for workers and community health and safety related grievances. Contract specific Workers Grievance Mechanism is to be setup by the contractor. It shall include a contract specific grievance focal person (GRC Convener) assigned by the Contractor who will file the grievances and appeals of contracted workers and will be responsible to facilitate addressing them. If the issue cannot be resolved at contractor's level within a reasonable time, then it will be escalated to the Principal Employer (MMRDA), by the GRC members nominated by the General Consultants. The work of the GRC Convener will be closely monitored by the GC and periodically reviewed by the Executive Engineer and OSD-Environment at the MMRDA. The proposed GRM is elaborated, building from previous experience of MMRDA for effective management of grievances. All project contract related grievances are tagged, and a register is maintained.

### 5.2. Grievance Redressal Committee

239. The contractor will form a Grievance Redressal Committee. The GRC will have nine members as below:

S.No.	Position in GRC	Designation	Organisation
1	Chairperson	Project Manager	Contractor
2	Member Convener	Chief Safety, Health and Environment Manager	Contractor
3	Member	Labour Welfare Officer	Contractor
4	Member	Environmental Manager	Contractor
5	Member	Chief Safety Expert	General Consultant
6	Member	Environmental Expert	General Consultant
7	Member	Executive Engineer	MMRDA
8	Member	OSD-Environment	MMRDA
9	Nominated Member	Social Worker	Nominated by MMRDA

### 5.3. Grievance Redressal Process

240. The Grievance Redressal Process

1. The Convener will register the grievances in a formal manner in register or in electronic format to be easily tracked for its resolution. These contractor nominated GRC members will meet, as soon as a grievance arises, review the grievances and provide redress for those within the purview of the contractor. Grievances are filed by workers/ community through written, voice/ text messages or verbal forms and registered in grievance logbook. The convener will acknowledge each of the received grievance.
2. The GRC committee will meet once in a month. If required, under any emergency, the Convener may call for an emergency meeting. The key functions of the committee are to a) review the grievances received and redressed during the previous month, b) assess if the grievances are redressed in a reasonable timeframe without causing any hardship to the aggrieved, c) assess the satisfaction levels of the aggrieved with the redressal, through interacting with some of the aggrieved parties.

<sup>7</sup> GRM for Land, Livelihoods, etc. related issues is provided in the SIA.

3. The complaints/grievance could relate, among others, to: (1) wages, (2) working conditions, (3) health and safety issues, (4) facilities to be provided at worker accommodation, (5) conflicts among workers/ with community, (6) complaints/ grievances from the community, (7) health and safety of community, (8) disruption to utilities, (9) inconveniences due to construction work and (10) Other grievances related to workers/ community. For most of the grievances related to worker and utility disruptions the redressal time has to be immediate or within one day. For other grievances the MMRDA will set the redressal times.
4. Grievance raised is screened by the GRC Convener, discussed with the contractor nominated GRC members and based on its severity/ jurisdiction forwarded to respective manager/ engineer/ officer of the contractor for redressing.
5. The concerned Manger/ Engineer/ Officer discusses the grievance with the Convener and provides adequate redress
6. The GC nominated GRC members will enquire about the grievances received and redressed on a daily basis, and if a grievance is not redressed in stipulated period, then the GRC members nominated by GC will escalate the same to the Principal Employer (MMRDA).
7. The MMRDA nominated GRC member will visit the site and decides on calling for an emergency GRC meeting to redress the grievance or issue instructions to contractor on providing the redress.
8. MMRDA's instructions are scrupulously followed by the Contractor. If contractor does not redress a just grievance even after MMRDA's instruction, then MMRDA has the responsibility to redress the same and deduct the costs from the contractor's invoices.
9. Once a grievance is redressed, the Convener collects feedback from the complainant and complaint closed upon verification from the complainant.
10. Once all possible redress has been proposed and if the complainant is still not satisfied then they should be advised of their right to legal recourse.
11. The Contractor will prominently communicate the GRC members contacts at prominent places.

#### **5.4. Documentation of the Processes**

241. The convener keeps a record of grievances, and submits monthly reports on the grievances received and redressed to MMRDA. The Convener of the GRCs will maintain a Grievance Register that would, among others, help with monitoring and evaluation of the functioning of GRC but also to document the processes of GRC. The register will have the following details:

1. Serial Number
2. Name of Complainant
3. Gender
4. Full Address of the Complainant
5. Main complaint/grievance
6. List of documents attached
7. History of Previous complaint/grievance, if any
8. Date of receipt of complaint/grievance
9. Date of acknowledgement of complaint/grievance
10. Date of start of redressal process
11. Progress – redressed, pending or rejected
12. Date, Mode and Medium of communication to complainant/grieved person

- 13. Feedback from the complainant
- 14. GRC comments if any
- 15. Date of closing of complaint/grievance
- 16. Whether escalated to next level
- 17. Whether complainant is seeking legal redress

242. The grievance redress process will be a continuous, transparent and participatory process that would be an integral part of the project's accountability and governance agenda.

### **5.5. Legal Option**

243. The complainants will have the option to approach the general legal environment consisting of courts of law to address their grievance. These options will be disclosed to the workers and community during the public consultation process.

### **5.6. Gender Based Violence**

244. All contractors (employing more than 10 employees) are mandated under the POSH Act to set up an Internal Committee (IC) in their organisation to address complaints of sexual harassment. A complainant facing sexual harassment working in an organization that has less than 10 employees, can file a complaint to the Local Complaints Committee (LCC) setup in each district by the district administration.



## Chapter 6. Analysis of Potential Environmental Impacts and Mitigation Measures

### 6.1. Introduction

245. With rapid strides in economic development, particularly in urban development, the need for rationalizing and upgrading the transport system is imperative. The main aim of the project is to decongest the road traffic and project is designed keeping in view population growth, future traffic demands and environmental protection aspects. Very often the process of development has adversely affected the environment leading to ecological imbalances. The importance of conserving and enhancing the environmental assets has assumed urgency.

246. Environmental Impact Assessment (EIA) is a tool to identify the environmental, social and economic impacts of a project prior to decision-making. It aims to predict environmental impacts at an early stage in project planning and design, find ways and means to reduce adverse impacts, shape projects to suit the local environment and present the predictions and options to decision-makers. Identification, evaluation and prediction of impacts is the most important step of an environmental impact assessment study. Superimposing identified and predicted impacts over collected baseline environmental scenario, provides an understanding of the resultant environmental impact due to the project.

247. The proposed project alignment is traversing through and along the existing road majorly. Mangrove vegetation patches exist at location of small creek (north Kasheli creek) which is the part of Ulhas River. Proposed project alignment is impacting human settlement area (commercial and residential). Interface of the project and these existing land use, may impact the various social and environmental aspects including sensitive receptors in these locations. No CPR will be affected due to proposed project. The environment in the vicinity of the proposed project is expected to be affected by:

- i) Activities for site preparation, construction and ancillary component during construction phase.
- ii) Operation and maintenance of the project during operation phase.
- iii) Economic growth and urbanization in the connected area of the project in future.

248. Various techniques and methods are being used to conduct the environment impact study. Both qualitative and quantitative methods are used for assessing the environmental impacts of the project. Quantitative techniques used include rating matrices. Qualitative analysis is carried out where quantification of impact assessment in terms of measurable units may not be possible due to lack of information/data, uncertainties involved and complex inter- relationships between various attributes of the environment. In such cases, only qualitative predictions have been made based on rationale, experience elsewhere and reasonable judgment.

249. The activities wise probable impacts of project on various environmental attributes (such as air, water, noise and vibration, soil, biota, socio-economic, topography, geology, climate change, ecology both flora and fauna, etc.) have been identified and listed in **Table 6.1**. After identification, the impacts have been assessed and evaluated and are classified as permanent/temporary, long-term impacts/short-term significant/moderate/low and reversible/irreversible under the various sections. Most of these impacts are envisaged to be short term impacts as they are confined to the construction period. However, some impacts majorly due to noise and vibration generation are also anticipated which are long term and are associated with the operation of metro rail. It is found that impacts are of high to low significance both during construction and operation phase but can be reduced to acceptable limit by adopting appropriate mitigation measures. These mitigation measures are discussed in respective sections in this chapter.

**Table 6.1 : Potential Adverse Impacts and Proposed Mitigation Measures during construction phase**

<b>S. No.</b>	<b>Environmental Attributes</b>	<b>Potential Impact</b>	<b>Mitigation Measures Suggested</b>
1.	Air environment	<ul style="list-style-type: none"> <li>• Generation of Dust</li> </ul>	<ul style="list-style-type: none"> <li>• Compliance to CTEs and CTOs</li> <li>• Identified dust-generating plants and machinery such as batching plants shall be placed at a minimum distance of 500 m from residential and sensitive areas in a downwind direction as far as possible</li> <li>• Sprinkling of water</li> <li>• Dust screens where required</li> <li>• Regulation of construction timings near sensitive receptors and settlements</li> <li>• Covering of loose construction material, construction debris, and transportation vehicles</li> <li>• Provision of wheel washing facilities</li> <li>• Provision of mask for workers</li> </ul>
		<ul style="list-style-type: none"> <li>• Gaseous Pollution</li> </ul>	<ul style="list-style-type: none"> <li>• Vehicles and machinery will be regularly maintained to conform to the emission standards</li> <li>• Construction camps and casting yards sites should be preferably sited more than 500 m away from the residential and sensitive area in a downwind direction</li> <li>• All construction and transportation should have valid PUC</li> <li>• Use of clean fuel like LPG for cooking at labor camps</li> <li>• The height of the stack shall be as per CPCB norms</li> <li>• Use of masks by workers engaged in construction</li> </ul>
2.	Noise environment	<ul style="list-style-type: none"> <li>• The increased Noise level during construction due to various activities</li> </ul>	<ul style="list-style-type: none"> <li>• Properly maintained construction equipment, machinery, vehicles to be used</li> <li>• Noise levels of machinery used shall conform to the relevant standard</li> <li>• Regulation of timing of construction work generating noise pollution near the residential and sensitive areas</li> <li>• Temporary noise barriers shall be provided near the residential and sensitive areas (to be provided all along the RoW as the entire alignment is in urban area comprising of residential area, sensitive receptors, commercial/industrial area and mangrove habitat and at all these locations, ambient air quality standards are required to be maintained)</li> <li>• Ear plugs and muffs will be provided to workers as per requirement during construction activities</li> <li>• Noise barriers should be erected during construction stage for all residential/sensitive</li> </ul>

			receptor locations (Kapurbawadi, Samta Nagar (Ch 1200-1900), Ashok Nagar, Swaraj Nagar, Kahler, Kopar, Oswal wadi) along the alignment so as Ambient noise levels are not affected due to project operation. Further these noise barriers will also act as visibility barrier and barrier to prevent collision of avifauna with running train.
3.	Vibration	<ul style="list-style-type: none"> <li>• Vibration in the nearby area (upto 25 m) due to piling</li> <li>• Vibration due to heavy construction equipment</li> </ul>	<ul style="list-style-type: none"> <li>• No historic building, old building or monument lies within 25 m of proposed alignment and thus no impact due to vibrations is anticipated due to piling works. Where there are residential structures within 25 m of proposed alignment (Kapurbawadi), the contractor will take necessary precautions to avoid any impacts on these structures and reflect these in the SHE Plan.</li> <li>• Also no impact due to vibration from piling is anticipated on flora &amp; fauna as ecologically rich areas are at distance from project site</li> <li>• Properly maintained construction equipment and machinery to be used</li> <li>• Heavy vibrating machinery can be placed vibration absorption pads</li> </ul>
4.	Water environment	<ul style="list-style-type: none"> <li>• Impact on rivers/creek due to construction activities near banks and construction pier inside the water bodies</li> </ul>	<ul style="list-style-type: none"> <li>• Bridges, piers, and other structures shall be constructed without affecting the original course and flow of water bodies</li> <li>• Stabilization and turfing of slopes along the water bodies will be done, where required.</li> </ul>
		<ul style="list-style-type: none"> <li>• Siltation of water bodies</li> </ul>	<ul style="list-style-type: none"> <li>• Silt fencing around water bodies during construction will be installed to filter out the silt-laden runoff before entering to the water body</li> <li>• Turfing or pitching of embankments of affected water bodies will be done to prevent erosion that also causes siltation in the water bodies</li> <li>• No solid waste will be dumped in or near the water bodies or rivers</li> <li>• Excavated earth and other construction materials shall be stored away from water bodies</li> </ul>
		<ul style="list-style-type: none"> <li>• Water for construction</li> </ul>	<ul style="list-style-type: none"> <li>• Water source would be selected so that local availability is not affected</li> <li>• Camps will have separate water supply facilities so that local water sources are not affected</li> </ul>
		<ul style="list-style-type: none"> <li>• Contamination from wastes</li> </ul>	<ul style="list-style-type: none"> <li>• Provision of septic tanks to prevent any untreated sewage discharge from construction workers camps and sites to the water bodies</li> <li>• Sullage from septic tank shall be disposed of periodically through authorized agencies only</li> </ul>

			<ul style="list-style-type: none"> <li>• Oil interceptors shall be provided at construction machine maintenance workshops.</li> <li>• No waste shall be stored near to the water bodies and shall not be disposed off in any water bodies. Waste management rules shall be followed for the management and disposal of different types of waste</li> </ul>
		<ul style="list-style-type: none"> <li>• Contamination from fuel and wastes</li> </ul>	<ul style="list-style-type: none"> <li>• Vehicle maintenance will be carried out in a confined area, away from water sources, and it will be ensured that used oil or lubricants are not disposed to water courses</li> <li>• Fuel shall be stored in covered containers which should be placed on paved surfaces. Containment shall be provided to contain spillage if any.</li> <li>• Oil spill kits shall be provided for managing the oil spill and staff shall be trained to use them.</li> <li>• A drip tray shall be provided with all the vehicles and the machinery</li> </ul>
		<ul style="list-style-type: none"> <li>• Sanitation and waste water from construction sites and labor camps</li> </ul>	<ul style="list-style-type: none"> <li>• Proper sanitation facilities will be provided including toilets with water facilities etc. at labour camps and sites</li> <li>• Waste water from toilets and kitchen shall be disposed off through septic tanks and soak pits or modular STPs shall be provided. Treated water from STP shall be used for dust suppression and landscaping</li> <li>• Workers shall be educated not to contaminate the water bodies</li> <li>• Waste water from batching plants and transit mixers shall be properly treated before disposal</li> <li>• Regular monitoring shall be conducted for surface, ground water, and drinking water as per EMoP. If STP is installed then wastewater and treated water quality shall also be monitored on daily basis.</li> </ul>
5.	Land environment	<ul style="list-style-type: none"> <li>• Loss of topsoil</li> </ul>	<ul style="list-style-type: none"> <li>• Topsoil on stripping shall be removed and stockpiled for plantation and greenbelt development.</li> <li>• Fertile land will be avoided for earth borrowing. If needed, topsoil will be separated and reused for plantation and greenbelt development.</li> </ul>
		<ul style="list-style-type: none"> <li>• Soil contamination</li> </ul>	<ul style="list-style-type: none"> <li>• Proper waste management as per the waste management rules</li> <li>• Proper storage of the fuel, waste oil, and construction material on paved surfaces in covered conditions</li> <li>• Minimizing the spillage of fuel, waste oil, and construction material</li> <li>• Oil and waste/wastewater storage containers/tanks shall be inspected regularly for leakages</li> </ul>

		<ul style="list-style-type: none"> <li>Land-use change</li> </ul>	<ul style="list-style-type: none"> <li>An elevated corridor has been selected for the proposed project which minimizes the land requirement.</li> </ul>
6.	Social environment	<b>Loss of structures</b> There are approx. 313 structures (i.e., Residential, Commercial, and others) which are coming within the project corridor.	Applicable compensation for the private structures will be paid as per the Right to Fair Compensation & Transparency in Land Acquisition, Rehabilitation & Resettlement Act, 2013.
		<b>Land acquisition and loss of livelihood</b> The total land required for the proposed project is approx. 35.411 ha. out of which 7.064 ha is government land 27.649 ha. is private land and 0.698 ha is Forest land.	The compensation to project affected persons will be paid as per the Right to Fair Compensation & Transparency in Land Acquisition, Rehabilitation & Resettlement Act, 2013 and relevant Acts and guidelines of the Government of India and rules of concerned state governments.
		<b>Loss of Common Property Resources (CPRs)</b> There are no CPRs structures within the project corridor	No impact
		<b>Utility shifting</b> There are approx. 4 no of utility to be shifted	<ul style="list-style-type: none"> <li>Utilities shall be shifted through the concerned dept. by paying the required fee.</li> <li>New facilities shall be provided before disturbing the existing utilities as possible</li> <li>In case a new facility cannot be provided before disturbing the existing utility then concerned users shall be pre-informed about the same</li> </ul>
7.	Waste generation Generation	Municipal Waste	<ul style="list-style-type: none"> <li>Municipal waste from site, labour camp and other project facilities shall be collected, segregated, treated and disposed off as per SWM Rules, 2016</li> <li>Source segregation of waste shall be adopted</li> <li>Onsite treatment facility for food waste and other compostable waste shall be established</li> <li>Recyclable waste shall be sold to authorized vendors only</li> <li>Reject fraction of waste shall be disposed off through the local waste management agencies in the area</li> <li>STP/Septic tank sludge shall be disposed off through the authorized vendors only</li> </ul>

			<ul style="list-style-type: none"> <li>• Permission for generation, storage and disposal of waste shall be obtained from concerned local bodies as applicable and condition of the permissions obtained shall strictly be followed</li> </ul>
		C&D waste	<ul style="list-style-type: none"> <li>• C&amp;D waste shall be handled as per the Guidelines of C&amp;D Waste Management Rules 2016.</li> <li>• Permission will be obtained from local bodies for disposal of C&amp;D waste</li> </ul>
		Hazardous waste including PCBs in transformers (if, any) and SF6	<ul style="list-style-type: none"> <li>• The authorization shall be obtained from SPCB for storage handling and disposal of hazardous waste</li> <li>• Hazardous waste shall be disposed off only through an authorized vendor</li> <li>• Hazardous waste shall be stored in covered HDPE containers on the paved surfaces</li> <li>• Inventories of PCBs and SF6</li> </ul>
		Bio medical waste	Bio medical waste from first aid centers shall be collected, stored, and disposed off as per the Bio medical waste management rules, 2016
		Other waste	Other waste like packaging waste, plastic waste, e-waste, battery, etc. may also be generated which shall be disposed off as per the respective regulations in India
8.	Flora	<p>The RoW will be cleared off the vegetation</p> <p>Approx. 708 nos. of trees are falling within the project RoW, Other than this, approx. 50-60 trees exist at depot site which may need to be removed from the site and impacting mangrove area of 0.6983 Ha. which is classified as reserve forest</p> <p>More than 3 km distance from notified ecological areas like SGNP and Thane Creek Flamingo Sanctuary thus there is no impact on the SGNP/Thane Creek due to the project</p>	<ul style="list-style-type: none"> <li>• Opting for the elevated corridor has minimized land requirement, forest diversion, and tree cutting</li> <li>• Planning shall be done to minimize tree cutting. Nos. of trees to be cut shall be finalized only after joining visit of the project team with concerned Govt. department</li> <li>• Only required trees shall be cut and other trees shall be saved</li> <li>• The transplantation approach shall be adopted for trees between the girth 30-75 cm as possible.</li> <li>• Compensatory plantation shall be carried out in consultation with the forest department as per the guidelines of concerned Tree Authority under Maharashtra (Urban Area) Tree Preservation Act, 1975 and its amendments</li> <li>• The strips of short stature trees/ shrubs may be planted along the corridor wherever possible in the available spaces</li> <li>• Only native species shall be planted</li> <li>• Green belts shall be developed at stations, depot, and along the corridor as possible</li> <li>• No impact anticipated on flora &amp; fauna of SGNP and Thane Creek Flamingo Sanctuary. Also proposed project is outside the boundary and ESZ of these sanctuaries</li> </ul>

9.	Fauna (No significant wildlife found in area as the alignment traverse through the urban area)	Loss/ Defragmentation of Habitat and Degradation of Habitat Quality	<ul style="list-style-type: none"> <li>•The adoption of an elevated corridors system will facilitate the movement of fauna across the corridor</li> <li>•Precautions will be taken to avoid leakage of chemicals, any hazardous materials due to construction activities.</li> <li>•Labour camps will be located far from the green habitats and labourers will be strictly guided not to disturb the flora &amp; fauna</li> <li>• On any encounter with wild species, the forest department will be informed in case of handling will be required.</li> </ul>
		Noise-Induced physiological and Behavioural Changes	<ul style="list-style-type: none"> <li>•Since SGNP and Thane Creek Flamingo Sanctuary are at distance of 3.4 km and 8.0 km respectively no such changes on fauna of these areas is anticipated due to project but for additional safety, Noise walls/barriers shall be provided near the sensitive habitats.</li> </ul>
		Injury/mortality to birds (A study was carried out to assess the extent of habitat loss of the birds due to tree cutting envisaged due to the project and no active nest site was found in this area)	<ul style="list-style-type: none"> <li>•Construction sites shall be barricaded to prevent trespassing of any domesticated or wild fauna</li> <li>•Faunal movement will not be impacted due to the project as the project is elevated in nature</li> <li>•No machinery shall be parked outside the barricaded boundary which may harm/injure fauna</li> </ul>
		Reduce access to water sources	<ul style="list-style-type: none"> <li>•Creation of small ponds and improvement of water bodies will be done for the wild animals or birds for drinking need.</li> </ul>
10.	Borrowing and Quarrying areas (However borrow area may not be required for the project and material may be purchased from licensed vendors)	<ul style="list-style-type: none"> <li>• Land degradation if borrowing and quarrying areas are not restored or maintenance.</li> </ul>	<ul style="list-style-type: none"> <li>•All the borrow areas shall be opened and closed only after approval from an engineer.</li> <li>•All borrow areas shall be restored after borrowing is complete</li> <li>•Borrowed land must be reclaimed/restored to the acceptable level by the land owner.</li> </ul>
11.	Occupational Health and Safety Community Health and Safety	Occupational risks on workers Health and safety risks of workers and community due to hazardous substances including PCBs in transformers (if, any) and SF6	<ul style="list-style-type: none"> <li>•Child labour shall strictly be prohibited at work site and shall not be allowed at its supplier sites also</li> <li>•To provide and maintain safe work environment, safe plant and equipment's, and safe system of work.</li> <li>•To provide information, instruction training and supervision to execute the work in safe and healthy manner.</li> <li>•To provide suitable occupational health and safety management arrangements,</li> </ul>



			<ul style="list-style-type: none"> <li>•To provide appropriate personnel protective equipment to workers.</li> <li>•Safe and convenient passage for vehicles and pedestrians will be arranged during construction work.</li> <li>•Inventories of PCBs in transformers (if, any) and SF6</li> <li>•Training and awareness programs to workers and in Community</li> </ul>
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**Source: Study Team**

250. **Table 6.2** provides potential adverse impacts and proposed mitigation measures during construction phase on various components of environment. Most of these impacts are long term impacts. However, the significance of most of these impacts is envisaged to be low to moderate, as discussed in the following sections.

**Table 6.2 : Potential Adverse Impacts and Proposed Mitigation Measures during operation phase**

S. No.	Environmental Attributes	Potential Impact	Mitigation Measures Suggested
Operational Phase			
1	Noise and Vibration	<ul style="list-style-type: none"> <li>• Generation of high noise and vibration due to movement of metro rail</li> </ul>	<ul style="list-style-type: none"> <li>• Noise and vibration mitigation measures are integrated with the project design to minimize noise and vibrations due to Rail &amp; wheel interaction, pantograph, aerodynamic noise, etc.</li> <li>• Noise barriers should be erected all residential/sensitive receptor locations (Kapurbawadi, Samta Nagar (Ch 1200-1900), Ashok Nagar, Swaraj Nagar, Kahler, Kopar, Oswal wadi) along the alignment so as Ambient noise levels are not affected due to project. Further these noise barriers will also act as visibility barrier and barrier to prevent collision of avifauna with running train.</li> <li>• Proper maintenance shall be carried out for rail, rolling stock, etc. to minimize the noise and vibration generation</li> <li>• Noise &amp; vibration monitoring shall be conducted along the corridor as per the proposed environment monitoring plan</li> <li>• Honking shall be prohibited near and within the station and depot areas</li> </ul>
2	Water Resources	<ul style="list-style-type: none"> <li>• Requirement of water for drinking, cleaning, fire-fighting and landscaping purpose at stations, trains and depot</li> </ul>	<ul style="list-style-type: none"> <li>• Water shall be procured from ground sources, surface water sources, pipelines etc only after obtaining permission from concerned agency. Conditions of the permission shall strictly be followed</li> <li>• Water requirement shall be minimized by installing water conservation fixtures</li> <li>• Water wastage shall be reduced by optimizing water usage and preventing wastage by provision of alarm systems</li> </ul>

			<p>with water tanks and timely repair &amp; maintenance of leakages in pipelines &amp; tanks</p> <ul style="list-style-type: none"> <li>• Rainwater harvesting shall be practices to harvest rainwater form viaduct, stations and depot as feasible. Collected rain water shall either be directly used or recharged to ground after appropriate treatment as per CGWB guidelines</li> </ul>
3	Water Quality	<ul style="list-style-type: none"> <li>• Generation of sewage from toilets &amp; kitchen at stations, depot and trains</li> <li>• Generation of effluent at maintenance depot and workshops</li> </ul>	<ul style="list-style-type: none"> <li>• Sewage generated shall be disposed off through the city sewerage system/septic tank as feasible as per CPCB norms.</li> <li>• Sewage shall be treated at generation site if generation exceeds 10 KLD within inhouse STP upto tertiary level. Treated water from STP shall be used for non-potable use within site like flushing and landscaping</li> <li>• ETP shall be provided at depot. Effluent containing contaminants like chemicals, grease, oil etc shall be treated in ETP only upto tertiary level. ETP treated water shall be used for flushing purpose.</li> <li>• Sludge of STP and ETP shall be disposed off through authorized vendors only as per the law.</li> </ul>
4	Air Quality	<ul style="list-style-type: none"> <li>• Overall project quality may improve due to modal shift from road to metro</li> <li>• Emissions due to operation of DG sets</li> </ul>	<ul style="list-style-type: none"> <li>• Water sprinkling, fountains and sprinklers shall be provided near the roads within and outside the station areas</li> <li>• Vehicles with valid PUC shall only be allowed to enter the station premises</li> <li>• MMMOCL shall coordinate with the concerned development authorities, so as to assure that width of the roads connecting the stations is adequate to handle the existing traffic and anticipated new traffic to prevent congestion near stations</li> </ul>
5	Waste	<ul style="list-style-type: none"> <li>• Waste Generation</li> </ul>	<ul style="list-style-type: none"> <li>• Waste to be generated from maintenance depot and stations shall be segregated at source and shall be disposed off as per the Waste Management Laws in India</li> <li>• NOCs as applicable shall be obtained from concerned local bodies and SPCBs as applicable for storage, treatment and disposal of the waste to be generated. Conditions of these permission shall be followed.</li> </ul>
6	Risk and Disaster	<ul style="list-style-type: none"> <li>• Loss of life and property</li> </ul>	<ul style="list-style-type: none"> <li>• Emergency Response System Devices for real-time communication must be available at all sites.</li> <li>• The alarm system should be installed in control rooms and stations.</li> <li>• A specific Risk and Disaster Management</li> </ul>

			Plan is to be formulated for the project
7	Energy Consumption	<ul style="list-style-type: none"> <li>Consumption of electrical energy for operation and stations.</li> </ul>	<ul style="list-style-type: none"> <li>Metro rail operation is more efficient than road transport</li> <li>Alternate energy sources like solar power generation may be adopted to minimize the energy requirement</li> <li>Green building rating may be obtained for the stations and depot buildings</li> <li>Energy star-rated equipment and fixtures will be used to minimize the energy consumption – e.g., energy-efficient motors and pumps, use of energy-efficient lighting, energy-efficient luminaries, adequate and illumination levels optimized as per tasks, and energy-efficient.</li> </ul>
8.	Occupational Health and Safety Community Health and Safety	<p>Occupational risks on workers Health and safety risks of workers and community due to hazardous substances including PCBs in transformers (if, any) and SF6</p> <ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Child labour shall strictly be prohibited at work site and shall not be allowed at its supplier sites also</li> <li>To provide and maintain safe work environment, safe plant and equipment's, and safe system of work.</li> <li>To provide information, instruction training and supervision to execute the work in safe and healthy manner.</li> <li>To provide suitable occupational health and safety management arrangements,</li> <li>To provide appropriate personnel protective equipment to workers.</li> <li>Safe and convenient passage for vehicles and pedestrians will be arranged during construction work.</li> <li>Inventories of PCBs in transformers (if, any) and SF6</li> <li>Training and awareness programs to workers and in Community</li> </ul>

*Source: Study Team*

## 6.2. Rating of Environmental Impacts

251. Environmental impacts due to the implementation of the Metro Line-05 project are identified during the various stages of the project planning and implementation. Broadly impacts are categorized into locational impacts, design impacts, construction impacts and operation & maintenance impacts and are discussed below. Identified impacts due to the project along with their rating on basis of subjective analysis by experts are tabulated below and rating for these impacts are provided in **Table 6.3**.

- **Location impacts:** Impacts associated with site selection, including impacts on environment and resettlement or livelihood related impacts on communities and impacts to the environmental sensitive locations (Sanctuaries, forest areas, national parks, etc.)
- **Design impacts:** Impacts arising from project design, including fixing of alignment/curve improvements, safety measures, etc.
- **Construction impacts:** Impacts resulting from construction activities including site clearance, earthworks, civil works, etc.
- **O&M impact:** Impacts associated with the operation and maintenance of the roads

**Table 6.3 : Rating of Identified Impacts**

<b>Impacts due to project location and design</b>			
<b>Identified Impact</b>	<b>Rating Pre-mitigation</b>	<b>Type of Impact Pre-mitigation</b>	<b>Rating Post-mitigation</b>
Displacement and loss of livelihood of Project Affected People (PAPs)	R1	Permanent, negative, irreversible, can be mitigated, scale to be evaluated	R2
Change of Land use	R2	Permanent, negative, irreversible, can be mitigated, small scale	R2
Loss of trees and impact on ecology	R1	Permanent, negative, irreversible, can be mitigated, small scale.	R2
Drainage and Utilities: Diversion /shifting	R2	Short term and/or permanent, negative, irreversible can be mitigated; small scale	R3
Impact on Archaeological Monuments and Heritage Assets	R4	Permanent, negative, irreversible, can be mitigated, small scale	R4
Right of Way: Optimal choice of length of elevated	R1	Permanent, negative as well as positive, irreversible, can be mitigated, small scale	R1
Alignment: Route and design of alignment Stations, Track design and Architecture	R1	Permanent, negative as well as positive, irreversible & can be mitigated, small scale	R2
Inter Modal Integration	R1	Long term, negative as well as positive, irreversible, can be mitigated, small scale. Negative Impact on environment around station will be significant if integration of metro with other modes is not implemented.	R2
Use of Energy and Water at stations and depot	R1	Permanent, negative, irreversible & can be mitigated, small scale.	R2
Risk Due to Natural Hazards	R4	Permanent, negative, irreversible & can be mitigated, small scale	R4
<b>Impacts due to project construction</b>			
Air pollution: Particulate air pollution due to activities like excavation; emissions due to transportation of muck and material Noise, Vibration	R1	Temporary, negative, reversible can be mitigated, small scale	R3
Water demand and water quality	R1	Temporary, negative, reversible, can be mitigated, small scale	R2
Soil erosion and land subsidence	R2	Temporary, negative, irreversible, can be mitigated, small scale	R3
Traffic diversions	R2	Temporary, negative, reversible, can be mitigated, small scale	R3
Labor camp and on-site labour	R1	Temporary, negative,	R2

safety/ welfare		reversible, can be mitigated, small scale	
Supply of construction material	R2	Temporary, negative, irreversible, can be mitigated, small scale.	R3
<b>Impacts Due to Project Operation</b>			
Noise and Vibration	R1	Permanent, negative, irreversible, can be mitigated, small scale	R2
Energy, water supply at stations & depot	R1	Permanent, negative, irreversible, can be mitigated, small scale	R2
Traffic congestions around stations	R1	Permanent if inter modal integration is not done, negative, reversible, can be mitigated, small scale	R2
Impacts due to Depot: Water supply, Waste water disposal, Oil Pollution, Noise Pollution, Solid Waste disposal, Loss of trees.	R1	Permanent, negative, reversible except in case of ecology, can be mitigated, small scale.	R2
<b>Positive impacts due to project</b>			
Employment Opportunities	Positive impact	Permanent, positive, small scale.	--
Benefits to Economy: access, reduced costs of road infrastructure, vehicle operating & time, accidents.	Positive impact	Permanent, positive, large scale	--
Reduction in road traffic, fuel consumption and air pollution, GHG emission	Positive impact	Permanent, positive, large scale	--
Rating: R1: High; R2: Moderate; R3: Low; R4: No impact is expected			

### 6.3. Impact Due to Project Location

#### 6.3.1. Change in Land Use of Project RoW

##### **Construction Phase**

252. Pre-construction stage will involve land acquisition, vegetation removal and land clearing activities including utility shifting and demolition of structures in proposed RoW for development of the proposed project. Development of the project will change the land use of the strip of the land to be developed. However, this impact cannot be reduced as elevated option is already considered for development for proposed project which has minimal land requirement. ROW of 2 -12 m is required for development of metro rail project depending on its location.

253. Apart from this it is also likely that land use of the adjoining land may get affected temporarily due to some of the activities like establishment of construction camps, labour camps, storage yards, casting yards, site offices, stacking of soil, construction debris and removed vegetation during pre-construction and construction phase. These impacts can be minimised by selecting appropriate sites for establishment of above-mentioned temporary facilities and proper management of muck, C&D debris and removed vegetation. The impact will be significantly reduced by adopting following mitigation measures:

##### **Mitigation measures:**

- RoW clearing activities are to be carried out with least disturbance to the surrounding by restricting the project activities within the define RoW

- Before start of construction activities, sites for C&D waste disposal shall be identified. These sites should be at minimum 500 m distance from residential, sensitive and water body location and shall always be above the HFL of the nearest water body (Ulhas river). These sites should be provided with adequate drainage and silt arresting mechanism. As per the data available with MMB, HFL in the project area is 500 mm (0.5 m) BGL (or 1.2 m AMSL) and existing ground level is 1.7 m AMSL. Project area is about 500 mm above the HFL and has not been inundated in past due to floods in Kasheli creek.
- Preferably waste land and barren land shall be considered for establishment of the C&D waste disposal site.
- Labour camp, storage yards, casting yards and plant site (batching plant, stone crushers) should be at minimum 500 m distance from residential, sensitive and water body location.
- All the sites being used for the construction purposes temporary shall be restored back to the original condition.

### **6.3.2. Land Acquisition and Resettlement Impacts.**

254. Approx. 22.4137 ha of private land is acquired for the project and 7.4150 ha of government land is procured for the project. out of total government land required, 1.27 ha is required permanently, and 6.15 ha is required temporarily for temporary office/ site office, segment casting yard).

255. As per the detailed design, it has been estimated that nearly 313 structures are getting affected. In the total affected structures, 56 are residential, 232 are commercial, 25 were locked and 10 were non-responsive. The compensation for the structure loss and the livelihood assistance shall be estimated as per the Entitlement Matrix formulated for the project. Further details on the land acquisition and the R&R assistance are given in the Social Impact Assessment (SIA) report.

#### **Mitigation measures:**

- SIA and RAP is prepared and being implemented
- Compensation shall be provided as per approved RAP and entitlement matrix
- Grievance redress mechanism shall be implemented and adequately be monitored

### **6.3.3. Design Considerations to Avoid Environmental Impacts**

256. Based on the assessment, the following are the design considerations to avoid or to minimize the environmental impacts

- Planned within and along the RoW of existing road
- Minimizing tree cutting by opting for transplantation
- Elevated design has helped minimizing the land requirement
- Avoidance of forest/environmentally protected areas
- Minimization of habituated and settlement areas

### **6.3.4. Climate Risks and Adaptation Measures**

257. To mitigate the expected impact of project on micro-climate, following measures are adopted:

- Preferring for transplantation (495 trees out of 708 trees) in place of cutting (166 trees to be cut and 47 to be trimmed out of 708) thereby reducing trees to be cut. Other than this, approx. 50-60 trees exist at depot site. Joint visits will be undertaken by the civil, planning and environment team to understand requirement of tree cutting which shall minimize the number of trees to be cut. Compensatory plantation will also be undertaken for the affected 50-60 trees.

- Undertaking compensatory plantation for each tree to be affected as per guideline of concerned Tree Authority under Maharashtra (Urban Area) Tree Preservation Act, 1975 and its amendments and Maharashtra Felling of Trees (Regulation) Act, 1964.
- Planned within and along the RoW of existing road, minimizing tree cutting, private land acquisition, impact on settlements and changing land use
- Minimizing impact on forest land and environmentally protected areas
- Adoption of green building technology for making project more energy efficient
- Usage of low embodied material for construction like fly-ash
- Provision of solar power plant at the roof top of stations/depot and other utility area
- Provision of rain water harvesting system to harvest rain water and recharge ground water resources
- Design of all structures above HFL of the nearby rivers (As per the data available with MMB, HFL in the project area is 500 mm (0.5 m) BGL (or 1.2 m AMSL) and existing ground level is 1.7 m AMSL. Project area is about 500 mm above the HFL and has not been inundated in past due to floods in Kasheli creek. Proposed project is elevated thus most of the structure is above HFL and significant impact on project infrastructure due to floods is not anticipated. Height of the viaduct for the proposed project varies between 8.7 m to 23.7 m thus impact of inundation of viaduct due to floods is not anticipated. Also the entry and exit of the proposed stations is designed above HFL. All stations are elevated thus risks of inundation is minimal.)
- Measures adopted for water resources conservation such as usage of curing compound, water conservation fixtures etc
- Piers at waterbody crossings are so designed that they will occupy minimum space in the river bed. Modelling study are carried out to assess the impact of construction of river banks/beds. This will minimize the impact on the carrying capacity of the water bodies and will not aggravate the flooding.
- Implementation of proposed environmental management plan to prevent impact on environmental components

#### 6.4. Pre – Construction Impacts and Mitigation Measures

258. Necessary consents, permits and NoC as indicated in chapter 4, shall be obtained. Failure to obtain necessary consents, permits, NOCs, etc. can result in the delay of works. The following shall be done to prevent any delay in work:

- Obtain all necessary consents, permits, clearance, NOCs, etc. to prevent violation of any legal requirement
- Comply with all the conditions of obtained NOC/Consents/Permits etc as stated above and submit the compliance report as per requirement on regular basis
- Conditions of the issued consents, permits, clearance, NOCs, etc. shall be incorporated in the project design, construction EMP to assure the conditions are being implemented
- Utilities: Interruption of services (water supply, toilets, bathing areas, etc.) will be scheduled and intermittently related to localized construction activities. To mitigate impacts, following measures are required:
  - Identify and include locations and operators of these utilities in the detailed design documents to prevent unnecessary disruption of services during the construction phase.
  - Obtain permission from concerned authorities prior disturbing any utility. Avoid, shifting of utility but if unavoidable, it shall be done by concerned agency at the cost of MMRDA
  - MMRDA shall also arrange/pay for the alternative required during utility shifting
  - Require Contractor to prepare a contingency plan to include actions to be done in case of unintentional interruption of services.
  - If relocations are necessary, Contractor along with Supervision Consultant will coordinate with the providers to relocate the utility

259. **Social and Cultural Resources:** No impact is anticipated as no archaeologically protected



monument will be affected due to the project, however any work involving ground disturbance can uncover and damage archaeological and historical remains. Hence during the excavation operation, care should be taken not to damage any chance finds. Following measures shall be adopted while undertaking excavation works:

- Develop a protocol for use by the Contractors in conducting any excavation work, to ensure that any chance finds are recognized and measures are taken to ensure they are protected and conserved.
- Inform Archaeological Survey of India and/or State Department of Archaeology in case of finding any archaeological artifact/item

**260. Sites for Construction Work Camps and Areas for Stockpile, Storage, and Disposal:**

The priority is to locate the construction camp; storage and area of stockpile are adjacent/near to the project sites, however minimum distance of 500 m shall be maintained from residential and sensitive areas. The Contractor will be required to meet the following criteria for the sites:

- Any settlement area, forest area, protected areas shall be avoided for establishment of the casting yard, labour camps, storage yard, site offices etc
- Minimum distance of 500 m shall be maintained from residential areas, forest area, sensitive receptors
- Establishment of the casting yard, labour camps, storage yard, site offices etc shall not require cutting of trees/clearing of any major vegetation
- The disposal will not be allowed into a nearby watercourse or any nearby sensitive areas which may pollute surface water or can cause inconvenience to the community.
- The construction camp, storage of fuel and lubricants should be avoided at the river bank.

**261. Sources of Construction Materials/Establishment of quarries/borrow areas:**

Significant amounts of gravel, sand, and cement will be required for the construction of proposed project. Extraction of materials can disrupt natural land contours and vegetation resulting in accelerated erosion. However, the material will preferably be purchased from licensed vendors existing in around project area thus no significant impact is anticipated. The contractor shall identify the licensed source of materials and use them with the consent of MMRDA. Following measures shall be taken

- Procure materials from the licensed suppliers preferably
- Use existing quarry sites and sources permitted by Government.
- Verify the suitability of all sourced material and obtain approval from the MMRDA prior procurement
- If additional quarries/borrow areas are required after construction has started, obtain written approval from MMRDA
- New quarry site/crusher shall be established only after obtaining environmental clearance and consent from MPCB as applicable
- Submit to MMRDA on monthly basis the documentation detailing the source of materials
- Borrow pits shall not be installed at the forest land/agricultural land/close to water bodies/existing roads/settlement areas
- Minimum distance of 8 m shall be maintained between two borrow pits
- The depth of borrow pits shall not exceed 45 cm and it may be dug out to a depth of not more than 30 cm after stripping the 15 cm top soil aside
- Prior permission shall be obtained from District Collector for establishment of borrow area
- For the redevelopment of the borrow area, the contractor shall evolve site-specific redevelopment plan for each borrow area location, which shall be implemented after the approval of the MMRDA.
- The haul roads and borrow areas will be managed and maintained by the Contractor as established.
- Topsoil shall be preserved in stockpiles.

**262. Increased traffic and Issues in Access:** Construction work will require blocking completely or temporarily the roads or diversion of existing road which may impact traffic movement in the area leading to congestion. Movement of construction/transportation vehicles to site may enhance the traffic in the project area especially during peak hours. Further, establishment of barricading board may obstruct access to residential/commercial establishments located along the project area. Anticipated traffic choke points are:

- Kalher Pipeline intersection (near Pier P222)
- Anjur Chowk (near Pier P322)
- Anjur Phata (near Pier No. P338)
- Railway crossing (ROB, near Pier P329)
- Kolshet Road (near Pier P11)
- Station Entry and Exit structure works

**263. Measures to be taken to prevent the impact are as follows**

- Plan transportation routes so that heavy vehicles do not use narrow local roads, except nearby delivery sites.
- Schedule transport and hauling activities during non-peak hours.
- Locate entry and exit points in areas where there is low potential for traffic congestion.
- Keep the site free from all unnecessary obstructions.
- Drive vehicles in a considerate manner.
- Provide free access to households and businesses/shops along the ROWs during the construction phase
- Parking of transportation/construction vehicles/machinery on road shall not be allowed on public roads
- All activities including stockpiling of materials/debris etc shall be exclusively undertaken within RoW
- Proper traffic safety measures like provision of adequate barricading and safety signages shall be provided at all the roads to be blocked/diverted to prevent any accident. Site specific traffic diversion/management shall be prepared.
- Public shall be pre-informed about the completely/temporarily blocked roads through appropriate media and shall be suggested to take alternate route
- Road blockage/diversion signages shall be provided from at least 1 km of the affected point

**264. Affected trees:** Approx. 708 trees fall within the project RoW and about 110 trees at depot site. Following measures are propose to minimize the impact on trees

- In place of cutting, it is proposed to transplant 495 trees, cut 166 trees and trim 47 trees out of 708 trees within RoW. This has minimized tree cutting requirement
- Joint visits will be undertaken by the civil, planning and environment team to understand requirement of tree cutting which shall minimize the nos. of trees to be cut at depot site
- Compensatory plantation in will be undertaken to compensate the loss as per guideline of concerned Tree Authority under Maharashtra (Urban Area) Tree Preservation Act, 1975 and its amendments
- Adequate after care lime timely watering, provision of guarding etc. shall be undertaken for transplanted and planted trees to assure high survival rate
- Transplantation and plantation shall be carried out during monsoon to assure higher survival rate

## **6.5. Anticipated Impacts during Construction Phase and Mitigation Measures**

**265. Soil Erosion and Quality:** Project is majorly elevated, thus significant risk of soil erosion are not anticipated. Erosion risks are anticipated at approaches of bridges/embankment of water body, borrow area site and quarry site. Soil quality can be impacted due to following:

- Loss of productive top soil due to land clearing, vegetation removal and excavation activities
- Loss of the productive agricultural soil due to development of borrow areas. However, borrow area may not be established for this project and material may be procured from licensed vendors preferably
- Soil erosion due to wind and water action on the cleared and excavated land parcels
- Due to spillage and improper storage/disposal of construction material, fuel, construction and other waste, contaminated runoff, wastewater from labour camps, waste & waste water from workshops etc.
- Due to spillage of materials and construction waste during hauling, storage or transport from site;
- Due to leakage of fuel from tanks of construction vehicles and machinery
- The soil contamination may take place near the construction camp site due to untreated discharge of sewerage, spillage from the material storage area, surface run off in the monsoon months from the construction sites.

266. Measures to be adopted for prevention of impact on soil quality and prevention of soil erosion are given below

#### Soil Quality

- Top soil from the RoW shall be removed upto the depth of 15 cm and shall be stored for later usage for landscaping and dressing of the temporarily affected areas at the time of restoration
- Top soil shall be stored in the form of stock piles. Slope and height of the stock pile shall be maintained as per the angle of repose of the material. Minimum distance of 250 m shall be maintained b/w the two-stock pile to allow the access. These stock piles shall be sprinkled with water to minimise the erosion.
- Excavated slopes shall be stabilised through appropriate engineering and biological measures like pitching, mulching, turffing etc.
- Loose construction material, construction debris and excavated earth shall be stored and transported in covered conditions
- Stockpiles of construction materials, construction debris, top soil and excavated earth shall be located away from rivers, streams, fertile agricultural lands, recorded forest lands or inhabited area.
- Appropriate measures like silt fence, perimeter dikes, water bars etc be installed around stockpiles to retain silt from run-off.
- Temporarily drainage shall be provided at the construction sites and excavated areas to divert the runoff. These drains shall be provided with sedimentation tanks to arrest the silt.
- Silt fencing shall be done near all the water bodies prior start of work.
- Fuel/waste oil shall be stored in covered HDPE containers only on paved surface having provision of containment of spillage. Oil interceptors shall be provided with the drains near the fuel/waste oil storage. Oil spill management kits shall be available at the site to manage the spill, if any
- Sewage from labour camps & construction sites and effluent from workshops shall be treated to the acceptable discharge/re-use standards as prescribed CPCB in EP Rules, 1986
- Waste to be generated during pre-construction and construction phase shall be stored, managed and disposed off as per the relevant waste management rules. Waste management plan is given in the sections below
- All transportation vehicles and machinery shall be provided with the drip trays and collected fuel shall be disposed off through authorized vendors only
- Explore possibility of usage of fly ash to reduce the soil/sand requirement for construction purpose

#### Soil Erosion

- Excavated pits shall be stabilized by shoring to prevent any collapse of excavation and soil erosion
- Excavation shall not be carried out during monsoon and excavated pits shall be covered with tarpaulin to prevent filling with water. Soil laden water filled in the pit shall be pumped into sedimentation tank and the settled silt shall be re-used within the project
- Approaches for bridges shall be stabilized and pitched as required to prevent any erosion
- Excavated earth/stock piles shall not be piled at construction site and shall regularly be removed. They shall be stored in covered condition to prevent erosion due to wind and water action. Height of the stock piles shall be maintained. High and very close stock piles shall be avoided. Drainage facility shall be provided in the stock pile area to prevent erosion/washing away of stock piles
- Nearby land shall not be used for any purpose like parking of vehicles, storage of materials etc as any work movement/activity

**267. Impacts on Water Resources and Quality:** It is anticipated that the water requirement during construction phase is 175.85 MLD for construction purpose and 72 MLD for domestic use of construction labour. Water for construction purpose will be either procured from the surface or ground water resources available in the project area which will impact the water resources and downstream users in the project area. Project alignment traverses a few rivers, stream and creek from which water can be used after proper treatment. Also ground water resources can be used for construction purpose as the area falls in safe category as per CGWB. If ground water is extracted for meeting water requirement during construction phase, permission shall be obtained from CGWB. Water quality of the project area may get impacted due to following activities:

- Undertaking construction activities, storage of construction materials and waste material, storage of fuel, establishing of workshops and undertaking vehicles washing near the water body.
- Contamination of the runoff due to spillage and improper storage/disposal of construction material, fuel, construction & other waste, wastewater from labour camps, waste & waste water from workshops, silt from the excavated area etc.
- Due to spillage of materials and construction waste during hauling, storage or transportation in water body
- Due to discharge of untreated sewerage, effluent and waste in the water bodies. During construction phase, about 60 KLD of sewage will be generated from construction/labour camp during peak time. Improper disposal of sewage and wastewater may impact the water quality of the nearby water bodies.
- Due to storage of sewerage and effluent in the unlined tanks within 100 m area of water body.
- Due to percolation of contaminants (waste oil, sewerage, fuel etc.) into the ground water if the contaminants are stored in the unlined pits or remains spilled on soil for the long time.

**268. Measures to be adopted for prevention of impact on water resources & quality are given below**

- The priority shall be given to use surface water wherever surface water source is available. Ground and Surface water may be used only after obtaining necessary permissions from the respective Government authorities.
- Rain water harvesting shall be carried out where ever feasible.
- STP treated water shall be procured from nearby STPs and shall be used preferably for sprinkling and landscaping.
- Minimizing water requirement by using water conservation measures such as covering the water tanks, providing visual notice for water conservation, low flow taps in toilets etc.
- Regular inspection to detect leakage in water pipelines and water tanks.
- Labour camps, plant sites, casting yards, parking area, workshops, material and fuel

- storage areas should be located at minimum 500 m distance from the water body;
- Fuel and all hazardous materials/waste on-site should be stored on paved surface having the provisions of containments
  - Oil and grease interceptors shall be provided with the drains at construction site, material storage area, parking sites and workshops
  - Oil spill kits shall be provided at the site and the staff shall be trained to use these kits during emergency
  - A floating oil collection boom may be placed on waterbody to collect the oil in case of working inside or near the water body (especially for construction of bridges)
  - Suitable drainage at construction site/camp should be provided to avoid formation of stagnant pool of water that leads to water logging and breeding of mosquitoes.
  - Excavation activities shall not be undertaken during monsoon season. All excavated pits and borrow area sites shall be covered with tarpaulins during rains. Garland drains shall be provided around the excavated pits and borrow sites to prevent entry of run-off from surroundings into the excavated pits.
  - Stockpiled soil and other loose material should be stored in covered areas or shall be covered with tarpaulin. Drains with sedimentation tanks shall be provided in these areas to facilitate drainage of run-off and arresting the silt from run-off.
  - Silt fencing or appropriate silt arresting measures shall be taken up while working in and near the water body to prevent entry of sediment in the water bodies
  - Proper sanitation facilities (toilet with water facility) at the construction sites and labour camps shall be provided
  - Sewage from toilets at labour camp and construction sites shall be disposed off complying to the guideline of CPHEEO and SPCB/CPCB. Sewage shall be disposed off through septic tanks and soak pits. Septic tanks shall be evacuated through authorized agencies only. Soak pits shall not be provided anywhere within 100 m from any water body or where ground water table is less than 4 m. If sewage generation at one site is more than 10 KLD, then preferably STP shall be provided. Sewage shall be treated upto tertiary level and shall meet the discharge standards as specified by CPCB. Treated water shall be used at site for water sprinkling and landscaping.

269. **Hydrology.** Impacts are anticipated on natural drainage pattern and are listed below:

- Project alignment crosses both perennial and seasonal water bodies; construction of piers inside the water bodies may affect the flow of the streams.
- Improper disposal of the waste on the land and in the water, body may choke the local drainage and cause flooding in the nearby area.
- Increase in run-off from the viaduct/stations area which will accumulate and fall cumulatively on road leading to local flooding situation and even accident due to impact dropping of accumulated water on the running vehicles underneath.  
Measures to be adopted for prevention of impact on hydrology are given below
- Construction on the pier inside the water body should be avoided. Long spans shall be used to minimise the nos. of piers inside the water body.
- Hydrological flow study shall be undertaken for each water body to assess the impact on its flow due to construction of the pier. Pier shall be constructed in the water body only if the impact on the flow is negligible or mitigable.
- All the drains along the RoW and near the camps site shall be cleared off prior the onset of monsoon.
- C&D waste, excavated muck and other waste shall be stored, transported and disposed off as per the waste management plan and waste management rules/guidelines
- No material should be dumped into natural drains that may block, impede or alter drainage channels.
- Adequate cross drainage structures and longitudinal drains shall be provided in & along service roads (if any) to ensure the cross drainage of the run off as required. The cross-drainage structure of service road shall be connected to the nearest existing drainage

system

270. **Impacts on Air Quality:** During construction air quality may be degraded for short periods due to (i) the exhaust emissions from the operation of construction machinery; (ii) fugitive emissions from batching/crusher plants/quarry/borrow area; (iii) the dust generated from the haulage of materials, exposed soils and material stockpiles; (iv) cleaning of the road; (v) material loading; (vi) unloading; and (vii) blasting activities. The impact is expected to be localised, temporary and confined to construction areas. After removal of the vegetation, suspension of particulate matter is also supposed to be higher in the air by wind and vehicular/machinery movements. Impacts are discussed in detail in **table 6.4**.

**Table 6.4 : Impact on Air Quality during Construction Stage**

Sl. No.	Impact	Source
1.	Generation of Dust	<ul style="list-style-type: none"> <li>• Transportation of raw materials from quarries and borrow sites;</li> <li>• Stone crushing, handling and storage of aggregates</li> <li>• Site levelling, clearing of trees, demolition of old structures;</li> <li>• Concrete batching plants;</li> <li>• Construction of structures and allied activities</li> </ul>
2.	Generation of polluting gases including SO <sub>2</sub> , NO <sub>x</sub>	<ul style="list-style-type: none"> <li>• Large construction equipment, trucks</li> <li>• The movement of heavy machinery and vehicles</li> <li>• Inadequate vehicle maintenance and the use of adulterated fuel in vehicles.</li> </ul>

271. As described in table above, there is a potential for increased dust particularly during summer/dry season due to stockpiling of excavated materials. Emissions from vehicles transporting workers, construction materials and debris/materials to be disposed off may cause an increase in air pollutants within the construction zone. These are inherent impacts that are site-specific, low magnitude, short in duration and can be easily mitigated. Special care is required to be undertaken near residential area and sensitive receptors. The Contractor will be required to follow mitigation measures as provided below:

**Measures for Dust Control:**

- Siting of stone quarry, batching plant, stone crushers plant should be established at least 500 m in down wind direction from any settlement.
- Proper and prior planning and appropriate sequencing and scheduling of all major construction activities will be done, and timely availability of infrastructural supports needed for construction will be ensured to shorten the construction period vis a vis reduce pollution.
- Construction materials (sand, aggregate, soil, etc.) and C&D waste shall be stored in covered condition to prevent the fugitive emissions.
- Construction materials and debris shall be transported in the covered conditions.
- Adequate dust suppression measures such as regular water sprinkling on unpaved haul roads, stone quarry, batching plant and stone crushers sites & fugitive dust during material handling, loading/unloading & other activities at haul road particularly at vulnerable areas near habitation shall be controlled especially in the dry seasons
- Dust during loading and unloading will be controlled with careful handling and by adopting following measures:
  - ✓ Increasing moisture content: In some cases, slight moisture may be added to the material to reduce dust during loading.
  - ✓ Reducing falling distance: Shortening the falling distance between the material discharge point and the material pile will slow material velocity and reduce particle impacts, lessening dust generation.
  - ✓ Adding physical barriers at the loading point: Create walls or areas where personnel are removed from the affected area to avoid dust exposure could occur.

**Measures for Emission Control:**

- During construction period, all applicable clearances for air quality management and approvals such as 'Consent to Establish' and 'Consent to Operate' for batching plant, stone crushers area, stone quarry shall be obtained from the State Pollution Control Board and complying all the conditions. All vehicles operating for the Contractor shall obtain Pollution under Control (PUC) certificate.
- Environmental clearances shall be obtained from authorities for establishing new quarries, and crushers as applicable. Contractor shall strictly comply to all the conditions in the clearances.
- DG sets shall be provided with stack of adequate height as per CPCB norms ( $H = h + 0.2\sqrt{KVA}$ , where H= total height of the stack, h=height of the building in meters, KVA=total generator capacity of the set in KVA)
- It will be ensured that all the construction equipment & vehicles are in good working condition, and maintained to keep emissions within the permissible limits. Idling of the vehicles shall be minimised and engines should be turned off when not in use to reduce pollution.
- Only clean fuel shall be utilized for all cooking purposes at labor camps.
- Raw materials shall be procured from nearest local sources.
- Provision of wheel wash facility will be installed to contain project site dust within the site.
- Recycled construction materials like fly-ash and sludge from cement plant for construction purpose may be utilized.
- Temporary Electricity connections at the sites will be obtained to minimize usage of DG sets etc.

272. **Noise and Vibration Impacts:** Noise and vibration assessments are key elements of the environmental impact assessment process for metro rail projects. Experience has shown that noise and vibration are among the major concerns with regard to the impact of a metro rail project on the surrounding community.

273. Source of noise pollution during the design and construction phase are site clearing, operation of excavators/earth moving equipment and leveller, operation of heavy machinery and equipment for construction purpose, loading & unloading of construction material and piling activities. Expected noise generation from various construction activities is given in **Table 6.5**.

**Table 6.5 : Noise Generation from Various Construction Equipment/Machinery**

<b>Clearing</b>		<b>Structure Construction</b>		<b>Grand and compacting</b>	
Bulldozer	80	Crane	75-77	Grader	80-93
Front end loader	72 - 84	Welding generator	71-82	Roller	73-75
Dump truck	83-94	Concrete mixer	74-88	<b>Paving</b>	
Jack hammer	81-98	Concrete pump	81-84	Paver	86-88
Crane with ball	75-87	Concrete vibrator	76	Truck	83-94
<b>Excavation &amp; Earth Moving</b>		Air compressor	74-87	Tamper	74-77
Bulldozer	80	Pneumatic tools	81-98	<b>Landscaping and Cleanup</b>	
Backhoe	72-93	Bulldozer	80	Bulldozer	80
Front end loader	72-84	Cement & dump trucks	83-94	Backhoe	72-93
Dump truck	83-94	Front end loader	72-84	Truck	83-94
Jack Hammer	81-98	Dump truck	86-88	Front end Loader	72-84



Front end loader	80-93		Dump Truck	83-94
			Paver	86-88

Source: DPR

274. Other than above equipment, piling is the major activity which generates high noise level ranging from 85-90 dB(A). It is evident that operation of the construction equipment will generate high noise levels which it may affect the health of construction labour and nearby residents if the adequate mitigation measures are not taken. As per occupation standards, workers' exposure to 90 dB(A) noise level (at 10 m from source) should not be more than 8 hours. OSHA guidelines should be followed for exposure to specific noise levels for workers and are listed in **Table 6.6**. Thus, the high noise levels are required to be managed by proper noise level reduction measures and preventive measures so as to minimize the impact on health due to exposure to high noise level. Conducting regular hearing tests for workers may help in monitoring the impact of the higher noise level on workers' health.

**Table 6.6 : OSHA noise exposure limits for the work environment**

Noise Levels in dB(A)	Permissible Exposure (hours & minutes)
85	16 hrs
90	8 hrs
96	3 hrs 30 minutes
102	1 hr 30 minutes
108	40 min
115	15 min
121	6 min
127	3 min
130	1 min

Source: Marsh, 1991, p.322

275. As per existing baseline data available from MPCB website it is seen that existing ambient noise level are on higher than prescribed standards (**Table 6.7**-Indian Standards as per Noise Rules, 2000) at multiple locations along project corridor, during both day and night. This shows that undertaking construction activities in the project area may further aggravate the noise levels.

276. However, the noise associated with the construction activity will be restricted to construction period only and thus the impact is considered to be short term & temporary. Construction machinery & equipment will not be operated throughout the day thus noise generation from this equipment is considered to be of intermittent type. Further, by undertaking the mitigation measures, impact due to noise pollution can be managed.

**Table 6.7 : Ambient Air Quality Standards with Respect to Noise**

Area Code	Category of Area/Zone	Limits in dB(A) Leq*	
		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:**

1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is defined as an area comprising not less than 100 meters around hospitals, educational institutions and courts. The silence zones are zones, which are declared as such by the competent authority.

4. Mixed categories of areas may be declared as one of the four-abovementioned categories by the competent authority.  
\*dB (A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

A “decibel” is a unit in which noise is measured.

“A” in dB (A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.

Leq: It is energy mean of the noise level over a specified period.

**Source: Noise Pollution (Regulation and Control) Rules, 2000**

277. Noise attenuates with the distance; thus, the impact of high noise level reduces with the increase in distance from activity area. Thus, it is required to maintain safe distance between the noise source and sensitive receptors (residential areas, man-made sensitive receptors and eco-sensitive areas). Considering the noise level to be generated during construction phase as 90 dB(A) at 10 m from source, safe distance is calculated for different land uses. Equation for calculating the attenuation in noise and safe distance is given below:

$$L_2 = (L_1 - 20 \log D_2/D_1 - A_e - A_n)$$

278. L1 and L2 are the noise levels at a distance of D1 and D2 from the noise source; Ae and An are attenuation coefficient due to environment correction and background respectively. (Table 6.8 and 6.9)

**Table 6.8 : Estimated Noise levels Due to Construction Activities at Varying Distance**

Distance from noise sourcelocation (m)	Highest Noise Level During Construction phase
10	90.00
30	80.46
50	76.02
100	70.00
200	64.00
500	56.00

**Source: Study Team**

**Table 6.9 : Safe Distance for Different Land Use**

Land Use	Day Time Standards dB(A) Leq	Safe Distance (m) Day Time	Night Time Standards dB(A) Leq	Safe Distance Night Time
Residential	55	562.3	45	1778.2
Commercial	65	177.8	55	562.3
Industrial	75	56.23	70	100
Silence	50	1000	40	3162.2

**Source: Study Team**

279. Measures for prevention of impact due to high noise level are given below

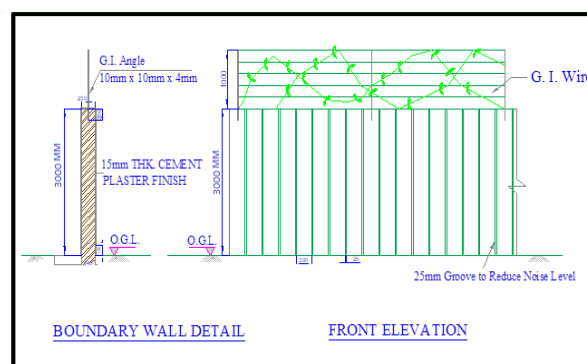
- Barricading (Temporary noise barrier<sup>8</sup>) the construction site to minimize the noise level

<sup>8</sup> Schematic design for temporary noise barrier has been provided as presented in below figure and material used will be foam concrete & height of these temporary barriers will be 3m.

outside the site boundary.

- Management of construction traffic to avoid residential areas.
- Restriction on Honking at the project site.
- Heavy noise generating activities like piling preferably shall not be carried out at residential and sensitive areas during night time (10:00 PM to 6:00 AM).
- Periodic monitoring (monthly level) of noise levels to check the level of pollutants and effectiveness of proposed EMP.
- Stationary noise source like generator sets shall be provided with acoustic enclosures. The plants, equipment and vehicle used for construction should strictly conform to CPCB standards. Vehicles and equipment should be fitted with silencer and maintained accordingly.
- All equipment should be fitted with silencers/noise mufflers and will be properly maintained to minimize its operational noise. Noise level will be one of the considerations in equipment selection, which will favour lower sound power levels.
- Personal Protective Equipment (earplugs or earmuffs) should be provided to the workers operating near high noise generating machines.
- Hearing test for the workers prior to deployment at site and high noise areas followed by periodic testing at every six months.
- Job rotations systems for workers who will be working in high noise level areas.
- Noise barrier along the sensitive receptors which are within the 100 m distance of the alignment shall be provided.
- Barriers for restriction of noise, bird collision and visibility along the corridor during Operation Phase

**280. Impact Due to Vibration:** During construction, some equipment may cause ground-borne vibration, most notably pile driving equipment. Construction equipment can produce vibration levels at 25 feet (7.62 m) that range from 58 VdB for a small bulldozer to 112 VdB for a pile driver. Operation of construction equipment causes ground vibrations which spread through the ground and diminish in strength with distance. Building founded on the soil in the vicinity of the construction site responds to these vibrations, with varying results ranging from no perceptible effects at the lower levels, low rumbling sounds and feeble vibrations at moderate levels and slightly damage at the highest levels. The level of construction vibration is related to the scale of the project and the sensitivity of the surrounding land use. Ground vibrations from construction activities very rarely reach the levels that can damage structures, but can achieve the audible and feeble ranges in buildings very close to the site. A possible exception is the case of old, fragile buildings of historical significance where special care must be taken to avoid damage. Pile driving is potentially the greatest source of vibration associated with equipment used during construction of a project. During the construction phase of project, the most severe vibration could be expected from impact pile driver. Impact driving is the best method for driving piles into difficult ground or final driving of piles to level in panel form. With a correctly selected and sized hammer it is the most effective way of completing deep penetration into hard soils in most conditions. There are several types of impact hammer available to suit the particular requirements of a site. The downside of this equipment is an environmental concern, that it can be noisy & maximum



vibration generating equipment and could not be suitable for sensitive or restricted sites. Measures proposed to minimize the impact on nearby structures due to vibrations effect are given below:

- Building damage from construction vibration is only anticipated from pile driving at very close distances to buildings (Approx 7 -8 m). If piling is more than 7-8 m from buildings, or if alternative methods such as push piling or augur piling can be used, damage from construction vibration is not expected to occur. Other sources of construction vibration do not generate high enough vibration levels for damage to occur. Prior to construction, preconstruction surveys shall be conducted at locations close to piling to document the existing condition of buildings in case damage is reported during or after construction. Damaged buildings would be repaired, or compensation paid to the owners.
- Notify the local people prior to undertake the construction activities associating with higher vibration level such as activities using vibrating rollers.
- The vibrations should be reduced considerably by ensuring and keeping correct track geometry by advanced measurement.

281. After assessing potential human impacts (or building damage) from construction vibrations, the next step is to identify control measures. Mitigation of construction vibration requires consideration of equipment location and processes as follows:

#### **Design consideration and project layout**

- Route heavily loaded trucks away from residential streets, if possible. Selects street with fewest homes, if no alternatives available.
- Operate earthmoving equipment on the construction plot as far away from vibration-sensitive sites.

#### **Sequence of operations**

- Phase demolition, earthmoving and ground-impacting operations so as not occur in the same time period.
- Avoid night-time activities. People are more aware of vibration in their homes during the night-time hours.

#### **Alternative construction methods**

- Avoid impact pile driving where possible in vibration-sensitive areas. Drilled piles or use of a sonic or vibratory pile driver causes lower vibration levels where levels where geological conditions permit their use. However, continuous operation at a fixed frequency may be more noticeable to nearby residents, even at lower vibration levels. Furthermore, the steady-state excitation of the ground may increase resonance response of building components. Resonant response may be unacceptable in cases of fragile buildings or vibration-sensitive manufacturing processes. Impact pile drivers, in contrast, produce a high vibration level for a short time (0.2 s) with sufficient time between impacts to allow any resonant response to decay.
- Select demolition methods not involving impact, where possible.
- Avoid vibratory rollers and packers near sensitive areas.

282. **Impact on Micro-climate:** The project may affect approx. 708 nos. of trees within RoW and 50-60 trees at Kasheli depot. Assuming all the trees<sup>9</sup> as mature trees, it is estimated approx. 17.80 tonnes of CO<sub>2</sub> will not be fixed per year (@48 pound/year/adult tree of CO<sub>2</sub> fixation<sup>10</sup>). On an average tree take 8-10 years to grow fully into a mature tree. Thus, total loss of CO<sub>2</sub> fixation due to the project in 8 years is approx. 314.14 tonnes of CO<sub>2</sub>. Other than this there may be loss of Oxygen formation by these trees. It is estimated approx. 96.47 tonnes of O<sub>2</sub> (@ 260

<sup>9</sup> No of trees considered in this calculation is 818 which was approximate sum of affected trees in RoW and depot area. No of trees are taken as per initial survey and has not been altered for this calculation

<sup>10</sup> Source: Urban forestry

pound/year/adult tree of O<sub>2</sub> formation) will not be formed every year, leading to loss of 771.8 tonnes of O<sub>2</sub> in eight years. Excess generation of CO<sub>2</sub> may add on to heating impact as it is green-house gas. Further impact on micro-climate is anticipated due to

- Temporarily warming effect due to operation of large number of heavy construction machineries;
- Continuous running of DG set at the construction camp;
- Clearing of vegetative cover may also lead to rise in the temperatures in local area over long term.
- Measures proposed to be taken to minimize the impact on micro-climate are given below
- Compensatory plantation shall be carried out as per the requirement of Tree Authority under Maharashtra (Urban Area) Tree Preservation Act, 1975 and its amendments and Maharashtra Felling of Trees (Regulation) Act, 1964.
- Transplantation shall be preferred over the tree cutting. Transplantation shall be carried out following the scientific approach in appropriate season and with all the utilities available through an experienced agency only to assure the high survival rate of transplanted tree.
- Maximum Survival Rate of the plantation shall be maintained and additional trees shall be planted for every tree lost
- Proper measures for tree care like provision of guards, watering, manuring etc shall be provided as required to protect tree from cattle and weather action
- Plantation shall preferably be carried out with the native species having minimal aftercare requirement and high survival rate
- Trees having high CO<sub>2</sub> and other pollutant absorbing capacity shall preferably be planted
- Exotic and ornamental species shall be avoided
- Regular monitoring of the plantation shall be done on fortnight basis
- Proper maintenance of machinery and oiling to minimize heating of the machinery and minimize the emissions
- Monitoring of DG Sets for performance evaluations
- Good quality of coolant shall be used to check the overheating of DG sets and other machineries.
- No CFCs/HFCs will be used for the project development
- All the electrical equipment (traction/auxiliary transformers) will be PCBs free completely in compliance to International Convention on Hazardous Materials. Transformer oil as per IS 12463 has been used in transformers
- Provision of sensors and alarm system to detect the leakage of SF<sub>6</sub><sup>11</sup> followed by tripping of circuit breakers in RMUs and switch breakers

**283. Impacts on Flora:** The major land use of the area is urban and along or within RoW of existing road, thus, no significant wild species of flora and fauna are found in project area. However, there are trees of various species in form of avenue plantations, homestead plantations etc within the proposed ROW which may require to be removed. Approx. 708 nos. of trees will be affected due to the project RoW and 50-60 trees due to the Kasheli depot. Most of these species are native and have thick canopy and provides various benefits to the eco-system like shade, oxygen, habitat to birds and small mammals etc. Cutting of these trees will impact the flora and associated benefits of this flora. Detailed impacts are discussed below

<sup>11</sup> The Gas Insulated switchboards and Circuit breakers are equipped with SF<sub>6</sub> gas density monitor for each breaker and busbar chamber. A SF<sub>6</sub> density monitor is a device that measures the density of SF<sub>6</sub> in a gas-insulated switchgear (GIS) or other electrical equipment. The monitor typically consists of a pressure sensor and a temperature sensor, which are used to measure the pressure and temperature of the SF<sub>6</sub> gas. In case of any leakage in the chamber an audible alarm will be generated by density monitor in switchboard and similarly an alarm will appear in SCADA workstation in OCC.

- A total of 0.6983 ha of Forest area having 31 numbers of mangroves at Kasheli is required to be cleared for project development. Mangroves offer a rich habitat to various floral and faunal species. Thus, loss of mangroves will significantly impact the ecology of area. However, the project is elevated and the land will be utilized for construction of piers only in the viaduct section so mangroves are likely to grow back between the piers.
- The construction of the proposed project will affect approx. 708 nos. of trees within the proposed RoW, which are to be cut, trimmed or transplanted. Out of 708, only 166 will be cut, 495 will be transplanted and 47 will be trimmed. This has minimized the loss of trees. Other than this, approx. about 110 trees exists at depot site which may need to be removed from the site. The impact on these trees and loss of vegetation cover may affect the local ecological balance, such as the disruption of habitat for birds, mammals, etc.
- There will be dust deposition on the leaves of the flora in the surrounding of the construction sites. Deposition of dust on the leaf surface will close the stomata and reduce the photosynthetic activity that will hinder the plant growth.
- Emission of the gaseous pollutants from the engine will impact the health of the floral elements.
- Also, exposure to spilled chemicals or oil, if mixed with the runoff, may damage of aquatic flora.
- Labour may cut the vegetation/trees for cooking fuel and other purpose. This will disturb the natural community and
- There are chances of fire setting out of the human activities and negligence.

Measures to prevent impact on flora are discussed below

- No labour camp shall be established on the forest land.
- The boundary of the diverted forest land shall be suitably demarcated. No additional or new path will be constructed inside the mangrove area for transportation of construction materials for execution of the project work.
- Alternate fuel shall be provided to the labours in the labour camps to ensure that no firewood will be used for cooking etc.
- Smoking, hunting & fishing shall be prohibited. Contractor shall conduct regular awareness trainings related to non-use of firewood, prohibition on smoking in natural areas, bush fires accidents, safe handling of animals (if encountered), prohibition of fishing etc.
- Noise will be kept under control by regular maintenance of equipment and vehicles. Noisy activity shall be prohibited during night in forest areas.
- Dust control measures will be adequately applied with the dust generating activities.
- Trees located outside the RoW shall not be felled. Minimum number of trees will be felled within the Row with transplantation of trees upto maximum possible extent will be performed as much as possible.
- The loss of trees shall be compensated through compensatory plantations in accordance with requirement of Tree Authority under Maharashtra (Urban Area) Tree Preservation Act, 1975 and its amendments. The height and collar girth (specie wise) shall be measured & recorded at the time of plantation. Data of height, collar girth and survival percentage (species wise) twice a year (April & November month) shall be recorded & and maintained.
- No labour camps shall be permitted in the vicinity of any water body in order to avoid the deterioration of water quality and any human induced impact on aquatic life nor shall workers be permitted to use waterbodies for bathing and washing.
- Designates place will be used to store the construction material. Proper care will be taken that no spill of the construction material or the debris shall take place and get mixed into any river body or washed away in heavy rains.
- Greenbelt development options shall be explored especially at depot site
- Moreover, all provisions of Environmental Management Plan made for the air, water,

noise pollution control will be implemented, and thus will also be helpful to control the negative impacts on the flora as well.

### Impact on Fauna

284. The alignment traverses through city/urban area and no wildlife exists in project area. SGNP and Thane Creek Flamingo Sanctuary are at distance of approximately 3.0 km, thus due to large distance impact of project is not anticipated on flora & fauna of SGNP and Thane Creek Flamingo Sanctuary. However arboreal and micro fauna associated with the tree/shrub vegetation may get impacted due to the project. Project also affect mangroves which may impact the fragile faunal eco-system with it. The alignment traverses also through the water body including Ulhas river which supports aquatic fauna. Approx 13 piers will be constructed at point of crossing the waterbody near Kasheli. Construction of piers may impact the water quality during construction and may affect the flow post construction, thereby impacting the habitat of the aquatic fauna. Impacts on fauna are listed below

- The removal of trees and other vegetation for the RoW will disrupt the habitat for birds, mammals, etc.
- During the construction phase, vegetation removal from the site will expose the large areas to the erosive forces of wind and rain. This will increase the suspended solids in the water bodies which may impact the aquatic organisms.
- Generation of noise and vibration may may disturb the fauna of the vicinity.
- Trespassing of the labour into the forests area or in the natural vegetation may disturb the faunal elements. Cutting of trees for fuel-wood, fire incidents are direct threats to the fauna and their habitats.

285. Measures proposed for mitigating the impact on fauna are given below:

- Smoking, hunting & fishing shall be prohibited in the natural habitats/forests.
- Awareness will be spread among the workers towards nature's conservation.
- All staff / workers will be instructed not to chase/hunt if any wildlife seen near the project area. The incidence of sighting wildlife near project site should be reported to Forest Department for safe handling.
- Construction activities will be avoided in night time near the natural habitats.
- All kind of the pollution and noise causing machinery/engines will be properly serviced to keep the disturbance level at minimum or under the prescribed limits.

286. **Impact due to Waste Generation:** Construction activities will produce excavated soils, construction materials and solid wastes (such as removed concrete, wood, trees and plants, packaging materials, empty containers, oils, lubricants, and other similar items). Waste anticipated to be generated during construction phase is given in **Table 6.10**. These wastes, if not managed properly, have potential to impact the air, water and soil quality of the project area.

**Table 6.10 : Waste Anticipated to be Generated during Construction Phase**

S. No.	Type of Waste	Activities Involved	Concerned Regulation in India	NOC required	Treatment	Disposal
1.	Municipal Waste	Domestic Usage by Labour and Staff, Kitchen/food waste, packaging waste (only bio-degradable like paper, cartons), Vegetation Removal, Discarded PPEs	Municipal Solid Waste (Management & Handling) Rules, 2016	NOC from local bodies	Composting of wet waste within site as feasible	If not treated to be given off to piggeries or to local bodies for disposal



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		like shoes, jackets etc.				
2.	Plastic Waste	Packaging plastic & foam Waste, disposable plates/glasses, HDPE & PVC pipes & drums, buckets, tarpaulins, water tanks and Waste from the snacks packets & water bottles in canteen majorly, Discarded PPEs like goggles, gloves, jackets, helmets, harness etc	Plastic Waste Management Rules, 2016	NOC from local bodies	--	Handed over to recyclers or to be given to local bodies for disposal
3.	Construction and Demolition Waste	Excavated muck, demolition debris, broken bricks, broken cement blocks, metal waste, wires, discarded machinery & tools, plywood/planks etc.	Construction and Demolition Waste Management Rules, 2016	NOC from local bodies	--	To be used for construction of road, backfilling and restoration of borrow pits. Surplus to be given to their construction projects in vicinity or disposed off to the C&D waste disposal site
4.	Hazardous Waste	Used engine and hydraulic oil, waste oil, greased cotton, empty paint tins, dried paint, dried cements, cement slurry, discarded hazardous chemicals, used transformer oil, air filters etc.	Hazardous & Other Waste (Management & Transboundary Movement) Rules, 2016 as amended	NOC from SPCB	--	To be given to recyclers or to TSDF site for disposal
5.	Battery Waste	Lead Acid batteries in vehicles, workshops	Battery Waste Management Rules, 2022	NOC from SPCB/CPCB	--	To be sold to recyclers
6.	Bio-Medical Waste	Waste from OHCs, first aid kits in labour camps, vehicles & ambulance etc.	Bio-Medical Waste Management Rules, 2016	NOC from SPCB/CPCB	--	To be disposed off through authorized recyclers and disposal site
7.	E-Waste	Used electronic appliances like laptops & its	E-waste (Management) Rules, 2016	Return to be filled and	--	To be sold to authorized

		accessories, computers & its accessories, printers, ACs, Xerox machines, Microwaves, Induction, Digital gauges etc.	and subsequent amendments	submitted to SPCB/CPCB		recyclers and disposal sites
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287. Measures proposed to minimize the impacts on fauna are given below

- Contractor shall follow and comply with all the rules pertaining to the management and disposal of waste in India as described in Table 6.10
- Contractor shall obtain NOC for generation, management and disposal of all kind of waste generated from SPCBs and local bodies as applicable.
- Contractor shall follow the conditions of all the NOC obtained pertaining to the waste generation
- Waste generated at the site shall be segregated at source and treated or re-used at site to the extent possible. Recyclable materials shall be segregated and sold to the authorized recyclers. Reject fraction of waste shall be disposed-off through the authorized local waste management agencies in the area
- If local agencies/facility for waste collection and disposal are not available for municipal and C&D waste, in the project area then contractor shall identify the sites for waste/construction debris disposal. Debris disposal sites shall be selected prior to start of construction and approval shall be obtained from MMRDA prior the start of construction.
- Any hazardous materials to be used will also need to be stored and handled correctly to prevent spills and pollution. Hazardous material shall be stored in covered conditions only in the confined location and shall be provided with the containment for any spillage. Hazardous waste containers shall properly be marked and kept in isolated locations only. Hazardous waste transportation shall be carried out only through the authorized transporters and TREM card shall be maintained for transportation
- Effort shall be made to re-use C&D waste to the possible extent such as filling material for casting yards or other local construction projects. Surplus shall be sent for recycling to the recyclers or for disposal at approved sites
- Excavated soil shall be used for backfilling excavations and surplus shall be given to the other construction projects in vicinity or disposed-off to the C&D waste disposal site
- No dumping should be carried out outside the RoW including private and government land, road side, low lying areas, wetlands, water bodies, forest area, ecologically sensitive areas etc.
- All the workers engaged in waste management shall be provided with the adequate PPEs like jackets, gloves, masks, face shield etc
- Waste generation shall be minimized by providing adequate material storage and covering facility and providing training to the workers for proper handling of the material and machinery

288. Impacts **on Topography and Appearance:** Construction activities of the project will bring permanent changes in the local-level topography and appearance of the project site. There will be loss in aesthetic beauty of the project area mainly due to the construction, barricading, staging of machinery, stockpiling of material & debris etc. The following **Table 6.11**, elaborates potential effects on the topography and appearance and appropriate mitigation measures.

**Table 6.11 : Potential Effects on Topography by the Proposed project**

SI. No.	Construction activity	Potential effect on topography and appearance	Mitigation measures
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1	Stone quarrying	Scarring of landscape and potential landslides (rock slides/falls). There may be permanent changes in the landscape.	Stone quarrying should only be undertaken in legally approved areas. Controlled and environmentally friendly quarrying should be carried out to minimise landslides and erosion.
2	Earthwork from borrow areas (However borrow area may not be established for the project and material may be procured from licensed vendors preferably)	Scarring of landscape due to unearthing activities. Minor but permanent changes in landscape.	Borrow areas should be in legally approved locations. As soon as construction activities are complete, they should be re-vegetated and brought back as far as possible to their previous appearance.
3	Waste disposal	Disposal of cut soils and debris at improper locations will make the area look untidy and unattractive.	Cut off material should be used for project development or shall be given to other projects for re-use
4	Establishment of labour camps	Disposal of waste and litter at improper locations and deforestation for fire- wood will make the area look dirty and unattractive.	Provision and allocation of proper waste disposal bins and sites are required. A supply of cooking gas should be provided by the contractor to eliminate the use of fire wood.

289. Measures proposed for minimizing the impact on aesthetics are given below:

- Proper housekeeping shall be carried out at site
- Entire site shall be barricaded by full height barricades as per design approved by MMRDA
- No machinery/equipment/vehicle shall be staged/parked outside the project site/RoW
- No material/debris shall be piled up/stacked outside the RoW. All materials shall properly be stacked neatly within the project RoW/Casting Yards/Storage yards
- Proper dustbins and waste storage area shall be provided at the project site to store waste. Waste storage bins/areas shall be covered

290. **Impacts on Occupational Health and Safety:** Workers need to be mindful of occupational hazards that can arise from construction works. Exposure to work-related chemical, physical, biological and social hazard is typically intermittent and of short duration but is likely to reoccur. Anticipated impacts are listed below:

- Accidents due to construction activities, operation of heavy construction machinery & electrical appliances & cables, transportation of construction & waste materials, handling of hazardous chemicals & explosives, exposure to UG/OH utilities, external traffic, biological hazards like venomous snakes & wild animals, exposure to heat/high temperature, drowning due to work on/near water body etc may affect health and safety of worker at the project site
- There may be probability of spreading of contagious diseases like Covid-19 and Cholera due to creation of unhygienic conditions at the site & labour camps etc.
- Chance of spreading of sexually transmitted diseases (STDs) among the construction workers like HIV/AIDS
- Habit of intoxications is also a labour health associated issue, and this may also affect

mental peace and health of others too.

- There may be chances of labour suffering with dust associated respiratory diseases, due to dust generation from the construction activities, operation of batching plant, transportation and handling of construction and waste material, operation of quarry and crusher unit etc.
- There may be impact on the workers' health like temporary or permanent loss of hearing abilities by noise and vibration generation due to construction and associated activities

291. Potential impacts on occupational health and safety are negative and long-term but reversible by mitigation measures. Overall, the contractor should comply with IFC EHS General and Railway Guidelines on Occupational Health and Safety. Other measures for mitigating the impacts are given below:

#### **Health Related Measures**

- Contractor shall have safety and health management system for all the construction activities to control and prevent any occupational accidents as per the National and International guidelines whichever is stringent as applicable
- Contractor shall implement workers health awareness and surveillance program including health check-ups, regular health monitoring systems for the workers, vaccination drives for prevention of diseases and awareness program
- Contractor shall establish occupational health centres at multiple locations and ensure availability of adequate first aid kits, first aiders, nurses, occupational officers at OHC 24 X 7 as per the National and International guidelines whichever is stringent as applicable
- Workers shall be providing with the hydrating drinks like ORS as required to prevent heat stress/exhaustion
- Provision of covered rest areas at regular intervals with proper facilities like resting desks, drinking water facility, toilets etc.
- Contractor shall provide all the facilities such as potable drinking water, toilets with water facility, kitchen area, clean cooking fuel, proper bedding, adequate no of toilets and bathing areas, maintenance of cleanliness and sanitation etc at the labour camp site. Labour camp establishment shall strictly follow the BOCWA, 1996 and the Maharashtra BOCW Rules, 2007
- Ambulance with all the required facilities as per BOCWA, 1996 and the Maharashtra BOCW Rules, 2007, should be provided at all work sites to take injured persons to hospitals.
- Emergency contact details (including nearest hospitals and health centres) should be displayed at appropriate locations at construction sites & labour camps.
- Full time medical facility should be provided at each labour camp with first aid kits & first aider
- Sufficient supply of potable water should be ensured for all workers and employees on-site. Conducting regular monitoring of drinking water quality at site and labour camps
- Provision of dust and noise shields and maintenance of adequate distance between the workers and noise/dust generation activities as applicable
- Contractor shall implement administrative controls like practicing job rotation, maintaining work hours of labour, implementing work permit system, implementing LOTO, for the workers to prevent continuous exposure to dust, noise, heat, etc.
- Workers shall be provided proper training to handle any health-related emergency if any.
- All workers and staff should be provided with Personal Protective Equipment (PPE) appropriate to their job on site to minimize exposure to the dust and noise like masks, ear plugs etc.
- EMP for dust and noise control shall strictly be followed as suggested.
- Framing and implementation of drugs/intoxicants prohibition policy by contractor during the construction phase
- Ensuring availability of snake charmers at the site 24X7 for catching the snakes and contacts details of the snake catching organizations shall be provided at the site to

handle the situation in case of sighting of a snake. Anti-venoms can be kept in the nearest hospitals/PHCs to treat the snake bites if any

- Drinking water quality, air quality and noise level shall regularly be monitored at all the labour camps sites as per CPCB guidelines in regular intervals as suggested in EMoP
- COVID-19: WHO has declared COVID-19 as a pandemic which has affected entire world including India. In view of the prevailing COVID-19 pandemic, the contractors and workers would need to take additional measures to avoid the spread of the disease and shall follow various guidelines/guidance notes issued by the national/state government, WHO, ILO, World Bank/IFC from time to time. As described in these guidelines, the Contractors shall undertake a COVID-19 risk

### **Safety Related Measures**

- Safe work method statement including HIRA shall be prepared and implemented for all the construction activities
- Provision of adequate fire detection and firefighting system at the site like extinguishers, sand buckets, fire blankets, usage of fire-resistant materials/wires etc
- Contractor shall prepare emergency preparedness plan to handle any contingency due to construction accidents and natural or man-made disasters like earthquakes, floods and dust storms
- Contractor shall develop traffic management plan to prevent any traffic related accidents at or outside the site. Contractor shall provide defensive training to the drivers to minimize the accidents
- Contractor shall fence all electric sub-stations, high-tension towers and other areas to minimize electrocution risk and shall also provide proper earthing, proper warning signs and conduct security patrols.
- Contractor shall ensure provision of safe work environment, provision of competent supervision, provision of safe equipment & machinery and provision of proper training to ensure safety at work site
- Contractor should appoint an agency to provide awareness about the prevention of STDs among the workers. The agency shall work in close coordination with NACO and SACS for organizing the awareness campaigns. Workers shall be provided with the condoms and diaphragms as required for minimizing spread of STDs
- Regular home visit holidays shall be given to the workers to ensure their proper mental health
- All workers shall be provided with job specific training, behavioural based safety training and awareness for ensuring the safety
- Smoking shall be prohibited at the site to prevent the health and fire hazard
- All construction sites should be barricaded with proper tamper proof fencing & security lighting and conduct regular security patrols and other security measures. All the construction activity and storage of material shall be strictly within the RoW. All hazardous chemicals & waste and explosives (if any) shall be stored as per the guidelines in the respective laws
- Avoiding usage of the chemicals or paints which may impact the health of the workers or community and shall encourage use of the VOC free paints etc. No banned material like asbestos shall be used at the construction site
- All workers and staff should be provided with Personal Protective Equipment (PPE) like safety jackets, helmets, gloves, goggles, life jackets in case of work on/near water body appropriate to their job on site to minimize exposure to the hazards
- Coordination with local police to curb the anti-social activities and usage of drugs & narcotics.
- Contractor will have regular monitoring and audits/inspection system for ensuring effective implementation of safety management system and shall ensure continuous improvement of its safety management system
- All the workers shall be tested for vertigo prior assigning working at height. Workers working at height shall be provided with the adequate PPEs like Harness with lifelines,

Safety Jackets, Goggles and helmets

- Proper safe and wide working platform with railing shall be provided for the workers working at height. These working platforms shall be anti-slipping type
- A safety expert shall always be available at the site to supervise works being carried out at height
- All the ladders, platforms shall be inspected prior installation and shall regularly be inspected for fitness
- Manlifts shall be avoided and if is required all precautions shall be taken to ensure the safety
- Electrical safety inspections shall be conducted on daily, weekly and monthly basis. Scores for the monthly electrical audits shall be checked and improved every month to achieve the higher safety score.
- External electrical safety audits shall be conducted annually to ensure the electrical safety
- Findings of all the inspections and audits shall be closed with satisfactory requirements within given time frames by auditors/safety experts/electrical engineers
- Follow up audits/inspections for electrical and general safety shall be performed for verification of closure of the findings of inspections and audits
- Usage of silicon oil as replacement fuel
- Electrical safety at the site shall be ensured as per IEC-61439-1 & ISO-14001. Specific electrical safety measures are given below
  - Proper earthing of all electrical equipment is ensured as per IS 3043 and IEEE 80.
  - Proper Permit to work system is followed for proper isolation and safe working for all sections.
  - Lightning protection is provided as per IS 2309.
  - All electrical switchgears are equipped with latest numerical relays to isolate any faulty section within minimum time.
  - Fire alarm and detection system is installed as per IS 2189: 2008.
  - Electric shock and treatment chart and artificial respirators are provided at each installation of MMRDA lines as per CEA guidelines.
  - Insulating mat as per IS 15652 are provided for each HV and LV switchgears.
  - Regular awareness programs regarding electrical safety are being conducted for ensuring proper safety.

292. **Impact on Community Health:** Impacts on community health due to proposed project are discussed below

- Associated risks from accidents will affect health and safety of nearby residents in and around the project site.
- There may be probability of spreading of contagious diseases like Covid-19, Cholera, STDs, etc.
- There may be chances of suffering with dust associated respiratory diseases from the crusher unit, transportation of construction and waste material etc.
- There may be impact on the community like sleep disturbances, reduced hearing abilities by noise and vibration generation due to construction and associated activities
- Increase of crime like thefts, social unrest, unfair practices etc., in nearby communities due to establishment of labour camps

293. Measures proposed to mitigate the impact are discussed below

- All construction sites should be surrounded with secure tamper proof fence, with security lighting, regular security patrols and other security measures to prevent trespassing. Only authorised person shall be allowed to enter into the construction camps/sites.
- Contractors shall have health and safety management system to effectively prevent any accidents happening at construction sites.

- All materials and components should be stored and stacked safely in dedicated secure areas.
- Avoid use of any paints containing lead or its compounds as well as high VoCs and any banned material like CFC, asbestos etc.
- Public health system capacity relies on detecting, testing, contact tracing, and isolating those who are or might be sick, or have been exposed to known or suspected communicable diseases. It is important to stop broader community transmission and prevent communities from having to implement or strengthen further community mitigation efforts. This can be done by organizing regular community health check-ups. Awareness program and vaccination camps will be organized in the nearby settlements/villages.
- Ensure that first aid kits are available in all working areas, supplied with adequate material and medicine as per the BOCWA 1996. Facility of ambulance needs to be ensured.
- Record of all nearest hospitals and health centres should be kept at each construction sites.
- EMP for dust and noise control shall strictly be followed as suggested.
- Labour camps shall preferably be established at minimum distance of 500m from the residential/institutional areas
- Framing and implementation of drugs/intoxicants prohibition policy by contractor during the construction phase

**294. Impact on Indigenous/Tribal Communities:** Indigenous communities are the communities that live within, or are attached to, geographically distinct traditional habitats or ancestral territories, any which identify themselves as being part of a distinct cultural group, descended from group present in the area before modern states were created and current borders defined. The project area traverses through Thane District of Maharashtra and presence of no such indigenous or ethnic community is reported in project area. No indigenous or tribal community is found to exist in the project area thus no impact is anticipated due to project development on indigenous/tribal communities due to the project development.

**295. Impacts on Socio-Economic Activities:** Manpower is required during the 30 months construction phase. This can help generate contractual employment and an increase in local revenue. Thus potential impact is positive and short-term. However, the contractor will need to adopt the following mitigation measures:

- Leave space for access between mounds of soil.
- Provide walkways and metal sheets that were required to maintain access to shops/businesses along trenches.
- Consult businesses and institutions regarding operating hours and factoring this into work schedules.
- Provide signboards for pedestrians to inform the nature and duration of construction works and contact numbers for concerns/complaints.
- Employ at least 50% of the labor force, or to the maximum extent, local persons within the 2-km immediate area if manpower is available

**296. Sensitive location such as School, College and Hospital along the Project.** As per the safeguard survey no sensitive locations. Adequate compensation will be provided as per RAP. No CPR is being affected due to the project.

**297. Impact due to Labour Camp:** There may be involvement of approx. 1000 labour/staff during construction phase and labour camp is required to be established. Land will be required for establishment of the labour camps which may lead to change in the land use temporarily. Further for establishing the labour camp, there may be requirement of clearing the vegetation and cutting of tree. Labour camps if established close to the existing residential areas may



increase the stress on existing resources being used by the nearby community and also may increase the social unrest in the area. Due to improper unhygienic and sanitation conditions at the labour camp, there may be spread of infectious and contagious diseases like Covid-19, Cholera, STDs, etc. Dumping of the waste and sewage to be generated from the camp site may impact the soil, water and air quality of the area also. However, the labour camps will be established only upto the construction period, thus impact anticipated is short-term and temporary. Detailed environmental and social risks due to establishment of labour camps is given below

#### i. Environmental Risks and Impacts

- **Inadequate waste disposal and illegal waste disposal sites:** Large population of migrant labours generate increased amounts of waste, for which no sufficient local waste management capacities may exist, which would likely lead to improper disposal practices.
- **Wastewater discharges:** Project-related activities, along with workers' camps and a lack of appropriate wastewater discharges may pollute nearby water resources. Major health risks can occur if latrine pits spill over into local streams that are used for drinking water by the host community.
- **Increased demand on freshwater resources:** The provision of clean drinking water and water for hygiene purposes can result in increased pressure on freshwater resources in the project or camp site area.
- **Camp related land use, access roads, noise and lights:** In ecologically sensitive areas, workers' camps can have impacts on the local wildlife. This may include disturbance of species, as well as illegal hunting. In the same context, new access routes for workers' camps may have impacts on natural habitats. However proposed project does not traverse through ecological sensitive areas
- **Increased deforestation, ecosystem degradation, and species loss:** These can result from forest or land conversion for worker housing/ labour shed and migrant labours' agricultural subsistence activities
- **Increased use of / demand for natural resources:** This can include logging for construction, fuel wood collection, use of water resources, farming and grazing, hunting and fishing, potential introduction of invasive or non-native species, and land degradation.

#### ii. Social Risks and Impacts

- **Risk of social conflict:** Conflicts may arise between the local community and the migrant labours, which may be related to religious, cultural or ethnic differences, or based on competition for local resources. Tensions may also arise between different groups within the labor force and pre-existing conflicts in the local community may be exacerbated. Ethnic and regional conflicts may be aggravated if workers from one group are moving into the territory of the other.
- **Increased risk of illicit behaviour and crime:** The influx of migrant labours into communities may increase the rate of crimes and/or a perception of insecurity by the local community. Such illicit behaviour or crimes can include theft, physical assaults, substance abuse, prostitution and human trafficking. Local law enforcement may not be sufficiently equipped to deal with the temporary increase in local population.
- **Influx of additional population (“followers”):** Especially in projects with longer timeframe, people can migrate to the project area in addition to the labor force, thereby exacerbating the problems of labor influx. These can be people who expect to get a job with the project, family members of workers, as well as traders, suppliers and other service providers, particularly in areas where the local capacity to provide goods and services is limited.
- **Impacts on community dynamics:** Depending on the number of migrant labours and their engagement with the host community, the composition of the local community, and with it the community dynamics, may change significantly. Pre-existing social conflict may intensify as a result of such changes.

- **Increased burden on and competition for public service provision:** The presence of migrant labours (including their families) can generate additional demand for the provision of public services, such as water, electricity, medical services, transport, education and social services. This is particularly the case when the influx of migrant labours is not accommodated by additional or separate supply systems.
- **Increased risk of communicable diseases and burden on local health services:** The influx of migrant labours may bring communicable diseases to the project area, including sexually transmitted diseases (STDs), or the incoming migrant labours may be exposed to diseases to which they have low resistance. This can result in an additional burden on local health resources. Workers with health concerns relating to substance abuse, mental issues or STDs may not wish to visit the project's medical facility and instead go anonymously to local medical providers, thereby placing further stress on local resources. Local health and rescue facilities may also be overwhelmed and/or ill-equipped to address the industrial accidents that can occur in a large construction site.
- **Child labor and school dropout:** Increased opportunities for the host community to sell goods and services to the incoming migrant labours can lead to child labor to produce and deliver these goods and services, which in turn can lead to enhanced school dropout.
- **Local inflation of prices:** A significant increase in demand for goods and services due to labor influx may lead to local price hikes and/or crowding out of community consumers.
- **Increased pressure on accommodations and rents:** Depending on project worker income and form of accommodation provided, there may be increased demand for accommodations, which again may lead to price hikes and crowding out of local residents.
- **Increase in traffic and related accidents:** Delivery of supplies for migrant labours and the transportation of migrant labours can lead to an increase in traffic, rise in accidents, as well as additional burden on the transportation infrastructure

298. Measures proposed to be undertaken to prevent the impact on labour camps are listed below and in **Table 6.12**.

- Camp locations should be carefully selected to avoid the land use categories: residential, sensitive and Eco sensitive areas. Distance of minimum 500 m shall be maintained between the said land use and labour camp locations. Camps sites shall preferably be established on waste and barren land so as the vegetation removal and tree cutting can be minimized.
- Camps shall also be established at approx. 500 m distance from the water bodies to prevent any impact on the water body
- NOC shall be obtained from the land owner and the concerned authority prior establishment of the labour camp.
- Land shall be restored back to its original condition immediately after the completion of construction works and prior handing over the land back to the land owner. All waste materials, temporary/permanent structures etc shall be removed from the camp site and the site shall be re-vegetated with the native species of trees
- Training and awareness shall be provided to the labour to not indulge in the unfair practices
- Labour camp should be enclosed with boundary wall.
- Movement of the workers should be monitored by providing adequate security checks and all the workers shall be checked for availability of valid ID cards.
- A cooked food canteen on a moderate scale shall be provided for workers so that they can have their meal at a definite place. All the wastes generated from the canteen shall be treated/disposed of as detailed in the other sections of the waste disposal. The labour need not to depend the nearby facilities for food and so interaction with the nearby community will be minimised.

- Firewood and other conventional fuels like dung cakes, paper, waste materials etc shall not be used for cooking and camp fire . Contractor must provide only clean fuel for cooking like LPG gas.
- Health problems of the workers should be taken care of by providing basic health care facilities through a health centre set up at the construction camps. The health centre will have at least a doctor (part time), nurses, duty staff, medicines and minimum medical facilities to tackle first-aid requirements for minor accidental cases. Some arrangements will be made with the nearest hospital to refer patients of major illnesses or critical cases. The health centre will carry out quarterly awareness programme of HIV – AIDS with the help of AIDS control society. Posters will be exhibited in the health care clinic for awareness. This will not only be beneficial for the labours/workers health but also very significant to protect the health of the nearby communities especially against the contagious diseases.
- Facilities at the camp sites shall be provided as per BOCWA, 1996 so as to establish proper sanitation facility and waste management system at the site to prevent impact on air, water and soil quality of the area. Details are presented below:
- Construction camps shall be provided with sanitary latrines and urinals with the water facility. Closed drainage systems and the proper sewage treatment system according to the local conditions should be provided for proper disposal meeting the standards as prescribed by CPCB. If sewage generation is more than 10 KLD then STP shall be provided if less than 10 KLD then sewage can be disposed through septic tank/soak pit. Soak pits shall not be provided within 100 m of the water body or any water source to prevent impact on water quality
- Food waste shall be handed over to the piggeries or any pig farm in nearby areas. Food and other compostable waste can also be treated within the camp through composting (vermi composting/pit composting/organic waste convertors).
- All the municipal waste shall be disposed off through the authorized local waste management agencies only if any in-house treatment facility is not available
- A Waste disposal and management plan will be prepared by the contractor before start of construction works and submitted to MMRDA for their review and approval.

**Table 6.12 : Labour influx Risks and Management Measures**

Sl.no	Labour Influx Risks and Impacts	Management Measures
<b>Environmental Risks and Impacts</b>		
1.	Inadequate waste disposal and creation of illegal waste disposal sites	<ul style="list-style-type: none"> <li>• Reduction of waste generation;</li> <li>• Sound practices for waste disposal</li> </ul>
2.	Wastewater Discharges	<ul style="list-style-type: none"> <li>• Ensuring workers' camp and ancillary facilities are connected to septic tank or other wastewater systems which are appropriate and of sufficient capacity for the number of workers and local conditions.</li> </ul>
3.	Increased demand on freshwater resources	<ul style="list-style-type: none"> <li>• Water conservation and recycling of water;</li> <li>• Consideration of use of rainwater where feasible;</li> <li>• Avoiding contamination of fresh water sources</li> </ul>
4.	Camp related land use, access roads, noise and lights	<ul style="list-style-type: none"> <li>• Placement of workers' camp away from environmentally sensitive areas to avoid impacts on the local wildlife;</li> <li>• Routing of new access routes for workers' camp to avoid/minimize environmentally sensitive areas.</li> </ul>

5.	Increased deforestation, ecosystem degradation, and species loss	<ul style="list-style-type: none"> <li>• Only wood from commercial sources to be used on the project;</li> <li>• Use of wood for fuel prohibited;</li> <li>• Reduction in energy demand, reduced noise and light generation, reduced and safe use of dangerous chemical substances.</li> </ul>
6.	Increased use/demand on natural resources	<ul style="list-style-type: none"> <li>• Minimized land use change and use of other natural resources;</li> <li>• Avoidance of deforestation around camp area;</li> <li>• Prompt and effective response to environmental and social issues raised by supervision engineer.</li> </ul>
<b>Social Risks and Impacts</b>		
7.	Risk of social conflict	<ul style="list-style-type: none"> <li>• Provision of information regarding Worker Code of Conduct in local language(s);</li> <li>• Provision of cultural sensitization training for migrant labours regarding engagement with local community.</li> </ul>
8.	Increased risk of illicit behaviour and crime (including prostitution, theft and substance abuse)	<ul style="list-style-type: none"> <li>• Paying adequate salaries for migrant labours to reduce incentive for theft;</li> <li>• Paying salaries into workers' bank accounts rather than in cash;</li> <li>• Sourcing of local workforce;</li> <li>• Creation of supervised leisure areas in workers' camp;</li> <li>• Cooperation with local law enforcement;</li> <li>• Introduction of sanctions (e.g., dismissal) for workers involved in criminal activities;</li> <li>• Provision of substance abuse prevention and management programs</li> </ul>
9.	Adverse impacts on community dynamics	<ul style="list-style-type: none"> <li>• Provision of services in the workers' camp to reduce the need for workers to use local community facilities;</li> <li>• Provision of entertainment and events for migrant labours within camp to reduce incentives for mixing with local community</li> </ul>
10.	Influx of Additional Population ("Followers")	<ul style="list-style-type: none"> <li>• Contractor to hire workers through recruitment offices and avoid hiring "at the gate" to discourage spontaneous influx of job seekers.</li> </ul>
11.	Increased burden on public service Provision	<ul style="list-style-type: none"> <li>• Workers' camp to include wastewater disposal and septic systems;</li> <li>• Identification of authorized water supply source and prohibition of use from other community sources;</li> <li>• Separate service providers for community and workers' camp/construction site;</li> <li>• Worker Code of Conduct on water and electricity consumption.</li> </ul>

12.	Increased risk of communicable diseases (including STDs and HIV/AIDS)	<ul style="list-style-type: none"> <li>• Vaccinating migrant labours against common and locally prevalent diseases;</li> <li>• Contracting of an HIV service provider to be available on-site;</li> <li>• Implementation of HIV/AIDS education program;</li> <li>• Information campaign on STDs among the migrant labours and local community;</li> <li>• Education about the transmission of diseases;</li> <li>• Provision of condoms</li> </ul>
13.	Child labor and school drop out	<ul style="list-style-type: none"> <li>• Ensuring that children and minors are not employed directly or indirectly on the project.</li> </ul>
14.	Local inflation of prices and crowding out of local consumers	<ul style="list-style-type: none"> <li>• Appropriate mix of locally and non-locally procured goods to allow local project benefits while reducing risk of crowding out of and price hikes for local consumers</li> </ul>
15.	Increased pressure on accommodation and rents	<ul style="list-style-type: none"> <li>• When accommodation supply is limited establishment of workers' camp facilities with sufficient capacity for workers including sub-contractors and associated support staff</li> </ul>
16.	Increased traffic and rise in accidents	<ul style="list-style-type: none"> <li>• Preparation and implementation of a traffic management plan to be approved by Engineer – in charge;</li> <li>• Building additional/separate roads to project and workers' camp sites;</li> <li>• Organization of commute from camp to project to reduce traffic;</li> <li>• Road safety training and defensive driving training for staff;</li> <li>• Sanctions for reckless driving</li> </ul>

## 6.6. Post – Construction Impacts and Mitigation Measures

299. **Impacts on Land Use:** Project may not have any direct impact on land use during operation phase but Development of the project may lead to enhancement of land price of the adjoining land parcels. Development authorities may also additional FSI permission along the metro corridor under Transit Oriented Development (TOD) which will enhance the infrastructure development in the area. This is anticipated to be positive impact for the socio economy, however pressure on existing resources in area such as parking space, green spaces, water resources, air quality, water quality, drainage, sewerage system etc will increase due to many-folds increase in population. Some of the mitigation measures are proposed below to minimise are given below

- Local development authorities of the affected area shall work on upgradation of basic facilities like drainage, waste management, water resources etc of the area prior sanction of increase in FSI.

300. **Impact on Soil Quality:** Soil quality at the stations may get impacted if the sewage generated and the waste generated at the stations is not managed properly and is disposed off in open on land. It is estimated approx. 25.2 KLD of sewage will be generated from stations. However, there is provision of the septic tanks for disposal of sewage at the stations.

301. Waste to be generated during operation phase will be municipal waste comprising of small quantity of food waste, wrappers of packed food and paper waste from offices. Small quantity of used oil may be generated from DG sets. Twin colour dustbins will be provided at the station for collection and at source segregation of waste into recyclable and rejected fraction. Recyclable

fraction will be sold to authorized vendors on regular basis and rejected fraction will be disposed off through local agencies in the area responsible for waste management. Used oil will be disposed off through the authorized vendors. Measures proposed to be taken for minimizing impact on soil quality are listed below

- Disposal of sewage through septic tank at stations and timely evacuation of the septic tanks.
- No area should be left excavated or open after any repair & maintenance works
- Fuel, waste oil & used oil should be stored in HDPE containers in isolated areas on paved surface. These paved surfaces should be provided with the drains and oil interceptors should be installed in the drains.
- Hazardous waste, if any should be stored, managed, transported and disposed as per Hazardous & Other Waste Rules, 2016
- Authorization shall be obtained from SPCB for generation of hazardous waste
- Waste generated should be properly collected and segregated at each station in twin bin system. Recyclable fraction of waste should be sold to authorized vendor periodically and non-recyclable/rejected version should be disposed on daily basis through local agencies in the area responsible for waste management
- Used oil shall be disposed through authorized vendor only

**302. Impact on Water Resources and Quality:** Total Water Demand for Operation & Maintenance is 73 KLD. The water demand at stations and depot shall preferably be met through piped water supply or ground water as per availability. Water quality during operation phase may get impacted due Contamination of the runoff due to spillage and improper storage/disposal of fuel from parking areas and due to improper discharge of untreated sewerage, wastewater and waste to be generated from station and depot sites. Measures to prevent impact on water resources of the area are given below

- Minimize water requirement by using water conservation measures such as providing visual notice for water conservation, low flow taps and dual flushing system in toilets etc.
- Prevent leakage of water from water pipeline and water tanks
- Provision of STP preferably if sewage is more than 10 KLD. Using the STP treated water for flushing and landscaping
- If sewage is disposed off in septic tank/soak pit, these shall be timely emptied and septage shall be disposed off through authorized agencies to nearby STP
- Hazardous material, hazardous waste, other waste and fuel shall be stored in covered condition on paved surfaces
- Adequate sanitation facility shall be provided at stations and depot in accordance to CPHEEO and CPCB/SPCB norms
- Sewage and the wastewater from the depot/maintenance sites shall be treated upto the prescribed standards of CPCB. Treated water shall be re-used at site by deploying appropriate techniques like dual plumbing system for flushing, landscaping and dust suppression system at depot site
- Waste shall be stored, managed and disposed off as per the waste management laws of country
- No area should be left excavated or open after any repair & maintenance works so as there will not be chance of sediments getting mixed with the rainfall run-off
- Proper storm water drainage system and rain water harvesting pits should be provided to harvest the storm water and recharge the same into ground water aquifer system to augment the ground water level and reduce the run-off into the surface water bodies. Along with the stations, it is also proposed to provide the pits at the viaducts to harvest the storm water from viaducts also
- Storm water drains and pits shall be cleared every year prior start of monsoon
- ETPs shall be provided at the depot for treatment of waste water from repair and maintenance facilities.

303. **Impacts on Air Quality (Air quality Emissions).** No significant impact on air quality is envisaged due to operation of metro rail project as entire project is electrified. Air quality may get impacted due to operation of DG sets at stations/depot during power failure which is very minimal. Measures to minimize the air quality degradation are given below

- Provide adequate height of the stack of DG set to have wider dispersion of the gaseous emission and also to attain the mixing height.
- Regular stack monitoring of DG set will be done to check their emission level.
- Water sprinkling to be carried out at depot and station area to minimise dust.
- Sufficient parking space should be available at all the stations so as people can leave their private vehicle and travel in metro. Further parking of private vehicle should not lead to congestion on roads.
- Wide access pathways and sufficient nos. of exit & entry should be provided at each station to minimize the congestion
- Rumble strips should be provided on the roads in front of stations so as the speed of vehicle is regulated near station area and chances of accident is minimized
- Adequate feeder services should be provided so as to maximize the catchment area of proposed metro system and minimize the usage of private vehicle to reach the station. These feeder buses should be integrated and linked to city bus services and other para-transit systems like auto rickshaws and Non-motorized vehicles (NMVs)
- Roads in the station area should be properly maintained and sprinkled with water

304. **Noise Impacts:** During the operation phase the main source of noise will be from running of metro trains. Existing data shows that the noise levels inside the rail transit cars ranges between 65 to 105 dB(A) during normal operation, but it will depend on various factors like train speed, type of way structure, sound insulations of car body, type and design of mechanical equipment, cooling fan noise, wheel-rail interaction, electric generator etc. A study was conducted by National Physical Laboratory for Delhi metro for noise levels in elevated and underground metro stations. The Noise Level at 15 m from track Centre Line and at 25 km/h is  $75.0 \pm 10.0$  while interior noise level is about  $78.0 \pm 8.0$ .

305. The major noise level generating activities includes; Approach and breaking of rolling stocks, Rolling stock leaving from station, during its travel between two stations and announcements on the Metro station. Noise radiated from train operations and track structures generally constitute the major noise sources. Airborne noise is radiated from elevated structures. The noise level at 2 m distance from the rail alignment is about 73 dB(A). Typical noise level at Exterior and Internal Tracks Noise Levels are given in **Table 6.13**.

**Table 6.13 : Average Noise Level at Exterior and Interior Tracks**

Elevated Tracks		Internal Tracks	
Background Noise Level	64.0± 1.5	Train stationary	62.0± 1.0
Train entering the PF (Max)	84.0± 1.5	Train starting	62.0± 1.0
Train leaving the PF (Max)	84.0± 0.5	Train motoring	70.0± 2.5
Train stopping in PF	79.0± 0.0	Train coasting	72.0± 2.0
Train stationary in PF	76.0± 0.5	Train at max. speed	78.0± 1.0
Train starting from PF	78.5± 1.0	Train decelerating	69.0± 0.5
Train braking	86.0± 0.0	Train stopping	64.4± 1.0
Announcement	74.0± 0.5	Train braking	74.5± 1.0
Overall	76.0± 7.0	W/R Noise	75.0± 1.5
		Overall	69.0± 5.0

306. Basic sources of wayside airborne noise

- Wheel / Rail Noise: Due to wheel /rail roughness
- Propulsion Equipment: Traction motors, cooling fans for TM, reduction gears etc.
- Auxiliary Equipment: Compressors, motor generators, brakes, ventilation systems, other

- car mounted equipment
  - Elevated Structure Noise
    - o At low speed (<15 km/h) auxiliary equipment may predominate
    - o At speeds up to approx. 50 km/h, W/R noise predominates
    - o At speeds greater than 50 km/h, the propulsion equipment noise predominates
    - o For light weight steel elevated structures, the structure noise can predominate at all speeds above 15 km/h.
307. Wide range of noise levels depends on following factors:
- Train speed (V): Car interior noise levels vary from 15 log<sub>10</sub> V to 40 log<sub>10</sub> V.
  - Type of Way structure: Noise levels lowest on AG ballast and tie-welded track and highest for operations on light-weight structures
  - Sound Insulations of car body: Single leaf or Sandwich construction.
  - Type & Design of Mechanical Equipment: Propulsion system & Auxiliary Equipment (A/c system, compressors and motor generator sets).
  - Wheel and Rail conditions: Rail corrugations and wheel flats can increase the noise levels by 10- 15 dB(A).
308. To manage the high noise and vibration level due to metro train operation, following measures shall be adopted
- Provision of anti dumping floor and noise absorption material
  - Low speed compressor, blower and air conditioner
  - Mounting of under frame equipment and anti-vibration pad
  - Smooth and gradual control of door
  - Provision of GRP baffle on the via duct for elimination of noise transmission
  - Provision of sound absorbing material in the supply duct and return grill of air conditioner
  - Sealing design to reduce the aspiration of noise through the gap in the sliding doors and piping holes
  - Provision of bolsters less type bogies having secondary air spring
  - Ballast less track supported on two layers of rubber pads can be used to reduce track noise and ground vibrations
  - In sensitive areas, track on floating slab can be used to reduce track noise and ground vibrations
  - Trackside lubrication can be effective in avoiding wheel squeal, which often occurs as Metro rail vehicles traverses tight-radius curves. This installation automatically deposits a small amount of biodegradable lubricant on the top of the rail, and has effectively eliminated wheel squeal and associated complaints from nearby residents
  - To prevent development of surface irregularities on the rail, a fairly heavy rail section is to be used. Further, rail grinding at regular intervals by Rail grinding machine and also lubrication of rail by vehicle mounted lubricator have been contemplated
  - Rail shall be continuously welded and also shall be laid to fine tolerances so that any noise/vibration on account of irregular track geometry could be reduced. Rails should be grinded in regular basis to minimize the vibrations
  - The vibration generated from rail-wheel interaction will be greatly absorbed by the elastic fastening system proposed to be used. Resilient fasteners are used to fasten the rail to concrete track slabs or ballast less bed.
  - A ballast mat consists of a rubber or other type of elastomer pad that is placed under the ballast can be used for reducing vibrations. The mat generally must be placed on a concrete base to be effective
  - Other measures which can be taken to reduce vibrations are usage of resiliently supported ties in which concrete ties are supported by rubber pads
  - Wheel turning or wheel truing to re-contour the wheel, provides a smooth-running surface and remove wheel flats. The most dramatic vibration reduction results from



removing wheel flats. However, significant improvements also can be observed simply from smoothing the running surface. Install wheel flat detector system to identify vehicles which are most in need of wheel truing.

- Implement vehicle reconditioning programs, particularly when components such as suspension system, brakes, wheels, and slip-slide detectors will be involved. The regular regime of reconditioning helps not only mitigation of vibration but also in lower resultant defect generation.
- In addition, it is proposed to provide skirting on coach shells covering the wheel, which will screen any noise coming from rail-wheel interaction from propagating beyond the viaduct
- Noise barrier<sup>12</sup> helps in reduction of the noise level. Noise level reduction with the help of the barriers is depicted in Figure 6.3. Noise barriers can reduce the noise level from 6-15 dB (A). Noise barriers should be provided to minimize the noise levels at sensitive locations/residential areas/depot area. Noise barrier comprising of absorptive type metal panel and reflective type polycarbonate sheets can be located on edge of the viaducts to reduce the noise intensity to be generated due to metro movement. Height of these barriers can be kept 1.5-2.0 m above the top of rail. The barrier must be long enough to screen out a moving train along most of its visible path. Thus, length of the barrier shall be considered additional 1 m on both ends at proposed locations.

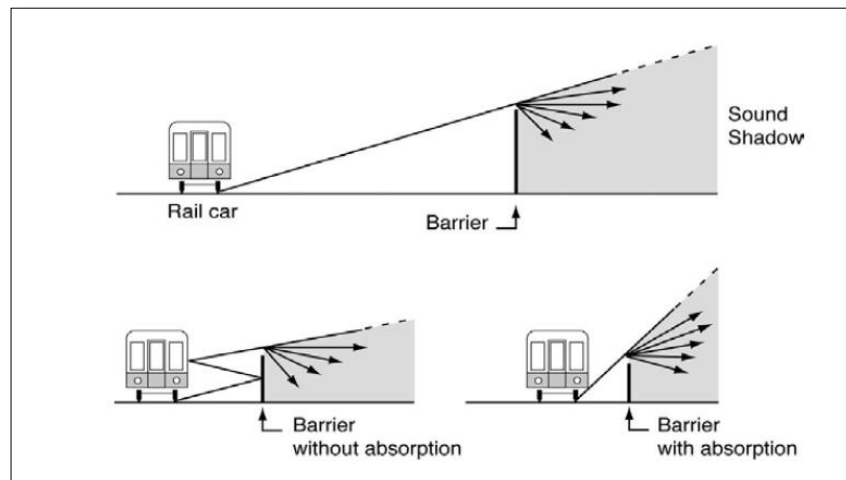
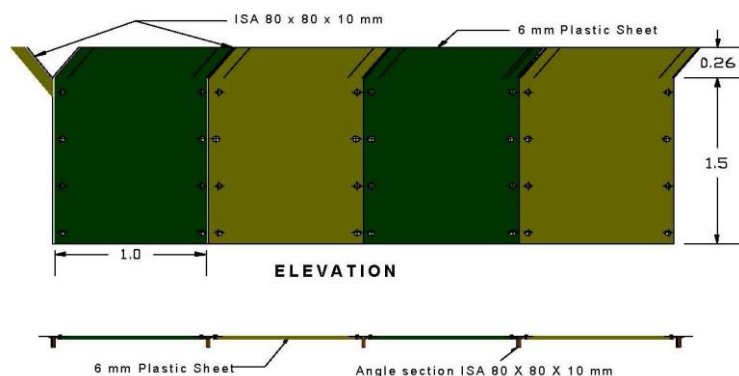


Figure 6.1 : Schematic Representation of Noise Barrier Mechanism

309. **Vibrations:** Ground vibrations by railway traffic are generated by two prime excitation mechanisms (i) the quasi- static displacement caused by the axle load as the wheel moves along the track, and (ii) the inertia forces due to the acceleration of the unsprung mass of the train as it rolls over the irregular profile of the railhead. Rail irregularity profiles have generally an erratic nature. Therefore, the associated ground vibrations tend to display a stochastic character.



Irregularity of the railhead and the wheel tread are important forms of track imperfection that have long been recognized as major sources of vibration by railway traffic. Railhead irregularity may be considered to cover wave-lengths from a few millimetres to 50 meters and more. Irregularities corresponding to short wavelengths, commonly referred to as corrugation and roughness, are essentially responsible for high frequency vibration and noise.

310. Human response to vibration is subjective and will be different for different people. When the vibrations reach the floors and walls it may result in perceptible vibration depending on the amplitude and frequency of the vibrations. People may be more annoyed if they are exposed to both noise and vibration compared to when only vibration is felt. According to the U.S. Department of Transportation, (1998) the perception threshold of humans for peak particle velocity is about 0.04 mm/s (65VdB with reference 1e-6 inch/sec). For a person in their residence, the lower threshold for annoyance is 72 VdB (FTA 2006). The vibration affects human health by causing fatigue, increased pulse & respiration rates, dizziness & loss of balance, anger and irritation. However, being elevated in nature, vibrations are not anticipated to be significant issue in case of proposed project which may not be perceivable to the people outside the metro system or may not cause any damage to the nearby structures as the vibration impact will be reduced or nullify by the time they reach to ground level in case of elevated metro rail projects.

311. Mitigations for vibration impact: Design measures adopted to reduce the impact due to vibrations are already discussed in the section above.

312. **Traffic:** It is expected that the proposed metro project will shift the load from road to metro thereby reducing the nos. of private vehicle on road. It is estimated that approx. 11% two-wheeler traffic, 13% car/taxi traffic, 21% auto rickshaw traffic and 31% of bus traffic will be shifted to metro after development of the project. Thus, the project will decongest the existing road infrastructure, road network and the traffic congestion. Further apart from this it is planned by MMMOCL/MMRDA to overall improve the transportation network of the MMR. MMMOCL/MMRDA shall take measures like provision of additional feeder bus service and shared bicycle by MMMOCL/MMRDA 1A. These buses will increase the catchment of the proposed metro route. Also, the feeder buses and city buses are planned on such routes that they get integrated with other modes of transportation like city buses, auto-rickshaws & NMVs. This will improve overall traffic pattern in the area and reduce the congestion.

313. Micro-climate: As per DPR, it is expected that GHG emissions of approx. 1,024.35 kg/1000 liters of fuel used, will be reduced due to project development. Also it is estimated that fuel consumption will be reduced by 0.17687252 l/km. Due to this significant GHG emissions can be saved and thus will help in minimizing impact of project on micro-climate.

314. **Ecological Impacts:** Since most of the trees will be transplanted, major impact on flora & fauna of area is not anticipated. However, following measures shall be undertaken to minimize impact on ecology.

- Proper aftercare and monitoring of trees transplanted & planted for minimum 3 year or as per the permission granted by tree authority/forest department
- Replanting the dead trees or follow the conditions as per the permission granted by tree authority/forest department
- Preferring native species for plantation
- Planted trees shall not be cut for any purpose
- Water sprinkling on flora of areas nearby stations/depot
- Development of green belt at depot area as per CPCB guidelines for Green Belt Development, 2000
- Taking measures to attract birds for nesting on the planted trees

315. **Occupational Health and Safety:** Operation & maintenance involves various risks for the staff, passengers and people residing near the metro corridor & allied facilities. The risks

associated are accidents of metro, accident of people, collapse of structures, fall/slip while working, electrical shocks, electrical fire, fire in DG sets & fuel tanks etc. Various safety measures are proposed to be followed which should be taken to prevent the accidents and near miss.

- All the staff should be given training for carrying out the work assigned keeping the safety as priority.
- All staff should be provided with personal protective equipment like HT gloves, safety helmets, safety jackets, ear muffs, safety belts, welding masks, safety shoes, Goggles, safety shoes, full body harness) as required
- Periodic inspection of PPE should be done to ensure that they are in proper condition by keeping the records
- Tests should be undertaken for workers working at heights prior joining. Work at height should be undertaken during day time only.
- Fall arrest system should be provided at the areas which involves working at height
- Induction training should be given to all the workers at the time of joining which should include awareness of the activities to be carried out by worker, tools involved, risks involved and personal protective equipment to be used
- Health check-ups should be undertaken for workers every year
- Proper signage about the stations, entry, exit, fire exit, directions, safety messages, conservation of energy & water, non-spitting, non-littering, restricted entry etc. should be provided at all the stations and inside the metro to make the passenger and staff about the risks involved and required safety measures to be taken
- Adequate emergency exit should be provided in the metro and at station and the location of the same should be displayed at all the suitable locations. Along with the visual display, audio messages should also be communicated at the stations and in metro about the safety measures to be taken
- Proper guards/safety provision should be made along the railings of elevated metro stations. Entry beyond the certain points should be restricted for the passengers
- Entry to the control rooms, firefighting rooms, DG area and other similar areas should be restricted for passengers and entry of such areas should be guarded
- Elevators provided should be regularly maintained and checked for proper functioning
- Maintenance of the metro and other equipment should be carried out regularly as per the approved maintenance schedule.
- Functioning of metro, stations, electrical equipment & network, DG sets etc. should be audited and inspected by eligible third part on regular basis.
- All the platforms should be properly guarded to ensure people board & deboard in queue and do not stand beyond the demarcated area.
- Certified First aid trainer should be present at all the stations all the time
- System of work permits should be issued in case any maintenance work is being undertaken at track, electrical wires, OHE, control room and any such area. LOTO system should be implemented to minimize the accidents
- Every day PEP Talks should be taken up with the security & maintenance staff to communicate the major safety principle to be followed and kept in mind.
- Safety meetings should be held monthly to discuss the existing safety practices and measures for improvising the procedures
- Mock drills should be conducted to train staff for handling emergency situations
- Emergency preparedness & response plan prepared for the project should be followed
- Dos and Dont's during the natural calamity and accidents should be displayed at stations and in metro for passengers and staff so as they know what is to be done during and after emergency.
- Trainings should be conducted for drivers on regular basis to train them about the safety procedures and strictly following the rules.
- Regular monitoring, servicing & maintenance of all the signalling, transmission and communication system to minimize the chances of accidents.
- Emergency contact numbers should be displayed at the stations & in metro.

- Photography should be restricted in the metro premises.
- Floors of stations and metros should be cleaned on daily basis
- Lifting equipment engaged should be thoroughly and regularly examined before use
- Fire-fighting equipment should be provided at all the locations, i.e. inside metro, stations at depot as per the granted NOC from local Fire Department. Fire evacuation plan should be displayed at all the desired locations.
- Accident records should be maintained. Accident reporting should be done within 1 day after accident and detailed root cause analysis should be carried out for each accident so as preventive measures can be taken to prevent any similar accidents in future
- Regular maintenance of the viaduct, piers, pier caps, OHE system should be done. Regular inspections should be carried out to detect any breakage, cracks or deformity

316. **Landscape/Aesthetics:** Since the metro corridor is elevated section, it may obstruct the views from the nearby building which. Also, the existence of the metro corridor along the road or along the median in the busy stretch of the roads may also affect the aesthetic value of the area. Further the areas under the viaducts if not maintained may be used by people for dumping waste or may be encroached upon by slum dwellers. Sometime outer areas of the stations are also encroached by the slum dwellers. Thus, following measures should be taken to prevent the impact on aesthetics in the area.

- Area under the viaduct and near the stations should be regularly monitored and no commercial establishments or slums should be allowed to come up
- Colour of the viaducts and piers should be kept white.
- Bills should not be allowed to be stick on the piers and other structures.
- Regular cleaning of the stations, nearby areas and the areas under via duct should be carried out
- Area under viaducts and additional land if available near stations and depot should be used for development of green area

317. **Quality of Life:** Project is proposed with the ambit of improving the public transportation system in the MMR. Planned metro system is light weight rail system and is safe, reliable, comfortable and cost-effective. Proposed project will help in shifting the road traffic to the proposed metro and thus will help in reducing the congestion on roads, reducing emissions/pollution emitting due to traffic congestion, improved environment, reduction in time of travelling, reducing the cost involved in travelling and improved transportation system. This will overall improve the quality of life of the people of the area. Further metro project will generate substantial employment opportunity, i.e. for app 1000 people. This will increase the earning of people and will improve their purchasing power and will improve their quality of life. Overall impact of the project on quality of life of people is positive.

318. **Construction Site Restoration:** Site clean-up is necessary after construction activities. The Contractor will be required to:

- Backfill any excavation and trenches, preferably with excess excavation material generated during the construction phase.
- Use removed topsoil to reclaim disturbed areas.
- Re-establish the original grade and drainage pattern to the extent practicable.
- Restore access roads, staging areas, and temporary work areas.
- Stabilize all areas of disturbed vegetation using weed-free native shrubs, grasses, and trees.
- Remove all tools, equipment, barricades, signs, surplus materials, debris, and rubbish. Demolish buildings/structures not required for O&M. Dispose of in designated disposal sites.
- Request in writing for inspection & approval from MMRDA that construction zones have been restored
- Encroachment of any type or within the RoW, shall be discouraged. A systematic

awareness among road-side communities shall be carried out, in association with the Local Governing Bodies.

- Monitor the success of revegetation and tree re-planting. Replace all plants determined to be in an unhealthy condition.

## **6.7. Conclusion**

319. The interaction of activities and their impacts vary between construction and operational phase. Regarding the proposed project, major activities occur in the construction phase. Therefore, major impacts are anticipated during construction and various impacts have been discussed keeping their nature in view. The impacts during construct phase vary from low to high significance. But these impacts are short term and are restricted only to the construction zone and time only and can be reduced significantly by adopting suggested measures.

320. However, some impacts due to project planning and location like: land acquisition, resettlement, tree cutting, vegetation removal etc are long term and irreversible but the impact can be reduced to an acceptable level by adopting the suggested mitigation measures.

321. Impacts due to operation phase, majorly due to noise & vibration impact, water requirement, waste generation etc are long term and vary from moderate to high level. This impact also can be mitigated to accepted value after adopting the suggested mitigation measures.

## Chapter 7. Stakeholder Consultation and Information Disclosure

### 7.1.1. Consultation and Participation Strategy

322. Stakeholder engagement is a continuous process throughout the project period, during project preparation, implementation, and monitoring stages. The sustainability of any infrastructure development depends on the participatory planning in which public consultation plays a major role. Experience indicates that involuntary resettlement generally causes numerous problems for the affected population. These problems can be reduced to a great extent, if people are properly informed and consulted about the project and are allowed to make meaningful choices or preferences. This serves to reduce the insecurity and opposition to the project, which is otherwise likely to occur during project implementation. The overall objective of the consultation program is to minimize negative impact in the project corridors and to make people aware of the project.

323. With its experience of implementing social safeguards for a variety of projects, including those funded by Multilateral Agencies, and the responses of the affected communities, the MMRDA has devised a Consultation Strategy spanning across various stages of the project. The basic components and details of the strategy are presented in **Table 7.1**.

**Table 7.1 : Consultation Strategy**

Sr. No.	Project Stage	Stakeholders	Process
1	Preparation – After basic features of the project are decided but social surveys and impacts are yet to be assessed	General Public, Civil Society Groups, NGOs etc.	<ul style="list-style-type: none"> <li>• Declaration of project, including alignment map, and intention to carry out EIA/SIA and hold public consultation meeting for obtaining views and suggestions at specific time, date and venue is announced in advance</li> <li>• Invitation Letters are sent to other stakeholders, as considered necessary.</li> <li>• Details of all attendees are entered in registers.</li> <li>• Public Consultation meeting is held with all facilities and proceedings are recorded through photographs, videos, audio recording etc.</li> <li>• The meeting is attended by concerned senior officers of the project and overall project details, technical details of the project, likely impacts, policy framework for mitigation measures and social safeguards and contact details for further information are presented in language understood by participants.</li> <li>• The queries made by participants are clarified and information is provided on how various issues raised by them will be dealt.</li> <li>• Proceedings of the meeting are prepared and shared with those seeking details and are included in the SIA report for disclosure.</li> </ul>
2	During Social Surveys	Project Affected Persons and Community	<ul style="list-style-type: none"> <li>• Introduction Letter is provided to the Consultants engaged for survey and SIA.</li> <li>• MMRDA officials accompany Consultants and hold meetings in the Community to provide necessary information, if so necessary.</li> <li>• Meetings are held with community leaders / groups by Senior officers of MMRDA, if so necessary.</li> </ul>

Sr. No.	Project Stage	Stakeholders	Process
			<ul style="list-style-type: none"> <li>• Discussions by Consultant’s social personnel with affected community about extents of impacts, social risks, safety, common property resources, occupations and work places, vulnerable population, awareness, opinions and preferences about project etc.</li> <li>• Focus Group Discussion with community groups such as community leaders, land-owners, occupants of commercial establishments, women, local CBOs and key informants.</li> <li>• In-depth interviews with individuals and sharing of basic information on eligibility and entitlement, grievance redress etc. with the PAPs</li> </ul>
2	Preparation – After completion of social surveys and preparation of Draft SIA	All Project Affected Persons	<ul style="list-style-type: none"> <li>• Individual Invitation Letters are sent to all likely PAPs as identified in census survey for a common consultation at specific time, date and venue in advance (about 15 days).</li> <li>• Details of all attendees are entered in registers.</li> <li>• Consultation meeting is held with all facilities and proceedings are recorded through photographs, videos, audio recording etc.</li> <li>• Information brochures with basic features of the project, framework for LA&amp;R&amp;R, eligibility and entitlements, Public Information Centres, Grievance Redress mechanism and contact details are printed in multiple languages (Marathi, Hindi and English) and circulated to all participants.</li> <li>• The meeting is attended by concerned senior officers of the project and specific project details, (including space requirements during execution, likely implementation schedule etc.), findings of SIA, framework for land acquisition and impacts, eligibility and entitlements, Public Information Centres, Grievance Redress Mechanism and contact details are presented in language understood by participants.</li> <li>• The queries made by participants are clarified and information is provided on how various issues raised by them will be dealt.</li> <li>• Proceedings of the meeting are prepared and shared with those seeking details and are included in the SIA report for disclosure.</li> </ul>
3	Implementation – During Resettlement Action Plan Implementation	Various Categories and Individual PAPs	<ul style="list-style-type: none"> <li>• Individual letters / notices are sent to each PAP identified as affected to contact officers of LA &amp; R&amp;R Unit for initiating the process of LA &amp; R&amp;R and submit any suggestions objections on the same. After due hearing, replies are sent to them informing decisions on issues raised by them, if any.</li> <li>• Written communication is sent to individual PAPs about their eligibility and compensation and resettlement options.</li> </ul>

Sr. No.	Project Stage	Stakeholders	Process
			<ul style="list-style-type: none"> <li>• Consultations and, as required, negotiations are held in series of meetings with groups such as land owners, residential PAPs, commercial PAPs, PAPs whose structures are partly affected, Persons interested in Community Structures and also individual PAPs to discuss and finalise compensation and resettlement options.</li> <li>• Specific consultations and negotiations are held with groups such as vulnerable households, aged, handicapped PAPs etc. to ascertain and meet their special needs, as may be necessary.</li> <li>• PAPs are informed in writing about the procedure for completing the process of allotment etc.</li> </ul>
4	Post Implementation	Resettled PAPs	<ul style="list-style-type: none"> <li>• Building-wise meetings are held with PAPs to facilitate registration of their Co-operative Housing Societies (CHSs) and subsequently Association of CHSs.</li> <li>• Office bearers of CHSs are provided guidance and training.</li> <li>• Meetings are held with groups of resident PAPs to hear their issues related to maintenance funds, allotment and use of common amenity tenements, payment of taxes and charges, repairs of buildings and tenements etc.</li> <li>• PAPs are interviewed, on sample basis, as a part of evaluation of the R&amp;R process.</li> </ul>

324. The MMRDA will use and implement the above strategy in the process of land acquisition and R&R for Metro 5.

## 7.2. AIIB Information Disclosure Requirements

325. As per the AIIB's ESF, two types of information disclosures have to be adopted. i.e. Information disclosure by the MMRDA and (ii) Information disclosure by the AIIB.

326. **Information disclosure by the MMRDA:** AIIB requires MMRDA to ensure that the relevant information about environmental and social risks and impacts of the proposed project is made available in the project area in a timely and accessible manner and a form and language (Marathi) understandable to the Project-affected people, other stakeholders, and the general public, so they can provide meaningful inputs into the design and implementation of the Project. The documentation for disclosure includes Draft and Final documents (including Environmental Impact Assessment (EIA), Social Impact Assessment (SIA), Resettlement Planning Framework, (RPF) and Tribal Peoples Plan (TPP), ES due diligence report and other documents as applicable to the project). As per the ESF requirements, this English EIA and its Marathi executive summary will be disclosed on the MMRDA website.

327. **Information disclosure by the AIIB:** AIIB will disclose the project documents by sharing the web link of the MMRDA on their website so that the general.

## 7.3. Information Disclosure for Phase I of Metro Line-05 Project

328. The activities undertaken for disclosure of project information in the preparatory stage in line with the consultation and participation strategy explained above are as follows:



- Information about the project was disseminated to stakeholders.
- The overall project details, technical details of the project, likely impacts, policy framework for mitigation measures and social safeguards and contact details for further information are informed during public consultation meeting and proceedings of such meeting are shared, as necessary.
- Information related to project, impacts and mitigation measures etc. is shared with community leaders, groups, PAPs on project sites and in MMRDA office, as necessary by the officials of MMRDA and Consultant during the process of survey.
- Information brochures with basic features of the project, framework for LA&R&R, eligibility and entitlements, Public Information Centres, Grievance Redress mechanism AIIB's Project Affected People Mechanism and contact details printed in multiple languages (Marathi, Hindi and English) are provided to PAPs.
- The details mentioned above are shared through presentations and interactive sessions with participants during PAP Consultation meeting and proceedings of such meeting are shared, as necessary.

#### **7.4. Public / PAP Consultation**

##### **7.4.1. Details of Public Consultation During Surveys**

329. Keeping in mind the significance of consultation and participation of the people likely to be affected or displaced due to the proposed project, both formal and informal discussions were conducted with PAPs during census survey when the social experts consulted with the key Project Affected People/stakeholders and discussed the issues regarding land acquisition, structures likely to be affected, social risk, presence of significant CPR (Common Property Resource) and vulnerable population, mitigation measures, value of affected assets, and other assistance & allowances. In this chapter, detailed methodology adopted for stakeholder consultation and key findings of consultations are discussed. Public consultations/ Focus Group Discussions were held with various sections of affected persons such as traders, women, squatters, kiosks and other inhabitants in the area as likely to be affected by the project. During public consultations, issues related to land acquisition, compensation, income restoration, employment generation, information flow, grievance redressal, safety, role of administration etc. were discussed. The RAP addresses all issues raised during public consultation and recommends measures as well.

330. Community consultation held on 16/01/2020 at Balkum site office of the metro-5, all owner and tenants of Kapurbawadi and Kasheli attended consultation. Mr. Vishram Patil; Chief SDC, Mr. Bhavesh Joshi; CDO; SDC; Mr. Rama Patil; ACDO; SDC; Mr. Atul Patil; Executive engineer metro -5 from MMRDA; and GC representative and EIA consultants address the consultation and give depth understanding of metro-5 alignment, important of survey, redevelopment, compensation and possible impact on their structure, they have satisfied with the discussion and allow to start Sia process along with survey.

331. Community consultation held on 30/06/2021 for BSES survey beginning of Balkum Station. Consultation participants were attended by Mr. Prakash Bhoir, Mr. Bhalchandra Bhoir and Mr. Chandrakant Pawar all are residents of Balkum and owner of affected property. EIA consultants representative Mr. Aditya Pandav, Ms. Reshma Kharade explained the purposed of BSES survey and discussed the requirement during survey.

332. EQMS representative Mr. Aditya Pandav, Ms. Reshma Kharade explained the purposed of BSES survey and discussed the requirement during survey Community consultation held on 17/06/2021 for BSES survey beginning of Kasheli Station. Consultation participants were attended by Mr. Haresh Patil, Prashant Patil and Mr. Chandrakant Pawar all are residents of Kasheli and owner of affected property.

333. Informal consultation was conducted for the Kasheli depot site focusing the environmental

and social impact of proposed project on 5th April 2023. The letter sent to Talathi, Kalher for informing landowners of Kasheli depot about the consultation. During the meeting, most of the farmers agreed to give their land for the project and many repetitive suggestions were made by the participants like: (i) give compensation to all the landowners of the Kasheli depot as per the factor 2 and as per the increased rates given in other projects like Bullet Train, Virar-Alibag Multimodal Corridor.; (ii) to provide approach road on the remaining land for easy access to their fields; and (iii) to provide job opportunities to the members of affected families. Detailed MOM of the informal consultations is attached as Appendix 6.1.

334. The following methods were adopted for conducting public consultation:

- Walk-through informal group consultation at affected places along the alignment.
- Focus Group Discussions (FGD) with different groups of affected people including the PAPs.
- In-depth individual interviews
- Discussions and interviews with key informants
- Sharing the opinion and preferences of the PAPs

## 7.5. Formal Consultation

335. A formal public consultation meeting for the project was organized on 12th May 2023 focusing on environmental and social aspects. Notice to the stakeholder about the meeting was given by making advertisement in newspaper on 3rd May 2023 (English, Hindi & Marathi). During the consultation, affected people raised their grievances which are being submitted to MMRDA and MMRDA assured that the action is being undertaken on the same. Details of Minutes of meeting of the formal consultation meeting is attached as Appendix 6.2.

## 7.6. Disclosure of EIA, SIA / RAP

336. The effectiveness of the Environment Management Plan, Resettlement Action Plan (RAP) is directly related to the degree of continuing involvement of those affected by the project. Several additional rounds of consultations with PAPs will form part of the project implementation. Consultations during EMP/RAP implementation will involve discussions on compensation and assistance options and entitlement package. Another round of consultation will occur when compensation and assistance are provided. All the environmental safeguard documents like EIA, EMP & executive summary will be shared with the concerned district authorities and also will be available on company's website for easy access of public. The following set of activities will be undertaken for effective implementation of the plan:

- The Environment management and LA & R&R Unit will conduct information dissemination sessions in the project area and solicit the help of the local community/ leaders and encourage the participation of the PAP's in RAP implementation.
- Consultation and focus group discussions will be conducted with the vulnerable groups like women, families of BPL, Scheduled Castes, if any identified to ensure that the vulnerable groups understand the process and their needs are specifically taken into consideration, if necessary.
- The Environment Management and LA & R&R Unit will organize public meetings and will appraise the communities about the progress in the implementation of project works and payment and assistance paid to the community. Regular update of the program of resettlement component of the project will be placed for public display at the project offices.
- Taking into consideration the risks of HIV/ AIDs during the project construction period, specialist will be invited to undertake activities related to their core competency. Lastly, participation of PAPs will also be ensured through their involvement in various local committees. PIU and field offices will maintain an ongoing interaction with PAPs to identify problems and undertake remedial measures in line with the stakeholder engagement strategy specified in para 4.1 above.

337. During project implementation, the Environment Management and Land & R&R Unit of the PIU will conduct Information and Community Consultation Program (ICCP) in the project area before starting the process of land acquisition and R&R. The main objectives of the ICCP are to: (i) inform and explain the entitlement policy and the various options to the affected people prior to payments of compensation and other assistance; and (ii) socially prepare the Small Business Enterprises (SBE), and households for relocation and assist them in the process and (iii) reducing the environmental impact of the project.

338. The measures proposed to be undertaken for further disclosure of information during the implementation stage in line with the consultation and participation strategy explained above are as follows:

- Efficient implementation of Environment Management Plan and Monitoring the effectiveness through regular supervision
- Public Information Centres manned by dedicated personnel will be established in MMRDA office and project sites where basic documents such as DPR, Survey Reports and Maps, SIA / RAP report, information brochures etc. will be made available for examination and for taking copies, if any.
- Official correspondence will be held with each of the PAP regarding their eligibility and entitlements.
- EMP and RAP implementation is a continuous process. Necessary information will be provided to PAPs and other persons approaching the LA & RR Unit for queries, grievances, entitlements etc. throughout the resettlement process.
- Site visits to resettlement sites will be arranged for PAPs and necessary details will be provided.
- The EIA/SIA / RAP will be disclosed on MMRDA's web site.
- Grievance Redress Committees will be made functional, which will further disseminate information about the redress process.

## Chapter 8. Environmental Management Plan

### 8.1. Introduction

339. The Environmental Management Plan stands as a guidance material and would consist of all mitigation measures for each activity to be undertaken during the project life cycle to minimize adverse environmental impacts as a result of the activities of the project. It would also delineate the environmental monitoring plan for compliance of various environmental regulations and emergency response plan for dealing with emergency situations at the site.

340. EMP provides a well-structured planning with implementation & monitoring aspects to ensure effective implementation of the proposed mitigation measures and suggestive management plans provided in EMP. EMP also comprise of enhancement measures related to the improvement of natural, physical and aesthetic environment and enhancement of safety of community.

341. The objectives of these EMP measures include:

- To propose measures for mitigation of the identified adverse impacts in timebound manner
- To design the mechanism for institutionalizing the implementation of EMP
- To define the budget for environment management
- To define the training and capacity building requirement of the organization to ensure implementation of EMP
- To define the environmental monitoring plan for monitoring the various environmental aspects to check the effectiveness of implementation of EMP
- To protect the natural environmental resources
- To enhance the aesthetic appeal of the proposed project
- To generate goodwill amongst local community by ensuring the safety etc.

342. Executing agency of the proposed project is MMRDA and the project will be operated by Maha Mumbai Metro Operation Corporation Limited (MMMOCL). For the efficient implementation of the EMP of the proposed project following resources and arrangements will be required:

- Incorporation of the environment management plan and safety systems in the contractors' bid documents to ensure its implementation
- Deployment of supervision consultant for supervision of the EMP implementation
- Monitoring of the environmental performance by respective agencies, MMRDA and MMOCL through periodic audits and inspections during construction and operation phases as applicable
- Arrangement/ allocation of environmental management budget
- Establishing the institutional structures and human resource with defined role & responsibilities for implementation of EMP
- Establishment of grievance redress mechanism for addressing stakeholders' grievances
- Information, communication, training and capacity building of the concerned staff
- Development of reporting and documentation system
- Updating of EMP as and when required with a minimum frequency of one year
- The proposed activities shall be restricted to the affected area around the project. The entire activities proposed shall be treated as project and shall be monitored. Contractors appointed by MMRDA in their supervision should take responsibility for the implementation of mitigation measures during the construction phase and MMOCL shall be responsible for implementation of EMP during operation phases. An outline of the major project activities and their potential impacts in different progressive phases i.e. planning/design, construction and operation stages have been provided.

**Table 8.1 : Environmental Management Measures and allocation of Responsibilities in Planning/Design Phase**

S. No.	Project / Environmental Component	Management Actions	Responsibility Allocation	
			Planning, Implementation and Reporting	Supervision
1	Complying to Regulatory Requirements	<ul style="list-style-type: none"> <li>• Contractor shall be responsible for obtaining all the permissions which may be required for carrying out the work at site and shall include but will not be limited to the following:               <ul style="list-style-type: none"> <li>○ Tree Cutting permission</li> <li>○ Permission for diversion of reserved forest land under Mangroves</li> <li>○ Permission under CRZ Notification 2011</li> <li>○ Permission from Bombay High Court for Tree Cutting</li> <li>○ Permission for ground water extraction from CGWA/State Water Resource Department</li> <li>○ Permission for working on or near the waterbodies and for Withdrawal of water from Surface Water bodies</li> <li>○ Consent to Establish and Consent to operate for Batching Plant, Stations, Quarries, and Stone Crushers etc.</li> <li>○ Pollution Under Control Certificate</li> <li>○ Permissions under Electricity Act for DG sets/sourcing the power</li> <li>○ Other permission form Centre/State/Local bodies for execution of works as required</li> </ul> </li> <li>• Contractor shall strictly comply with the conditions of statutory clearances as obtained by MMRDA or by themselves</li> <li>• Contractor shall prepare and submit the compliance reports of the conditions of clearance letter to MMRDA as per the requirement</li> <li>• Contractor shall prepare site specific EMP detailing the environment management and monitoring measures &amp; plan in line with the project EMP, requirement of Gol and requirement of the international funding agencies (if any)</li> <li>• Contractor shall strictly comply with the environment management and monitoring plan and shall implement all the project activities considering the measures specified in EMP and EMoP</li> <li>• Strictly no child labour shall be allowed at work site and supplier sites</li> </ul>	Contractor	MMRDA, Supervision Consultant
2	Rehabilitation and Resettlement	<ul style="list-style-type: none"> <li>• Detailed SIA study and RAP is being formulated for the project in line with the RFCTLARR, 2013 for the project shall strictly be followed for acquisition of the land and providing the compensation to the affected population</li> <li>• The compensation to project affected persons shall be paid as per the Right to Fair Compensation &amp; Transparency in Land Acquisition, Rehabilitation &amp; Resettlement Act, 2013 and relevant Acts and guidelines of the Government of India and rules of concerned state governments.</li> </ul>	MMRDA	MMRDA

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		<ul style="list-style-type: none"> <li>• Transparency shall be maintained with the land owners while sharing the project information and the details to affected land owners through regular consultation and meeting with the affected communities</li> <li>• Grievance Redressal Mechanism shall be developed.</li> <li>• No land shall be taken forcefully and without obtaining consent from land owner</li> </ul>		
3	Micro-climate	<ul style="list-style-type: none"> <li>• Preferring for transplantation (495 trees out of 708 trees) in place of cutting (166 trees to be cut and 47 to be trimmed out of 708) thereby reducing trees to be cut. Other than this, about 110 trees exist at depot site. Joint visits will be undertaken by the civil, planning and environment team to understand requirement of tree cutting which shall minimize the nos. of trees to be cut</li> <li>• Undertaking compensatory afforestation for each tree to be affected. as per guideline of concerned Tree Authority under Maharashtra (Urban Area) Tree Preservation Act, 1975 and its amendments. Total 4799 trees will be planted for affecting total 708 trees. Similarly compensatory afforestation will be undertaken for the affected 110 trees also.</li> <li>• Planned within and along the RoW of existing road, minimizing tree cutting, private land acquisition, impact on settlements and changing land use</li> <li>• Minimizing impact on forest land and environmentally protected areas</li> <li>• Adoption of green building technology for making project more energy efficient</li> <li>• Usage of low embodied material for construction like fly-ash</li> <li>• Provision of solar power plant at the roof top of stations/depot and other utility area</li> <li>• Provision of rain water harvesting system to harvest rain water and recharge ground water resources</li> <li>• Design of all structures above HFL of the nearby rivers (As per the data available with MMB, HFL in the project area is 500 mm (0.5 m) BGL (or 1.2 m AMSL) and existing ground level is 1.7 m AMSL. Project area is about 500 mm above the HFL and has not been inundated in past due to floods in Kasheli creek. Proposed project is elevated thus most of the structure is above HFL and significant impact on project infrastructure due to floods is not anticipated. Height of the viaduct for the proposed project varies between 8.7 m to 23.7 m thus impact of inundation of viaduct due to floods is not anticipated. Also the entry and exit of the proposed stations is designed above HFL. All stations are elevated thus risks of inundation is minimal.)</li> <li>• Measures adopted for water resources conservation such as usage of curing compound, water conservation fixtures etc.</li> <li>• Piers at waterbody crossings are so designed that they will occupy minimum space in the river bed. Modelling study are carried out to assess the impact of construction of river banks/beds. This will minimize the impact on the carrying capacity of the water bodies and will not aggravate the flooding.</li> </ul>	Contractor	MMRDA, Supervision Consultant

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		<ul style="list-style-type: none"> <li>• Implementation of proposed environmental management plan to prevent impact on environmental components</li> <li>• No CFCs/HFCs will be used for the project development</li> <li>• All the electrical equipment (traction/auxiliary transformers) will be PCB free completely in compliance to International Convention on Hazardous Materials. Transformer oil as per IS 12463 has been used in transformers</li> <li>• Provision of sensors and alarm system to detect the leakage of SF6<sup>13</sup> followed by tripping of circuit breakers in RMUs and switch breakers.</li> </ul>		
4	Land-Use	<ul style="list-style-type: none"> <li>• RoW clearing activities are to be carried out with least disturbance to the surrounding by restricting the project activities within the define RoW</li> <li>• Before start of construction activities, sites for C&amp;D waste disposal shall be identified. These sites should be at minimum 500 m distance from residential, sensitive and water body location and shall always be above the HFL of the nearest water body (Ulhas river). These sites should be provided with adequate drainage and silt arresting mechanism. As per the data available with MMB, HFL in the project area is 500 mm (0.5 m) BGL (or 1.2 m AMSL) and existing ground level is 1.7 m AMSL. Project area is about 500 mm above the HFL and has not been inundated in past due to floods in Kasheli creek.</li> <li>• Preferably waste land and barren land shall be considered for establishment of the C&amp;D waste disposal site.</li> <li>• Labour camp, storage yards, casting yards and plant site (batching plant, stone crushers) should be at minimum 500 m distance from residential, sensitive and water body location.</li> <li>• All the sites being used for the construction purposes temporary shall be restored back to the original condition.</li> </ul>	Contractor	MMRDA, Supervision Consultant
5	Vegetation removal and tree felling and plantation	<ul style="list-style-type: none"> <li>• A joint survey shall be undertaken by MMRDA team and forest department/municipal authority/Tree officer to identify the trees falling within the RoW.</li> <li>• MMRDA team shall work to identify the trees which are essentially required to be cut for the project development while saving the rest. The trees required to be cut shall properly be marked and shall only be cut</li> <li>• Transplantation shall be preferred over cutting for tree having girth size between 30 cm- 75 cm. Transplantation shall be carried out in presence of expert and following proper approach while securing the root ball of the tree</li> <li>• In place of cutting, it is proposed to transplant 495 trees, cut 166 trees and trim 47 trees out of 708 trees within RoW. This has minimized tree cutting requirement</li> </ul>	MMRDA, Contractor	MMRDA, Supervision Consultant

<sup>13</sup> The Gas Insulated switchboards and Circuit breakers are equipped with SF6 gas density monitor for each breaker and busbar chamber. A SF6 density monitor is a device that measures the density of SF6 in a gas-insulated switchgear (GIS) or other electrical equipment. The monitor typically consists of a pressure sensor and a temperature sensor, which are used to measure the pressure and temperature of the SF6 gas. In case of any leakage in the chamber an audible alarm will be generated by density monitor in switchboard and similarly an alarm will appear in SCADA workstation in OCC.

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		<ul style="list-style-type: none"> <li>MMRDA shall carry out compensatory afforestation for the trees to be cut in forest area as per guideline of concerned Tree Authority under Maharashtra (Urban Area) Tree Preservation Act, 1975 and its amendments. Total 4799 trees will be planted for affecting total 708 trees</li> <li>About 110 trees exist at depot site. Joint visits will be undertaken by the civil, planning and environment team to understand requirement of tree cutting which shall minimize the nos. of trees to be cut at depot site. Compensatory afforestation will also be undertaken for the affected 110 trees.</li> <li>Adequate after care like timely watering, provision of guarding etc. shall be undertaken for transplanted and planted trees to assure high survival rate</li> <li>Transplantation and plantation shall be carried out during monsoon to assure higher survival rate</li> <li>Top soil up to depth of 15 cm shall be extracted and stored separately so as it can be later used for plantation works</li> <li>MMRDA shall strictly follow all the laws and regulations pertaining to tree cutting and shall comply with them</li> <li>Green belt development plan shall be prepared for development of green belt at the locations wherever space is available along the corridor, in casting yards, labour camp locations, open areas etc. during construction phase and shall be implemented</li> <li>Green belt development shall be carried out at all feasible locations such as along the corridor and at depot locations</li> <li>No firewood extraction from trees shall be allowed. Firewood shall not be used for cooking or open burning. Workers shall be provided with clean cooking fuel and appropriate rest shelters &amp; accommodation to prevent usage of wood for open burning &amp; cooking purpose</li> </ul>		
6	High Noise & Vibration Level Generation	<ul style="list-style-type: none"> <li>Barricading shall be provided all along the corridor to prevent unauthorized access during construction phase. These barriers will of full height and will also act as noise barrier</li> <li>Entire corridor shall be provided with the noise cum visibility blocking barrier as the corridor lies in the heavily populated urban area. Noise barrier comprising of absorptive type metal panel and reflective type polycarbonate sheets can be located on edge of the viaducts to reduce the noise intensity to be generated due to metro movement. Height of these barriers can be kept 1.5-2.0 m above the top of rail. The barrier must be long enough to screen out a moving train along most of its visible path. Thus, length of the barrier shall be considered additional 1 m on both ends at proposed locations.</li> <li>Noise barriers should be erected during construction stage for all residential/sensitive receptor locations (Kapurbawadi, Samta Nagar (Ch 1200-1900), Ashok Nagar, Swaraj Nagar, Kahler, Kopar, Oswal wadi) along the alignment so as Ambient noise levels are not affected due to project operation. Further these noise barriers will also act as visibility barrier and barrier to prevent collision of avifauna with running train.</li> <li>Provision of anti-dumping floor and noise absorption material</li> </ul>	Contractor	MMRDA, Supervision Consultant



		<ul style="list-style-type: none"> <li>• Low speed compressor, blower and air conditioner</li> <li>• Mounting of under frame equipment and anti-vibration pad</li> <li>• Smooth and gradual control of door</li> <li>• Provision of GRP baffle on the via duct for elimination of noise transmission</li> <li>• Provision of sound absorbing material in the supply duct and return grill of air conditioner</li> <li>• Sealing design to reduce the aspiration of noise through the gap in the sliding doors and piping holes</li> <li>• Provision of bolsters less type bogies having secondary air spring</li> <li>• Ballast less track supported on two layers of rubber pads can be used to reduce track noise and ground vibrations</li> <li>• In sensitive areas, track on floating slab can be used to reduce track noise and ground vibrations</li> <li>• Trackside lubrication can be effective in avoiding wheel squeal, which often occurs as Metro rail vehicles traverses tight-radius curves. This installation automatically deposits a small amount of biodegradable lubricant on the top of the rail, and has effectively eliminated wheel squeal and associated complaints from nearby residents</li> <li>• To prevent development of surface irregularities on the rail, a fairly heavy rail section is to be used. Further, rail grinding at regular intervals by Rail grinding machine and also lubrication of rail by vehicle mounted lubricator have been contemplated</li> <li>• Rail shall be continuously welded and also shall be laid to fine tolerances so that any noise/vibration on account of irregular track geometry could be reduced. Rails should be grinded in regular basis to minimize the vibrations</li> <li>• The vibration generated from rail-wheel interaction will be greatly absorbed by the elastic fastening system proposed to be used. Resilient fasteners are used to fasten the rail to concrete track slabs or ballast less bed.</li> <li>• A ballast mat consists of a rubber or other type of elastomer pad that is placed under the ballast can be used for reducing vibrations. The mat generally must be placed on a concrete base to be effective</li> <li>• Other measures which can be taken to reduce vibrations are usage of resiliently supported ties in which concrete ties are supported by rubber pads</li> <li>• Wheel turning or wheel truing to re-contour the wheel, provides a smooth-running surface and remove wheel flats. The most dramatic vibration reduction results from removing wheel flats. However, significant improvements also can be observed simply from smoothing the running surface. Install wheel flat detector system to identify vehicles which are most in need of wheel truing.</li> <li>• Implement vehicle reconditioning programs, particularly when components such as suspension system, brakes, wheels, and slip-slide detectors will be involved. The regular regime of reconditioning helps not only mitigation of vibration but also in lower resultant defect generation.</li> </ul>		
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		<ul style="list-style-type: none"> <li>In addition, it is proposed to provide skirting on coach shells covering the wheel, which will screen any noise coming from rail-wheel interaction from propagating beyond the viaduct</li> </ul>		
7	Concrete Mixing, Batching Plants, Plants and Crushers etc.	<ul style="list-style-type: none"> <li>Consent should be obtained before establishment and operation of work sites for the establishment and operation from State Pollution Control Boards.</li> <li>Compliance with relevant emission control legislation at the State level must be ensured for all equipment, machine, engineers, generators and vehicles which involve in the crushers, and concrete batching plants and material transfer.</li> <li>At least 500 m, distance must be maintained between these plants and the human settlements/sensitive receptors/forest land/water bodies in the downwind direction.</li> <li>All suggested mitigation measures for air and dust pollution, noise pollution, water pollution etc. shall strictly be implemented</li> <li>Compliance report to the condition of these consents shall be prepared and submitted to respective SPCBs</li> <li>Establishment of the casting yard, labour camps, storage yard, site offices etc shall not require cutting of trees/clearing of any major vegetation</li> <li>The disposal will not be allowed into a nearby watercourse or any nearby sensitive areas which may pollute surface water or can cause inconvenience to the community.</li> <li>The construction camp, storage of fuel and lubricants should be avoided at the river bank.</li> </ul>	Contractor	MMRDA, Supervision Consultant
8	Environmental impacts due to installation of Construction machinery and the vehicles	<ul style="list-style-type: none"> <li>Fuel exhaust standards for all the engines/vehicles must be checked with those as defined under EPA, 1986 and Motor Vehicles Act, 1988 before deploying on the work.</li> <li>Bureau of India Standard (BIS) norms must be complied for engines, machinery equipment's and vehicles.</li> <li>PUC certificate shall be obtained for all the construction machinery &amp; vehicles as applicable</li> <li>Old machinery/engines/vehicles/loaders must not be used at site.</li> <li>All machinery and the vehicles shall be properly and timely be services and maintained to prevent noise issues and accidents</li> <li>All electrical/power equipment and heavy machinery shall be inspected prior installing and commissioning</li> <li>Construction methodology and method statement for each construction activity/installation of heavy machinery shall be submitted for approval and shall comprise of guidelines on environment and safety management</li> </ul>	Contractor	MMRDA, Supervision Consultant
9	Consumption of Water	<ul style="list-style-type: none"> <li>The priority shall be given to use surface water wherever surface water source is available.</li> <li>Ground and Surface water may be used only after obtaining necessary permissions from the respective Government authorities.</li> <li>Statutory permits must be obtained from the Central Ground Water Authority and concerned State Irrigation Departments as applicable.</li> <li>Rain water harvesting provisions shall be made in design during both construction and operation phase</li> </ul>	Contractor	MMRDA, Supervision Consultant

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		<ul style="list-style-type: none"> <li>• STP treated water shall be procured from nearby STPs and shall be used preferably for sprinkling and landscaping.</li> <li>• Minimizing water requirement by using water conservation measures such as covering the water tanks, providing visual notice for water conservation, low flow taps in toilets etc.</li> <li>• Regular inspection to detect leakage in water pipelines and water tanks.</li> </ul>		
10	Borrowing and Quarrying Activities	<ul style="list-style-type: none"> <li>• Plan shall be submitted to engineer for approval of borrow area/quarry site location prior establishment. Plan shall comprise of the location details &amp; photograph of borrow area, type and quantity of material expected to be borrowed, environmental &amp; social sensitivity of borrow areas, nearest borrow area etc.</li> <li>• Procure materials from the licensed suppliers</li> <li>• Use quarry sites and sources permitted by Government.</li> <li>• Verify the suitability of all sourced material and obtain approval from the MMRDA prior procurement</li> <li>• If additional quarries/borrow areas are required after construction has started, obtain written approval from MMRDA and the clearances from respective concerned authorities</li> <li>• Statutory permits/clearances shall be obtained from the government bodies including SEIAA, MoEF&amp;CC, SPCB, Mining Department etc., as applicable for the establishment of quarries and borrow areas. Conditions of these statutory permissions shall strictly be complied and report on compliance shall be submitted to the concerned authority on regular basis as per requirement</li> <li>• Specific routes shall be designated for transportation of material from borrow site to the construction site while avoiding village and small roads. Also peak traffic hours shall be avoided for transportation of material</li> <li>• Logistic arrangements, development of haul roads should be with taken care for the minimum environmental disturbance.</li> <li>• In the case of the borrowing of the earth material an advance agreement must be signed between the executing agency and the owner of the land.</li> <li>• Excavation depth shall not exceed the permitted limit</li> <li>• Excavation activities shall not be undertaken during monsoon season</li> <li>• Garland drains shall be provided around the excavated pits and borrow sites to prevent entry of run-off from surroundings into the excavated pits</li> <li>• Borrow pits shall not be installed at the forest land/agricultural land/close to water bodies/existing roads/settlements</li> <li>• Minimum distance of 8 m shall be maintained between two borrow pits</li> <li>• The depth of borrow pits shall not exceed 45 cm and it may be dug out to a depth of not more than 30 cm after stripping the 15 cm top soil aside</li> <li>• Prior permission shall be obtained from District Collector for establishment of borrow area</li> <li>• For the redevelopment of the borrow area, the contractor shall evolve site-specific redevelopment plan for each borrow area location, which shall be implemented by contractor</li> </ul>	Contractor	MMRDA, Supervision Consultant

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		<p>after the approval of the MMRDA</p> <ul style="list-style-type: none"> <li>• Borrow sites shall properly be restored and shall be stabilized with proper vegetation</li> <li>• Topsoil shall be preserved in stockpiles</li> </ul>		
11	Procurement of Construction Material	<ul style="list-style-type: none"> <li>• Materials shall be procured only from licensed and authorized suppliers</li> <li>• Suppliers shall be in possession of the valid clearance document for extraction and supplying of the material being procured from them</li> </ul>	Contractor	MMRDA, Supervision Consultant
12	Labour Welfare	<ul style="list-style-type: none"> <li>• Local people shall preferably be given employment</li> <li>• All the labor shall be followed and the license shall be obtained for hiring the labour and contractual labour</li> <li>• All facilities shall be provided to the labour as per the BOCWA, 1995 and BOCWR, 1996</li> <li>• Occupational health and safety management plan for labour shall be followed</li> </ul>	Contractor	MMRDA, Supervision Consultant
13	Safety enhancement and Disaster management	<ul style="list-style-type: none"> <li>• The civil and structural designs of the proposed project must include the aspects of seismicity (Zone III), floods (Prone to floods) and ground subsidence of the area.</li> <li>• All the structures shall be designed above the HFL (As per the data available with MMB, HFL in the project area is 500 mm (0.5 m) BGL (or 1.2 m AMSL) and existing ground level is 1.7 m AMSL. Project area is about 500 mm above the HFL and has not been inundated in past due to floods in Kasheli creek. Proposed project is elevated thus most of the structure is above HFL and significant impact on project infrastructure due to floods is not anticipated. Height of the viaduct for the proposed project varies between 8.7 m to 23.7 m thus impact of inundation of viaduct due to floods is not anticipated. Also, the entry and exit of the proposed stations is designed above HFL. All stations are elevated thus risks of inundation is minimal.)</li> <li>• Geological study including study on strata, soil type, Soil bearing capacity, rock structure etc shall be carried out during the detailed project report.</li> <li>• System shall be established to receive updates from IMD on daily basis regarding specific &amp; extreme weather Phenomenon like storms, heavy rainfall, flooding etc and work shall be managed accordingly</li> <li>• Safe shelters shall be identified so as men and material can be transported to these locations during flood</li> <li>• To ensure the passage of the surface run-off to avoid the flooding the natural drainage system must not be clogged or changed. Proper cross drainage channels are to be provided at identified locations.</li> </ul>	Contractor	MMRDA, Supervision Consultant
14	Drainage	<ul style="list-style-type: none"> <li>• Existing drains shall be checked for blockage prior start of work, if blocked shall be clean to prevent stagnation of water. These drains shall be kept clean all the time. Monthly monitoring of the drains shall be carried out</li> <li>• Temporary drainage system shall be provided at all construction sites, construction yards, labour camp locations and other temporarily occupied locations to facilitate draining of runoff and prevention of flood</li> <li>• Rain water harvesting shall be practices to use rainfall water at site for various purpose like</li> </ul>	Contractor	MMRDA, Supervision Consultant

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		<p>water sprinkling etc. or shall be collected and recharged into ground (if water quality meets the criteria and if the water is not polluted) from all the permanent and temporary structures/sites established for the project</p> <ul style="list-style-type: none"> <li>• Oil &amp; grease traps shall be provided with drains at parking lots, fuel storage area, refuelling area etc.</li> <li>• Sedimentation tanks shall be provided with drains so as silt can be arrested from run-off prior entering into a water body</li> <li>• No material should be dumped into natural drains that may block, impede or alter drainage channels</li> </ul>		
15	Working on or near water bodies	<ul style="list-style-type: none"> <li>• Construction methodology and method statement shall be submitted for carrying out works on or near water bodies detailing the measures on environment and safety management</li> <li>• Modeling study shall be carried out for each proposed pier location to assess its impact on the water flow, bed erosion, scouring, bank erosion etc.</li> <li>• No of piers in the water body shall be minimized by proper planning and usage of longer spans between the piers</li> <li>• Permissions from concerned authority shall be obtained prior initiation of any construction work on or near water body</li> <li>• Plan for management of water from dewatering activity, management of muck, wet slurry and mud shall be provided and followed</li> <li>• Plan for restoration of water body, removal of filled material and removal of temporary construction structures shall be placed in water body</li> </ul>	Contractor	MMRDA, Supervision Consultant
16	Setting up of the labour Camp	<ul style="list-style-type: none"> <li>• Camp locations should be carefully selected to avoid the land use categories: residential, sensitive and Eco sensitive areas. Distance of minimum 500 m shall be maintained between the said land use and labour camp locations. Camps sites shall preferably be established on waste and barren land so as the vegetation removal and tree cutting can be minimized.</li> <li>• Camps shall also be established at approx. 500 m distance from the water bodies to prevent any impact on the water body</li> <li>• NOC shall be obtained from the land owner and the concerned authority prior establishment of the labour camp.</li> <li>• Land shall be restored back to its original condition immediately after the completion of construction works and prior handing over the land back to the land owner. All waste materials, temporary/permanent structures etc shall be removed from the camp site and the site shall be re-vegetated with the native species of trees</li> <li>• Training and awareness shall be provided to the labour to not indulge in the unfair practices</li> <li>• Labour camp should be enclosed with boundary wall.</li> <li>• Movement of the workers should be monitored by providing adequate security checks and all the workers shall be checked for availability of valid ID cards.</li> <li>• A cooked food canteen on a moderate scale shall be provided for workers so that they can have their meal at a definite place. All the wastes generated from the canteen shall be</li> </ul>	Contractor	MMRDA, Supervision Consultant

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		<p>treated/disposed of as detailed in the other sections of the waste disposal. The labour need not to depend the nearby facilities for food and so interaction with the nearby community will be minimized.</p> <ul style="list-style-type: none"> <li>• Firewood and other conventional fuels like dung cakes, paper, waste materials etc shall not be used for cooking and camp fire .Contractor must provide only clean fuel for cooking like LPG gas.</li> <li>• Health problems of the workers should be taken care of by providing basic health care facilities through a health center set up at the construction camps. The health center will have at least a doctor (part time), nurses, duty staff, medicines and minimum medical facilities to tackle first-aid requirements for minor accidental cases. Some arrangements will be made with the nearest hospital to refer patients of major illnesses or critical cases. The health center will carry out quarterly awareness programme of HIV – AIDS with the help of AIDS control society. Posters will be exhibited in the health care clinic for awareness. This will not only be beneficial for the labours/workers health but also very significant to protect the health of the nearby communities especially against the contagious diseases.</li> <li>• Facilities at the camp sites shall be provided as per BOCWA, 1996 so as to establish proper sanitation facility and waste management system at the site to prevent impact on air, water and soil quality of the area. Details are presented below:</li> <li>• Construction camps shall be provided with sanitary latrines and urinals with the water facility. Closed drainage systems and the proper sewage treatment system according to the local conditions should be provided for proper disposal meeting the standards as prescribed by CPCB. If sewage generation is more than 10 KLD then STP shall be provided if less than 10 KLD then sewage can be disposed through septic tank/soak pit. Soak pits shall not be provided within 100 m of the water body or any water source to prevent impact on water quality</li> <li>• Food waste shall be handed over to the piggeries or any pig farm in nearby areas. Food and other compostable waste can also be treated within the camp through composting (vermi composting/pit composting/organic waste convertors).</li> <li>• All the municipal waste shall be disposed off through the authorized local waste management agencies only if any in-house treatment facility is not available</li> <li>• A Waste disposal and management plan will be prepared by the contractor before start of construction works and submitted to MMRDA for their review and approval.</li> <li>• There must be proper sewage and solid waste handling and management for the labour camps. The drainage must be proper in the camp area with no stagnancy of the water. Also, the drainage from the camps must not affect the domestic supply of the public water.</li> </ul>		
17	Children and Women protection and rights	<ul style="list-style-type: none"> <li>• Child labour shall strictly be prohibited at site</li> <li>• The contractor agencies are responsible to protect the women rights. Suitable care &amp; welfare services are to be provided i.e. changing rooms, separate toilets, crèche, feeding rooms etc. as per BOCWA &amp; BOCWR</li> </ul>	Contractor	MMRDA, Supervision Consultant

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18	Utility shifting	<ul style="list-style-type: none"> <li>Plan for shifting and reconstruction of utilities to be impacted shall be prepared prior start of construction. The plan shall be discussed and agreed upon with all the concerned agency</li> <li>Utility shifting shall preferably be carried out through the concerned agency only and the compensation amount shall be paid as requested for the same. This compensation amount shall also be included in the project cost to prevent any impact</li> <li>Utility shifting shall preferably be carried out while minimizing the disturbance to the community and its dependents. New facility shall be provided before dismantling the old facility. In case that is not possible, dependents/community shall be pre-informed about the discontinuation of the utility with the timeline of its restoration. Also an alternative shall be provided to community in the block period.</li> <li>Affected utilities like electric poles, water pipe lines, hand pumps, etc. shall be relocated with prior approval of the concerned agencies.</li> </ul>	MMRDA, Contractor	MMRDA, Supervision Consultant
19	Ethnic Community and Indigenous People	<ul style="list-style-type: none"> <li>No ethnic community or indigenous people are found to exist in the project area during the study</li> </ul>	MMRDA	MMRDA
20	Cultural and Religious site	<ul style="list-style-type: none"> <li>Develop a protocol for use by the Contractors in conducting any excavation work, to ensure that any chance finds are recognized and measures are taken to ensure they are protected and conserved.</li> <li>Inform Archaeological Survey of India and/or State Department of Archaeology in case of finding any archaeological artifact/item</li> </ul>	Contractor	MMRDA

Source: Study team

Table 8.2 : Environmental Management Measures and allocation of Responsibilities in Construction Phase

SNo.	Project / Environmental Component	Mitigation/ Management Measures	Responsibility Allocation	
			Planning, Implementation and Reporting	Supervision
1	Micro-climate	<ul style="list-style-type: none"> <li>Temporarily warming effect due to operation of large number of heavy construction machineries;</li> <li>Continuous running of DG set at the construction camp;</li> <li>Clearing of vegetative cover may also lead to rise in the temperatures in local area over long term.</li> <li>Measures proposed to be taken to minimize the impact on micro-climate are given below</li> <li>Compensatory plantation shall be carried out as per guideline of concerned Tree Authority under Maharashtra (Urban Area) Tree Preservation Act, 1975 and its amendments. Total 4799 trees will be planted for affecting total 708 trees</li> </ul>	Contractor	MMRDA, Supervision Consultant

		<ul style="list-style-type: none"> <li>• Other than this, approx. 50-60 trees exists at depot site. Joint visits will be undertaken by the civil, planning and environment team to understand requirement of tree cutting which shall minimize the nos. of trees to be cut. Compensatory afforestation will also be undertaken for the affected 50-60 trees.</li> <li>• Transplantation shall be preferred over the tree cutting. Trees having width between 30-75 cm shall preferably be planted. Transplantation shall be carried out following the scientific approach in appropriate season and with all the utilities available through an experienced agency only to assure the high survival rate of transplanted tree.</li> <li>• Survival rate of the plantation shall be maintained and additional trees shall be planted for every tree lost</li> <li>• Proper measures for tree care like provision of guards, watering, manuring etc shall be provided as required to protect tree from cattle and weather action</li> <li>• Plantation shall preferably be carried out with the native species having minimal aftercare requirement and high survival rate</li> <li>• Trees having high CO2 and other pollutant absorbing capacity shall preferably be planted</li> <li>• Exotic and ornamental species shall be avoided</li> <li>• Regular monitoring of the plantation shall be done on fortnight basis</li> <li>• Proper maintenance of machinery and oiling to minimize heating of the machinery and minimize the emissions</li> <li>• Monitoring of DG Sets for performance evaluations</li> <li>• Good quality of coolant shall be used to check the overheating of DG sets and other machineries.</li> <li>• No CFCs/HFCs will be used for the project development</li> <li>• All the electrical equipment (traction/auxiliary transformers) will be PCB free completely in compliance to International Convention on Hazardous Materials. Transformer oil as per IS 12463 has been used in transformers.</li> <li>• MMRDA/ MMOCL will keep an inventory of all transformers; both functioning and non-functioning, with oils, replacements, disposed, etc.</li> <li>• Provision of sensors and alarm system to detect the leakage of SF6 followed by tripping of circuit breakers in RMUs and switch breakers.</li> <li>• MMRDA/ MMOCL will maintain an inventory of all SF6 containing equipment; both functioning and non-functioning, leakages, rectifications, replacements, disposed, etc.</li> </ul>		
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2	Air pollution and dust control measures	<ul style="list-style-type: none"> <li>• Siting of stone quarry plant, batching plant, stone crushers plant should be done in down wind direction</li> <li>• Proper and prior planning and appropriate sequencing and scheduling of all major construction activities will be done, and timely availability of infrastructural supports needed for construction will be ensured to shorten the construction period vis a vis reduce pollution.</li> <li>• Construction materials shall be stored in covered condition to prevent the fugitive emissions.</li> <li>• Construction materials and debris shall be transported in the covered conditions.</li> <li>• Adequate dust suppression measures such as regular water sprinkling on unpaved haul roads, stone quarry, batching plant and stone crushers sites &amp; fugitive dust during material handling, loading/unloading &amp; other activities at haul road particularly at vulnerable areas near habitation shall be controlled especially in the dry seasons</li> <li>• Dust during loading and unloading will be controlled with careful handling and by following measures: <ul style="list-style-type: none"> <li>✓ Increasing moisture content: In some cases, slight moisture may be added to the material to reduce dust during loading.</li> <li>✓ Reducing falling distance: Shortening the falling distance between the material discharge point and the material pile will slow material velocity and reduce particle impacts, lessening dust generation.</li> <li>✓ Adding physical barriers at the loading point: Create walls or areas where personnel are removed from the affected area to avoid dust exposure could occur.</li> </ul> </li> <li>• During construction period, all applicable clearances for air quality management and approvals such as 'Consent to Establish' and 'Consent to Operate' for batching plant, stone crushers area, stone quarry shall be obtained from the State Pollution Control Board and complying all the conditions. All vehicles operating for the Contractor shall obtain Pollution under Control (PUC) certificate.</li> <li>• Environmental clearances shall be obtained from authorities for establishing new quarries and crushers. Contractor shall strictly comply to all the conditions in the clearances.</li> <li>• DG sets shall b provided with stack of adequate height as per CPCB norms (<math>H= h+0.2\sqrt{KVA}</math>, where H= total height of the stack, h=height</li> </ul>	Contractor	MMRDA, Supervision Consultant
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		<p>of the building in meters, KVA=total generator capacity of the set in KVA)</p> <ul style="list-style-type: none"> <li>• It will be ensured that all the construction equipment &amp; vehicles are in good working condition, and maintained to keep emissions within the permissible limits. Idling of the vehicles shall be minimised and engines should be turned off when not in use to reduce pollution.</li> <li>• Only clean fuel shall be utilized for all cooking purposes at labor camps.</li> <li>• Raw materials shall be procured from nearest local sources.</li> <li>• Provision of wheel wash facility will be installed to contain project site dust within the site.</li> <li>• Recycled construction materials like fly-ash and sludge from cement plant for construction purpose may be utilized.</li> <li>• Temporary Electricity connections at the sites will be obtained to minimize usage of DG sets etc.</li> </ul>		
3	Noise level Controlling measures	<ul style="list-style-type: none"> <li>• Barricading (Temporary noise barrier) the construction site to minimize the noise level outside the site boundary.</li> <li>• Management of construction traffic to avoid residential areas.</li> <li>• Restriction on Honking at the project site.</li> <li>• Heavy noise generating activities like piling preferably shall not be carried out at residential and sensitive areas during night time (10:00 PM to 6:00 AM).</li> <li>• Periodic monitoring (monthly level) of noise levels to check the level of pollutants and effectiveness of proposed EMP.</li> <li>• Stationary noise source like generator sets shall be provided with acoustic enclosures. The plants, equipment and vehicle used for construction should strictly conform to CPCB standards. Vehicles and equipment should be fitted with silencer and maintained accordingly.</li> <li>• All equipment should be fitted with silencers/noise mufflers and will be properly maintained to minimize its operational noise. Noise level will be one of the considerations in equipment selection, which will favour lower sound power levels.</li> <li>• Protection devices (earplugs or earmuffs) should be provided to the workers operating near high noise generating machines.</li> <li>• Hearing test for the workers prior to deployment at site and high noise areas followed by periodic testing at every six months.</li> <li>• Job rotations systems for workers who will be working in high noise level areas.</li> </ul>	MMRDA	Contractor and Supervisor Consultants

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		<ul style="list-style-type: none"> <li>• Noise barrier along the sensitive receptors which are with in the 100 m distance of the alignment shall be provided.</li> <li>• Barriers for restriction of noise, bird collision and visibility along the corridor during Operation Phase</li> <li>• Noise barriers should be erected during construction stage for all residential/sensitive receptor locations (Kapurbawadi, Samta Nagar (Ch 1200-1900), Ashok Nagar, Swaraj Nagar, Kahler, Kopar, Oswal wadi) along the alignment so as Ambient noise levels are not affected due to project operation. Further these noise barriers will also act as visibility barrier and barrier to prevent collision of avifauna with running train.</li> </ul>		
5	Vibration	<ul style="list-style-type: none"> <li>• Prior construction, preconstruction surveys shall be conducted at locations close to piling to document the existing condition of buildings in case damage is reported during or after construction. Damaged buildings would be repaired, or compensation paid to the owners.</li> <li>• Notify the local people prior to undertake the construction activities associating with higher vibration level such as activities using vibrating rollers.</li> <li>• The vibrations should be reduced considerably by ensuring and keeping correct track geometry by advanced measurement.</li> <li>• Route heavily loaded trucks away from residential streets, if possible. Selects street with fewest homes, if no alternatives available.</li> <li>• Operate earthmoving equipment on the construction plot as far away from vibration-sensitive sites.</li> <li>• Phase demolition, earthmoving and ground-impacting operations so as all activities does not occur in the same time period.</li> <li>• Avoid night-time activities. People are more aware of vibration in their homes during the night-time hours.</li> <li>• Avoid impact pile driving where possible in vibration-sensitive areas. Drilled piles or use of a sonic or vibratory pile driver causes lower vibration levels where levels where geological conditions permit their use. However, continuous operation at a fixed frequency may be more noticeable to nearby residents, even at lower vibration levels. Furthermore, the steady-state excitation of the ground may increase resonance response of building components. Resonant response may be unacceptable in cases of fragile buildings or vibration-sensitive manufacturing processes. Impact pile drivers, in contrast, produce a high vibration level for a short time (0.2 s) with sufficient time between impacts to allow any resonant response to decay.</li> </ul>	MMRDA	Contractor and Supervisor Consultants

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		<ul style="list-style-type: none"> <li>Select demolition methods not involving impact, where possible.</li> <li>Avoid vibratory rollers and packers near sensitive areas.</li> </ul>		
6	Biological Environmental: Flora	<ul style="list-style-type: none"> <li>No labour camp shall be established on the forest land.</li> <li>The boundary of the diverted forest land shall be suitably demarcated. No additional or new path will be constructed inside the forest area for transportation of construction materials for execution of the project work.</li> <li>Alternate fuel shall be provided to the labours in the labour camps to ensure that no firewood will be used for cooking etc.</li> <li>Smoking, hunting &amp; fishing shall be prohibited. Contractor shall conduct regular awareness trainings related to non-use of firewood, prohibition on smoking in natural areas, bush fires accidents, safe handling of animals (if encountered), prohibition of fishing etc.</li> <li>Noise will be kept under control by regular maintenance of equipment and vehicles. Noisy activity shall be prohibited during night in forest areas.</li> <li>Dust control measures will be adequately applied with the dust generating activities.</li> <li>Trees located outside the RoW will not be felled. Minimum number of trees will be felled within the Row with translocation of trees upto maximum possible extent will be performed as much as possible.</li> <li>The loss of trees shall be compensated through compensatory plantations in the recognized CA land in accordance with requirement of Tree Authority. Standard size saplings with minimum height &amp; minimum collar girth of native mixed species as approved by the State Govt. shall be planted in the selected CA land. The height and collar girth (specie wise) shall be measured &amp; recorded at the time of plantation. Data of height, collar girth and survival percentage (species wise) twice a year (April &amp; November month) shall be recorded &amp; maintained.</li> <li>No labour camps shall be permitted in the vicinity of any water body in order to avoid the deterioration of water quality and any human induced impact on aquatic life nor shall workers be permitted to use waterbodies for bathing and washing.</li> <li>Designates place will be used to store the construction material. Proper care will be taken that no spill of the construction material or the debris shall take place and get mixed into any river body or washed away in heavy rains.</li> </ul>	Contractor	MMRDA, Supervision Consultant

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		<ul style="list-style-type: none"> <li>Moreover, all provisions of Environmental Management Plan made for the air, water, noise pollution control will be implemented, and thus will also be helpful to control the negative impacts on the flora as well.</li> </ul>		
7	Biological Environmental: Fauna	<ul style="list-style-type: none"> <li>Smoking, hunting &amp; fishing shall be prohibited in the natural habitats/forests.</li> <li>Awareness will be spread among the workers towards nature's conservation.</li> <li>All staff / workers will be instructed not to chase/hunt if any wildlife seen near the project area. The incidence of sighting wildlife near project site should be reported to Forest Department for safe handling.</li> <li>Construction activities will be avoided in night time near the natural habitats.</li> <li>All kind of the pollution and noise causing machinery/engines will be properly serviced to keep the disturbance level at minimum or under the prescribed limits.</li> </ul>	Contractor	MMRDA, Supervision Consultant
8	Waste Management	<ul style="list-style-type: none"> <li>Contractor shall follow and comply with all the rules pertaining to the management and disposal of waste in India</li> <li>Contractor shall obtain NOC for generation, management and disposal of all kind of waste generated from SPCBs and local bodies as applicable.</li> <li>Contractor shall follow and comply with the conditions of all the NOC obtained pertaining to the waste generation</li> <li>Waste generated at the site shall be segregated at source and treated or re-used at site to the extent possible. Recyclable materials shall be segregated and sold to the authorized recyclers. Reject fraction of waste shall be disposed off through the authorized local waste management agencies in the area</li> <li>If local agencies/facility for waste collection and disposal are not available for municipal and C&amp;D waste, in the project area then contractor shall identify the sites for waste/construction debris disposal. Debris disposal sites shall be selected prior start of construction and approval shall be obtained from MMRDA prior the start of construction.</li> <li>Any hazardous materials to be used will also need to be stored and handled correctly to prevent spills and pollution. Hazardous material shall be stored in covered conditions only in the confined location and shall be provided with the containment for any spillage. Hazardous waste containers shall properly be marked and kept in isolated locations only. Hazardous waste transportation shall be carried out only through</li> </ul>	Contractor	MMRDA, Supervision Consultant

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		<p>the authorized transporters and TREM card shall be maintained for transportation</p> <ul style="list-style-type: none"> <li>• Hazardous waste shall be sold only to authorized vendors</li> <li>• Fuel/waste oil shall be stored in covered HDPE containers only on paved surface having provision of containment of spillage. Oil interceptors shall be provided with the drains near the fuel/waste oil storage. Oil spill management kits shall be available at the site to manage the spill, if any</li> <li>• Effort shall be made to re-use C&amp;D waste to the possible extent such as filling material for casting yard or can be given to other local construction projects. Surplus shall be sent for recycling to the recyclers or for disposal at approved sites</li> <li>• Excavated soil shall be used for backfilling excavations and surplus shall be given to the other construction projects in vicinity or disposed off to the C&amp;D waste disposal site</li> <li>• No dumping should be carried out outside the RoW including private and government land, road side, low lying areas, wetlands, water bodies, forest area, ecologically sensitive areas etc.</li> <li>• All the workers engaged in waste management shall be provided with the adequate PPEs like jackets, gloves, masks, face shield etc.</li> <li>• Waste generation shall be minimized by providing adequate material storage and covering facility and providing training to the workers for proper handling of the material and machinery</li> </ul>		
9	Top Soil Preservation and soil compaction prevention	<ul style="list-style-type: none"> <li>• Top soil from the RoW shall be removed upto the depth of 15 cm and shall be stored for later usage for landscaping and dressing of the temporarily affected areas at the time of restoration</li> <li>• Top soil shall be stored in the form of stock piles. Slope and height of the stock pile shall be maintained as per the angle of repose of the material. Minimum distance of 250 m shall be maintained b/w the two stock pile to allow the access. These stock piles shall be sprinkled with water to minimise the erosion</li> <li>• Excavated earth/stock piles shall not be piled at construction site and shall regularly be removed. They shall be stored in covered condition to prevent erosion due to wind and water action. Height of the stock piles shall be maintained. High and very close stock piles shall be avoided. Drainage facility shall be provided in the stock pile area to prevent erosion/washing away of stock piles</li> </ul>	Contractor	MMRDA, Supervision Consultant

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10	Slope Protection, Stripping, stocking	<ul style="list-style-type: none"> <li>Excavated slopes shall be stabilised through appropriate engineering and biological measures like pitching, mulching, turfing, etc.</li> <li>Excavated pits shall be stabilized by shoring to prevent any collapse of excavation and soil erosion</li> <li>River bed slopes (Ulhas river) from where vegetation is removed or destabilized for construction of bridges shall be stabilized through appropriate biological and engineering methods</li> <li>Approaches for bridges shall be stabilized and pitched as required to prevent any erosion</li> </ul>	Contractor	MMRDA, Supervision Consultant
11	Management of stockpiles/ Construction Raw Material	<ul style="list-style-type: none"> <li>Loose construction material and excavated earth shall be stored and transported in covered conditions</li> <li>Stockpiles of construction materials, top soil and excavated earth shall be located away from rivers, streams, fertile agricultural lands, recorded forest lands or inhabited area.</li> <li>Appropriate measures like silt fence, perimeter dikes, water bars etc. be installed around stockpiles to retain silt from run-off.</li> </ul>	Contractor	MMRDA, Supervision Consultant
12	Drainage	<ul style="list-style-type: none"> <li>Temporarily drainage shall be provided at the construction sites, parking areas, casting yards, vehicle/machinery washing areas and excavated areas to divert the runoff. These drains shall be provided with sedimentation tanks to arrest the silt.</li> <li>These drains shall be kept clean and shall remain functional. Drainage shall be inspected every month</li> <li>Adequate cross drainage structures and longitudinal drains shall be provided in &amp; along service roads (if any) to ensure the cross drainage of the run off as required. The cross-drainage of service road structure shall be connected to the nearest existing drainage system</li> </ul>	Contractor	MMRDA, Supervision Consultant
13	Silt Management of water bodies and prevention of soil erosion	<ul style="list-style-type: none"> <li>Silt fencing around water bodies during construction will be installed to filter out the silt-laden runoff before entering to the water body</li> <li>Turfing or pitching of embankments of affected water bodies will be done to prevent erosion that also causes siltation in the water bodies</li> <li>No solid waste will be dumped in or near the water bodies or rivers</li> <li>Excavated earth and other construction materials shall be stored away from water bodies</li> <li>Excavation shall not be carried out during monsoon and excavated pits shall be covered with tarpaulin to prevent filling with water. Soil laden water filled in the pit shall be pumped into sedimentation tank and the settled silt shall be re-used within the project</li> <li>Excavated earth/stock piles shall not be piled at construction site and shall regularly be removed. They shall be stored in covered condition to</li> </ul>	Contractor	MMRDA, Supervision Consultant

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		prevent erosion due to wind and water action. Height of the stock piles shall be maintained. High and very close stock piles shall be avoided. Drainage facility shall be provided in the stock pile area to prevent erosion/washing away of stock piles		
14	Construction materials Transportation and haul road maintenance	<ul style="list-style-type: none"> <li>• Water sprinklers must be working on the haul roads.</li> <li>• Speed limits should be below 20km/hr on haul roads. Over speeding shall be strictly prohibited</li> <li>• Trucks/loaders should be properly covered with no spillage of the materials</li> <li>• No vehicle shall be overloaded</li> <li>• Drivers shall be trained for defensive driving, first aid, fire extinguishing</li> <li>• Drivers shall be instructed to take only designated route for transportation of material and shall avoid peak traffic hours</li> </ul>	Contractor	MMRDA, Supervision Consultant
15	Management of construction vehicles	<ul style="list-style-type: none"> <li>• All transportation vehicles and machinery shall be provided with the drip trays and collected fuel shall be disposed off through authorized vendors only</li> <li>• All the construction vehicle shall regularly be serviced and maintained</li> <li>• PUC shall be procured for each construction vehicle</li> <li>• Construction vehicle shall be inspected on regular basis</li> <li>• All construction vehicle shall be parked only in designated locations</li> <li>• All drivers shall be provided induction training, defensive driving training, training for providing first aid and handling fire in vehicle</li> <li>• Drivers shall be instructed to follow the traffic rules, respect the designated speed limit and follow the designate routes</li> <li>• Wheel washing facility shall be provided at the exit point at site and the water from the wheel washing facility shall be channelized into sedimentation tank through proper leak proof drainage system. This water shall be re-used for sprinkling purpose as required</li> </ul>	Contractor	MMRDA, Supervision Consultant
16	Water Quality	<ul style="list-style-type: none"> <li>• The priority shall be given to use surface water wherever surface water source is available. Ground and Surface water may be used only after obtaining necessary permissions from the respective Government authorities.</li> <li>• Rain water harvesting shall be carried out where ever feasible.</li> <li>• STP treated water shall be precured from nearby STPs and shall be used preferably for sprinkling and landscaping.</li> <li>• Minimizing water requirement by using water conservation measures such as covering the water tanks, providing visual notice for water conservation, low flow taps in toilets etc.</li> </ul>	Contractor	MMRDA, Supervision Consultant



		<ul style="list-style-type: none"> <li>• Regular inspection to detect leakage in water pipelines and water tanks.</li> <li>• Labour camps, plant sites, casting yards, parking area, workshops, material and fuel storage areas should be located at minimum 500 m distance from the water body;</li> <li>• All necessary statutory approvals should be secured from local authorities prior extraction of surface or ground water</li> <li>• All applicable water quality standards should be complied with, at all construction sites along the proposed alignment route during the entire period of construction activity;</li> <li>• It should be ensured that no liquid is discharged from any construction site/activity without treatment;</li> <li>• Site drainage should be retained in purpose-built lagoons for enough time to allow most sediment to settle out before discharge to natural or urban drains</li> <li>• Suitable drainage at construction site/camp should be provided to avoid formation of stagnant pool of water that leads to water logging and breeding of mosquitoes.</li> <li>• Excavation activities shall not be undertaken during monsoon season. All excavated pits and borrow area sites shall be covered with tarpaulins during rains. Garland drains shall be provided around the excavated pits and borrow sites to prevent entry of run-off from surroundings into the excavated pits.</li> <li>• Stockpiled soil and other loose material should be stored in covered areas or shall be covered with tarpaulin. Drains with sedimentation tanks shall be provided in these area to facilitate drainage of run-off and arresting the silt from run-off.</li> <li>• Sewage from toilets at labour camp and construction sites shall be disposed off complying to the guideline of CPHEEO and PHED. Sewage shall be disposed off through septic tanks and soak pits. Septic tanks shall be evacuated through authorized agencies only. Soak pits shall be not be provided anywhere within 100 m from any water body or where ground water table is less than 4 m. If sewage generation at one site is more than 10 KLD, then preferably STP shall be provided. Sewage shall be treated upto tertiary level and shall meet the discharge standards as specified by CPCB. Treated water shall be used at site for water sprinkling and landscaping.</li> <li>• Proper sanitation facilities (toilet with water facility) at the construction sites and labour camps shall be provided as per PHED norms</li> </ul>		
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		<ul style="list-style-type: none"> <li>Oil and grease interceptors shall be provided with the drains at construction site, material storage area, parking sites and workshops</li> </ul>		
17	Handling of Petroleum products, fuel, lubricants etc.	<ul style="list-style-type: none"> <li>Fuel and all hazardous materials/waste on-site should be stored on paved surface having the provisions of containments</li> <li>Permission should be obtained for handling and use of the POL under MSIHC Rules, 1989 and Petroleum Rules 2002.</li> </ul>	Contractor	MMRDA, Supervision Consultant
18	Oil Spill Management	<ul style="list-style-type: none"> <li>Any spillage of oil and lubricant must be immediately cleared.</li> <li>Oil spill kits shall be provided at the site and the staff shall be trained to use these kits during emergency</li> <li>A floating oil collection boom may be placed on waterbody to collect the oil in case of working inside or near the water body (especially for construction of bridges)</li> </ul>	Contractor	MMRDA, Supervision Consultant
19	Management of Labour Camps and Labour Welfare Measures	<ul style="list-style-type: none"> <li>Labour camps shall be provided with all the facilities as per BOCWA, BOCWR including drinking water facility, sanitation facility, waste management facility, bedding, ventilation, lighting, drainage, toilets etc.</li> <li>Labour camps shall be inspected on monthly basis</li> <li>All the non-compliances pointed out during the inspections shall be closed at the earliest</li> </ul>	Contractor	MMRDA, Supervision Consultant
20	Occupational Health and safety Management	<p>Health Related Measures</p> <ul style="list-style-type: none"> <li>Contractor shall have safety and health management system for all the construction activities to control and prevent any occupational accidents as per the National and International guidelines whichever is stringent as applicable</li> <li>Contractor shall implement workers health awareness and surveillance program including health check-ups, regular health monitoring systems for the workers, vaccination drives for prevention of diseases and awareness program</li> <li>Contractor shall establish occupational health centers at multiple locations and ensure availability of adequate first aid kits, first aiders, nurses, occupational officers at OHC 24 X 7 as per the National and International guidelines whichever is stringent as applicable</li> <li>Workers shall be providing with the hydrating drinks like ORS as required to prevent heat stress/exhaustion</li> <li>Provision of covered rest areas at regular intervals with proper facilities like resting desks, drinking water facility, toilets etc. at construction site. These rest shelters shall be inspected on monthly basis and the non-compliances shall be monitored regularly</li> <li>Contractor shall provide all the facilities such as potable drinking water, toilets with water facility, kitchen area, clean cooking fuel, proper</li> </ul>	Contractor	MMRDA, Supervision Consultant

		<p>bedding, adequate no of toilets and bathing areas, maintenance of cleanliness and sanitation etc. at the labour camp site. Labour camp establishment shall strictly follow the BOCWA, 1996</p> <ul style="list-style-type: none"> <li>• Ambulance with all the required facilities as per BOCWA, 1996, should be provided at all work sites to take injured persons to hospitals.</li> <li>• Emergency contact details (including nearest hospitals and health centers) should be displayed at appropriate locations at construction sites &amp; labour camps.</li> <li>• Full time medical facility should be provided at each labour camp with first aid kits &amp; first aider</li> <li>• Sufficient supply of potable water should be ensured for all workers and employees on-site. Conducting regular monitoring of drinking water quality at site and labour camps</li> <li>• Provision of dust and noise shields and maintenance of adequate distance between the workers and noise/dust generation activities as applicable</li> <li>• Contractor shall implement administrative controls like practicing job rotation, maintaining work hours of labour, implementing work permit system, implementing LOTO, for the workers to prevent continuous exposure to dust, noise, heat, etc.</li> <li>• Workers shall be provided proper training to handle any health-related emergency if any.</li> <li>• All workers and staff should be provided with Personal Protective Equipment (PPE) appropriate to their job on site to minimize exposure to the dust and noise like masks, ear plugs etc.</li> <li>• EMP for dust and noise control shall strictly be followed as suggested.</li> <li>• Framing and implementation of drugs/intoxicants prohibition policy by contractor during the construction phase</li> <li>• Ensuring availability of snake charmers at the site 24X7 for catching the snakes and contacts details of the snake catching organizations shall be provided at the site to handle the situation in case of sighting of a snake. Anti-venoms can be kept in the nearest hospitals/PHCs to treat the snake bites if any</li> <li>• Drinking water quality, air quality and noise level shall regularly be monitored at all the labour camps sites as per CPCB guidelines in regular intervals as suggested in EMoP             <ul style="list-style-type: none"> <li>○ COVID-19: WHO has declared COVID-19 as a pandemic which has affected entire world including India. In view of the prevailing COVID-19 pandemic, the contractors and workers would need to take additional measures to avoid</li> </ul> </li> </ul>		
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		<p>the spread of the disease and shall follow various guidelines/guidance notes issued by the national/state government, WHO, ILO, World Bank/IFC from time to time. As described in these guidelines, the Contractors shall undertake a COVID-19 risk</p> <p>Safety Related Measures</p> <ul style="list-style-type: none"> <li>• Safe work method statement including HIRA shall be prepared and implemented for all the construction activities</li> <li>• Provision of adequate fire detection and firefighting system at the site like extinguishers, sand buckets, fire blankets, usage of fire-resistant materials/wires etc</li> <li>• Contractor shall prepare emergency preparedness plan to handle any contingency due to construction accidents and natural or man-made disasters like earthquakes, floods and dust storms</li> <li>• Contractor shall develop traffic management plan to prevent any traffic related accidents at or outside the site. Contractor shall provide defensive training to the drivers to minimize the accidents</li> <li>• Contractor shall fence all electric sub-stations, high-tension towers and other areas to minimize electrocution risk and shall also provide proper earthing, proper warning signs and conduct security patrols.</li> <li>• Contractor shall ensure provision of safe work environment, provision of competent supervision, provision of safe equipment &amp; machinery and provision of proper training to ensure safety at work site</li> <li>• Contractor should appoint an agency to provide awareness about the prevention of STDs among the workers. The agency shall work in close coordination with NACO and SACS for organizing the awareness campaigns. Workers shall be provided with the condoms and diaphragms as required for minimizing spread of STDs</li> <li>• Regular home visit holidays shall be given to the workers to ensure their proper mental health</li> <li>• All workers shall be provided with job specific training, behavioural based safety training and awareness for ensuring the safety</li> <li>• Smoking shall be prohibited at the site to prevent the health and fire hazard</li> </ul>		
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		<ul style="list-style-type: none"> <li>• All construction sites should be barricaded with proper tamper proof fencing &amp; security lighting and conduct regular security patrols and other security measures. All the construction activity and storage of material shall be strictly within the RoW. All hazardous chemicals &amp; waste and explosives (if any) shall be stored as per the guidelines in the respective laws</li> <li>• Avoiding usage of the chemicals or paints which may impact the health of the workers or community and shall encourage use of the VOC free paints etc. No banned material like asbestos shall be used at the construction site</li> <li>• All workers and staff should be provided with Personal Protective Equipment (PPE) like safety jackets, helmets, gloves, goggles, life jackets in case of work on/near water body appropriate to their job on site to minimize exposure to the hazards</li> <li>• Coordination with local police to curb the anti-social activities and usage of drugs &amp; narcotics.</li> <li>• Contractor will have regular monitoring and audits/inspection system for ensuring effective implementation of safety management system and shall ensure continuous improvement of its safety management system</li> <li>• All the workers shall be tested for vertigo prior assigning working at height. Workers working at height shall be provided with the adequate PPEs like Harness with lifelines, Safety Jackets, Goggles and helmets</li> <li>• Proper safe and wide working platform with railing shall be provided for the workers working at height. These working platforms shall be anti-slipping type</li> <li>• A safety expert shall always be available at the site to supervise works being carried out at height</li> <li>• All the ladders, platforms shall be inspected prior installation and shall regularly be inspected for fitness</li> <li>• Manlifts shall be avoided and if is required all precautions shall be taken to ensure the safety</li> <li>• Electrical safety inspections shall be conducted on daily, weekly and monthly basis. Scores for the monthly electrical audits shall be checked and improved every month to achieve the higher safety score.</li> </ul>		
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		<ul style="list-style-type: none"> <li>• External electrical safety audits shall be conducted annually to ensure the electrical safety</li> <li>• Findings of all the inspections and audits shall be closed with satisfactory requirements within given time frames by auditors/safety experts/electrical engineers</li> <li>• Follow up audits/inspections for electrical and general safety shall be performed for verification of closure of the findings of inspections and audits</li> <li>• Usage of silicon oil as replacement fuel</li> <li>• Electrical safety at the site shall be ensured as per IEC-61439-1 &amp; ISO-14001. Specific electrical safety measures are given below <ul style="list-style-type: none"> <li>➤ Proper earthing of all electrical equipment is ensured as per IS 3043 and IEEE 80.</li> <li>➤ Proper Permit to work system is followed for proper isolation and safe working for all sections.</li> <li>➤ Lightening protection is provided as per IS 2309.</li> <li>➤ All electrical switchgears are equipped with latest numerical relays to isolate any faulty section within minimum time.</li> <li>➤ Fire alarm and detection system is installed as per IS 2189: 2008.</li> <li>➤ Electric shock and treatment chart and artificial respirators are provided at each installation of MMRDA lines as per CEA guidelines.</li> <li>➤ Insulating mat as per IS 15652 are provided for each HV and LV switchgears.</li> </ul> </li> </ul> <p>Regular awareness programs regarding electrical safety are being conducted for ensuring proper safety</p>		
21	Traffic Congestion & Diversions and issues in access M	<ul style="list-style-type: none"> <li>• Traffic management plan shall be prepared and submitted for the project to engineer for approval. Traffic management plan shall also consist of HIRA for traffic diversion</li> <li>• Site specific traffic management plans shall be prepared detailing about the traffic diversions measures required at various locations</li> <li>• Adequate nos. of traffic marshals shall be deputed at diversion site, construction yard and construction sites for management of traffic</li> <li>• Traffic control measures like signages, cautionary notices etc shall be provided for managing the traffic and diversion as required</li> </ul>	Contractor	MMRDA, Supervision Consultant

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		<ul style="list-style-type: none"> <li>• Plan transportation routes so that heavy vehicles do not use narrow local roads, except nearby delivery sites.</li> <li>• Schedule transport and hauling activities during non-peak hours.</li> <li>• Locate entry and exit points in areas where there is low potential for traffic congestion.</li> <li>• Keep the site free from all unnecessary obstructions.</li> <li>• Drive vehicles in a considerate manner.</li> <li>• Provide free access to households and businesses/shops along the ROWs during the construction phase</li> <li>• Parking of transportation/construction vehicles/machinery on road shall not be allowed on public roads</li> <li>• All activities including stockpiling of materials/debris etc shall be exclusively undertaken within RoW</li> <li>• Proper traffic safety measures like provision of adequate barricading and safety signages shall be provided at all the roads to be blocked/diverted to prevent any accident. Site specific traffic diversion/management shall be prepared</li> </ul>		
22	Installation and Operation / Maintenance of Electrical Equipment in Construction Yards	<ul style="list-style-type: none"> <li>• A standard operating procedure shall be prepared and displayed at all the site for installation and operation of the electrical equipment</li> <li>• Earthing shall be done for all the electrical equipment</li> <li>• The electrical equipment should be inspected prior installation and regularly after installation</li> <li>• All the wires should be insulated and no bare wiring should be left.</li> <li>• Wires shall properly be managed and stacked and provided with color coding</li> </ul>	Contractor	MMRDA, Supervision Consultant
23	Handling of Heavy Machinery	<ul style="list-style-type: none"> <li>• All the heavy machinery shall be inspected prior installation and shall be inspected on regular basis</li> <li>• The heavy machinery shall be inspected internal as well as through third party</li> <li>• Proper color coding, SLI etc shall be maintained for the cranes/lifting machinery</li> <li>• The operator, helpers, riggers and the support staff shall properly be trained for handling heavy machinery</li> <li>• All the operations with heavy machinery shall be undertaken in presence of qualified supervisor and safety expert</li> </ul>	Contractor	MMRDA, Supervision Consultant

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24	Cultural and Religious site	<ul style="list-style-type: none"> <li>• If construction work is carried out in the limits of prohibited area (within 100 meters) or regulated area (100-200 meters) of any designated heritage or archaeological sites and remains, permission should be obtained from the relevant authorities</li> <li>• Prescribed procedures for taking permission from the local authority or village Panchayat or local community should be done before excavation of any burial ground, graveyard or 'Idgah' if identified during construction</li> <li>• If valuable or invaluable articles such as coins, artifacts, structure or other geographic or archaeological rare discovered, the excavation should be stop and ASI shall be informed.</li> <li>• Work area shall be barricaded with hard barricading of appropriate height to prevent any accident in vicinity to such site</li> <li>• Adequate lighting shall be provided in the construction area during night time</li> <li>• No authorized entry shall be allowed within the RoW and construction zone</li> <li>• No machinery shall be staged, no material or debris shall be stored and no project facility/utility shall be located outside the RoW especially in vicinity to buildings of heritage, cultural and historical importance</li> <li>• Noisy activities shall be scheduled during night time (when the facility is closed for visitors) to minimize disturbance to tourist or shall be done on closure day</li> <li>• The area shall be restored back to original condition after completion of construction</li> <li>• All waste material including redundant material, debris, material, excavated muck, other waste etc shall be left in the area after construction is completed</li> </ul>	Contractor	MMRDA, Supervision Consultant
25	Management of Sensitive Receptors	<ul style="list-style-type: none"> <li>• Community shall be consulted prior shifting of any such sensitive receptor. Alternate shall be provided for the community facilities like crematorium, public building, post office etc if getting impacted. Till now no CPR is expected to get impacted due to project</li> <li>• Construction works near these sensitive receptors shall be scheduled in a way to minimize impact on user.</li> <li>• A schedule of construction shall be developed in consultation with the concerned control authority of user to minimize the impact. Time of noisy construction works shall be selected as per the sensitivity of</li> </ul>	Contractor	MMRDA, Supervision Consultant



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		<p>receptor like night-time is sensitive for hospitals, day time is sensitive for schools etc.</p> <ul style="list-style-type: none"> <li>• No sensitive receptor shall be impacted or demolished without consent of the dependents/users/owner</li> <li>• Safety measures like barricading of adequate height, adequate lighting, gated access shall be provided to the construction site near these sensitive receptors to minimize the impact</li> <li>• The area shall be restored back to original condition after completion of construction</li> <li>• All waste material including redundant material, debris, material, excavated muck, other waste etc. shall be left in the area after construction is completed</li> </ul>		
26	Community Health	<ul style="list-style-type: none"> <li>• All construction sites should be surrounded with secure tamper proof fence, with security lighting, regular security patrols and other security measures to prevent trespassing. Only authorised person shall be allowed to enter into the construction camps/sites.</li> <li>• Contractors shall have health and safety management system to effectively prevent any accidents happening at construction sites.</li> <li>• All materials and components should be stored and stacked safely in dedicated secure areas.</li> <li>• Avoid use of any paints containing lead or its compounds as well as high VoCs and any banned material like CFC, asbestos etc.</li> <li>• Public health system capacity relies on detecting, testing, contact tracing, and isolating those who are or might be sick, or have been exposed to known or suspected communicable diseases. It is important to stop broader community transmission and prevent communities from having to implement or strengthen further community mitigation efforts. This can be done by organizing regular community health check-ups.</li> </ul>	Contractor	MMRDA, Supervision Consultant

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		<p>Awareness program and vaccination camps will be organized in the nearby settlements/villages.</p> <ul style="list-style-type: none"> <li>• Ensure that first aid kits are available in all working areas, supplied with adequate material and medicine as per the BOCWA 1996. Facility of ambulance needs to be ensured.</li> <li>• Record of all nearest hospitals and health centers should be kept at each construction sites.</li> <li>• EMP for dust and noise control shall strictly be followed as suggested.</li> <li>• Labour camps shall preferably be established at minimum distance of 500m from the residential/institutional areas</li> <li>• Framing and implementation of drugs/intoxicants prohibition policy by contractor during the construction phase</li> </ul>		
27	Restoration of damaged property	<ul style="list-style-type: none"> <li>• Any private, government or property of any party got damaged during construction shall be repaired/restored to its original condition</li> </ul>	Contractor	MMRDA, Supervision Consultant
28	Post construction clean-up	<ul style="list-style-type: none"> <li>• RoW and all the sites temporary occupied for construction and related activities shall be cleaned up and restored back to their original condition</li> <li>• The site shall be levelled and treated with vegetative measures</li> <li>• All the debris and redundant machinery shall be removed from the site as per the requirements under various legislation of GoI</li> <li>• Backfill any excavation and trenches, preferably with excess excavation material generated during the construction phase.</li> <li>• Use removed topsoil to reclaim disturbed areas.</li> <li>• Re-establish the original grade and drainage pattern to the extent practicable.</li> <li>• Restore access roads, staging areas, and temporary work areas.</li> <li>• Stabilize all areas of disturbed vegetation using weed-free native shrubs, grasses, and trees.</li> <li>• Remove all tools, equipment, barricades, signs, surplus materials, debris, and rubbish. Demolish buildings/structures not required for O&amp;M. Dispose of in designated disposal sites.</li> <li>• Request in writing for inspection &amp; approval from MMRDA that construction zones have been restored</li> <li>• Encroachment of any type or within the RoW, shall be discouraged. A systematic awareness among road-side communities shall be carried out, in association with the Local Governing Bodies.</li> <li>• Monitor the success of revegetation and tree re-planting. Replace all plants determined to be in an unhealthy condition.</li> </ul>	Contractor	MMRDA, Supervision Consultant

**Table 8.3 : Environmental Management Measures and allocation of Responsibilities in Operation Phase**

SNo.	Project / Environmental Component	Mitigation/ Management Measures	Responsibility Allocation	
			Planning, Implementation and Reporting	Supervision
1	Climate	<ul style="list-style-type: none"> <li>Solar PV cell shall be installed on roof top of all the buildings like station, maintenance depot to harness the solar energy;</li> <li>To design the building in compliance to the Energy Conservation Building Code (ECBC) 2017 to reduce the power requirement;</li> <li>Adoption of Green building rating system for station and depot is preferable</li> <li>Minimizing/optimizing use of air conditioning system at maintenance depot.</li> </ul>	MMMOCL	MMMOCL
2	Land-use	<ul style="list-style-type: none"> <li>Local development authorities of the affected area shall work on upgradation of basic facilities like drainage, waste management, water resources etc of the area prior sanction of increase in FSI</li> </ul>	MMMOCL	MMMOCL
3	Soil Quality	<ul style="list-style-type: none"> <li>Parking area must be paved to prevent the soil erosion from vehicular movement. The paving should with the perforated pavers to allow water to percolate and to minimize the rain runoff.</li> <li>Parking areas should be provided with proper storm water drainage filtered with oil interceptors.</li> <li>Hazardous chemicals &amp; waste, used/waste oil and fuel shall be stored in covered areas only as per the guidelines given in MSIHC rules 1987, Hazardous Waste Management Rules, 2016 and material safety datasheets to prevent leakage and spillages. These shall be stored only in the paved areas provided with the provision of containment of the spillages, if any.</li> <li>Oil spill management kit shall be available at all stations and depot. Staff shall be trained to use these kits for cleaning for spills.</li> <li>Disposal of sewage through septic tank at stations and timely evacuation of the septic tanks.</li> <li>No area should be left excavated or open after any repair &amp; maintenance works</li> <li>Fuel, waste oil &amp; used oil should be stored in HDPE containers in isolated areas on paved surface. These paved surfaces should be provided with the drains and oil interceptors should be installed in the drains.</li> <li>Authorization shall be obtained from SPCB for generation of hazardous waste</li> <li>Waste generated should be properly collected and segregated at each station in twin bin system. Recyclable fraction of waste should be sold to authorized vendor periodically and non-recyclable/rejected version should be disposed on daily basis through local agencies in the area responsible for waste management</li> </ul>	MMMOCL	MMMOCL

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4	Water Resources	<ul style="list-style-type: none"> <li>• Minimize water requirement by using water conservation measures such as providing visual notice for water conservation, low flow taps and dual flushing system in toilets etc.</li> <li>• Prevent leakage of water from water pipeline and water tanks by timely and regular inspections</li> <li>• Provision of STP preferably if sewage is more than 10 KLD. Using the STP treated water for flushing and landscaping</li> <li>• If sewage is disposed off in septic tank/soak pit, these shall be timely emptied and septage shall be disposed off through authorized agencies to nearby STP</li> </ul>	MMMOCL	MMMOCL
5	Water quality and Wastewater treatment	<ul style="list-style-type: none"> <li>• Hazardous material, hazardous waste, other waste and fuel shall be stored in covered condition on paved surfaces</li> <li>• Proper toilet facilities with sewage treatment and disposal facilities should be provided at stations and depot accordance to CPHEEO and CPCB/SPCB norms. For sewage treatment and disposal septic tanks with soak pits or STPs can be provided depending on the quantum of the sewage generation. If sewage generation exceeds 10 KLD STPs shall be provided preferably.</li> <li>• Sewage and the wastewater from the depot/maintenance sites shall be treated upto the prescribed standards of CPCB. Treated water shall be re-used at site by deploying appropriate techniques like dual plumbing system for flushing, landscaping and dust suppression system</li> <li>• Waste shall be stored, managed and disposed off as per the waste management laws of country</li> <li>• ETPs shall be provided at the depot for treatment of waste water from repair and maintenance facilities.</li> <li>• No area should be left excavated or open after any repair &amp; maintenance works so as there will not be chance of sediments getting mixed with the rainfall run-off</li> <li>• Proper storm water drainage system and rain water harvesting pits should be provided to harvest the storm water and recharge the same into ground water aquifer system to augment the ground water level and reduce the run-off into the surface water bodies. Along with the stations, it is also proposed to provide the pits at the viaducts to harvest the storm water from viaducts also</li> <li>• Storm water drains and pits shall be cleared every year prior start of monsoon</li> </ul>	MMMOCL	MMMOCL
6	Air pollution	<ul style="list-style-type: none"> <li>• Provide adequate height of the stack of DG set to have wider dispersion of the gaseous emission and also to attain the mixing height.</li> <li>• Regular stack monitoring of DG set will be done to check their emission level.</li> <li>• Water sprinkling to be carried out at maintenance depot and station area to minimise dust.</li> </ul>	MMMOCL	MMMOCL

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		<ul style="list-style-type: none"> <li>• Sufficient parking space should be available at all the stations so as people can leave their private vehicle and travel in metro. Further parking of private vehicle should not lead to congestion on roads.</li> <li>• Wide access pathways and sufficient nos. of exit &amp; entry should be provided at each station to minimize the congestion</li> <li>• Rumble strips should be provided on the roads in front of stations so as the speed of vehicle is regulated near station area and chances of accident is minimized</li> <li>• Adequate feeder services should be provided so as to maximize the catchment area of proposed metro system and minimize the usage of private vehicle to reach the station. These feeder buses should be integrated and linked to city bus services and other para-transit systems like auto rickshaws and Non-motorized vehicles (NMVs)</li> <li>• Roads in the station area should be properly maintained and sprinkled with water</li> <li>• MMMOCL may coordinate with the concerned development authorities, so as to assure that width of the roads connecting the stations is adequate to handle the existing traffic and anticipated new traffic to prevent congestion near stations</li> <li>• Vehicles with valid PUC shall only be allowed to enter the station premises</li> </ul>		
8	Noise and Vibration	<ul style="list-style-type: none"> <li>• Noise barriers should be erected during construction stage for all residential/sensitive receptor locations (Kapurbawadi, Samta Nagar (Ch 1200-1900), Ashok Nagar, Swaraj Nagar, Kahler, Kopar, Oswal wadi) along the alignment so as Ambient noise levels are not affected due to project operation. Further these noise barriers will also act as visibility barrier and barrier to prevent collision of avifauna with running train.</li> <li>• Maintenance of the noise barriers provided along the RoW and in depot area</li> <li>• Proper maintenance and timely servicing of the entire system (train, track, rail etc) to minimize vibration</li> <li>• Rail grinding on a regular basis, particularly for rail that develops corrugations. Rail condition monitoring systems are available to optimize track conditions.</li> <li>• Wheel truing to re-contour the wheel, provide a smooth-running surface, and remove wheel flats. The most dramatic vibration reduction results from removing wheel flats. However, significant improvements also can be observed simply from smoothing the running surface.</li> <li>• Adjust night-time schedules to minimize train movements during the most sensitive hours.</li> <li>• Reduce the vehicle speed while passing through the sensitive areas.</li> <li>• Use the equipment that generates the lowest vibration levels during the night-time hours when people are most sensitive to vibration</li> </ul>	MMMOCL	MMMOCL
9	Flora	<ul style="list-style-type: none"> <li>• Proper aftercare and monitoring of trees transplanted for minimum 1 year and trees planted for minimum 3 years shall be done</li> <li>• Replanting the dead trees</li> <li>• Preferring native species for plantation</li> </ul>	MMMOCL	MMMOCL

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		<ul style="list-style-type: none"> <li>Planted trees shall not be cut for any purpose</li> <li>Water sprinkling on flora of areas nearby stations/depot</li> <li>Development of green belt at depot area as per CPCB guidelines for Green Belt Development, 2000</li> <li>Taking measures to attract birds for nesting on the planted trees</li> <li>Since the distance from SGNP and Thane Creek flamingo sanctuary is more than 3.0 km, no impact is envisaged on these areas due to proposed project. Also proposed project is outside the boundary and ESZ of these sanctuaries</li> </ul>		
10	Development of Green belt	<ul style="list-style-type: none"> <li>Green belts shall be developed at depot site as per CPCB Green Belt Development Guideline</li> <li>Only native species of trees are to be planted.</li> <li>Arrangements for the watering must be ensured to achieve higher survival rate.</li> <li>Dead saplings must be replaced with the new ones regularly.</li> </ul>	MMMOCL	MMMOCL
11	Training for operational staff, construction workers & officers	<ul style="list-style-type: none"> <li>All the deployed staff must be well trained, well informed about their responsibilities and operation standards.</li> <li>Trainings must be arranged at regular intervals on Safety, Health and Environment etc.</li> </ul>	MMMOCL	MMMOCL
12	Emergency Response System	<ul style="list-style-type: none"> <li>Devices for the real-time communication must be available at all sites.</li> <li>Alarm system should be installed at control rooms and stations.</li> </ul>	MMMOCL	MMMOCL
13	Waste Handling and Disposal	<ul style="list-style-type: none"> <li>Waste to be generated from maintenance depot and stations shall be segregated at source and shall be disposed off as per the Waste Management Laws.</li> <li>Any hazardous materials to be used will also need to be stored and handled correctly to prevent spills and pollution.</li> <li>All the rules pertaining to the management and disposal of waste in India shall be followed</li> <li>NOC for generation, management and disposal of all kind of waste generated from SPCBs and local bodies as applicable shall be obtained and all the conditions in the NOC obtained shall be followed</li> <li>Waste generated at the train, stations and depot areas shall be segregated at source and treated to the extent possible. Recyclable materials shall be segregated and sold to the authorized recyclers. Reject fraction of waste shall be disposed off through the authorized local waste management agencies in the area</li> <li>Any hazardous materials to be used will also need to be stored and handled correctly to prevent spills and pollution. Hazardous material shall be stored in covered conditions only in the confined location and shall be provided with the containment for any spillage. Hazardous waste containers shall properly be marked and kept in isolated locations</li> </ul>	MMMOCL	MMMOCL

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		<p>only. Hazardous waste transportation shall be carried out only through the authorized transporters and TREM card shall be maintained for transportation</p> <ul style="list-style-type: none"> <li>• No dumping should be carried out outside the defined project area limit or on any private and government land, road side, low lying areas, wetlands, water bodies, forest area, ecologically sensitive areas etc.</li> <li>• All the workers/staff engaged in waste management shall be provided with the adequate PPEs like jackets, gloves, masks, face shield etc</li> <li>• Waste generation shall be minimized by providing adequate material storage and covering facility and providing training to the workers for proper handling of the material and machinery</li> </ul>		
14	Health and safety	<ul style="list-style-type: none"> <li>• There shall be standard operating procedure for operation and maintenance work and a system for implementation and continuous monitoring.</li> <li>• There shall be provision of competent supervision, safe work environment and provision of safe equipment to prevent work related accident during maintenance work in depot and substations.</li> <li>• Competent workers shall be inducted, and training and awareness program shall be administered for competency enhancement.</li> <li>• Proper administrative control shall be implemented like practicing job rotation, maintaining work hours, ergonomically designed work platforms, implementing work permit system and LOTO for maintenance work etc.</li> <li>• Worker health awareness and surveillance program to continuously monitor the health-related issues of the worker.</li> <li>• There shall be health centers equipment with medical practitioners for administering medical aids.</li> <li>• Provision of health and safety training and awareness program to workers to make them aware about the various hazards and risk which may encounter during their course of work.</li> <li>• All the staff should be given training for carrying out the work assigned keeping the safety as priority.</li> <li>• All staff should be provided with personal protective equipment like HT gloves, safety helmets, safety jackets, ear muffs, safety belts, welding masks, safety shoes, Goggles, safety shoes, full body harness) as required</li> <li>• Periodic inspection of PPE should be done to ensure that they are in proper condition by keeping the records</li> <li>• Tests should be undertaken for workers working at heights prior joining. Work at height should be undertaken during day time only.</li> <li>• Fall arrest system should be provided at the areas which involves working at height</li> </ul>	MMMOCL	MMMOCL

		<ul style="list-style-type: none"> <li>• Induction training should be given to all the workers at the time of joining which should include awareness of the activities to be carried out by worker, tools involved, risks involved and personal protective equipment to be used</li> <li>• Health check-ups should be undertaken for workers every year</li> <li>• Proper signage about the stations, entry, exit, fire exit, directions, safety messages, conservation of energy &amp; water, non-spitting, non-littering, restricted entry etc. should be provided at all the stations and inside the metro to make the passenger and staff about the risks involved and required safety measures to be taken</li> <li>• Adequate emergency exit should be provided in the metro and at station and the location of the same should be displayed at all the suitable locations. Along with the visual display, audio messages should also be communicated at the stations and in metro about the safety measures to be taken</li> <li>• Proper guards/safety provision should be made along the railings of elevated metro stations. Entry beyond the certain points should be restricted for the passengers</li> <li>• Entry to the control rooms, firefighting rooms, DG area and other similar areas should be restricted for passengers and entry of such areas should be guarded</li> <li>• Elevators provided should be regularly maintained and checked for proper functioning</li> <li>• Maintenance of the metro and other equipment should be carried out regularly as per the approved maintenance schedule</li> <li>• Functioning of metro, stations, electrical equipment &amp; network, DG sets etc. should be audited and inspected by eligible third part on regular basis</li> <li>• All the platforms should be properly guarded to ensure people board &amp; deboard in queue and do not stand beyond the demarcated area</li> <li>• Certified First aid trainer should be present at all the stations all the time</li> <li>• System of work permits should be issued in case any maintenance work is being undertaken at track, electrical wires, OHE, control room and any such area. LOTO system should be implemented to minimize the accidents</li> <li>• Every day PEP Talks should be taken up with the security &amp; maintenance staff to communicate the major safety principle to be followed and kept in mind.</li> <li>• Safety meetings should be held monthly to discuss the existing safety practices and measures for improvising the procedures</li> <li>• Mock drills should be conducted to train staff for handling emergency situations</li> <li>• Emergency preparedness &amp; response plan prepared for the project should be followed</li> <li>• Dos and Dont's during the natural calamity and accidents should be displayed at stations and in metro for passengers and staff so as they know what is to be done during and after emergency.</li> <li>• Trainings should be conducted for drivers on regular basis to train them about the safety procedures and strictly following the rules</li> </ul>		
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		<ul style="list-style-type: none"> <li>• Regular monitoring, servicing &amp; maintenance of all the signaling, transmission and communication system to minimize the chances of accidents</li> <li>• Emergency contact numbers should be displayed at the stations &amp; in metro</li> <li>• Photography should be restricted in the metro premises</li> <li>• Floors of stations and metros should be cleaned on daily basis</li> <li>• Lifting equipment engaged should be thoroughly and regularly examined before use</li> <li>• Fire-fighting equipment should be provided at all the locations, i.e. inside metro, stations at depot as per the granted NOC from local Fire Department. Fire evacuation plan should be displayed at all the desired locations</li> <li>• Accident records should be maintained. Accident reporting should be done within 1 day after accident and detailed root cause analysis should be carried out for each accident so as preventive measures can be taken to prevent any similar accidents in future</li> <li>• Regular maintenance of the viaduct, piers, pier caps, OHE system should be done. Regular inspections should be carried out to detect any breakage, cracks or deformity</li> </ul>		
15	Community Health	<ul style="list-style-type: none"> <li>• In case of outbreak of any epidemic, all the prevention and control guidelines of Central and State Govt. shall strictly be followed. Also, signs, banners, posters may be displayed at stations to make aware the passengers about the precautions and appropriate behaviors etc. for the infectious diseases.</li> </ul>	MMMOCL	MMMOCL
16	Micro- climate	<ul style="list-style-type: none"> <li>• All the electrical equipment (traction/auxiliary transformers) will be PCB free completely in compliance to International Convention on Hazardous Materials. Transformer oil as per IS 12463 has been used in transformers.</li> <li>• MMRDA/ MMOCL will keep an inventory of all transformers; both functioning and non-functioning, , with oils, replacements, disposed, etc.</li> <li>• Provision of sensors and alarm system to detect the leakage of SF6 followed by tripping of circuit breakers in RMUs and switch breakers.</li> <li>• MMRDA/ MMOCL will maintain an inventory of all SF6 containing equipment; both functioning and non-functioning, leakages, rectifications, replacements, disposed, etc.</li> </ul>	MMRDA/ MMMOCL	MMRDA/ MMMOCL
17	Traffic	<ul style="list-style-type: none"> <li>• MMOCL shall take measures like provision of additional feeder bus service and shared bicycle by MMOCL. These buses will increase the catchment of the proposed metro route. Also, the feeder buses and city buses are planned on such routes that they get integrated with other modes of transportation like city buses, auto-rickshaws &amp; NMVs. This will improve overall traffic pattern in the area and reduce the congestion.</li> </ul>	MMMOCL	MMMOCL
18	Aesthetics	<ul style="list-style-type: none"> <li>• Area under the viaduct and near the stations should be regularly monitored and no commercial establishments or slums should be allowed to come up</li> <li>• Color of the viaducts and piers should be kept white</li> <li>• Bills should not be allowed to be stick on the piers and other structures</li> <li>• Regular cleaning of the stations, nearby areas and the areas under via duct should be carried out</li> </ul>	MMMOCL	MMMOCL

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		<ul style="list-style-type: none"><li>• Area under viaducts and additional land if available near stations and depot should be used for development of green area</li></ul>		
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343. The budgetary provision Rs. 6,80,06,150 for cost of environmental protection measures for implementation of the Environmental Management Plan has been provided. Environment Management Budget is given in **Table 8.4**.

**Table 8.4 : Environmental Management Budget (Tentative)**

Sl. No.	Item	Quantity	Unit	Unit Cost (INR)	Total Cost (INR)
<b>1.</b>	Compensatory Plantation, NPV, New Plantation and Transplantation				
a	For compensatory plantation	4799 Trees	Nos.	1000/tree for plantation plus 3 years of maintenance	47,99,000
b	Transplantation	495 Trees	Nos.	@8000/tree with one year maintenance	39,60,000
c	Mangrove compensatory afforestation, management and maintenance	0.6983 Ha.	Ha	5,00,000/ha	3,49,150
<b>2</b>	Barriers for restriction of noise, bird collision and visibility along the corridor During Operation Phase	@20 % of alignment 11.88 km = 2.54 km, on both sides thus 5.08 km	Rmt	9000 for 1 m length and 2-3 m height	4,57,20,000
<b>3.</b>	Sprinkling water on the road, especially in/near the settlement Areas	9	Months	4,00,000	36,00,000
<b>4.</b>	Training and Awareness Programme for workers and staff	60 (2 trainings per month for 30 months)	Nos	25,000	15,00,000
<b>6.</b>	Env Monitoring			Refer Table 8.9	63,28,000
<b>Additional Cost as per Applicability</b>					
<b>7.</b>	Restoration of borrow pit site by compaction, landscaping and re-vegetating	5	Site	150000	7,50,000
<b>8.</b>	Restoration of quarry site by stabilizing landscaping and re-vegetating	1	Site	10,00,000	10,00,000
<b>Total</b>					<b>6,80,06,150</b>

## 8.2. Responsibilities for EMP Implementation

344. MMRDA has established institutional mechanism for implementation of Environment management plan. The Project Director (PIU) will head the overall safeguard implementation in close coordination with MMRDA. The Project Implementation Unit (PIU) shall have an Environmental cell. The PIU shall be supported/ assisted by a Supervision Consultant to ensure good construction practices and the implementation of the safeguard provisions. Contractor shall be overall responsible for implementation of proposed environment management plan under supervision of supervision consultant during construction phase. Supervision consultant will regularly update PIU on contractors performance on the same. Supervision consultant will be responsible for addressal of any query from third party and assisting MMRDA in being statutory complied organization. The roles and responsibilities of the respective parties and agencies for implementing EMP.

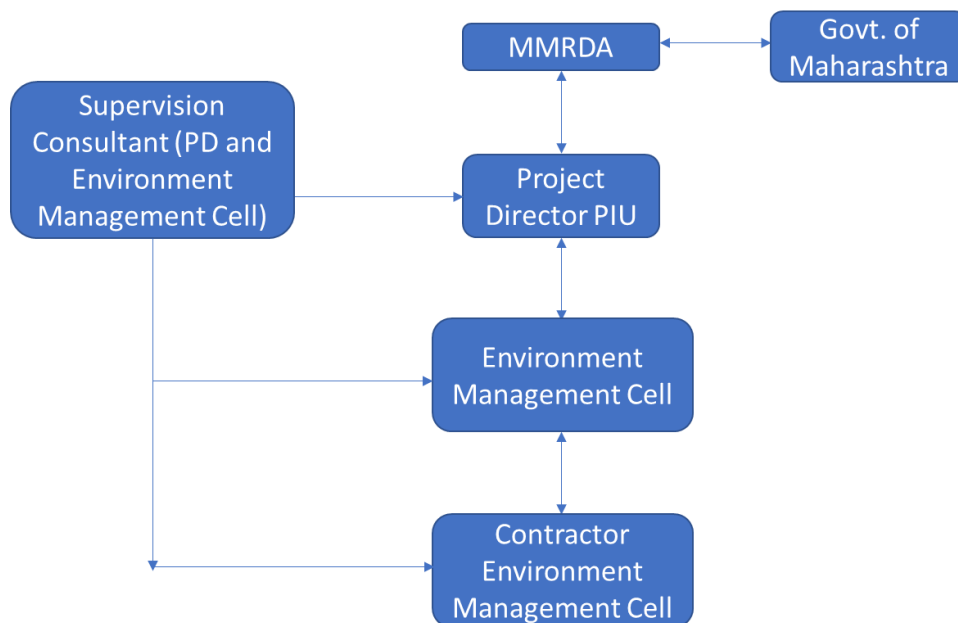
345. **Environmental Cell:** The Metro PIU has an Environmental Cell to manage activities related to environmental safeguards for all MMRDA projects, including construction and installation works for Metro Rail Projects. The EMC will ensure compliance with National and international environmental safeguard requirements as stated in the employer SHE manual/ condition of contracts, and Environmental Impact Assessment & Environmental Management Plan, of the project. The EMC will

conduct regular site inspections and review environmental monitoring reports submitted by the contractors and supervision consultants.

346. **Supervision consultants:** The supervision consultants will be responsible for supervision of construction of Metro Line-5. Supervision will include monitoring of implementation of the Employer SHE manual/ EMP by the contractor. The Supervision consultants team includes an Environmental Expert, Chief Safety Expert which are supported by site-level environmental specialist and safety engineer focal persons for daily supervision and monitoring of on-site EMP and SHE implementation. environmental reports prepared by the contractor. Based on site inspections, and review of environmental reports from the contractor, the environmental expert will prepare semi-annual environmental monitoring reports as per the requirement of the AIIB. The supervision consultants will also carry out capacity building activities, as needed, on the implementation of environmental safeguards through training workshops and on-site training for the contractor.

347. **Contractors.** The contractors will appoint an Environmental Officer/Manager and Safety Manager along with supporting staff to ensure proper implementation of the EMP and SHE manual, in accordance with the contract agreement. Contractor will be responsible for obtaining permits, no-objection certificates, consent to establish and operate, etc. for RMC/ batching plants, and for preparing monthly reports on the implementation of the EMP and SHE manual for submission to the supervision consultants and the PIU.

348. **Maha Mumbai Metro Operation Corporation Limited (MMMOCL):** Project will be operated by MMOCL and will be solely responsible for implementation of EMP during operation phase of the project.



**Figure 8.1 : Institutional Mechanism for Implementation of EMP**

### 8.3. SHE POLICY AND SHE MANUAL

349. MMRDA has well established SHE policy and SHE Manual for management of safety, health and environment at all its projects. These SHE Policy and Manuals are made part of the contract documents volume 2, conditions of contracts on Safety, Health and environment of the contract agreement to ensure its compliance. MMOCL has safety manuals as mentioned in the previous chapters.

## 8.4. Environmental Monitoring Program

350. To ensure the effective implementation of the EMP, it is essential to design an effective monitoring program. For proposed project, the monitoring plan is based on the following objectives.

- To evaluate the performance of mitigation measures proposed in the EMP;
- To suggest improvements in the management plans, if required;
- To satisfy the statutory and community obligations; and,
- To provide feedback on the adequacy of Environmental Impact Assessment

351. The monitoring program has a monitoring plan for all performance indicators and reporting systems.

### 8.4.1. Performance Indicators

352. The performance indicators are based on the physical, biological and environmental management components identified as of particular significance in affecting the environment at critical locations. The Performance Indicators are evaluated under three heads as:

- Environmental condition indicators** to determine the efficacy of environmental management measures in control of air, noise, water and soil pollution;
- Environmental management indicators** to determine compliance with the suggested environmental management measures
- Operational performance indicators** have also been devised to determine the efficacy and utility of the mitigation/enhancement designs proposed.

353. Performance Indicators and monitoring plans prepared for project Implementation are presented in the following **Table 8.5**.

**Table 8.5 : Performance Indicators for Project Implementation**

Sl. No.	Indicator	Details	Stage	Responsibility
<b>A</b>	<b>Environmental Condition Indicators and Monitoring Plan</b>			
1	Air Quality	The parameters to be monitored, frequency and duration of monitoring as well as the locations to be monitored will be as per the Monitoring Plan prepared and given below	Pre- Construction	Contractor through approved monitoring agency
			Construction	
			Operation	PIU through approved monitoring agency
2	Noise Levels		Pre- Construction	Contractor through approved monitoring agency
			Construction	
			Operation	PIU through approved monitoring agency
3	Water Quality		Pre- Construction	Contractor through approved monitoring agency
			Construction	
			Operation	PIU through approved monitoring agency

4	Soil Quality		Construction	Contractor through approved monitoring agency
			Operation	PIU through approved monitoring agency
<b>B</b>	<b>Environmental Management Indicators and Monitoring Plan</b>			
1	Construction Camps	Location of construction camps have to be identified and parameters indicative of environment in the area has to be reported	Pre- construction	Contractor and Supervision Consultant
2	Borrow Areas (If established)	Location of borrow areas have to be identified and parameters indicative of environment in the area has to be reported.	Pre- construction	Contractor and Supervision Consultant
3	Tree Cutting	Progress of tree removal marked for Cutting isto be reported at temporary constructions facility by contractor and within RoW by MMRDA	Pre- construction	Contractor, MMRDA, Supervision Consultant and Local Authority/tree officer/forest department
4	Tree Plantation	Progress of plantation works carried out at temporary construction facility by contractor and within RoW by MMRDA	Construction	Contractor, MMRDA, Supervision Consultant and Local Authority/tree officer/forest department
5	Disposal Site (if any)	No. of locations Approved for Debris disposal; Quantity disposed off at each location; No. site Rehabilitated and hand overed	Construction	Contractor and Supervision Consultant
6	Reuse and recycle of waste (include municipal waste, bio-medical waste, hazardous waste, plastic waste, battery waste, PPE waste, leather waste etc)	Quantity of waste reused/recycled; location and type of construction activity	Construction	Contractor and Supervision Consultant

7	Sensitization / awareness Training	No. and frequency of sensitization training; No. and type of target audience trained	Construction	Contractor and Supervision Consultant
8	Accidents/Incidents	No of accidents/incidents recorded	Construction	Contractor and Supervision Consultant
9	Health and Safety (including COVID-19)	As per the H&S plan requirements provided in EMP	Construction & Operation	Contractor and Supervision Consultant under supervision of MMRDA-construction Phase and MMRDA-operation phase
<b>C</b>	<b>Management &amp; Operational Performance Indicators</b>			
1	Survival Rate of Trees	The number of trees surviving during each visit will be compared with the number of saplings Planted. Status of replacement of dead trees	Operation	MMRDA
2	Status Regarding Rehabilitation of Borrow Areas (If established)	All borrow areas to be opened shall be closed and restored back to its original condition and shall be verified by supervision consultant, MMRDA and land owner	Operation	Contractor
3	Soil Erosion	Visual monitoring and operation inspection of embankments of affected water bodies	Operation	Contractor during construction and MMRDA post construction

#### 8.4.2. Monitoring Parameters and Standards

354. The environmental monitoring of the parameters involved and the threshold limits with respect to the Indian standards are discussed below.

##### 8.4.2.1 Ambient Air Quality Monitoring (AAQM)

355. The air quality parameters namely Sulphur Dioxide (SO<sub>2</sub>), Oxides of Nitrogen (NO<sub>x</sub>), Carbon Monoxide (CO), Particulate Matter (PM<sub>10</sub>) and Particulate Matter (PM<sub>2.5</sub>) shall be regularly monitored at identified locations from the start of the construction activity. The air quality parameters shall be monitored in accordance with the National Ambient Air Quality Standards as given in **Table 8.6**.

**Table 8.6 : National Ambient Air Quality Standards**

Sl. No	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Government)	Methods of Measurement
1	Sulphur Dioxide (SO <sub>2</sub> ), µg/m <sup>3</sup>	Annual* 24 hours**	50 80	20 80	-Improved West and Gaeke -Ultraviolet fluorescence

2	Nitrogen Dioxide (NO <sub>2</sub> ), µg/m <sup>3</sup>	Annual* 24 hours**	40 80	30 80	-Modified Jacob & Hochhieser (Na-Arsenite) -Chemiluminescence
3	Particulate Matter (size less than 10µm) or PM <sub>10</sub> µg/m <sup>3</sup>	Annual* 24 hours**	60 100	60 100	-Gravimetric -TOEM -Beta attenuation
4	Particulate Matter (size less than 2.5µm) or PM <sub>25</sub> µg/m <sup>3</sup>	Annual* 24 hours**	40 60	40 60	-Gravimetric -TOEM -Beta attenuation
5	Ozone (O <sub>3</sub> ) µg/m <sup>3</sup>	8 hours* 1 hours**	100 180	100 180	-UV photometric -Chemiluminescence -Chemical Method
6	Lead (Pb) µg/m <sup>3</sup>	Annual* 24 hours**	0.50 1.0	0.50 1.0	-AAS/ICP method after sampling on EMP 2000 or equivalent filter paper -ED-XRF using Tefloa filter
7	Carbon Monoxide (CO) mg/m <sup>3</sup>	8 hours* 1 hours**	02 04	02 04	-Non Dispersive Infra-Red (NDIR)spectroscopy
8	Ammonia (NH <sub>3</sub> ) µg/m <sup>3</sup>	Annual* 24 hours**	100 400	100 400	-Chemiluminescence -Indophenol blue method
9	Benzene (C <sub>6</sub> H <sub>6</sub> ) µg/m <sup>3</sup>	Annual*	05	05	-Gas chromatography based continuous analyser -Adsorption and Desorption followed by GC analysis
10	Benzo(a)Pyrene (BaP) particulate phase only, µg/m <sup>3</sup>	Annual*	01	01	-Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As) µg/m <sup>3</sup>	Annual*	06	06	-AAS/ICP method after sampling on EMP 2000 or equivalent filter paper
12	Nickel (Ni) µg/m <sup>3</sup>	Annual*	20	20	-AAS/ICP method after sampling on EMP 2000 or equivalent filter paper

\*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.

#### 8.4.2.2 Noise Quality Monitoring

356. The noise levels shall be monitored at identified locations in accordance with the Ambient Noise Quality standards given in **Table 8.7**.

**Table 8.7 : National Ambient Noise Quality Standards**

Area Code	Category of Zones	Limits of Leq in dB(A) Day*	Night*
<b>A</b>	Industrial	75	70
<b>B</b>	Commercial	65	55
<b>C</b>	Residential	55	45
<b>D</b>	Silence Zone **	50	40

\* Daytime shall mean from 6.00am to 10.00 pm and Night shall mean from 10.00 pm to 6.00 am

\*\* Silence zone is defined as area up to 100 meters around premises of hospitals, educational institutions and courts. Use of vehicles horns, loud speakers and bursting of cracking are banned in these zones.

#### 8.4.2.3 Water Quality Monitoring

357. Water quality parameters such as pH, BOD, COD, DO coliform count, total suspended solids, total dissolved solids, Iron, etc. shall be monitored at all identified locations during the construction stage as per standards prescribed by Central Pollution Control Board (IS: 2296) for surface water



quality monitoring and IS:10500: 2012 for ground water & drinking water monitoring.

#### **8.4.2.4**      *Monitoring Plans for Environment Condition*

358. For each of the environmental components, the monitoring plan specifies the parameters to be monitored; location of the monitoring sites and duration of monitoring. The monitoring plan also specifies the applicable standards, implementation and supervising responsibilities. The monitoring plan for the various environmental condition indicators of the project in construction and operation stages is presented in **Table 8.8** and **Table 8.9**. Monitoring plan does not include the requirement of arising out of regulation provision such as obtaining NOC/ consent for plant site operation. Monitoring shall be conducted through NABL laboratory only.

**Table 8.8 : Environmental Monitoring Plan**

Attribute	Project Stage	Parameter	Special Guidance	Standards	Frequency	Duration	Location	Implementation
<b>Air</b>	Construction	SO <sub>2</sub> , NO <sub>x</sub> , PM <sub>10</sub> , PM <sub>2.5</sub> , CO,	High volume sampler to be located 50m from the plant in the Downwind direction. Use method specified by CPCB for analysis	Air (prevention and Control of Pollution) Rules, CPCB, 2009	Fortnightly-- 24 hourly sample	24 hours Sampling	Along the corridor, casting yard batching plant & crusher	Contractor under the supervision of SC
	Operation				Two seasons in a year --24 hourly sample		At stations/depot	MMMOCL
<b>Water (Drinking/GW/SW)</b>	Construction	All essential characteristics and some of desirable characteristics as approved by MMRDA/Supervision consultant	Grab sample collected from source and Analyse as per Standard Methods for Examination of Water and Wastewater	Indian Standards for Inland Surface Waters (IS: 2296, 1982) for surface water bodies, IS 10500 for ground water and drinking water	Four seasons per year	Grab Sampling	GW structures along corridor, GW structures being used by contractor and GW structure developed & being used by contractor. All surface water bodies intercepted by project. Drinking water quality monitoring at each labour camp & active construction site	Contractor under the supervision of SC
	Operation				Four seasons		GW structures developed at stations/depot/other locations being used by MMOCL. Drinking water quality monitoring at each station and depot	MMMOCL

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<b>Noise</b>	Construction	Noise levels on dB (A) scale	Equivalent noise levels using an integrated noise level meter kept at a distance of 15 from edge of pavement Equivalent noise levels using an integrated noise level meter kept at a distance of 15 from edge of pavement	MoEF&CC Noise Rules, 2000	Fortnightly- 24 hourly sample	Leq in dB(A) of day time and night time	Along the corridor, casting yard, batching plant & crusher	Contractor under the supervision of SC
	Operation				Three seasons per year --24 hourly sample		At station/depot	MMMOCL
<b>Soil</b>	Construction	Monitoring of Pb, SAR and Oil & Grease	Sample of soil collected to acidified and analysed using absorption Spectrophotometer	Threshold for each contaminant set by IRIS database of USEPA until national standards are promulgated	Two seasons per year	Grab Sampling	Along the corridor, casting yard, fuel storage area, material storage area, disposal sites developed by contractor/MMRDA batching plant & crusher and soil leachate sample at batching plant	Contractor under the supervision of SC
	Operation				Two seasons		Depot site	MMMOCL
<b>H&amp;S (including COVID-19)</b>	Construction	As per the H&S plan given in EMP	Comply with IFC EHS Guidelines on Occupational Health and Safety		Once a month for Normal Health check-up	Biweekly for COVID 19	Construction and labour camps	Contractor under the supervision of SC
	Operation							
<b>Borrow area (if established)</b>	Construction	As per Guidelines	Visual Observation	-	Once in a month	-	Borrow area location	Contractor under the supervision of SC

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<b>Ecology/Tree plantation/ Tree Transplantation</b>	Operation stage	As per Design			Quarterly	-	Areas where plantation is being done	Contractor under the supervision of SC till contract period and MMMOCL post completion of contract
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**Table 8.9 : Environmental Monitoring Budget (Tentative)**

<b>S. No.</b>	<b>Parameters / Components</b>	<b>Unit Cost/Sample (Rs)</b>	<b>Total Cost (Rs)</b>
<b>1</b>	<b>Ambient Air Monitoring:</b> <b>At construction Stage:</b> At minimum 6 locations including casting yards/labour colony/batching plant site/etc and active sites (fortnightly) in 30 months <b>(Total 360 samples in 30 months)</b>	9,000	32,40,000
	<b>At Operation Stage:</b> At 7 locations quarterly at each station & depot (except monsoon) covering each station (Two consecutive samples in a quarter) <b>(Total 28 samples in 1 year)</b>	9,000	2,52,000
<b>2</b>	<b>Ground Water Quality</b> <b>At Construction Stage:</b> At minimum 4 locations including construction sites quarterly for 30 months. To be carried out for each GW structure being used by contractor whether existing/new. <b>(Total 40 samples)</b>	6,000	2,40,000
	<b>At Operation Stage:</b> At 7 locations quarterly at each station/depot <b>(Total 28 samples in 1 year)</b>	6,000	1,68,000
<b>3</b>	<b>Drinking Water Quality</b> <b>At Construction Stage:</b> Drinking water Quality Sampling-quarterly at all casting yard/labour colony/active construction sites. No of locations can be considered as approx. 4 locations <b>(Total 40 samples)</b>	6,000	2,40,000
	<b>At Operation Stage:</b> Drinking Water Quality measurement at Each Station/Depot/Other facility being used-Quarterly, Total 7 locations <b>(Total 28 samples)</b>	6,000	1,68,000
<b>4</b>	<b>Surface Water Sampling</b> <b>At Construction Stage:</b> At Ulhas River quarterly for 30 months <b>(Total 10 samples)</b>	6,000	60,000
<b>5</b>	<b>Noise</b> <b>At construction Stage:</b> At minimum 9 locations including casting yards/labour colony/batching plant site/etc and active sites fortnightly <b>(Total 540 samples in 30 months)</b>	3,000	16,20,000
	<b>At Operation stage:</b> At 7 locations quarterly at each station & depot covering each station <b>(Total 28 samples in 1 year)</b>	3,000	84,000
<b>6</b>	<b>Soil Monitoring:</b> <b>At Construction Stage:</b> To be carried out in casting yard, project RoW, fuel storage areas etc including leachate <b>(Total 6 samples)</b>	7,000	42,000
	<b>At Operation Stage:</b> At 1 location six monthly at depot <b>(Total 2 samples in 1 year)</b>	7,000	14,000

<b>7</b>	<b>Ecology: At construction stage</b> Ulhas river at Kasheli-quarterly plus plantation works Total 4 samples for aquatic ecology and plantation sites	50,000	2,00,000
<b>Total</b>	<b>63,28,000</b>		

#### 8.4.3. Reporting System

359. Reporting system suggested for the proposed project operate at two levels as:

- Reporting for environmental condition indicators and environmental management indicators (except tree cutting indicator)
- Reporting for operational performance indicators at the PIU level

360. Contractor and Supervision Consultant operates the reporting system for environmental conditions (EC) and environmental management (EM) indicators (except tree cutting). The Environmental Management Cell of PIU will operate the reporting system for environmental management (EM) tree cutting indicators and operational performance (OP) indicators. The PIU will set the targets for each activity envisaged in the EMP beforehand and all reports will be against these targets.

361. The Contractor will report to the Supervision Consultant of the progress of the implementation of environmental conditions and management measures as per the EMP. The Supervision Consultant will in turn report to the PIU every quarter. (Table 8.10).

**Table 8.10 : Summary details of Reporting**

Item	Stage	Contractor	Environment al Cell	Supervision Consultant (SC)		Project Implementation Unit (PIU)
				Implementation & Reporting to SC	Implementation & Reporting to PIU	Supervision
Identification of Disposal Locations	Pre-Construction	One Time	-	One Time	One Time	One Time
Setting up of Construction Camp	Pre-Construction	One Time	-	One Time	One Time	One Time
Borrow Area Identification	Pre-Construction	One Time	-	One Time	One Time	One Time
Tree Cutting/ Tree Transplantation	Pre-Construction	-	Monthly	-	-	Quarterly
Tree Plantation	Construction	-	Monthly	-	-	Quarterly
Top Soil Monitoring	Construction	Quarterly		Continuous	Quarterly	Quarterly
Redevelopment of Borrow Areas*	Operation	One Time		One Time	One Time	One Time
Checklist for Construction Safety	Construction	Quarterly		Continuous	Quarterly	Quarterly
Checklist for housekeeping	Construction	Quarterly		Continuous	Quarterly	Quarterly
Waste management checklist	Construction	Monthly		Continuous	Monthly	Monthly

Pollution Monitoring	Construction	As Per Monitoring Plan	-	Quarterly	Quarterly	Quarterly
Pollution Monitoring	Operation	-	-	-	-	As Per Monitoring Plan
Survival Rate of Trees	Operation	-	Quarterly	-	-	Quarterly
Status Regarding Rehabilitation of Borrow Areas*	Operation	-	-	-	-	Half Yearly
*Borrow areas may not be established for project as the material may be procured from licensed vendors						

## 8.5. Capacity Building

362. The Environmental officer of the Contractor will provide the basic training required for environmental awareness. Specific modules customized for the available skill set will be devised after assessing the capabilities of the members of the Training Programme and the requirements of the project. The entire training would cover basic principles of AIB safeguards requirements, Regulatory Requirements (National and State act and rules), Impact assessment, EMP implementation techniques, monitoring, and reporting methods, and tools. The proposed training program along with the frequency of session is presented in **Table 8.11**.

**Table 8.11 : Training Modules for Environmental Management**

Sl.No.	Training Program	Duration	Target Group	Responsibility
1.	Sensitization Workshop on <ul style="list-style-type: none"> <li>• Introduction to EMP requirement</li> <li>• Basic Concept of Environment</li> <li>• Environmental Regulations and Statutory requirements as per Govt. of India, Government of Maharashtra and AIB applicable for proposed project</li> </ul>	Half Working Day	Contractors, Supervision Consultant (Site supervisors, Field Engineers) and PIU	Environmental officer of the Contractor
2.	EMP implementation arrangements, good engineering practices as per EMP implementation requirement	Half Working Day	Contractors, Supervision Consultant (Site supervisors, Field Engineers) and PIU	Environmental officer of the Contractor
3.	Improved Co-ordination with other Departments: <ul style="list-style-type: none"> <li>• Statutory Permissions – Procedural Requirements</li> <li>• Co-operation &amp; Co-ordination with other Departments.</li> </ul>	¼ Working Day	Contractors, Supervision Consultant (Site supervisors, Field Engineers) and PIU	Environmental officer of the Contractor
4.	Roles and Responsibilities of Contractors/Supervision consultant/ PIU officials towards the implementation of EMP	¼ Working Day	Contractors, Supervision Consultant (Site supervisors, Field Engineers) and PIU	Environmental officer of the Contractor
5.	Monitoring and reporting system	Half Working Day	Contractors, Supervision Consultant (Site supervisors, Field Engineers) and PIU	Environmental officer of the Contractor

6.	The orientation of contractors at the time of issuing work orders on the implementation of EMP	¼ Working Day	Contractors	Environmental officer of the Contractor
7.	The orientation of Contractors on the implementation of EMP	¼ Working Day for every six month	Contractors	Environmental officer of the Contractor

### 8.6. EMP and EMoP in Bid Documents

- To ensure implementation of the EMP and EMoP, both shall be incorporated into the bid document and contract agreement
- The prepared EMP cost estimates/ budget should be incorporated in Bill of Quantities with a suitable bill number, which forms part of the Bid Documents.
- Penalty clauses for not complying with EMP requirements to be incorporated in the SHE Manual of Bid Document.



## Chapter 9. Conclusion and Recommendations

363. Based on the environmental impact assessment, the proposed project alignment does not have any major impact on the environmental and social aspects as the alignment does not impact any environmentally protected area and the forest area to be affected is only 0.6983 Ha. comprising of mangroves. The anticipated impacts are common for construction of any elevated metro rail project which are confined to RoW and mitigable with the suggested measures in EMP. The proposed project shall have traffic safety measures for safeguarding the road users & construction workers during construction phase. Project has been assigned Category A as per AIBs' ESF as the anticipated impacts are spread over large extent and involves clearing of 0.6983 ha of mangroves, removal of trees and resettlement and rehabilitation of people.

364. The presence of the receptors within RoW are almost negligible and hence during the project construction and operation significant impacts are not envisaged but a few receptors are along the alignment and measures are suggested in EMP to be undertaken to prevent spill-over impact of project activities on these receptors. However, the given EMP will be implemented by the Contractor for which the EMP has been included in the Bid Document to make it mandatory for implementation. For the loss of land and structures, adequate compensation has been worked out and given in the RAP. The suggested enhancement measures including the compensatory afforestation, deepening of water bodies shall add positive environmental benefits. Key impacts of project are listed as under.

**Table 9.1 : Key impacts of Project**

Identified Impact	Type of Impact Pre-mitigation	Mitigability
<b>Impacts due to project location and design</b>		
Displacement and loss of livelihood of Project Affected People (PAPs)	Permanent, negative, irreversible, can be mitigated, scale to be evaluated	Can be Compensated to Satisfactory level of Affected Population
Change of Land use	Permanent, negative, irreversible, can be mitigated, small scale	Can be minimized
Loss of trees and impact on ecology	Permanent, negative, irreversible, can be mitigated, small scale.	Can be Minimized and compensated in due course of time
Drainage and Utilities: Diversion /shifting	Short term and/or permanent, negative, irreversible can be mitigated; small scale	Can be mitigated
Impact on Archaeological Monuments and Heritage Assets	Permanent, negative, irreversible, can be mitigated, small scale	No impact
Use of Energy and Water at stations and depot	Permanent, negative, irreversible & can be mitigated, small scale.	Can be minimized and compensated
Risk Due to Natural Hazards	Permanent, negative, irreversible & can be mitigated, small scale	Can be Avoided
<b>Impacts due to project construction</b>		
Air pollution: Particulate air pollution due to activities like excavation; emissions due to transportation of muck and material Noise, Vibration	Temporary, negative, reversible can be mitigated, small scale	Can be minimized
Water demand and water quality	Temporary, negative, reversible, can be mitigated, small scale	Can be minimized
Soil erosion and land subsidence	Temporary, negative, irreversible, can be mitigated, small scale	Can be mitigated
Traffic diversions	Temporary, negative, reversible, can be mitigated, small scale	Can be minimized
Labor camp and on-site labour	Temporary, negative, reversible,	Can be minimized

safety/ welfare	can be mitigated, small scale	
<b>Impacts Due to Project Operation</b>		
Noise and Vibration	Permanent, negative, irreversible, can be mitigated, small scale	Can be minimized
Energy, water supply at stations & depot	Permanent, negative, irreversible, can be mitigated, small scale	Can be minimized
Traffic congestions around stations	Permanent if inter modal integration is not done, negative, reversible, can be mitigated, small scale	Can be minimized
Impacts due to Depot: Water supply, Waste water disposal, Oil Pollution, Noise Pollution, Solid Waste disposal, Loss of trees.	Permanent, negative, reversible except in case of ecology, can be mitigated, small scale.	Can be minimized

365. The Contractor should prepare site specific Construction EMPs based on final design and locations of construction camps, quarries and borrow areas etc to adequately assess the project locational and construction phase impacts based on the selected locations for casting yards, batching plant labour colony and other temporary facilities. EIA study shall be carried out again if there is any change in alignment for that particular section. Contractor shall establish good liaison.