Environmental, Social Impact Assessment (ESIA) and Environmental, Social Management Plan (ESMP) for PCMC to Nigdi (Phase-1, North Extension)

IND: Pune Metro Rail Project

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MAHARASHTRA METRO RAIL CORPORATION LIMITED

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ABBREVIATIONS

AIDS	-	Acquired immunodeficiency syndrome
BRTS	-	Bus Rapid Transit System
C&D	-	Construction and Demolition
CAWT	-	Coalition Against Wildlife Trafficking
CBD	-	Convention on Biological Diversity
CBR	-	Climate Bank Roadmap
CBSE	-	Central Board for Secondary Education
CGWA	-	Central Ground Water Authority
CGWB	-	Central Ground Water Board
CITES	-	Convention on International Trade in Endangered Species of Fauna and Flora
CMP	-	Comprehensive Mobility Plan
CMP	-	Comprehensive Mobility Plan
CMS	-	Convention on the Conservation of Migratory Species
CPCB	-	Central Pollution Control Board
CRZ	-	Coastal Regulatory Zone
CtE	-	Consent to Establish
CtO	-	Consent to Operate
DNAH	-	Do Not Significant Harm
DP	-	Displaced Person
DP/s	-	Displaced Person/s
DRM	-	District Resource Map
E&S	-	Environmental & Social
EHS	-	Environmental, Health, and Safety
EIA	-	Environmental Impact Assessment
EIB	-	European Investment Bank
EMoP	-	Environmental Monitoring Plan
EMP	-	Environmental Management Plan
EMS	-	Environment Management System
EPR	-	Environment Protection Rules
ESF	-	Environment and Social Framework
ESHS	-	Environment, Social, Health and Safety
ESI	-	Employees State Insurance
ESIA	-	Environmental & Social Impact Assessment
ESMP	-	Environmental & Social Management Plan
ESP	-	Environment and Social Policy
FGD	-	Focus Group Discussions
FTA	-	Federal Transit Administration
FTA	-	Federal Transit Administration
GC	-	General Consultants
GC	-	General Consultant
GI	-	Galvanised Iron
GoI		Government of India
GoM	-	Government of Maharashtra
GRC	-	GRIEVANCE REDRESS COMMITTEE
GRM	-	Grievance Redress Mechanism
GTF	-	Global Tiger Forum
HCA	-	Host Country Approval
HIV		Human immunodeficiency viruses
HT/HT line	-	High Tension / High Tension line
HW	-	Hazardous Waste
IFC-PS	-	International Finance Corporation – Performance Standards
ILO	-	International Labour Organization
IMD	-	India Meteorological Department
IMD	-	Indian Meteorological Department
INR	-	Indian National Rupee/s
ITTC	-	International Tropical Timber Organization
IUCN	-	International Union for Conservation of Nature and Natural Resources
IWC	-	International Whaling Convention
KBA/s	-	Key Biodiversity Area/s
KLD	-	Kilo Litres Per Day
LAP	-	Land Acquisition Plan

LRT	-	Light Rail Transit System
MDB	-	Multilateral Development Banks
MDB/s	-	Multilateral Development Bank/s
MFD	-	Maharashtra Forest Department
MFR	-	Model Factories Rules
MMRDA	-	Mumbai Metropolitan Region Development Authority
MoEF&CC	-	Ministry of Environment, Forests and Climate Change
MPCB	-	Maharashtra Pollution Control Board
MRTS	-	Mass Rapid Transit System
MRTS	-	Mass Rapid Transit System
MSEB	-	Maharashtra State Electricity Corporation Limited
MSW	-	Municipal Solid Waste
NA	-	Not Applicable
NAAQS	-	National Ambient Air Quality Standards
NBWL	-	National Board of Wildlife
NGT	-	National Green Tribunal
NTH	-	Non-title Holders
ODP	-	Ozone Depleting Potential
PAP/s	-	Project Affected Person/s
PC	-	Public Consultation
PCMC	-	Pimpri Chinchwad Municipal Corporation
PCR	-	Project Completion Report
PEB	-	Pre-Engineering Building
PIU	-	Project Implementation Unit
PMC	-	Pune Municipal Corporation
PMRP/-P1	-	Pune Metro Rail Project / - Phase 1
PRT	-	Personal Rapid Transit
RAP	-	Resettlement Action Plan
RDSO	-	Railway Design & Standards Organisation
RWH	-	Rainwater Harvesting
SAICM	-	Strategic Approach to International Chemicals Management
SEIAA	-	State Environment Impact Assessment Authority
SHE	-	Safety, Health & Environment
SHE	-	Safety, Health & Environment
SHEO	-	Safety, Health and Environmental Officer
SIA	-	Social Impact Assessment
SPV	-	Special Purpose Vehicle
SWD	-	Solid Waste Disposal
TBM	-	Tunnel Boring Machine
TH	-	Title Holders
ToD	-	Transit oriented Development
TRAFFIC	-	The Wildlife Trade Monitoring Network
UNCCD	-	United Nations Convention to Combat Desertification
UNESCO	-	United Nations Educational, Scientific and Cultural Organization
UNFCCC	-	United Nations Framework Convention on Climate Change
UNFF	-	United Nations Forum on Forests
USD	-	United States Dollar
VEC	-	Valued Environmental Components
VOC	-	Volatile Organic Compounds
WB	-	World Bank
WBG-EHS	-	World Bank Group – Environment, Health and Safety
WHO	-	World Health Organization

WEIGHTS AND MEASURES

amsl / AMSL	-	above mean sea level
^{o}C	-	degree Celsius
cu.m	-	cubic meters
dB(A)	-	decibel acoustic
ha.	-	hectare
km	-	kilometre
km/h, kmph	-	kilometre per hour
KLD	-	Kilo litre per day
kWe	-	kilowatt-electric
kV	-	Kilo volt(s)
kVA	-	kilo Volt-Amps
kW	-	kilowatt
m	-	meter
mm	-	millimeter
MLD	-	Million liter per day
msl / MSL	-	mean sea level
MVA	-	Megavolt Ampere
MW	-	Megawatt
m^3	-	cubic meter
m^3/hr	-	cubic meters per hour
mg/l	-	milligrams per liter
m/s	-	meters per second
MT	-	metric tons
MTPA	-	metric tons per annum
MW	-	megawatt
ppm	-	parts per million
ppt	-	parts per thousand
rpm	-	revolutions per minute
µg/m^3	-	microgram per cubic meter

NOTES

(i) The fiscal year (FY) of the Government of India ends on 31 March. “FY” before a calendar year denotes the year in which the fiscal year ends, e.g., FY2024 ends on 31 March 2024.

(ii) In this report, "$" refers to USD and “₹” refers to INR.

EXECUTIVE SUMMARY

The PCMC to Nigdi (Phase-1 Extension) of the Pune Metro Rail Project (PMRP) is a significant infrastructure initiative aimed at improving urban mobility in the rapidly growing Pimpri-Chinchwad region. This extension covers four elevated stations at Chinchwad, Akurdi, Nigdi and Bhakti Shakti. The project, financed by the European Investment Bank (EIB), addresses the increasing demand for an efficient and sustainable public transport system, helping reduce traffic congestion, air pollution, and reliance on private vehicles.

The Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) have been prepared in accordance with national regulations and the environmental and social standards of the EIB. These reports identify potential impacts, propose mitigation measures, and ensure compliance with applicable environmental and social policies.

A. PROJECT OVERVIEW

Pune, one of India's fastest-growing cities, has seen exponential growth in population, employment, and industrial activity over the past two decades. With the increase in private vehicle ownership and limited public transport options, the city faces severe traffic congestion and rising pollution levels. The extension of Pune Metro's Phase-1 from PCMC to Nigdi will provide a high-capacity mass transit solution.

The project is part of the Pune Metro Master Plan and aims to enhance public transport accessibility and connectivity. The **PCMC to Nigdi (Phase-1 Extension)** will alleviate pressure on road transport, promote economic growth, and contribute to a more sustainable urban environment.

B. OBJECTIVES OF THE ESIA-ESMP

- **Assessment of Environmental and Social Impacts:** Evaluate potential impacts on air quality, noise, water resources, ecology, and socio-economic conditions.
- **Mitigation Planning:** Develop measures to prevent, minimize, or compensate for adverse impacts.
- **Compliance with Regulations:** Ensure the project adheres to national and international environmental standards, particularly those of the EIB.
- **Stakeholder Engagement:** Involve local communities and stakeholders through public consultations and grievance redress mechanisms.

C. FINDINGS AND IMPACTS

- ***Environmental Impacts***
  - **Air Quality:** Increased dust and emissions during construction, mitigated through dust suppression measures.
  - **Noise and Vibration:** Temporary increase in noise and vibration levels, especially near sensitive receptors such as schools and hospitals, mitigated through noise and vibration control measures
  - **Water Resources:** Risk of negative impact on groundwater during construction activities.
  - **Ecology:** Minimal impact on flora and fauna, with compensatory tree planting proposed.

- ***Social Impacts***
  - Traffic Disruption: Temporary traffic congestion due to construction activities along existing road corridors.
  - Community Impact: Potential inconvenience to local businesses and restricted access to public services.

- Worker Safety: Occupational health and safety risks during construction phases.
- Acquisition of Land from Land and structure owners: The PCMC to Nigdi alignment involves permanent acquisition of approximately 5,579.13 sq.m of land, predominantly government-owned (86.9%), with the remainder consisting of private and religious land. Additionally, 493.73 sq.m of land will be temporarily utilized, including 305.31 sq.m of privately-owned land secured through lease agreements. The acquisition primarily impacts commercial structures required for construction of entry/exit points and station box areas.
- Resettlement: The land acquisition results in the displacement and resettlement of 34 Project Affected Families. Among them, 15 families are titleholders owning commercial properties, while 11 families are non-titleholder tenants operating businesses in the affected structures.
- Loss of Livelihood: The livelihood impacts mainly affect commercial activities, including retail shops, tea stalls, pan shops, small eateries, and other local businesses. There are no reported impacts on residential-cum-commercial properties or wage-employed individuals.

❖ ***Mitigation Measures***

To address the identified impacts, the ESMP outlines a comprehensive set of mitigation measures, including:

- During construction, key environmental mitigations include dust suppression, maintenance of machinery, scheduling of high-noise activities during non-sensitive hours, and installation of noise barriers near sensitive receptors like schools and hospitals. Water resource protection involves proper wastewater disposal, treatment of construction runoff, and the use of silt traps and sedimentation basins. Groundwater extraction, if necessary, will be regulated through prior approvals.
- To mitigate ecological impacts, the project includes compensatory tree plantation as per local norms, preservation of native species, and avoidance of ecologically sensitive areas. Waste management practices include segregation, reuse, and safe disposal of hazardous and construction & demolition (C&D) waste.
- Social mitigation measures address traffic diversions, public notifications, and continuous access to residences and businesses. Worker safety is ensured through the use of personal protective equipment (PPE), regular safety training, accident reporting, and on-site safety personnel.
- A detailed Environmental and Social Management Plan (ESMP) guides implementation, supported by sub-plans such as the Environmental Monitoring Plan, Waste Management Plan, Occupational Health & Safety Plan, and Traffic Management Plan. A Resettlement Action Plan has also been developed to address land acquisition and resettlement impacts including temporary and permanent as well as physical and economic displacement impacts. Oversight is provided by the Project Implementation Unit (PIU) and dedicated environment and social specialists, with contractors required to follow site-specific ESMPs and report compliance.
- Continuous stakeholder engagement, including consultations, grievance redress mechanisms (GRM), and public information sharing, ensures transparency and responsiveness to community concerns. Capacity building and periodic training of project staff further support the effective and sustainable implementation of these mitigation measures.

❖ ***Stakeholder Engagement and Public Consultation***

Public consultation has been an integral part of the ESIA process. Multiple consultations were conducted with local communities, government agencies, and other stakeholders. Feedback from these sessions has been incorporated into the project's design and management plan. Key concerns included traffic management, noise control, and timely project implementation.

The project also established a **Grievance Redress Mechanism (GRM)** to address community grievances during construction and operation.

Consultations and discussions were held along the project corridor with the affected families and other stakeholders. All affected Families were consulted while interacting with them during the project census survey. Consultation meetings were organized to get wider public input from both the primary and secondary stakeholders. In addition to the individual consultation with all affected Families during census survey, a total of 66 including 28 males and 38 females were consulted in 5 consultation meetings/focused group discussions. Some of the major issues that were discussed and feedback received from the project affected persons during the course of the consultations are presented in **Annexure-13**. The project has received acceptability among the local people as it is expected to provide smooth flow of traffic and reduce travel time, reduce fuel consumption and subsequently reduce air emissions. The project would bring positive socio-economic changes in the area.

- ***Institutional Framework and Legal Compliance***

The project complies with relevant national legislation, including the Environment (Protection) Act, 1986, and the Air and Water Pollution Acts. It also aligns with the EIB Environmental and Social Standards. The Metro Rail Policy 2017 guides the sustainable development of metro projects in India, ensuring integration with other urban transport systems. The project does not require prior environmental clearance under India's Environmental Impact Assessment Notification, 2006, as metro rail systems are exempt from Environmental Clearance. However, necessary clearances for tree felling, waste management, and water usage etc. will be obtained before construction.

D. CONCLUSION AND RECOMMENDATIONS

The **PCMC to Nigdi (Phase-1 Extension)** will significantly improve public transport accessibility, reduce traffic congestion, and promote sustainable urban development in Pune. While the project may have moderate environmental and social impacts during construction, these can be effectively managed through the proposed mitigation measures.

The following recommendations are made for the successful implementation of the project:

1. **Strict Adherence to the ESMP:** Ensure continuous monitoring and compliance with mitigation measures.
2. **Enhanced Stakeholder Communication:** Maintain transparent communication with stakeholders throughout the project lifecycle.
3. **Capacity Building:** Conduct training programs for project staff on environmental and social safeguards.
4. **Grievance Redressal:** Strengthen the GRM to address community concerns promptly.

In conclusion, the project will deliver substantial socio-economic benefits, supporting Pune's growth as a smart, sustainable city while minimizing environmental risks.

Chapter 1: INTRODUCTION

A. BACKGROUND

1. The eighth largest metropolis in India, Pune is located in the state of Maharashtra. It is the second largest city in the state after Mumbai, and is an important city in terms of its economical and industrial growth. Once the hometown of the mighty Marathas and a centre of power for the Maratha Empire, the presence of the numerous edifices in Pune links to its rich and glorious past, and the city leads as the 'veritable heartland' of cultural Maharashtra. Pune also has made its mark as the educational epicentre winning itself the sobriquet, '*The Oxford of the East*'. Not just that, it has a growing industrial hinterland, with information technology, engineering and automotive companies sprouting. The city is known for cultural activities like classical music, spirituality, theatre, sports, and literature. Pune is a pleasant travel getaway destination to spend a quiet holiday.

2. Pune & Pimpri Chinchwad is the next largest urban conglomerate to Mumbai Metropolitan Region in Maharashtra. These cities are considered to be an educational hub due to the establishment of large number of educational institutes across the city. Pune & Pimpri Chinchwad have been experiencing tremendous growth in population and employment since the last two decades. The growth in various industries, particularly automobile, IT and IT enabled services, in and around Pune & Pimpri Chinchwad has added further impetus to the urban sprawl and increase in population and employment. Further urbanization of Pune & Pimpri Chinchwad will receive a big impetus in the next 30 years due to the ambitious development plan of the 7000 sq. km Pune Metropolitan Region.

3. At present, the public transport system in Pune & Pimpri Chinchwad consists mainly of buses, and a few services of Bus Rapid Transit (BRT) System and suburban rail. The public transport share has been completely overthrown by the tremendous growth in private vehicle transport. The vicious cycle of increase in private vehicle ownership (mostly two-wheelers and cars) has become unstoppable due to the increased transport demand and lack of convenient public transport options. In a nutshell, in the absence of augmentation of mass transit services, Pune may head towards unsustainable urban transport scenario. In order to augment public transport system to cater to the rapid increase in demand for transportation services and make urban transportation in Pune & Pimpri Chinchwad sustainable, the implementation of metro rail was envisaged, and Metro Master Plan was prepared by Delhi Metro Rail Corporation (DMRC) in 2008.

1. PCMC to Nigdi (Phase-1 Extension)

4. In order to alleviate the transport-related problems in the city, CMP for Pune has been prepared in 2018. It identifies various short, medium and long-term measures of transport infrastructure in the city. CMP recommends mass transport systems along major travel corridors. Based on the proposals from CMP, an alternatives analysis has been carried out to find the most viable mass transit system along identified corridors. Alternatives analysis report recommends extension of mass transit corridors of Phase 1 in order to meet the future traffic demand.

5. Maharashtra Metro Rail Corporation Ltd. (Maha Metro) is a joint venture company of the Government of India (GoI) and Government of Maharashtra (GoM) established under the Companies Act, 2013 for the purpose of implementation of Metro Rail projects within Maharashtra, excluding the Mumbai metropolitan area. Maha Metro as the implementing agency, will be responsible for implementing, operating, and maintaining the city's metro system.

2. Nature, Size and Location

6. Extension of Phase 1 of the Pune Metro Rail Project (PMRP), i.e. from PCMC to Nigdi, and Swargate to Katraj, have received the in principal approval of Government of Maharashtra in October 2013. These extensions, as part of Pune Metro include:

- Extension of PMRP Phase 1 from PCMC to Nigdi in the North (North extension corridor);
- Extension of PMRP Phase 1 from Swargate to Katraj in the South (South extension corridor).

7. PCMC to Nigdi (Phase 1 extension) project, has received “In Principal" approval from Government of Maharashtra (GoM) in October 2013. Subsequently technical approval and Administrative Approval have also been obtained for project from State Government. The project is proposed to be financed by the European Investment Bank (EIB).

8. As per the Updated Detailed Project Report (DPR) for PCMC to Nigdi (Phase-1 Extension) dated Aug. 2021, the project covers around 4.413 km (4 elevated stations) as summarised in **Table 1-1** and shown in **Figure 1-1**.

Table 1-1: Description of PCMC to Nigdi (Phase-1 Extension)[1]

Corridor	Stations			Length (in Km) As per DPR		
	Elevated	At Grade	Total	Elevated	Underground	Total
PCMC to Nigdi (Phase-1 Extension),	4	**0**	**4**	4.413	0	4.413
Total	**4**	**0**	**4**	**4.413**	**0**	**4.413**

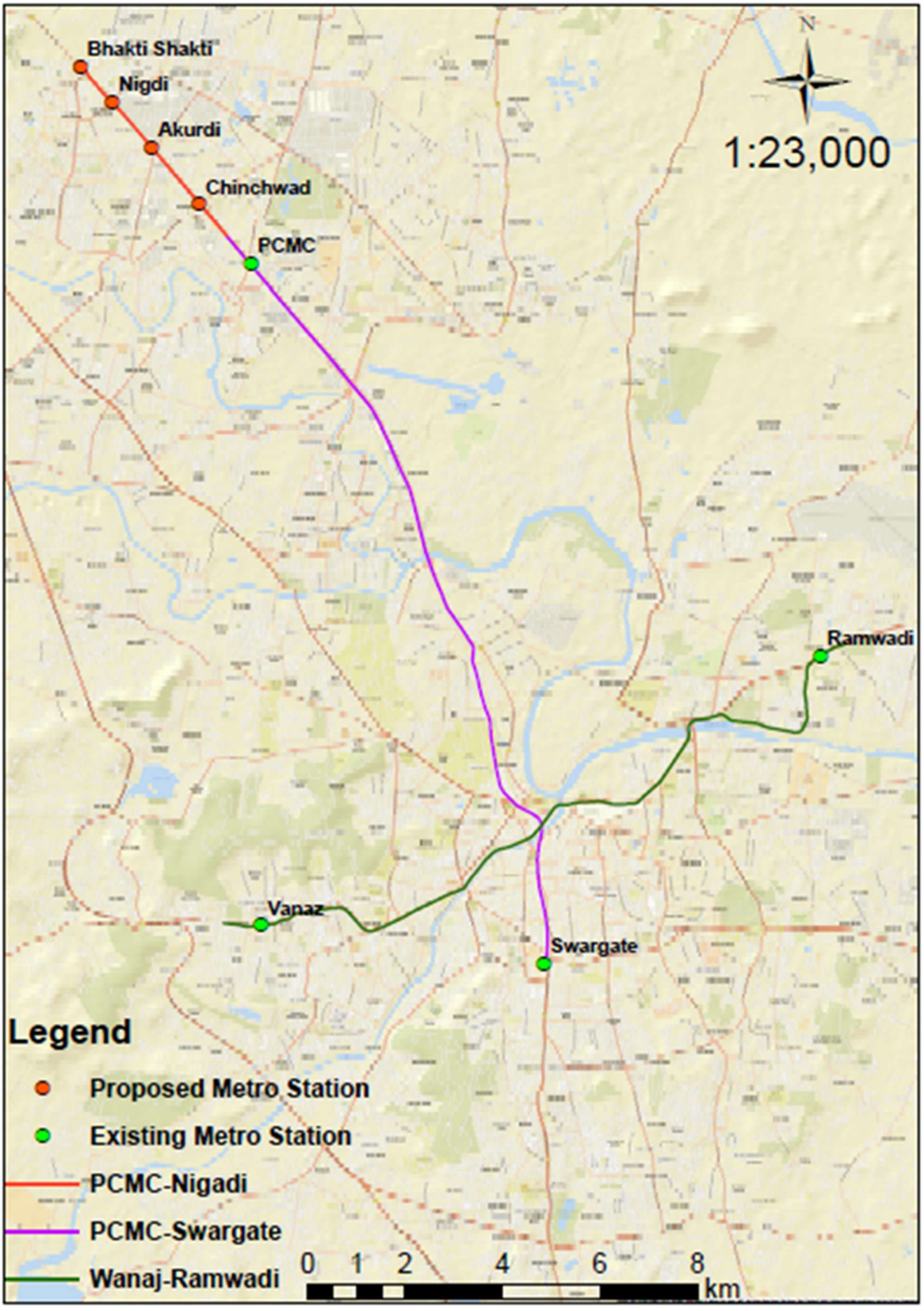
B. Objective Of The Study

9. The objective of the PCMC to Nigdi (Phase-1 Extension) project is to strengthen the need for augmenting the transport infrastructure in PCMC region. Rapid urbanization and intense commercial development in the recent past have resulted in steep rise in travel demand, putting the existing city’s transport infrastructure to stress.

10. The objectives of this ESIA study and ESMP is to, but not limited to, identify and assess any potential positive or negative impacts the project may have on the environmental and social areas, propose mitigation and management measures to either improve the positive impacts or to prevent, reduce or control the negative effects, while proposing also a monitoring program and management plans. In addition, the assessment intends to identify, monitor and manage any residual risks. The ESIA– (ESMP) studies also intends to raise awareness about development approaches that are ecologically sustainable.

[1] *Source: Updated Detailed Project Report (PCMC to Nigdi) dated August 2021*

Figure 1-1: Pune Metro Phase 1 corridors[2]



C. SCOPE OF THE ESIA-ESMP STUDY

11. The scope of work for the ESIA study is given below:

(i) Undertake Environmental & Social Impact Assessment (ESIA) and prepare Environmental & Social Management Plan (ESMP) in accordance with international funding agency policies (e.g., EIB, World Bank, IFC) and relevant environmental standards and regulations.

(ii) Review national, state, and local environmental regulations and assess external factors for project compliance. Identify and describe all applicable laws, regulations, and necessary approvals / consents for the project.

(iii) Conduct field visits, reconnaissance survey and consultation with local stakeholders; develop an environmental screening framework and categorization system to assess project impacts.

(iv) Identify environmental hot spots and conduct habitat analysis, including ecological baseline assessments.

(v) Establish baseline environmental conditions by conducting air, noise and vibration, surface and ground water quality monitoring. Study existing surface and subsurface water conditions and assess project location sensitivity. Conduct inventory surveys of sensitive receptors and assess impacts on land use patterns.

(vi) Conduct comprehensive Public Consultations through focus group discussion (FGD), Questionnaire survey (QS) and other methods to ensure stakeholders/ affected people are consulted on the project and their views are considered as part of the design, construction and operation of the project.

(vii) Based on environmental baseline established, carry out impact identification for environmental parameters like air, noise, vibration (through necessary modelling), ecology and socioeconomic environment.

(viii) Describe and evaluate project alternatives considering technical, environmental, and social aspects.

(ix) Develop mitigation measures, environmental management, and monitoring plans, including public consultation and disclosure strategies, as per applicable national laws and international funding agency guidelines.

D. ESIA-ESMP CONSULTANT

12. MITCON Consultancy & Engineering Services Ltd. is a rapidly growing ISO 9001-2015 certified consultancy company, promoted by ICICI, IDBI, IFCI, and state corporations of Maharashtra and public commercial banks. It was founded in 1982, with its Head Office at Pune and with supporting offices spread over the entire country including Mumbai, Delhi, Bangalore, Hyderabad, Chennai, Chandigarh, and Ahmadabad, etc. With experience, expertise and track record developed over the last almost three decades, MITCON provides diverse range of macro and micro consultancy services in the areas of environment management and engineering (EME), energy efficiency, biomass and co-gen power, agricultural business and bio-technology, infrastructure, market research, banking finance and securitization, micro enterprise development, IT training and education. EME division of MITCON serves various sectors like – GIS and RS, solid waste management, infrastructure, power, sugar, engineering, chemical, real estate, etc.

13. MITCON Consultancy & Engineering Services Ltd. is accredited from National Accreditation Board for Education and Training (NABET), Quality Council of India for EIA consultancy services in 14 sectors; NABET Certificate (No.: NABET/EIA/24-27/RA 0343 valid till Feb. 2027) is attached as **Annexure-1** of this report.

E. ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT

1. Categorization

14. Based on preliminary assessment of significance of impacts borne out of field visits and secondary information, PMRP –PCMC to Nigdi (Phase-1 Extension) will be expected to have significant impacts on noise, vibration, health and safety (mostly occupational), some air quality issues due to dust, etc. However, the proposed project will bring in many benefits to the project area.

15. The civil works of PCMC to Nigdi (Phase-1 Extension) will entail construction of viaducts and elevated stations. Also, construction will take place along existing road corridors in busy urban areas. Thus, the civil works may increase congestion and pose safety risks for traffic on the existing roads. Moreover, transport of large quantities of construction material and heavy equipment machinery may bring safety risks and inconvenience to the local communities in the project area. Thus, the environmental risks associated with the PCMC to Nigdi (Phase-1 Extension) Metro Project are considered to be significant in nature. However, these can be effectively reduced through the application of mitigation plans. Therefore, even if the project does not require an EIA/EMP report for clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India (GoI), it is classified as **High Risk** for environmental and social safeguards as per the EIB Group Environmental and Social Policy (February 2, 2022).

16. Rail-based systems have been excluded from the scheduled list under the EIA Notification of 2006 and its subsequent amendments under the under the Environment (Protection) Act, 1986. Therefore, the proposed PCMC to Nigdi (Phase-1 Extension) of the metro project is not required to secure prior environmental clearance in the form of an approved EIA from the MoEFCC, GoI as per national policies and regulations. Similarly, the metro stations and depots proposed along the metro rail corridor being part of Metro Rail project do not attract EIA Notification 2006, prescribing environmental clearance.

2. Purpose of the Environmental & Social Impact Assessment Report

17. This ESIA report documents the environmental & social impact assessment for PCMC to Nigdi (Phase-1 Extension) project. In this report the different activities that are likely to take place during construction and operation have been analysed and the accompanying potential impacts have been discussed. The ESIA addresses the environmental management requirements of GoI as well as those of the international funding agencies. In general, the ESIA Report is outlined as below to address various aspects:

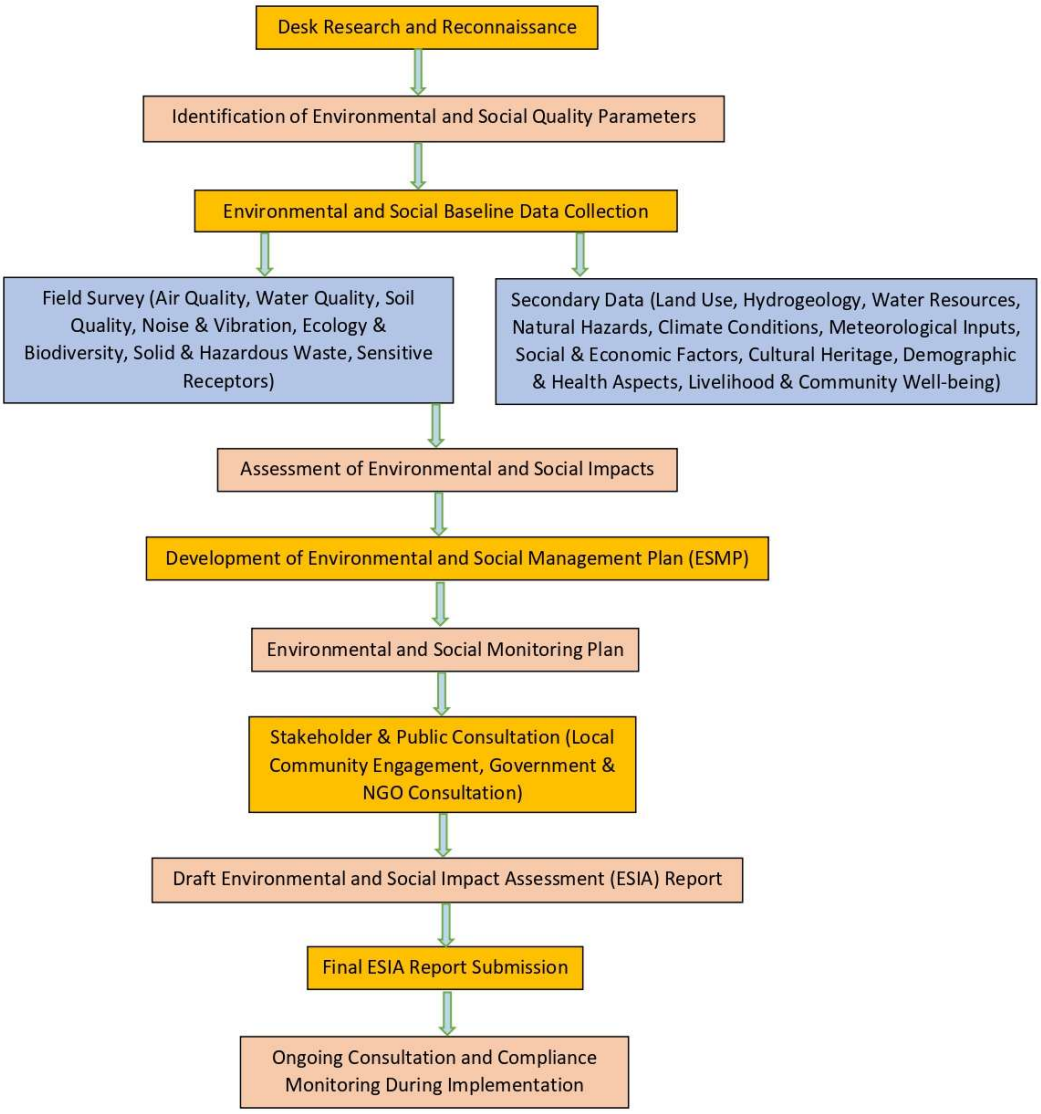
(i) Provide background of the project in terms of land use, existing metro rail network and the proposed Metrorail corridors, methodology of preparation of the report and its content;
(ii) Analysis of policy and legal framework within which environmental safeguards for the project will be recommended and implemented;
(iii) Provide information about the baseline environmental settings;
(iv) Provide information on potential environmental impacts of PCMC to Nigdi (Phase-1 Extension) with its magnitude, distribution, and duration;
(v) Provide information on required mitigation measures with cost to minimize the impacts;
(vi) Analysis of the alternatives considering alternative locations, designs, management approaches, for selection of most feasible and environmental acceptable options;
(vii) Provide details of stakeholders' consultations;
(viii) Plans for stakeholders to communicate grievances and suggestions and for their redressal; and
(ix) Formulate environmental management and monitoring plan with institutional measures for effective implementation of mitigation measures proposed.

3. Approach and Methodology

18. As shown in **Figure 1-2**, the ESIA study shall follow a number of steps, viz.:

(i) Review of available baseline reports, DPR, and other technical reports / studies related to PCMC to Nigdi (Phase-1 Extension).
(ii) Conduct field visits to collect primary and / or secondary data relevant to PCMC to Nigdi (Phase-1 Extension) to establish the environmental baseline;
(iii) Assess the potential impacts on environment, social and health & safety attributes due to the location, design, installation and operation of PCMC to Nigdi (Phase-1 Extension) through field investigations and data analysis;
(iv) Explore opportunities for environmental and health and safety enhancement and identify measures.
(v) Prepare an ESMP outlining the measures for mitigating the impacts identified, including the institutional arrangements;
(vi) Identify critical environmental parameters required to be monitored subsequent to the implementation of PCMC to Nigdi (Phase-1 Extension) and prepare an EMoP;
(vii) Carry out consultation with key stakeholders and administrative authorities to identify their perception on PCMC to Nigdi (Phase-1 Extension) by introducing project components and anticipated impacts; and
(viii) Disclose the draft ESIA at Maha Metro and EIB websites and prepare the executive summary in local language (Marathi) to be made publicly available.

Figure 1-2: Methodology followed in the present ESIA studies



19. Baseline data for air, water, and soil quality was collected within 100 m distance on either side of the proposed center line of the PCMC to Nigdi (Phase-1 Extension) alignment, while noise and vibration data was gathered within 50 m on either side of the alignment. Sensitive receptors located within 100 m on either side of the center line were identified according to the silence zones defined by the Central Pollution Control Board (CPCB). The structure of the ESIA report is as per **Table 1-2**.

Table 1-2: Structure of the ESIA-ESMP Report

No.	Item	Remarks
-	Executive Summary	Non-Technical Summary highlighting project details in terms of Environmental and social Impacts.
Chapter 1	Introduction	Introduction about the project, objectives and scope of work.
Chapter 2	Policies, legal and administrative framework	Provides over all legal frame work in relation to required regulatory compliance and institutional arrangement.
Chapter 3	Project description	This chapter describes the details of the proposed metro corridors.
Chapter 4	Environmental baseline	This chapter provides description on the present environmental setting of the project area.
Chapter 5	Anticipated impacts and mitigation measures	This chapter describes the environmental impacts associated with the proposed project during construction and operation phases, as well as the suggested measures for mitigation of the same
Chapter 6	Analysis of alternatives	This chapter provides a description of the qualitative assessment of various alternatives considered.
Chapter 7	Public consultations and information disclosure	This chapter explains in brief about the pubic consultations carried out for the project
Chapter 8	Grievance redress mechanism (GRM)	Description of the GRM in place for the project is given in this chapter
Chapter 9	Environmental & Social Management plan (ESMP)	Environmental strategy to offset / mitigate the probable adverse impacts, including the environmental monitoring plan (EMoP), has been outlined in this chapter.
Chapter 10	Conclusions and recommendations	This chapter summarizes the conclusions of this EIA EMP Report and outlines specific recommendations, if any.

Chapter 2: POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

20. India has a well-defined institutional and legislative framework with respect to its environment. The legislation covers all components of environment viz. air, water, soil, terrestrial & aquatic flora and fauna, natural resources, and sensitive habitats, etc. India is also signatory to various international conventions and protocols. The environmental legislations in India are framed to protect the valued environmental components and comply with its commitment to international community under above conventions and protocols. The funding agencies involved in this project also have defined environmental and social policies in place. This chapter will describe the applicability of above laws and regulations, conventions, protocols, and safeguards with regards to the PCMC to Nigdi (Phase-1 Extension)).

21. The laws, regulations, policies and guidelines applicable to this project based on the location, design, construction and operation are summarized in the subsequent sections in following order:

(i) National (India) Environmental Legislation and Institutional Framework,
(ii) EIB environmental and social policies and standards, and
(iii) Summary of international treaties and applicability to the project.

A. NATIONAL ENVIRONMENTAL LAWS, POLICIES AND REGULATIONS

22. GoI's environmental legal framework comprises a set of comprehensive acts and regulations aimed at conserving various components of the biological and physical environment including environmental assessment procedures and requirements for public consultation.

1. Metro Rail Policy 2017

23. Before the Metro Rail Policy 2017, the National Urban Transport Policy of 2006 governed urban transport in India. The policy included interventions such as Bus Rapid Transit System (BRTS), urban transit infrastructure, and financing for metro rail projects.

24. The Union Cabinet, Government of India (GoI) approved a new Metro Rail Policy in 2017 that aimed to enable the development and implementation of metro projects in a comprehensive and sustainable manner from the social, economic, and environmental perspectives. The Policy improves the integrated management of Metro development in three main aspects:

(i) The Policy proposes that every city should setup a Unified Metropolitan Transport Authority for planning and developing multimodal transportation, which enable the overall planning and development of all modes of transport under the strong lead institutions;
(ii) The need to carry out an alternative analysis is a welcome addition in the policy to help in better system selection; and
(iii) The requirement to look at the 5-km catchment area for providing feeder services through walking, cycling and para-transit modes is promising.

2. Legislations Relevant to the Project

25. The policies and requirements which are most relevant in the context of this Corridor are provided in **Table 2-1** below.

Table 2-1: Summary of Applicable Legislation for PCMC to Nigdi (Phase-1 Extension)

Legislation	Objective	Responsible Institution
- Environment (Protection) Act (1986) and Rules (1986); - National Conservation Strategy and Policy Statement on	To protect and improve the overall environment	Ministry of Environment, Forests, and Climate Change (MoEF&CC)

Legislation	Objective	Responsible Institution
Environment and Development of 1992; - National Environment Policy of 2006		
Environmental impact assessment (EIA) under EIB's Environmental and Social Standards (updated in February 2022)	To provide guidance on environmental clearance requirements and clarification on related specific technical issues	European Investment Bank (EIB) Environmental and Social Standards (2022)
The Noise Pollution (Regulation and Control) Rules, 2000 (Amended 2002)	To provide for the prevention and control of noise pollution and for the establishment of Boards to carry out these purposes	Central Pollution Control Board (CPCB)
Metro Rail Transit System, Guidelines for Noise and Vibrations, RDSO, Ministry of Railways, September 2015	To provide for the prevention and control of vibration	NA
The Water (Prevention and Control of Pollution) Act 1972 (Amended 1988) and Rules 1974	To provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water	CPCB
The Maharashtra Prevention of Water Pollution Act, 1969 (Amended 1981)		Maharashtra Pollution Control Board (MPCB)
The Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules 1982	To provide for the prevention, control and abatement of air pollution, and for the establishment of Boards to carry out these purposes	CPCB and Road Authorities
Policy Statement for Abatement of Pollution of 1992	To provide for the prevention, control and abatement of pollution	CPCB
- Municipal Solid Waste (MSW) Rules, 2000; - Solid Waste Management Rules, 2016	Provisions for collection, storage segregation, transportation, processing and disposal of municipal solid wastes	MPCB
Hazardous and Other Wastes (Management and Transboundary Movement) Amendment Rules 2019	To protection the general public against improper handling, storage and disposal of hazardous wastes	MPCB
Construction and Demolition Waste Management Rules, 2016	Large generators (which generate more than 20 tons or more in one day or 300 tons per project in a month) will submit waste management plan and get appropriate approvals from the local authority before starting construction or demolition or remodelling work	MPCB
Guidelines on Environmental Management of Construction and Demolition (C&D) Waste, March 2017	Hazardous wastes / toxic wastes streams, including asbestos, should be kept separately from other wastes to avoid further contamination, their disposal to be done in consultation with SPCBs/PCCs under HW Management Rules 2016. The concerned authorities shall examine the Demolition Plan submitted by the applicant to assess if there are any HW streams.	MPCB
The Mines and Minerals (Development and Regulation) Act, 1957	To protect the environment from quarry operation	State Department of Mines and Geology
Central Motor Vehicle Act (1988) and Rules (1988)	To control vehicular air and noise pollution. To regulate development of the transport sector, check and control vehicular air and noise pollution	State Transport Department
- Indian Treasure Trove Act, 1878	Conservation of Cultural and historical	Archaeological Survey of

Legislation	Objective	Responsible Institution
(as modified up to September 1949); - Ancient Monuments and Archaeological Sites and Remains Act (1958)	remains found in India (Chance finds, if any, during construction)	India (ASI), GoI
- National Policy on HIV/AIDS and the World of Work - National Policy on Safety, Health and Environment at Workplace	To regulate the safety, health and environment at workplace	Ministry of Labour and Employment
A. Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 B. Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2007. C. The Contract Labour (Regulation & Abolition) Act, 1970 D. Employees State Insurance Act, 1948 (ESI); E. Minimum Wages Act, 1948, The Payment of Wages Act, 1936, amended in 2005; F. The Maharashtra Labour Welfare Act & Rules, 1953 G. The Equal Remuneration Act 1976; H. Workmen's Compensation Act, 1923	To regulate the employment and conditions of service of building and other construction workers and to provide for their safety, health and welfare measures	Ministry of Labour and Employment
Interstate Migrant Workmen (Regulation of Employment and conditions of Service) Act 1979	In case workers and labourers working at the project sites are migrants from other states during construction	Ministry of Labour and Employment
Child and Adolescent Labour (Prohibition and Regulation) Act, 1986	To regulate the employment of children including age limits, type of employment, timing of work, information disclosure and health and safety	Ministry of Labour and Employment
Schedule – XIV of the Model Factories Rules 120 (MFR 120) under Section 87 of the Factories Act (1984)	Handling and processing of Asbestos, manufacture of any article of Asbestos and any other process of manufacture or otherwise in which Asbestos is used in any form.	Ministry of Labour & Employment (GoI), Directorate General Factory Advice Service & Labour Institute.
Occupational Safety, Health and Working Conditions Code, 2020 (OHSWC Code)	Laws regulating the occupational safety, health and working conditions of the persons employed in an establishment applicable in case of contract labour employed through contractor.	Ministry of Labour and Employment.

3. Required Clearances and/or Permissions

26. Railway / Metro project in India are not listed among activities requiring prior environmental clearance in GoI's EIA Notification 2006 and therefore PCMC to Nigdi (Phase-1 Extension) project does not require environmental clearance from MoEF&CC. However other milestones which need attention in this context, w.r.t Infrastructure projects in India, are briefly mentioned here:

(i) In 1992, in case of Konkan Railway, the Bombay High Court held that Environment Act 1986 had no application in respect of works undertaken under Railway Act 1989, which supersedes the same;

(ii) In February 2015, in case of Signature road bridge in Delhi, the NGT held that

construction of a 'bridge' or similar activity covering a built-up area ≥ 1,50,000 sq.m and/or covering an area of ≥ 50 hectares, would be covered under Entry 8(b) of Schedule to the EIA Notification 2006 and ordered the project proponent to obtain environmental clearance. environmental clearance was applied for and subsequently granted in February 2017.

(iii) In March 2016, in the case of Nagpur Metro (Phase I) as well as that of Mumbai Metro (9 Metro rail corridors in MMRDA), the MoEF&CC clarified that construction of buildings within Metro Rail projects for commercial purposes such as a mall, offices or residential buildings, etc. having built-up area equal to or more than 20,000m^2 will require prior environmental clearance from SEIAA and that the project has to incorporate green building features, rain water harvesting system, energy efficiency, water conservation, sewage and/or effluent treatment and/or disposal, solid waste management, vehicle parking, etc.

(iv) In May 2016, the National Green Tribunal (NGT) held that Metro construction from Noida to Greater Noida is a project covered under 8(b) of the Schedule to the Notification of 2006 as per the area of construction and directed project proponent to obtain environmental clearance. In September 2016 Supreme Court stayed NGT order which required prior environmental clearance for railway and Metro rail projects.

(v) In June 2017, ToR was issued for prior environmental clearance in the redevelopment of Anand Vihar railway station under section 8(b) of Schedule to EIA Notification 2006.

27. In light of the above, prior environmental clearance is not required for PCMC to Nigdi (Phase-1 Extension), if commercial development equal to or above threshold of 20,000 sq.m is not proposed. As all 4 proposed metro stations have built-up areas lesser than 20,000 sq.m, no environmental clearance is required for the same. Since Environmental Clearance is not required for Metro Projects hence Public Consultation is also not required. However, Public consultations have been conducted to meet out the EIB E&S Requirement. Moreover, before the start of civil works for any section of PCMC to Nigdi (Phase-1 Extension), Maha Metro through the contractor, must obtain necessary clearances and/or permissions related to environment and labour safeguards from statutory authorities of GoI, as applicable; these have been summarized in **Table 2-2**.

Table 2-2: Applicable Permissions and Clearances for PCMC to Nigdi (Phase-1 Extension) project

Sl	Permissions / Clearances	Acts / Rules / Notifications / Guidelines	Concerned Agency and approx. Timeline	Responsibility
A.	**Pre-Construction / Design Stage**			
1.	Permission for felling of trees	Procedural Guidelines developed by the Department of Environment, GoM; Maharashtra (Urban Area) Protection of Trees Act, 1975	Tree Authority Pimpri Chinchwad Municipal Corporation (PCMC), to be obtained before felling	Contractor engaged by Maha Metro
B.	**Construction Stage**			
2.	Consent to Establish (CtE) & Consent to Operate (CtO) for Ready Mix Concrete plant & Casting Yards	Air (Prevention and Control of Pollution) Act 1981	MPCB, to be obtained before installation (if applicable)	Contractor engaged by Maha Metro
3.	Permission for withdrawal / dewatering of groundwater[3]	Environment (Protection) Act, 1986; Groundwater Survey and Development Authority (GSDA), GoM; Guidelines / Criteria for evaluation of proposals / requests for groundwater	CGWA, 3 months (to be obtained before start of construction)	Contractor engaged by Maha Metro

[3] *The Contractor will avoid extraction of groundwater as much as possible. If unavoidable, the required permission will be obtained prior to abstraction.*

Sl	Permissions / Clearances	Acts / Rules / Notifications / Guidelines	Concerned Agency and approx. Timeline	Responsibility
		abstraction (With effect from 16.11.2015)		
4.	Authorization for storage () and disposal of Hazardous Waste	Petroleum Rules, 2002 and amendments Hazardous and Other Wastes (Management& Transboundary Movement) Amendment Rules, 2019	MPCB, 3 months, to be obtained before installation	Contractor engaged by Maha Metro
5.	Pollution Under Control (PUC) Certificate for various vehicles used during construction phase	Central Motor and Vehicle Act, 1988	Transport Department, Govt. of Maharashtra – Authorized Testing Centres, to be obtained before start of construction / project implementation) and regularly updated	Contractor engaged by Maha Metro
6.	Employing Labour / workers	The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	District Labour Commissioner, 1 month, to be obtained before start of construction / project implementation	Contractor engaged by Maha Metro
7.	Roof Top Rainwater Harvesting (RWH)	Central Groundwater Authority (CGWA) Guidelines	CGWA, 3 months, to be obtained before installation	Contractor engaged by Maha Metro
8.	Authorization for Disposal of Construction and Demolition (C&D) Waste	Construction and Demolition Waste Management Rules, 2016	PCMC, 2 months, to be obtained before installation	Contractor engaged by Maha Metro
9.	Consent to Establish, pre-casting and material yards, , batching plant,	Air (Prevention and Control of Pollution) Act 1981 and amendments; The Noise Pollution (Regulation and Control) Rules, 2000 and amendments; Water (Prevention and Control of Pollution) Act 1974 and amendments	MPCB, 3 months, to be obtained before installation	Contractor engaged by Maha Metro
10.	Consent for C&D waste (muck) disposal	Construction and Demolition Waste Management Rules, 2016 Solid Waste Management Rules, 2016	MPCB, 2 months, to be obtained before installation	Contractor engaged by Maha Metro
11.	Installation and operation of DG sets at stations	Air (Prevention and Control of Pollution) Act, 1981 amended 1987; CPCB Notification April 1994 of National Ambient Air Quality Standards	MPCB, 2 months, to be obtained before installation	Maha Metro

4. Institutional Framework

28. The administrative framework in India for implementation and monitoring of Metro Rail Projects involves following key agencies:

(a) Ministry of Environment, Forests and Climate Change

29. The Ministry of Environment Forest and Climate Change (MoEF&CC) is the nodal agency in the administrative structure of the GoI for planning, promotions, co-ordination and overseeing the implementation of India's environmental and forestry policies and programs. The MoEF&CC is mainly responsible for protection and enforcement of laws and regulations. In view of the growing importance of environmental affairs, the GoI set up a department in November 1980 under the portfolio of the Prime Minister. The department, later renamed as the MoEF&CC plays a vital role in environmental management for sustained development and for all environmental matters in the country. The major responsibilities of MoEF&CC include:

(i) Environmental resource conservation and protection, including environmental impact assessment, clearance of developmental projects;
(ii) Co-ordination with the other ministries and agencies, voluntary organizations and professional bodies for environmental action plans;
(iii) Promotion of research and development, manpower planning and training and creation of environmental awareness;
(iv) Liaison and coordination with international agencies involved in environmental matters.
(v) Developmental project proponents are also required to submit environmental impact statements and/or assessments to establish that preventive measures are planned by installing adequate pollution control and monitoring equipment, and that effluent discharged into the environment will not exceed permissible levels. The MoEF&CC appraises these statements and/or assessments and approves the project from the environmental angle.

(b) Central Pollution Control Board

30. The Central Pollution Control Board (CPCB) is responsible for pollution control throughout the country. In addition to the control of air, noise and water pollution it is also responsible to ensure effective control of disposal of hazardous wastes and storage and handling of hazardous chemicals and substances. With the enactment of air and water pollution laws, states have set-up their own State Pollution Control Boards (SPCBs) to monitor industrial emissions and effluents and to approve the operation of new industries after careful scrutiny. The functions of the SPCBs include:
(i) The planning of comprehensive state programs for the prevention and control of air and water pollution and to ensure the implementation thereof;
(ii) Inspection of pollution control equipment/ plants for monitoring of their efficiency.

31. The SPCB in consultation with the CPCB may establish norms for air quality, gaseous emissions, noise levels, etc.

(c) Maharashtra Pollution Control Board

32. The Maharashtra Pollution Control Board (MPCB) was established on 7 September, 1970 under the provisions of Maharashtra Prevention of Water Pollution Act, 1969. The Water (P&CP) Act, 1974 is a central legislation that was adopted in Maharashtra on 01.06.1981. Accordingly, the MPCB was formed under the provisions of Section 4 of Water (P&CP) Act, 1974. The Air (P&CP) Act, 1981 was adopted in the state in 1983. The Board is also functioning as the State Board under section 5 of the Air (P&CP) Act, 1981. The prime objective of these Acts is maintaining, restoring and preserving the wholesomeness of quality of environment and prevention of hazards to human beings and terrestrial flora and fauna.

(d) The National Green Tribunal

33. The National Green Tribunal (NGT) has been established on 18.10.2010 under the National Green Tribunal Act 2010 for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto. It is a specialized body equipped with the necessary expertise to handle environmental disputes involving multi-disciplinary issues. The Tribunal shall not be bound by the procedure laid down under the Code of Civil Procedure, 1908, but shall be guided by principles of natural justice.

34. The Tribunal's dedicated jurisdiction in environmental matters shall provide speedy environmental justice and help reduce the burden of litigation in the higher courts. The Tribunal is mandated to make an endeavour for disposal of applications or appeals finally within 6

months of filing of the same. Initially, the NGT is proposed to be set up at five places of sittings and will follow circuit procedure for making itself more accessible. New Delhi is the Principal Place of Sitting of the Tribunal while the other four are Bhopal, Pune, Kolkata and Chennai.

(e) Directorate of Industrial Safety and Health[4]

35. The Directorate of Industrial Safety and Health (DISH) (formerly known as Factory Inspectorate) is administrative machinery set up by Govt. of Maharashtra with an objective of enforcing the Factories Act, 1948 & Maharashtra Factories Rules, 1963 made there under so as to ensure Safety, Health and Welfare of the workers employed in the factories. With the growing industrialization amendments were made in the Factories Act, 1948 & Maharashtra Factories Rules, 1963 made there under from time to time.

(f) Ministry of Labour and Employment[5]

36. The Ministry of Labour & Employment is one of the oldest and important Ministries of the Government of India. The main responsibility of the Ministry is to protect and safeguard the interests of workers in general and those who constitute the poor, deprived and disadvantage sections of the society, in particular, with due regard to creating a healthy work environment for higher production and productivity and to develop and coordinate vocational skill training and employment services.

(g) Archaeological Survey of India[6]

37. Archaeological and historical pursuits in India started with the efforts of Sir William Jones, who put together a group of antiquarians to form the Asiatic Society on 15th January 1784 in Calcuta. The major activities of the ASI are maintenance, conservation and preservation of centrally protected monuments/sites and remains.

B. INTERNATIONAL AND REGIONAL AGREEMENTS AND CONVENTIONS

38. India is member of almost all major Multilateral Environmental Agreements (MEAs), under four clusters, as given below:

A.	**Nature Conservation**
1.	Ramsar Convention on Wetlands
2.	CITES (Convention on International Trade in Endangered Species of Fauna and Flora)
3.	TRAFFIC (The Wildlife Trade Monitoring Network)
4.	CMS (Convention on the Conservation of Migratory Species)
5.	CAWT (Coalition Against Wildlife Trafficking)
6.	CBD (Convention on Biological Diversity)
7.	ITTC (International Tropical Timber Organization)
8.	UNFF (United Nations Forum on Forests)
9.	IUCN (International Union for Conservation of Nature and Natural Resources)
10.	GTF (Global Tiger Forum)
B.	**Hazardous Material**
1.	Cartagena Protocol on Biosafety
2.	SAICM (Strategic Approach to International Chemicals Management)
3.	Stockholm Convention on Persistent Organic Pollutants (POPs)
4.	Basel Convention on the Control of Trans-boundary Movement of Hazardous Waste and Their Disposal

[4] https://mahadish.in/
[5] https://labour.gov.in/about-ministry
[6] https://asi.nic.in/HQ/history-view

5.	Rotterdam Convention on Prior Informed Consent (PIC) for certain Hazardous Chemicals and Pesticides in International Trade
C. Atmospheric Emissions	
1.	UNFCCC (United Nations Framework Convention on Climate Change)
2.	Kyoto Protocol
3.	UNCCD (United Nations Convention to Combat Desertification)
4.	Montreal Protocol (on Ozone Depleting Substances)
5.	Paris Agreement
D. Marine environment	
1.	International Whaling Convention (IWC)
E. **Human Resources**	
1.	International Labour Organization (ILO) Conventions: 8 conventions covering a wide area of social and labour issues
2.	UNESCO (United Nations Educational, Scientific and Cultural Organization)

39. The Nature conservation (A) and Atmospheric Emissions (Climate Change) agreements will be applicable to this Project.

1. Requirements of ESIA study as per EIB EHS (Feb 2022)[7]

40. This section discusses the processes and contents of the ESIA which ensure that the assessment meets requirements of EIB's Environmental and Social Standards, pertaining to the proposed PCMC to Nigdi (Phase-1 Extension) project. EIB's Environmental and Social Standards (updated in February 2022).

(a) Standard 1: Environmental and Social Impacts and Risks

41. This Standard promotes an integrated approach to impact assessment and risk management by ensuring that environmental, climate, social and human rights considerations are addressed and considered in the decision-making processes. It recognises the importance of the promoters' commitment to effective and sustained environmental and social performance through the establishment of an environmental and social management system commensurate with the identified impacts and risks.

42. This Standard outlines the promoter's responsibilities with regard to the process of assessing the potential environmental, climate and/or social impacts and risks associated with the project, and developing and implementing procedures for managing and monitoring these impacts and risks throughout the EIB's project cycle, specifically:

(i) Identifying, describing and assessing in an appropriate manner, the likely significant effects covering the direct effects and any indirect, secondary, positive and negative effects, as well as any cumulative and transboundary effects associated with the project and its ancillary/associated works/facilities, where appropriate;

(ii) Applying the mitigation hierarchy through the identification of measures to avoid, prevent and reduce any significant adverse effects and, if required, remedy/compensate any residual effects on project-affected people, communities and workers, as well as on the environment;

(iii) Ensuring respect for human rights by integrating human rights impacts and risks into the impact assessment process as described in this Standard;

(iv) Identifying measures to maximise the positive effects of the projects and considering the establishment of project benefit-sharing and/or community development programmes, where appropriate;

(v) Systematically following up and monitoring the implementation of agreed prevention, reduction and, if required, remedial/compensatory measures, as well as measures to

[7] *Source: European Investment Bank Environmental and Social Standards (2 Feb. 2022) [https://www.eib.org/en/publications/eib-environmental-and-social-standards].*

further enhance the environmental, climate and social performance of the projects.

43. This Standard applies to all projects likely to have significant environmental, climate and/or social impacts and risks. These impacts and risks need to be considered at the earliest possible stage of planning and decision-making processes, including to ensure consistency with "Do Not Significant Harm" (DNSH) and "Minimum Safeguards" (MS) principles and requirements.

44. In order to enhance the efficiency of the ESIA at project level, promoters are encouraged to use the SEA-type approach to ensure that environmental, climate and social considerations and alternatives are addressed as early as possible in plans or programmes that establish the framework for the development of specific projects, whenever relevant. The SEA should address direct and indirect effects, as well as the cumulative impacts. The ESIA process may involve some or all of the following steps: (i) the determination of the need for an ESIA; (ii) the scope and level of details of the assessment; and (iii) the preparation of an ESIA report and an environmental and social management plan (ESMP). Engagement with the project stakeholders is an integral part of this process.

(i) determining the need for an ESIA:
   a. An environmental and/or social impact assessment is required for projects listed in Annex I to the ESIA Directive (EIB E&S Standards, 2022) and/or when an ESIA is required by national legislation or based on the determination carried out according to paragraphs 18 and 19 of this Standard.
   b. For those projects listed in Annex II to the ESIA directive (EIB E&S Standards, 2022) and/or in the national legislation, the need to carry out an environmental and/or social impact assessment is determined through a case-by-case examination and considering the criteria specified in Annex 1a of this Standard.
   c. In determining the need for an ESIA, the promoter collects and provides the EIB with the information specified in Annex 1b of this Standard. The information should be comprehensive enough to provide the basis for the promoter's determination. The outcomes of the determination, including its justification, are communicated to the EIB and considered in its due-diligence process.

(ii) Where an ESIA is required, the promoter shall prepare a report that considers all relevant stages of the project and includes, at a minimum, the information specified in Annex 2a of this Standard.

(iii) The ESIA will be conducted in accordance with provisions of EIB Environmental and Social Practices (Feb 2022) which are relevant to this Project.

(b) Standard 2: Stakeholder Engagement

45. This Standard recognises the importance of stakeholder engagement, as a means to ensure respect for the rights to[8]: (i) access to information; (ii) public participation in decision-making processes; and (iii) access to justice. Stakeholder engagement is an inclusive and iterative process that involves, in varying degrees, the identification and analysis of stakeholders, engagement planning, information disclosure, meaningful consultation, and a mechanism ensuring access to grievance procedures and remedy. Stakeholder engagement is essential for the effective assessment, management and monitoring of environmental, climate and/or social impacts and risks, and contributes to the overall sustainability and better outcomes of projects. It enhances relevant stakeholders' benefits and understanding and, therefore, their support for projects.

46. This Standard outlines the promoter's responsibilities for the implementation of transparent and continuous engagement with project stakeholders, with the key objectives of:

[8] *In line with the spirit and principles of the United Nations Economic Commission for Europe (UNECE)'s Aarhus Convention on access to information, public participation in decision-making and access to justice in environmental matters.*

(i) Adopting an inclusive and systematic approach to engaging constructively with stakeholders, namely persons and/or communities who are directly or indirectly affected by a project, or those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively;
(ii) Ensuring that stakeholders have timely access to information on the project's environmental, climate and/or social risks and impacts in a manner that is culturally appropriate and understandable to all stakeholders, including those needing special measures or assistance;
(iii) Promoting and enabling the meaningful and free participation and input of stakeholders in project-related decision-making processes that may affect them, thereby seeking to build mutual trust and improving project outcomes;
(iv) Providing rights-holders with effective means to raise grievances and access remedies, and promoting organisational accountability and continuous learning and improvement.

47. This Standard applies to a specific project, when its relevance is determined during the environmental impact assessment/ environmental and social impact assessment (EIA/ESIA) process (as outlined in Standard 1), based on its likely environmental, climate, and/or social impacts and risks. Depending on such impacts and risks, specific requirements of this Standard apply throughout the EIB project cycle. The nature and extent of the stakeholder engagement shall be commensurate to the project's likely environmental, climate and/or social impacts and risks, considering the type and complexity of the project, sector and country context.

48. This Standard shall be read in conjunction with the requirements set out in the other EIB environmental and social standards whenever applicable, paying special attention to engagement with vulnerable, marginalised, and/or discriminated-against groups, Indigenous Peoples, workers and their representatives, as well as engagement in the context of involuntary resettlement and/or economic displacement, or emergency preparedness and response.

49. Public participation in environmental decision-making processes is not limited to the requirements of the EU EIA Directive and includes, where relevant, engagement in the planning and/or permitting processes, e.g. Directive 2001/42/environmental clearance on the assessment of the effects of certain plans and programmes on the environment (SEA Directive), the Industrial Emissions Directive), Directive 92/43/EEC on the conservation of natural habitats and wild fauna and flora (Habitats Directive), as amended; Directive 2000/60/environmental clearance establishing a framework for Community action in the field of water policy, as amended; Directive 2008/56/environmental clearance establishing a framework for community action in the field of marine environmental policy, as amended.

50. The specific requirements of this Standard for projects located in rest of the world other than EU, EFTA, Candidate and potential Candidate countries, is that the Promoter shall carry out a stakeholder engagement process that is proportionate to the nature and scale of the project and its potential impacts & risks, involving the following processes:
(i) the identification and analysis of the stakeholders;
(ii) the establishment and/or maintenance of a grievance mechanism, as well as some or all of the following elements to varying degrees as deemed necessary by the EIB;
(iii) engagement planning;
(iv) disclosure of information;
(v) meaningful consultation; and
(vi) monitoring and reporting.

(c) Standard 3: Resource Efficiency and Pollution Prevention

51. This Standard outlines the promoter's responsibilities to ensure an integrated approach to resource efficiency, pollution prevention and control of emissions to air, water and

land, noise pollution, radiation, prevention of accidents, as well as waste management and the safe use of hazardous substances and pesticides, avoiding the shift of pollution from one environmental medium to another, ensuring consistency with the "Do Not Significant Harm" principle.

52. This Standard applies to a specific project when its relevance is determined during the EIA/ESIA process (as outlined in Standard 1) and additionally to EIB-financed projects associated with modifications and/or extensions of existing activities/facilities, for which the promoter shall determine the appropriate requirements.

53. The following processes are involved as per the specific requirements of this Standard for projects located in rest of the world other than EU, EFTA, Candidate and potential Candidate countries:

(i) **Resource efficiency and circular economy.** The promoter assesses the effectiveness and efficiency of the project's use of materials and natural resources (e.g. land, soil, water, biodiversity), as well as energy, in particular in production processes, and the impacts on the environment resulting from resource use over the lifetime of the project and life cycle of any products produced. Based on the outcome of such life cycle assessment, the promoter, on a best effort basis, undertakes preventive and mitigating measures to protect natural resources and avoid any significant harm in order to preserve their long-term availability for human activity.

(ii) **Pollution prevention and control.** The promoter shall implement all environmental conditions attached to the decision(s) the measures envisaged to avoid, prevent or reduce and, if possible, offset significant adverse effects on the environment, as well as where appropriate, monitoring measures.

(iii) **Emergency prevention, preparedness and response.** The promoter shall be prepared to respond to any incident, accident and emergency by setting up effective management systems and implementing control measures for ensuring prevention, preparedness and adequate response to major accidents in line with the applicable legal framework and international good practices.

(iv) **Management of waste.** For projects involving the production of waste with significant environmental impact, the promoter shall include, as part of the EIA/ESIA Report a waste management plan containing measures planned to mitigate such impacts and feasible goals and objectives for waste prevention, reuse, recycling and recovery, in line with the waste hierarchy principle. Where applicable, the plan shall include life cycle assessment methods and indicators in order to identify and assess the environmental impacts associated with its products, processes, or activities by quantifying raw materials, energy and waste the project releases into air, water and soil. The promoter shall record and report on a regular basis the waste quantities generated, as well as their off-site transfer, as required by the national and/or EU legislation, the relevant international treaties and good practices. When third parties provide for the final disposal of waste and hazardous waste, the promoter shall ensure the use of licenced contractors.

(v) **Sound management of hazardous substances and materials.** The promoter shall seek to avoid, reduce or eliminate the use and storage of hazardous substances and materials of high concern and consider replacing them by less hazardous substitutes, where suitable economically and technically viable alternatives are available. Furthermore, the promoter is also encouraged to develop projects that lead to the innovative development and use of sustainable substitutes.

(vi) **Pesticide use and management.** When the activity includes the use of pesticides, the promoter shall implement the general standards of the sustainable use of pesticides. The promoter shall pay particular attention to avoiding pollution of surface water or groundwater by acting appropriately and reducing, as far as possible, or eliminating, if appropriate, the use of pesticides in sensitive areas (e.g. areas designated for abstraction of drinking water, on sealed or very permeable surfaces) that can lead to higher risk of pollution of the aquatic environment.

(d) Standard 4: Biodiversity and Ecosystems

54. This Standard recognises that protecting and conserving biodiversity & ecosystems and maintaining the ecological functions and processes of such ecosystems are fundamental to environmental and social sustainability. It recognises that growing pressures on natural resources and ecosystems lead to unprecedented biodiversity losses, which are exacerbated by the adverse impacts of climate change, and that the degradation of ecosystems may have a disproportionate impact on poor rural households and vulnerable and indigenous communities who depend on ecosystem services for their livelihoods and well-being. Therefore, the EIB promotes a holistic and human rights-based approach to the conservation and protection of biodiversity and ecosystems as well as to the sustainable use of natural resources.

55. This Standard applies to a specific project when its relevance is determined during the EIA/ESIA process (as outlined in Standard 1), and specifically to EIB financed projects which may entail a significant impact and risk affecting: (i) biodiversity and ecosystems; (ii) ecosystem services, including the communities whose access to or use of ecosystem services may be affected by project activities; (iii) protected areas or recognised areas of high biodiversity value; and (iv) critical habitats. The Standard also applies to projects that involve primary production and/or the procurement of living natural resources.

56. As a general requirement of this Standard, for all projects, the promoter shall identify, assess and manage the impacts and risks that could potentially affect biodiversity and ecosystems, either positively or negatively, directly or indirectly, and on which the project may depend on for its success.

57. Specific requirements of this Standard involve the following processes and considerations:

(i) Assessment of significant impacts and risks affecting biodiversity and ecosystems: As part of the EIA/ESIA as set out in Standard 1, the promoter shall consider the direct, indirect, cumulative and in-combination impacts of the project and ancillary and/or associated works and/or facilities, where relevant, when assessing the significance of the impacts and risks on habitats, species and ecosystems. This assessment shall also include, as a minimum, the threats to biodiversity and ecosystems such as the loss, degradation and fragmentation of habitats, the loss of species diversity and abundance, the loss of genetic diversity, the degradation of ecosystem services, pollution and incidental take, as well as project-related climate change impacts. Stakeholder engagement forms a key part of the assessment of impacts and risks affecting biodiversity and ecosystems, whether to obtain relevant data, understand the uses, values and benefits associated with biodiversity or develop acceptable mitigation strategies.

(ii) Protection and conservation of high-value biodiversity: Where the assessment identifies that the project could have significant, adverse and irreversible impacts on high-value biodiversity, the promoter shall not implement any project-related activities unless:
   (a) it is demonstrated that no other viable alternatives exist for the development of the project in areas of lesser biodiversity value;
   (b) the project is permitted to go ahead under applicable environmental legislation, recognising the biodiversity features that are of conservation importance;
   (c) meaningful consultation with relevant experts and stakeholders has been carried out; and
   (d) appropriate measures are put in place through the application of the mitigation hierarchy to ensure no loss and, where required, a Net Positive Impact on biodiversity features and the habitats that support them so as to achieve positive measurable conservation outcomes.

(iii) Protection and conservation of critical habitat: Critical habitat is the most sensitive of the high-value biodiversity features and is defined as comprising one of the following:

(a) A highly threatened and/or unique ecosystem;
(b) A habitat of priority and/or significant importance to critically endangered, endangered or vulnerable species, as defined by the IUCN red list of threatened species and in relevant national legislation;
(c) A habitat of priority and/or significant importance to a population, range or distribution of endemic or restricted-range species, or highly distinctive assemblages of species;
(d) A habitat required for the survival of migratory species and/or congregator species;
(e) Biodiversity and/or an ecosystem of significant social, economic or cultural importance to local communities and indigenous groups;
(f) A habitat of key scientific value and/or associated with key evolutionary processes.

(iv) In areas of critical habitat, the promoter shall not implement any project activities unless all of the following conditions are met:
(a) No other viable alternatives for the project exist either in terms of location or design, and there is rigorous justification of overriding public interest based on human health, public safety considerations and/or beneficial consequences of primary importance for the environment;
(b) The project does not lead to measurable adverse impacts that will result in any detrimental effect on the ecological and conservation status of the critical habitat, and impacts are avoided and minimised to the extent possible through changes in footprint or design;
(c) The project does not lead to a net reduction in the population of any vulnerable, endangered or critically endangered species over a reasonable period of time;
(d) Stakeholders are consulted in accordance with Standards 2 and 7;
(e) Positive conservation outcomes (Net Positive Impact) and continued ecological functionality are achieved though appropriate compensation measures for residual impacts that would otherwise occur despite impact avoidance, minimisation and restoration measures; and
(f) A robust, appropriately designed and long-term biodiversity monitoring and evaluation programme aimed at assessing the status of the critical habitat is integrated into the promoter's adaptive management programme.

(v) Compensation and offsets: As a last resort and in response to residual impacts, compensation measures may be implemented to reach a minimum of no loss of biodiversity overall. If the project is taking place in an area of critical habitat, a net positive impact on biodiversity and ecosystem services must be achieved. Compensation or offsets shall not be used as a mechanism to achieve no loss or a net positive impact until other forms of mitigation have been implemented to the fullest extent possible. Where a project is expected to have impacts that would compromise the viability of a critical habitat and/or a habitat of high biodiversity value or their associated features regardless of any proposed compensation or offset, the promoter shall undertake to redesign the project to avoid the need for such compensation/offset.

(vi) Legally protected areas and/or internationally recognised areas of biodiversity value: The EIB shall only finance a project within a protected area, or within a nationally or internationally designated or recognised or candidate area for biodiversity conservation, if the promoter is able to demonstrate that the proposed development in the area is legally permitted and that the design of the project is consistent with a recognised management plan for the protected or designated conservation area. In the absence of a recognised plan, the project should be compatible with the achievement of the relevant conservation objectives used to designate the area in question.

(vii) Invasive alien species: The promoter shall take into consideration the risks associated with the accidental or deliberate introduction of invasive alien species throughout the project's life cycle and take account of those risks when assessing the impacts on biodiversity and ecosystems and in the biodiversity management plan. The promoter

shall identify mitigation measures that control, or attempt to control, the spread of invasive species into areas where they currently are not established. In areas over which the promoter has management control, measures should be implemented to limit the spread of invasive species, or, if possible, to eliminate them.

(viii) Ecosystem services assessment: The identification of the project's impacts and risks that affect ecosystem services, as part of the EIA/ESIA process described in Standard 1, should be carried out by the promoter in collaboration with relevant stakeholders and local communities and Indigenous Peoples that depend on these services. A gender-sensitive approach should be taken, where feasible, acknowledging that men and women may place different values on ecosystems, and derive different benefits from them. Where practical and feasible, a screening of the levels of dependence on these services should be included as part of the assessment process. Ecosystem services critical to the viability of a proposed project should also be identified.

(ix) Supply chains: The promoter shall identify and assess the impacts and risks affecting biodiversity and ecosystems that are caused by its primary suppliers as part of the supply chain. Any mitigation measures identified through the assessment should ensure sustainable outcomes. Where the promoter is procuring living natural resource commodities, such as food, timber and fibre, that are known to be produced in regions where there is a risk of significant conversion or degradation of high-value biodiversity and/or critical habitat, the promoter shall contract with companies/suppliers in the sector that abide by recognised standards or certification schemes for sustainable management, where relevant. For commodities other than living natural resources, promoters involved in the purchasing, processing or trading of such commodities should seek to identify their supply chain risks in relation to adverse impacts on high-value biodiversity and/or critical habitats and assess their operational and reputational exposure to such risks. In situations where such concerns are identified, promoters shall find solutions in order to address them in a manner commensurate with their degree of control and influence and consistent with the requirements of this Standard.

(x) Sustainable management and use of living natural resources: Renewable natural resources shall be managed in a sustainable manner. Sustainable resource management is the management of the use, development, and protection of resources in a way, or at a rate, that enables people and communities, including Indigenous Peoples, to provide for their current social, economic and cultural well-being while also sustaining the potential of these resources to meet reasonably foreseeable needs of future generations.

(e) Standard 5: Climate Change

58. This Standard recognises the importance and urgency of combating climate change, which poses a major global threat and is a common concern of humankind, as rising temperatures increasingly result in severe, pervasive and irreversible negative impacts for people, economic activities, ecosystems and the regenerative capacity of the planet. This Standard further recognises the role of finance in supporting low-carbon and climate-resilient development, i.e. in (i) addressing climate change by reducing greenhouse gas (GHG) emissions; and (ii) building the resilience and adaptive capacity of people, nature and assets to cope with current and future climate change-induced impacts.

59. This Standard promotes the alignment of projects supported by the EIB with the goals and principles of: (i) the Paris Agreement[9] and (ii) the Sustainable Finance Action Plan. It does so by stipulating that climate change mitigation and adaptation considerations must be explicitly addressed and incorporated by promoters in the decision-making process of the projects that the EIB supports, in accordance with the approaches established in the EIB Group Climate Bank Roadmap (adopted on 11 November 2020 by the EIB Board of Directors) and the EIB Climate Strategy (Update adopted on 11 November 2020 by the EIB Board of

[9] *Adopted on 12 December 2015 at the 21st session of the Conference of the Parties to the UN Framework Convention on Climate Change (COP 21) in Paris.*

Directors).

60. This Standard outlines the responsibilities of the promoter with regard to assessing, managing and monitoring project-related (i) GHG emissions and transition climate risks and (ii) physical climate risks. More specifically, the promoter's responsibilities involve:

(i) Assessing GHG emissions at the project level and the project's alignment with pathways to limit global warming to 1.5° C above pre-industrial levels and options to reduce transition risks;

(ii) Assessing the project's resilience to physical climate risks, its alignment with climate-resilient development pathways, and the options to reduce physical climate risks to the project, its natural environment and the people that may be affected by it.

61. As part of the General Requirements of this Standard, all projects shall comply with the EIB's alignment framework, as set out in the EIB Group Climate Bank Roadmap (CBR), including to ensure consistency with the "Do No Significant Harm" principle to climate change mitigation or adaptation objectives, as defined by the EU Taxonomy Regulation. The promoter shall provide the EIB with information establishing the project's impact on GHG emissions and its vulnerability to physical climate change risks, as well as its alignment with relevant low-carbon and climate-resilient pathways.

62. When applying Standard 5, the promoter shall consider relevant environmental and social, including gender, aspects in line with the requirements outlined in other EIB standards, in particular: Standard 2 "Stakeholder Engagement", Standard 7 "Vulnerable Groups, Indigenous Peoples and Gender", and Standard 10 "Cultural Heritage".

63. Specifically following considerations / processes are required as part of this Standard:

(i) **Assessment and minimisation of GHG emissions**. The promoter shall provide to the EIB all relevant information on the nature and magnitude of the project's GHG emissions and/or sequestration, as required by the EIB in order to conduct its assessment. The promoter shall demonstrate, on request, that due consideration has been given to alternatives to minimise project-related GHG emissions. These measures may include, but are not limited to: the use of best available techniques (BAT) and/or any emerging techniques, energy efficiency, resource efficiency, adoption of less carbon-intensive or renewable energy sources, or the reduction of fugitive emissions.

(ii) **Physical climate risk assessment and minimisation.** The promoter shall provide to the EIB all relevant information relating to physical climate risks associated with a project as required by the EIB in order to determine a project's alignment with the EIB Group Climate Bank Roadmap (CBR), including consistency with the "Do No Significant Harm" principle to climate change adaptation objectives, as set out in the EU Taxonomy Regulation. Where a project is determined by the EIB to be at risk from physical climate hazards, the promoter shall carry out a Climate Risk and Vulnerability Assessment (CRVA), in line with the approach adopted by the EIB and other relevant EIB Standards. The CRVA shall (i) assess how climate change may affect the project and the system in which the project takes place, including the natural environment and the people potentially affected, and (ii) identify commensurate adaptation measures to reduce the risks posed by climate change to the project and the system in which it takes place.

(iii) **Climate-related aspects of economic analysis.** The promoter shall, on request, provide the EIB with climate-related information relevant to assessing the economic case for the project. This may include:

a) Climate change mitigation aspects: (i) the volume of GHG emitted per relevant time period, with and without the project; and (ii) the unit value and conceptual basis for the cost of carbon emissions;

b) Climate change adaptation aspects: (i) the change in exposure to physical climate risk per relevant time period, with and without the adaptation measures of a project; and (ii) the economic valuation of this change in risk;

c) For projects motivated primarily by climate considerations, when practical and feasible, the economic analysis should include an assessment of climate-related project impacts on different groups in society, with a particular focus on vulnerable groups.

64. For all projects listed in Annex I and Annex II of the ESIA (Environmental Impact Assessment) Directive, in respect of which the relevant competent authorities have concluded that an ESIA is required, the promoter shall ensure that the information relevant to the assessment of climate change mitigation and adaptation and its conclusions are clearly distinguishable and identifiable in the ESIA report.

(f) Standard 6: Involuntary Resettlement

65. Involuntary resettlement refers to displacement that occurs as a direct result of project-related land acquisition or restriction on land use. It includes: (a) physical displacement (i.e. physical relocation, loss of residence or loss of shelter); and/or (b) economic displacement (i.e. loss of assets, or access to assets, that leads to the loss of income sources or means of livelihood). Resettlement is involuntary when affected individuals or communities do not have the right to refuse such displacement. Involuntary resettlement can have severe negative effects on the economic, social and cultural well-being of rights-holders (affected persons and host communities). Income sources can be temporarily or permanently lost, persons can be relocated to environments where their skills may be less applicable and compensation may not be sufficient to prevent long-term hardship or disadvantage.

66. Social Impact assessment study has been carried out by Maha metro, which addresses the issues of involuntary resettlement involved in PCMC to Nigdi (Phase-1 Extension) Project.

(g) Standard 7: Vulnerable Groups, Indigenous Peoples, and Gender

67. Within the context of EIB projects, vulnerable or marginalised persons and groups are those that:

(i) are usually exposed to several risks and adverse impacts at once;
(ii) are more sensitive to those risks and impacts, often having been subject to pre-existing discrimination; and
(iii) have a weaker adaptive capacity for coping with those risks and recovering from those impacts, due to limited access or rights to required assets and/or resources. As a result, they can be disproportionately affected by project-related risks and impacts.

68. This Standard recognises that in some cases, certain individuals or groups are vulnerable, marginalised, systematically discriminated against or excluded on the basis of their socioeconomic characteristics. Such characteristics include, but are not limited to, sex, sexual orientation, gender, gender identity, caste, racial, ethnic, indigenous or social origin, genetic features, age, birth, disability, religion or belief, political or any other opinion, activism, membership of a national minority, affiliation to a union or any other form of workers' organisation, property, nationality, language, marital or family status, health status, or migrant or economic status.

69. These persons and groups are not inherently more vulnerable than others but due to discriminatory practices and norms, and therefore a less enabling environment, they often face additional barriers that limit their opportunity or ability to equally participate in decision-making related to the project and enjoy project benefits. Indigenous Peoples2 and ethnic minorities in particular have identities and aspirations that are distinct from dominant groups in national societies and are often disadvantaged by traditional models of development. Moreover, gender-based discrimination affects all societies and cuts across all other types of discrimination, often exacerbating vulnerability, exclusion, and/or marginalisation.

70. Importantly, discrimination, entrenched social and gender roles and attitudes, gender-based violence and lack of access to decision-making can weaken the resilience of the aforementioned individuals and groups and render them disproportionally vulnerable to adverse project impacts.

(h) Standard 8: Labour Rights

71. This Standard outlines the promoter's responsibilities with regard to the assessment, management and monitoring of labour-related impacts and risks associated with projects. It recognises workers and employers as both rights-holders and duty-bearers.

72. The Standard specifies the requirements in alignment with the rights and principles of the Fundamental Conventions of the International Labour Organisation (ILO) and the European Pillar of Social Rights. The objective of this Standard is to set out minimum requirements that the project's policies and procedures shall address, including:

(i) ensuring the fair treatment, non-discrimination and equal treatment and opportunity of workers, especially vulnerable workers facing particular risks due to context-specific socioeconomic characteristics;
(ii) zero tolerance for the use of forced labour and child labour;
(iii) respecting the principles of freedom of association and collective bargaining;
(iv) protecting and promoting safety and health at work;
(v) promoting a sound worker-management relationship;
(vi) ensuring that accessible and effective means to raise and address workplace concerns are available to workers.

73. This Standard applies to all projects and the specific requirements that need to be addressed, including to achieve consistency with the "Minimum Safeguards" (MS) principles[10], are determined during the EIA/ESIA process (as outlined in Standard 1).

74. This Standard applies to project workers including full-time, part-time, temporary, seasonal and migrant workers. Throughout this Standard, the term "project worker" is used to refer to:

(i) people employed or engaged directly by the promoter (including the project proponent and the project implementing agencies) to work specifically in relation to the project (direct workers);
(ii) people employed or engaged through third parties to perform work related to core functions of the project, regardless of location (third-party workers).

75. Some of the specific requirements of this Standard relevant to the PMRP Phase-1 extensions project are listed here:

(i) **Management of working relationships.** The promoter shall develop and/or maintain written labour management policies and procedures that are commensurate to its size and workforce and applicable to the project. These shall be communicated in a culturally appropriate manner to the project workers. The labour management policies and procedures shall also describe how the promoter plans to comply with the requirements deriving from national labour and employment law, applicable collective agreements and the requirements of this Standard. Project workers shall not be employed informally and they shall all have valid written employment contracts. The employment contracts shall set out working conditions and terms of employment including entitlement to wages, working hours, overtime arrangements and overtime compensation, and any benefits (such as leave for illness, maternity/paternity or holiday). Any material changes to the terms and conditions of employment shall be

[10] *As defined in the EU Taxonomy Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088 [https://eur-lex.europa.eu/eli/reg/2020/852/oj].*

communicated to the project workers in a culturally appropriate manner.

(ii) **Terms and conditions of employment.** The employment conditions of project workers (including wages, benefits, and working hours) shall not be less favourable than for the equivalent type of work in the relevant country/region of the operation and industry. The promoter shall ensure that wages paid are fair and in accordance with minimum thresholds under national legislation. The promoter shall ensure that project workers are paid on a regular basis as required by national law and labour management procedures. Working hours, including breaks and rest periods, shall comply with national legislation and any collective agreements.

(iii) **Child labour.** In line with the ILO Minimum Age Convention No.138 and the Worst Forms of Child Labour Convention No.182, the promoter shall not employ, use or benefit from child labour. The promoter shall comply with the minimum age requirements defined under the aforementioned ILO unless the national standards are more stringent. Children over the minimum age and under the age of 18 may be employed or engaged in connection with the project subject to an appropriate risk assessment prior to the work commencing and the regular monitoring of health, working conditions and working hours. Children shall not be employed informally, even when this is socially or culturally acceptable practice in the sector, country or region. If the practice of child labour is identified among the project workers (including all kinds of third-party workers), the promoter shall take immediate steps to correct and remedy them. The promoter shall also report to the EIB about such practices and the remedial measures taken. The promoter shall require its contractors to apply the same standards and practices with respect to child labour.

(iv) **Forced labour.** The promoter shall not employ forced or compulsory labour and shall ensure such labour does not take place in relation to the project, by its contractors and suppliers. Forced labour covers any kind of involuntary or compulsory labour, such as indentured labour, bonded labour, or similar labour-contracting arrangements as well as human trafficking. The promoter shall provide special attention to identifying which project workers might be at greater risk of trafficking due to certain socioeconomic characteristics such as age, disability, ethnicity and/or gender. Considering security concerns and the nature of the work, the promoter shall avoid any unnecessary restriction of the freedom of movement of its labour force during the course of their employment. Furthermore, the promoter shall not engage in or tolerate any form of corporal punishment, mental or physical coercion, or abuse of personnel. If the practice of forced labour is identified among the project workers (including all kinds of third-party workers), the promoter shall take immediate steps to terminate the practice, offer conditions of work that are not coercive and refer the case to the competent law enforcement authorities. The promoter shall also report to the EIB about such practices and the remedial measures taken.

(v) **Migrant workers.** The promoter shall identify the employment of migrant project workers and shall ensure their treatment is not less favourable than that of non-migrant project workers undertaking similar functions. This includes equal remuneration and the enjoyment of the same rights, equal opportunities and equal treatment. The promoter shall not tolerate any physical or psychological coercion of migrant workers, including unnecessary restrictions on their movement or the retention of workers' identity documents, such as passports, or personal belongings. The promoter shall make best efforts to ensure that the project's primary suppliers uphold the same principles.

(vi) **Non-discrimination and equality of opportunity and treatment.** The labour management policies and procedures shall be non-discriminatory and shall observe equal opportunities. Employment-related decisions shall be based on professional skills and competencies. The treatment of project workers must be fair and equal in all its aspects, including equal pay for equal value, recruitment, promotion, termination of employment and disciplinary practices. The promoter shall put in place measures, including workplace policies and an appropriate mechanism, to effectively prevent and address any form of violence and harassment, bullying, intimidation, and exploitation, including any form of gender-based violence and harassment at project

level

(vii) **Grievance mechanism.** The promoter shall set up an effective, culturally appropriate and gender-responsive grievance mechanism for project workers (and their organisations, where they exist) to raise reasonable workplace concerns. The promoter shall inform project workers of the grievance mechanism at the time of hire and make it easily accessible to them. The mechanism shall address complaints in a timely and effective manner using a transparent process that allows project workers to raise concerns without fear of retribution. The mechanism shall include provisions for anonymous and confidential complaints, as well as special protection measures that may be required by project workers, such as in the case of sexual and/or psychological harassment, exploitation and abuse and any other form of gender-based violence or discrimination. The mechanism shall ensure workers' rights to be present and to participate directly in the proceedings and to be represented by a trade union or person of their choosing.

76. The promoter shall conduct regular monitoring and reviews of the project's workforce, including contractors and subcontractors as well as primary suppliers, to be able to identify any labour risks or violation of labour standards with which the project may be involved and implement effective measures to address such risks and violations, setting priorities for acting on and evaluating the results. The promoter shall report to the EIB about the results of the monitoring activity as part of its regular reporting requirements.

(i) Standard 9: Health, Safety, and Security

77. The EIB recognises the need to safeguard the safety and health of workers, and to address rapid changes in the economy (notably the pathway towards green growth), demography and work patterns. This Standard recognises that project activities, equipment and infrastructure can expose workers and community to hazards, risks and impacts in terms of occupational and public health, safety and security.

78. The Standard requires promoters to use reasonable efforts to identify' these hazards, risks and impacts and to design and use of appropriate measures to avoid or mitigate adverse health and safety impacts associated with project activities on the rights-holders (project workers, supply chain workers, and affected people and communities).

79. This Standard recognises: (i) the right of workers to fair and just working conditions, and (ii) the right of workers and affected people and communities to life and to integrity. It also recognises the responsibilities of both workers and employers to securing a safe and healthy working environment.

80. This Standard, whilst acknowledging the role of relevant authorities in protecting and promoting the health and safety of workers and the public, outlines the promoter's responsibilities in assessing, managing and monitoring occupational and public health, safety and security risks associated with projects supported by the EIB, and specifically the following:

(i) Promote, protect and monitor the health, safety and security of project workers (including third party workers i.e. contractors, subcontractors, brokers, agents or intermediaries) throughout the project life-cycle, by ensuring a safe, healthy, and secure working environment (including gender-based violence risks as recognised in ILO C190 Violence and Harassment Convention & accompanying Recommendation R206) and, where applicable, accommodation conditions, and effectively implementing a management system, or equivalent, commensurate to the risks and impacts associated with the project.

(ii) Identify, assess and manage risks to the health and safety of project-affected people and communities, (including to project-related gender-based violence risks including sexual harassment, exploitation and abuse) during the life-cycle of the project.

(iii) Require that the provision of private or public security to protect project workers,

assets, communities and suppliers is consistent with international human rights standards and principles[11].

(iv) Provide that project workers and members of the public can effectively access the workers' grievance mechanism and the project grievance mechanism, respectively, in cases of health, safety or security concerns, risks or violations commensurate to the risks and impacts associated with the project.

81. Specific requirements of the Standard require that the project shall be designed and operated in compliance with the requirements of paragraphs 15 to 67 of this Standard. The promoter shall provide the EIB with satisfactory evidence18 and information on its practices (and, when relevant, those of its contractors and suppliers), both at the project appraisal stage and through regular monitoring, as per contractual obligations, and if and when requested. Processes and considerations of this Standard include:

(i) **Health and safety management.** The promoter shall put in place a well-defined Health and Safety Management System (HSMS) commensurate with the project risks for managing occupational and public health, safety and security including a Health and Safety Management Plan (HSMP), or equivalent which shall consider the hazards, risks and impacts of the project, as well as international best practice, such as ILO Guidelines on occupational safety and health management systems (ILO-OSH 2001). The HSMS shall have appropriate resources and expertise. Depending on the nature of work and size of the workforce, the promoter and/or the contractor shall assign a dedicated unit or team with the appropriate level of seniority for the above tasks. Already at the preliminary design stage, the promoter shall identify and assess occupational and public health and safety (including sexual harassment, abuse and exploitation) risks and impacts arising directly or indirectly from the project at any time during the life cycle of the project, including the use and storage of hazardous materials. The promoter shall ensure that appropriate attention is given to persons and groups that may be particularly exposed to or vulnerable to such risks based on their socio-economic characteristics. The promoter shall adopt a precautionary approach and apply adaptive management practices in which the implementation of mitigation and management measures are responsive to changing conditions and the results of project monitoring throughout the project lifecycle (for which risks assessments may be required). The adopted measures shall be commensurate with the nature and magnitude of the identified risks and impacts and shall be applied without discrimination, considering differences in risk exposure and the need to protect particularly sensitive risk groups against the dangers, which specifically affect them. The promoter shall provide to project workers as well as to the project-affected people and communities, relevant information, instructions and training in an accessible format. When providing such information, instructions and trainings, the promoter shall include individuals or groups within the workforce or communities that are traditionally excluded or discriminated against due to their socio-economic characteristics

(ii) **Workplace.** When providing project workers with a safe and healthy workplace, the promoter shall consider the needs of women and men, any inherent risks in its particular sector and location, as well as hazards that may be present. The promoter shall pay attention to workplace mental health and wellbeing and work-related psychosocial risks. The working environment shall respect human dignity, comply with general hygiene norms, and consider & ensure the physical and mental integrity of project workers. The promoter shall address gender specific risks and requirements, including gender based and sexual violence. The promoter shall ensure that project workers get medical benefits and employment injury benefits (including for occupational diseases). The promoter shall require all project workers and all persons accessing the project site (including suppliers, supervisors, visitors), to abide and

[11] *International human rights standards and principles include (i) the UN Basic Principles on the Use of Force and Firearms by Law Enforcement Officials, (ii) the UN Code of Conduct for Law Enforcement Officials, (iii) the Voluntary Principles on Security and Human Rights and (iv) the International Code of Conduct on Private Security Providers.*

comply with the applicable health and safety plans.

(iii) **Personal protective equipment.** Based on the assessment referred to in point a. above, and considering the hierarchy of controls, project workers shall be provided with appropriate personal protective equipment **(**PPE), free of charge. Such equipment shall be certified and suitable for the tasks to be carried out. Consideration shall be given to the specific physical characteristics of project workers.

(iv) **Health and safety training for project workers.** The promoter shall take all necessary actions to ensure that project workers are made aware of all risks associated with their work and how to implement protective measures with regard to their health and safety. The promoter shall provide project workers with adequate, timely and regularly updated training and information material on health and safety issues and procedures. The promoter shall ensure that project workers carrying out any activity in the project site are both trained and qualified.

(v) **Community health and safety**. The promoter shall identify and assess project-related risks and adverse impacts to the health and safety of the potentially affected people and communities including those who, because of their particular circumstances, may be more vulnerable. The promoter shall develop protection, prevention and mitigation measures proportionate to the impacts and risks, and appropriate to the stage, size and nature of the project. The promoter shall cooperate and consult with the relevant authorities, the project-affected community and other stakeholders, as appropriate, on mitigation measures and plans.

(vi) **Risks associated with the influx of workers**. To the extent possible, the promoter shall take the necessary measures to avoid, mitigate and manage the risks and potential adverse impacts on public health and safety arising from the influx of workers. Such risks and impacts may be associated with changes in population composition, intangible cultural heritage, health implications and exposure to communicable diseases and the increased vulnerability of communities in the area of influence of the project due to increased pressure on already scarce natural resources. The promoter shall protect affected people, especially women and children, from sexual harassment, exploitation and abuse in the context of the project. Where appropriate, the promoter shall adopt specific measures to prevent and address gender-based violence risks, including the organisation of training and awareness programmes for the project workers and the provision of confidential channels for reporting incidents and providing support. Participation of project workers and their representatives in the development of such measures is recommended. The promoter shall further find alternative means for remedying significant stress on natural resources caused by the increased population numbers.

(vii) **Traffic and road safety.** For all types of projects, traffic and road safety shall be considered at project planning and design to prevent and mitigate risks and impacts throughout the project life cycle. The promoter shall identify, evaluate and monitor the potential traffic and road safety risks to workers, communities and all road users throughout the project life-cycle. To this end, the promoter shall take into consideration road and traffic safety management standards and where appropriate develop measures and plans to address these risks. The promoter shall routinely monitor incident and accident reports to identify and resolve problems or negative safety trends and amend relevant plans and systems as appropriately. For projects that operate machinery, plant or equipment on public roads, the promoter shall take the necessary measures to avoid and minimise hazards, risks and impacts to both project workers and members of the public.

(viii) **Natural hazards and natural hazards triggering technological disasters.** The promoter shall identify and assess and minimize the potential health and safety risks caused by natural hazards or extreme weather events, such as, but not limited to, floods, droughts, heat waves, landslides, hurricanes, typhoons or earthquakes as relevant to the project. The promoter shall consider the interaction between natural disasters and industrial accidents (NaTech or Natural Hazard Triggering Technological Disasters) and the prevention of, preparedness for and response to industrial accidents including those capable of causing transboundary effects. Preventative

measures include land use planning and siting, modification of hazardous activities, disaster risk reduction, emergency preparedness through contingency planning, and the resilience of project-affected communities to natural and technological disasters.

(ix) **Exposure to diseases.** During the ESIA process, the promoter shall identify the risk of exposure to occupational and communicable diseases by both project workers and the people affected by the project and communities. To this end, the promoter shall consider the differentiated exposure to and/or higher sensitivity of workers and certain groups depending on their age, gender, health status and other factors that may lead to higher vulnerability to hazards. To the extent possible, and with the support of OHS professionals, the promoter shall take measures to contribute to avoid or contain the spread of pandemics, epidemics, and any transmission of communicable diseases associated with the influx of workers, such as SARs-CoV-2, malaria, tuberculosis, sexually transmitted diseases (including HIV/AIDS) etc. To this end, the promoter shall organise training and awareness programmes, and ensure that codes of conduct (for workers and people living in labour camps, if any) are implemented. Furthermore, the promoter shall endeavour to work with public authorities and other stakeholders (such as NGOs) and build upon existing measures to implement public programmes and policies that shall raise public's awareness and understanding of communicable and preventable diseases effectively countering their spread.

(x) **Essential sanitary facilities**. The promoter shall ensure that all project workers have access to adequate, safe and hygienic basic welfare facilities [In line with the ILO Welfare Facilities Recommendation, 1956 (No. 102)]. The promoter shall provide basic occupational health services including drinking water, sanitation and washing facilities. The promoter shall provide qualified first-aid at all times. In certain cases, when the scale or the nature of the activity being carried out so requires, availability of medical care shall be provided based on the principles of non-discrimination and equal opportunity. In providing the above, the promoter shall consider any gender specific requirements alongside those of persons with disabilities.

(xi) **Workers' accommodation.** Where a promoter provides accommodation for project workers, the promoter shall put in place and implement policies governing the quality and management of the accommodation and provision of basic services which must be adequate, safe and hygienic. The accommodation services shall be provided in accordance with good industry practice, such as ILO Workers' Housing Recommendation 1961 (No. 115), and in a manner consistent with the principles of non-discrimination and equal opportunity. The promoter shall consider the specific requirements of women and persons with disabilities. The promoter shall ensure that above-mentioned provisions include safeguards against sexual harassment and exploitation and other forms of gender-based violence. Workers' freedom of movement to and from the promoter-provided accommodation shall not be unreasonably restricted.

(xii) **Security.** The promoter shall identify and assess the security risks and threats to the project assets, the workforce and the wider community, in connection with the project. The assessment should be part of the ESIA referred to in Standard 1. Where risks have been identified, legitimate and proportionate security arrangements shall be put in place. Such security arrangements shall be defined in the HSMP and implemented in accordance with good international practice. The promoter shall ensure that the security arrangements, whether privately outsourced or publicly provided, do not create security risks and impacts upon workers, suppliers, or local communities. Particular attention shall be given to persons or communities that are traditionally discriminated against, based on their socio-economic characteristics, in and surrounding the project area. The promoter is expected to comply with applicable law and to be guided by The Principle of Proportionality (which states that responses should be proportional to the good that can be achieved and the harm that may be caused) and legitimate use of force, and good international practice when hiring, training, equipping and monitoring security personnel as well as when setting the rules for their conduct. The promoter shall incorporate the requirements stated above in the contracts and other agreements to be signed with the security providers.

(xiii) **Information dissemination and consultation.** The promoter shall ensure that both project workers and project-affected people and communities have been properly identified, consulted and informed in an accessible format of their rights in terms of health, safety and security (pursuant to Standard 2 on Stakeholder Engagement). The promoter shall further ensure that they can freely convene and express their views on project risks, impacts and the proposed health and safety management plans. Due attention should be paid to reaching out to individuals or groups within the project-affected communities that are vulnerable, marginalised, systematically discriminated against or excluded on the basis of their socioeconomic characteristics and Indigenous Peoples in the local communities (in accordance with Standard 7) and ensuring that risks to them have been adequately identified and protective and mitigation measure communicated.

(xiv) **Grievance mechanism.** As considered in Standard 8 the promoter shall set up an effective, culturally appropriate and gender-responsive grievance mechanism for project workers (and their organisations, where they exist) to raise reasonable workplace concerns. The promoter shall also grant members of the project-affected communities free and easy access to an independent, effective and free of reprisals grievance mechanism in line with the requirements defined in Standard 2. Both mechanisms shall address their health and safety concerns in a timely and effective manner and shall not impede access to other redress mechanisms, such as judicial, administrative and labour inspectorates or extrajudicial means of complaint. The promoter shall duly inform workers and project-community members of the existence of these grievance mechanisms. The promoter shall ensure that their grievance mechanisms can be used by affected communities and workers to report security concerns as well as allegations of abuses or unlawful acts by the security personnel. The promoter shall investigate such allegations, report to the public authorities when relevant and take appropriate measures to avoid reoccurrence.

(xv) **Accident and incident reporting system.** Before project construction and operation, the promoter shall establish project level procedures and systems for investigating, recording and reporting any type of accident and incident including those causing harm to people. These accidents can happen at the site, as well as within the project influence area, as a direct consequence of the construction works or project activities. Project related road and traffic accidents shall also be reported to the EIB.51 The mechanism shall address the health and safety concerns of the workers and member of the public in a timely and effective manner and shall not impede access to other redress mechanisms, such as judicial, administrative or extrajudicial means of complaint.

(xvi) **Third party workers.** The promoter shall ensure that the requirements of this Standard are applied to all workers, including those employed or engaged by contractors, subcontractors and any other third party or intermediary. The promoter shall put in place appropriate policies and procedures for managing and monitoring the performance of third-party employers. These policies and procedures should be commensurate with the size of the project and workforce.

(xvii) **Supply chain workers.** The promoter shall make reasonable efforts to assess if there are significant health and safety risks associated with the workers of the primary supplier of the goods and materials central to the core functions of the project. Where there are significant health and safety risks related to supply chain workers, the promoter shall resort to a primary supplier that can prove is compliant with this standard. The promoter shall require the relevant primary supplier to introduce procedures and mitigation measures to address such risks. The promoter shall periodically monitor and review the effectiveness of such procedures and mitigation measures.

(j) Standard 10: Cultural Heritage

82. This Standard recognises that protecting and conserving cultural heritage, which is a source of valuable historical and scientific information, an asset for economic and social

development and an integral part of people's cultural rights, identity and practices, is fundamental to environmental and social sustainability.

83. The objective of this Standard is to set out requirements applicable to EIB-financed projects that the promoter shall comply with. These requirements are intended to foster:

(i) the application of a precautionary approach to the management and sustainable use of cultural heritage;
(ii) the protection of cultural heritage from the potential adverse impacts of project activities;
(iii) the equitable sharing with local communities of financial and/or socioeconomic benefits derived from the commercialisation of cultural heritage; and
(iv) awareness, appreciation and enhancement of cultural heritage.

84. This Standard applies to a specific project, when its relevance is determined during the EIA/ESIA process (as outlined in Standard 1) and specifically to EIB-financed projects likely to have impact on known cultural heritage regardless of whether or not is legally protected and/or previously disturbed. This Standard also applies to projects under implementation that are likely to have a significant impact on cultural heritage but were not previously identified as such and for which chance find procedures shall be applied.

85. For the purpose of this Standard, cultural heritage includes both tangible and intangible heritage:

(i) Tangible cultural heritage[12] refers to monuments (Architectural works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of value to the local communities or peoples), individual buildings, groups of buildings (groups of separate or connected buildings which, because of their architecture, their homogeneity or their place in the landscape, are of value to the local communities or peoples) and sites (works of man or the combined works of nature and man, and areas including archaeological sites which are of value to the local communities or peoples).
(ii) Intangible cultural heritage[13] refers to practices, representations, expressions, knowledge and skills – as well as the instruments, objects, resources, artefacts and cultural spaces associated therewith – that rights-holders (communities, groups and, in some cases, individuals) recognise as part of their cultural heritage and which are transmitted from generation to generation.

86. This Standard applies also to natural heritage[14] recognised by the local communities and peoples as part of their history, values, beliefs, knowledge and/or traditions and which the communities and peoples consider valuable, and desires to sustain and transmit to future generations.

87. Where a project is likely to have significant impact on natural heritage, both cultural and biodiversity/ecosystem services aspects shall be considered and the requirements of Standard 4 shall apply in conjunction with the requirements presented in this Standard.

88. The promoter is responsible for locating and designing a project in such a manner that it will avoid significant adverse impacts on cultural heritage. When the promoter can

[12] *The UNESCO 1972 Convention concerning the Protection of the World Cultural and Natural Heritage [https://whc.unesco.org/archive/convention-en.pdf].*
[13] *The UNESCO 2003 Convention for the Safeguarding of the Intangible Cultural Heritage [https://ich.unesco.org/en/convention].*
[14] *Natural heritage refers to natural features consisting of physical and biological formations or groups of such formations, natural features, geological and physiographical formations, delineated areas that constitute the habitat of threatened species of animals and plants and natural sites of value from the point of view of science, conservation or natural beauty (Art. 2 of the UNESCO 1972 Convention concerning the Protection of the World Cultural and Natural Heritage).*

demonstrate that impacts cannot be avoided for reasons other than cost considerations, the promoter shall adequately assess if any cultural heritage is likely to be significantly affected by the project and/or if there are indications of the likelihood of any chance finds. Where the project site may potentially prevent access to previously accessible cultural heritage, the promoter shall allow continued access to these sites or shall provide alternative access, during construction and operation. In doing so, the promoter shall engage with relevant national or local regulatory authorities entrusted with the protection of cultural heritage, local communities and other relevant stakeholders as appropriate.

89. The promoter shall ensure that the impact on cultural heritage is duly considered in the ESIA process by considering the views of key relevant stakeholders and engaging professionals with appropriate expertise, experience and qualifications in cultural heritage to assist in the preparation of the assessment.

90. The cultural heritage assessment as a standalone study or as part of the ESIA report shall provide information on at least:

(i) The description of the project and the reasonable alternatives studied during the project preparation phases with an indication of whether the impact on cultural heritage was considered in the selection of the chosen option;
(ii) A baseline study compiling a comprehensive inventory of cultural heritage assets supported by a full description of their cultural significance using both desk-based research and field surveys;
(iii) The prediction and evaluation of the significance of both direct impacts (direct loss, destruction or disturbance of an element of cultural heritage) and indirect impacts which may affect the preservation of cultural heritage, including visual impacts;
(iv) The application of a mitigation hierarchy by identifying measures to avoid, prevent and reduce significant adverse impacts on cultural heritage, outlined in a cultural heritage management plan;
(v) A cultural heritage management plan to ensure that the proposed mitigation measures are properly implemented and that the cultural heritage asset is preserved in the desired state.

91. When defining the mitigation measures, the following order should be considered:

(i) Minimise adverse impacts with appropriate technical and/or management measures specific to the cultural heritage asset to be protected;
(ii) When minimisation is not possible, restore in situ after the adverse impacts have occurred to ensure full restoration of the functionality and significance of the cultural heritage for the affected communities;
(iii) When the promoter can demonstrate that minimisation and restoration are not feasible for reasons other than cost considerations, remedy/compensate for loss of cultural heritage in ways that are acceptable and have been agreed with the affected communities before any works affecting the cultural heritage have started.

92. Following processes and/or considerations are part of the specific requirements of this Standard:

(i) **Stakeholder engagement.** The promoter shall carry out meaningful consultation with and provide timely and adequate information to affected communities who use or have used the cultural heritage within living memory for longstanding cultural purposes, with due attention to intangible cultural heritage. Consultation shall be carried out to identify cultural heritage of importance and incorporate the views of the affected communities on such cultural heritage into the project design, while assessing risks and impacts, applying the mitigation hierarchy and identifying opportunities for potential benefit-sharing arrangements with the community. Consultation shall also involve other relevant stakeholders, including national or local regulatory authorities entrusted with the protection of tangible and/or intangible cultural heritage. The engagement process shall be carried out and documented in line with the requirements of Standard 2 and in line with the requirements of Standard

7 in case vulnerable groups or Indigenous People are likely to be affected.

(ii) **Protected cultural heritage areas.** Legally protected cultural heritage areas are important for the safeguarding and conservation of cultural heritage and therefore, additional measures are needed for any projects that would be permitted in these areas under the applicable national law.

(iii) **Chance find procedures.** The promoter shall ensure that provisions for managing chance finds (defined as cultural heritage encountered unexpectedly during project construction) are in place and included in contracts, as appropriate. Such provisions shall include: notification of relevant competent authorities of found objects or sites; delivering training to the project personnel, including contractor and sub-contractor employees, on the procedures to follow if chance finds are discovered; and securing the area of finds to avoid any further disturbance or destruction. The promoter shall not disturb any chance finds until an assessment by a designated and qualified specialist is made and actions consistent with national legislation and this Standard are identified.

(iv) **Project's use of cultural heritage.** Where a project proposes to use, for commercial purposes, a local community's cultural resources, knowledge, innovations or practices that embody traditional lifestyles, the promoter shall disclose all relevant information in a timely and context-specific manner, in an accessible place, and in a form and language(s) understandable to the community The information provided shall include as a minimum: (i) its rights under national law; (ii) the scope and nature of the proposed commercial development; and (iii) the potential consequences of such development.

93. The promoter shall proceed with such commercialisation only when it:

(i) enters into a good faith negotiation with the affected local communities;

(ii) documents their informed participation and the successful outcome of the negotiation; and

(iii) provides for fair and equitable sharing with the affected local communities of benefits derived from commercialisation of such knowledge, innovations or practices, consistent with their customs and traditions.

94. Where a project proposes to use the cultural resources, knowledge, innovations or practices of Indigenous Peoples, the requirements of Standard 7 also apply.

2. International Finance Corporation (IFC) Performance Standards (PS) on Environmental & Social Sustainability

95. The Policy on Environmental and Social Sustainability describes International Finance Corporation (IFC) commitments, roles, and responsibilities related to environmental and social sustainability. The performance standards are directed towards clients, providing guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and manage risks and impacts as a way of doing business in a sustainable way, including stakeholder engagement and disclosure obligations of the client in relation to project level activities. Performance standards issued by IFC are given below:

- Performance Standard 1 : Assessment and Management of Environmental and Social Risks and Impacts
- Performance Standard 2 : Labour and Working Conditions
- Performance Standard 3 : Resource Efficiency and Pollution Prevention
- Performance Standard 4 : Community Health, Safety, and Security
- Performance Standard 5 : Land Acquisition and Involuntary Resettlement
- Performance Standard 6 : Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Performance Standard 7 : Indigenous Peoples
- Performance Standard 8 : Cultural Heritage

C. APPLIED STANDARDS

96. The project will follow national as well as international best practices and standards related to environment, health and safety, including the Environmental, Health and Safety Guidelines for Railways [IFC, April 30, 2007). When host country regulations differ from the levels and measures presented in the International Guidelines, projects are expected to achieve whichever is more stringent. Appropriate and less stringent levels or measures than those provided in the International Guidelines can be adopted if they are protective of human health and the environment [World Bank Group (WBG) Environmental, Health, and Safety (EHS) General Guidelines April 30, 2007]. Some international standards for environmental components are listed here:

1. Air Quality

(i) WHO air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide [Global Update, 2005. (EHS Guidelines WBG April 2007)];
(ii) WBG EHS guidelines 2021; and
(iii) Environment (Protection) Seventh Amendment Rules 2009.

2. Water Quality

(i) Water Resources and Environment Technical Note D1, March 2003 WBG and EU standards for discharge from wastewater treatment plant;
(ii) Pollution Prevention and Abatement Handbook, WB 1998 / April 1999 for storm water;
(iii) General Standards of discharge for environmental pollutants Part A-Effluents, Schedule VI, Environmental Protection Rules 1986, MoEFCC, Government of India [In relation to Indian post-treatment inland surface water standards, WBG effluent discharge guideline values for toxic metals are more stringent; they prescribe coliform levels while Indian standards do not.];
(iv) Designated Best Use Classification of Surface water, CPCB 1978 for propagation of wildlife and fisheries;
(v) WHO Guidelines for Drinking Water Quality 2017; and
(vi) Drinking Water Specification IS 10500-2012, Bureau of Indian Standards (BIS); drinking water standards as per WHO cover fewer substances than Indian standards.

3. Soil (in terms of permissible content in foods)

(i) Environmental clearance Regulations 1881/2006, 629/2008 and 835/2011 cover toxic metals, nitrates, Persistent Organic Pollutants (POPs) and Polycyclic Aromatic Hydrocarbons (PAHs); and
(ii) In India, Prevention of Food Adulteration Rules 1955 prescribe permissible limits of lead, copper, arsenic, zinc, cadmium, mercury, chromium, nickel.

4. Noise

(i) WHO Guidelines for Community Noise ca. 1999;
(ii) The Noise Pollution (Regulation and Control) Rules, 2000 (Amended 2002);
(iii) EHS Guidelines WBG April 2007; and
(iv) Factories Act 1984 and the Model Rules under the Factories Act.

5. Vibration

(i) Transit Noise and Vibration Impact Assessment Manual, Federal Transit Administration, September 2018;
(ii) Transit Noise and Vibration Impact Assessment, US FTA, May 2006; and
(iii) Metro Rail Transit System Guidelines for Noise and Vibrations, RDSO, Sept 2015.

6. Biodiversity (**IFC Performance Standard 6**)

(i) Consider direct and indirect project related impacts on biodiversity and ecosystem services and identify any significant residual impacts;
(ii) Consider relevant threats to biodiversity and ecosystem services, especially focusing on habitat loss, degradation and fragmentation, invasive alien species, overexploitation, hydrological changes, nutrient loading, and pollution;
(iii) Consider the differing values attached to biodiversity and ecosystem services by stakeholders;
(iv) Seek to avoid impacts on biodiversity and ecosystem services. When avoidance of impacts is not possible, measures to minimize impacts and restore biodiversity and ecosystem services should be implemented; and
(v) Adopt a practice of adaptive management in which the implementation of mitigation and management measures are responsive to changing conditions and the results of monitoring throughout the project's lifecycle.

7. Asbestos Handling Waste and Management (IFC General EHS Guidelines - Hazardous Materials Management)

(i) Use of Asbestos Containing Materials (ACM) should be avoided in new buildings or as a new material in remodelling or renovation activities.
(ii) Existing facilities with ACM should develop an Asbestos Management Plan which clearly identifies the locations where the ACM is present, its condition (e.g. whether it is in friable form with the potential to release fibres), procedures for monitoring its condition, procedures to access the locations where ACM is present to avoid damage, and training of staff who can potentially come into contact with the material, etc. to avoid damage and prevent exposure.

8. Climate Change (EIB EHS 2022)

(i) Expanding the use of clean energy;
(ii) Encouraging sustainable transport and urban development;
(iii) Managing land use and forests for carbon sequestration;
(iv) Promoting climate-resilient development; a
(v) Strengthening policies, governance and capacities.

9. Occupational Health and Safety (WBG & EIB)

10. Community Health and Safety (WBG & EIB)

Chapter 3: PROJECT DESCRIPTION

A. RATIONALE

97. India has experienced rapid growth in urbanization over several decades, with the share of the urban population from about 18% in 1960 to around 36% in 2022[15]. By 2030, Indian cities are projected to be home to another 250 million people[16]. The metropolitan areas are facing extremely high population densities and traffic congestion.

98. The Ministry of Urban Development (MoUD) formulated the National Urban Transport Policy (NUTP) in 2006 to create safe, affordable, quick, comfortable, reliable, and sustainable urban transport systems for Indian cities. The NUTP proposes the development of a metro rail system in every city of India with a population of more than two million people. GoI's Union Cabinet approved a new Metro Rail Policy in 2017 that aims to enable the development and implementation of metro projects in a comprehensive and sustainable manner from the social, economic, and environmental perspectives. In the July 2022 report, that was tabled in Lok Sabha, it was confirmed that around 743 km long metro rail line is operational in the country in a total of 19 cities. The 17th Lok Sabha report also confirmed that over 1,000 km of metro rail line is presently under construction in 27 cities of India.

99. Pimpri Chinchwad Municipal Corporation forms part of core urban area of Pune Metropolitan Region (PMR) with an area of 170 sq. km. As per Census 2011, the population of PCMC area is 17.27 Lakh. For the last two decades, the decadal growth rate of population has been in the range of 100% while the previous two decades witnessed population growth in the range of 150%. (Source: City Development Plan, PCMC). Rapid urbanization and intense commercial developments in recent past have resulted in steep rise in travel demand putting city's transport infrastructure to stress. To relieve this stress MRTs system i.e. Maha Metro-Pune Metro is already under operation. The existing Public Transport system of the city is quite robust, yet inadequate in meeting the transport demand of the commuters. With a view of developing effective and efficient mass transit system in addition to the existing public transportation, the Maha Metro – Pune Metro (Maharashtra Metro Rail Corporation Ltd.) intends to extend the existing corridor.

100. Maha Metro is a Special Purpose Vehicle (SPV) created for the smooth implementation and operations of the Pune Metro Rail Project and is an equal equity joint venture of Government of India (GoI) & Government of Maharashtra (GoM). PMRP shall be solely responsible for the successful and timely completion of the project & its operations subsequently.

101. Systra has carried out the investigation and studies for Pune Metro Rail Project PCMC to Nigdi (Phase-1 Extension) and prepared a Detailed Project Report (DPR) in August 2021, based on which the project is proposed to be implemented.

B. DESCRIPTION OF PMRP PCMC TO NIGDI (PHASE-1 EXTENSION)[17]

102. Proposed PCMC to Nigdi (Phase-1 Extension) comprise of 4 elevated stations with a total length of 4.413 km.

103. Geotechnical investigations have been carried out along the proposed corridor to determine the strata, depth of foundation and safe bearing capacity of foundations required for the above proposed metro corridors. Drilling and sampling in soil and rock was carried out using rotary drilling rig. Borehole in soil was advanced using rotary drilling method.

[15] *Source: https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=IN.*
[16] *Source: Urbanization beyond Municipal Boundaries : Nurturing Metropolitan Economies and Connecting Peri-Urban Areas in India (worldbank.org).*
[17] *Source: Updated Detailed Project Report (PCMC to Nigdi Corridor 1 A), August 2021.*

104. Route Alignment – PCMC to Nigdi (Phase-1 Extension)

- Proposed alignment of Phase-1 starts from PCMC and goes up to Nigdi near Bhakti shakti Udyan. Total length of the corridor is 4.413 km which is completely elevated.
- This Project is an extension of existing corridor 1 under Phase 1 i.e. PCMC to Swargate.
- 4 Stations have been proposed in Phase 1, all of which are elevated stations. Summary of the section is given below:

105. The proposed alignment of Stations is an extension of Pune Metro Phase 1

106. Total 4 stations (Elevated), are proposed in this corridor are summarized as under **in Table 3-1,** while the alignment map is presented as **Figure 3-1**.

Table 3-1: PCMC to Nigdi (Phase-1 Extension) - Stations with chainage

Name of Stations	Chainage (m)	Type
Station 1 (Chinchwad)	1789.2	Elevated
Station 2 (Akurdi)	3459.2	Elevated
Station 3 (Nigdi)	4489.4	Elevated
Station 4 (Bhakti Shakti)	5492.9	Elevated

Figure 3-1: Alignment Map of PCMC to Nigdi (Phase-1 Extension) showing station locations

107. The end of chainage of PMRP Line 1, Phase 1 (PCMC- Swargate) is -1079.899 and the end of chainage of PCMC to Nigdi (Phase-1 Extension) is -5601.089. Thus, total length of

corridor is 4.413 km, which is fully elevated. Length of viaduct beyond the end point of terminal station (Bhakti-Shakti) is ~30 m. Scissor Crossover has been planned ahead of the terminal station i.e. Bhakti-Shakti Station at -5100 to -5181.6 chainage, in order to prevent encroachment of defence land. This is due non-availability of land beyond Bhakti-Shakti Station. The reduced viaduct length beyond station limits the operating speed. However, operation is still possible as proposed minimum headway is around 5 minutes. Permanent Speed restriction of 25kmph, 15kmph and 5kmph may be required to be imposed progressively for safe degraded operation.

1. Design Norms

Alignment Definition

108. The geometrical design norms are based on international practices adopted for similar systems with standard gauge on the assumption that the maximum permissible speed on the section is limited to 80 kmph. Planning for any higher speed is not desirable as the shorter inter station distance will not lead to significant difference in running time.

109. The elevated tracks will be carried on elevated deck supported by piers, generally spaced at varying centre to centre distance as per site requirement. 13m to 34m span length (pier centre to centre) is followed as much as possible with most of the piers located along the BRT and rest on footpath followed by private property to terminate at Bhakti – Shakti bus depot. The horizontal alignment and vertical alignment are, therefore, dictated to a large extent by the geometry of the road and ground levels followed by the alignment

Rolling stock assumptions for alignment study

110. The conditions of implementation of the MRT system, partly at-grade & partly elevated without impacting the space given to road vehicle circulations command the choice of a rail based MRT system rather than a BRT. Therefore, assumptions of MRT rolling stock had been used for the alignment studies.

Geometric design parameters

111. The design parameters related to the metro system described herewith have been worked out based on a detailed evaluation, experience and internationally accepted practices. Various alternatives were considered for most of these parameters, but the best-suited ones have been adopted for the system as a whole.

Transition Curves

112. Due to change in gradients at various locations in the corridor, it is necessary to provide frequent vertical curves along the alignment. It is desirable that the vertical curves and transition curves of horizontal curves do not overlap. These constraints may lead to reduced lengths of transition curves at certain locations. The transition curves have certain minimum parameters

- Length of Transitions of Horizontal curves (m)
  - ✓ Minimum: 0.44 times actual cant or cant deficiency (in mm) whichever is higher
  - ✓ Desirable: 0.72 times actual cant or cant deficiency, (in mm), whichever is higher
- Overlap between transition curves and vertical curves not allowed
- Minimum straight between two transition curves: either 25m or nil
- Minimum curve length between two transition curves: 25 m

Assumptions

Track gauge (between interior rails)	1435mm
Spacing of rail lines (between axes of rails)	1507mm
Distance between centre lines in straight alignment	4100mm in Line 1 & Line 2, 4600mm in Line 3
Maximum design speed*	90 km/h
Maximum operating speed*	80 km/h

Design value

Table 3-2: Design Value Summary

Parameters	theoretical formulae	requirements to comply with	
		Limiting	project's preferential
Theoretical equilibrium cant.	11.8V2/R	225 mm	195 mm
Cant.	-	125 mm	110 mm
Cant. deficiency	-	100 mm	85 mm
Cant. Gradient (geometrical variation of the cant)	-	≤ 1 in 500	≤ 1 in 750
Rate of change of cant.	-	55 mm / s	35 mm/s
Rate of change of cant. deficiency	-	55 mm / s	35 mm/s
Minimum radius in Running Track	-	120 m	225 m
Minimum radius in Depot	-	100 m	190 m
Length of pure circular arc between transitions	-	25	50 m
Length of Transition or Tangent Length	-	15 m	25 m
Minimum length of straight between reverse direction curves	-	25m or 0m	25 m

Vertical Alignment

113. Vertical curves shall wherever possible be positioned such that coincidence with horizontal transitions is avoided. Where such coincidence is unavoidable, the largest practicable vertical curve radius shall be employed

114. Vertical curves shall, for each location, be selected on the basis of the largest practicable vertical curve radius subject to the following limit:
- Minimum desirable radius 2500 m
- Absolute Minimum Radius 1500 m

115. The length of constant grade between consecutive vertical curves shall be as follows
- Desirable minimum 50 m
- Absolute minimum 25 m

116. At point and crossing work, vertical curves shall not coincide with any part of the overall length of switches or of cast crossings. At other point and crossing work vertical curves shall be avoided whenever possible. Where they cannot be avoided the vertical curve radius shall be 3000 m or more.

117. At station ends, the tangent point of the vertical curve shall be permitted to encroach within the length of the platform to a limited extent. This length of encroachment shall be such that the vertical offset of the curve from the station gradient at the platform end shall not exceed 15mm.

Gradient

118. For running lines, the desirable maximum gradient shall be 3% and where unavoidable shall be 4%. Where gradients of 1% or less are used they may be unrestricted in length. Gradients above 3.0% shall be kept as short as possible.

119. At stations, the track shall be level or of constant gradient not steeper than 0.2% throughout the platform length except for the limited lengths of vertical curves as specified in relevant clause under Vertical Alignment.

120. A drainage gradient shall be provided for all tunnel, other than at stations, as follows:

- Desirable minimum 0.5%
- Absolute minimum 0.25%

121. Sidings shall be level or shall fall away from the main line switch at a gradient not exceeding 0.25%. Train berths shall be level or shall fall towards the buffer stops at a gradient not exceeding 0.25%.

Levels

122. All levels shall be quoted in metres correct to three decimal places and shall be above mean sea level (MSL).

123. Rail level on canted track will refer to the level of the running edge of the lower rail.

Points and crossings

124. Whenever possible, points and crossing work shall not coincide with vertically or horizontally curved track.

125. Where it is not possible to avoid coincidence with vertical curves the switches and stock rails shall not be laid on vertical curves.

126. Points and crossing work shall not coincide with horizontal transitions.

127. No part of the switches' operating gear or crossing nose shall be over a structural movement joint.

128. In case of unavoidable circumstances, if the coincidence with horizontal curve cannot be avoided, the same may be laid in curve having radius greater than 1000m with cant. applied made zero.

129. Generally, 1 in 9 turnouts with 300m Radius (1 in 9 R300) is to be adopted in Main Line and 1 in 7 turnouts with 190m Radius (1 in 7 R190) is to be adopted in depot tracks.

Scissors crossovers

130. Scissors crossovers shall be based on a transitioned crossover with vertical rails.

131. The switch points and turnout radius shall be standard UIC or approved equivalent, designed to accommodate a minimum operational speed of 40 km/hr.

Turnouts

132. Turnouts shall be based on a transitioned turnout with vertical rails

- The speed through the turnout shall be 50 km/hr.
- Operational speed in the depot shall be 25 km/hr.

2. Stations

133. Stations have been located so as to serve major passenger destinations and to enable convenient integration with other modes of transport. However, effort has also been made to propose station locations such that the locations where maximum commuter travel.

134. This study comprises PCMC to Nigdi (Phase-1 Extension), for which 4 elevated stations are proposed. This section aims at presenting the stations locations, showing their sequencing and analysing their local catchment areas.

General

135. Stations have been located to serve major passenger catchment areas/destinations and to enable convenient integration with other modes of transport. The proposed route would have 4 numbers of elevated stations, in continuation to the existing Metro Line (Phase 1), starting at Chinchwad station of Line 1, Phase 1 and terminating at Nigdi. Stations vary in complexity along the route and have been located by an interactive process influenced by ridership forecasts, requirements with different modes of transport, station spacing, alignment, utilities, roads and pedestrian requirements, etc. **Figure 3-1** provides an overview of the proposed corridor as well as proposed stations locations.

Station-area characteristics

136. This section provides a general overview of the corridor and the proposed stations: locations, existing and future local urban fabric, landmarks, access etc.; For each station, an analysis has been conducted regarding:

- The station location;
- The main roads to access the station;
- The land use around the station;
- The issues and concerns identified;
- The potential for improvements.

137. The PCMC to Nigdi (Phase-1 Extension) is a 4.413 km long extension of Phase 1 Line 1, (which runs from PCMC to Swargate). It is proposed on Old Mumbai Road. 4 elevated stations are proposed on this corridor.

Local area along corridor:

- This corridor is populated with Commercial, Residential as well as Recreational establishments and is crowded (both in terms of population density and road congestion).
- Road contains flyovers / underpasses.

Areas covered by stations:

- Stations at the proposed locations cover existing famous Temples (Khandoba, Bhakti Shakti);
- Stations at the proposed locations also cover office areas as well as future developments proposed by respective local authorities.

Access to stations:

- Access to and egress from the stations will be guaranteed by the implementation of:
  - Pick-up and drop-off areas for different modes of transport (bus stops when relevant, IPT modes and car)
  - Pedestrians facilities (footpaths, pedestrian crossings, foot over bridge etc.)
  - Bicycle tracks / cycle stands etc.

138. General recommendations for access/egress to/from stations will also be made;
- ❖ For optimal access to stations:
- ❖ Four (4) entries are proposed for all stations, out of four, two entry shall be future entries.
- ❖ Entries/exits are mostly proposed between service roads and highways;
- ❖ Entries shall be covered;
- ❖ Station entries shall be also used for crossing the road for safety purpose;
- ❖ The proposed stations shall be differently abled.

Specific Characteristics of Proposed Stations

Station 1 (Chinchwad)

STATION INTRODUCTION: it is the first station on the PCMC to Nigdi (Phase-1 Extension). It is an elevated station proposed on the Old Mumbai Road near Chinchwad Station Chowk. The major roads connecting the station are Chinchwad Station Road and Chinchwad - Bhosari Road. The station caters the public, semi-public, commercial and the residential areas of Pimpri and Chinchwad and the Railway Station of Chinchwad through proposed FOB. It also caters the Sony complex building, Pimpri Police station and Mayur Tread Centre.	
ISSUES & CONCERN	**POTENTIAL FOR IMPROVEMENT**
● Lack of pedestrian facilities like footpath, pedestrian for crossing road along the road results in pedestrian spill over on road; ● Chaotic operations of Tempo services	● Dedicated non-motorized modes friendly facilities like footpath and cycle stands, and FOB is used for crossing roads; ● Planning of dispersal activities through feeder modes will cater to a larger catchment.

Figure 3-2: Some Photographs of Proposed Site - Chinchwad Station

1. Roadside encroachment and on-street parking.

2. PCMC empty land (may be used for entry structure in the future)

3. Commercial area along the road.

4. Road side encroachment and on-street parking.

Figure 3-3: Entry/Exit of Station 1 (Chinchwad)

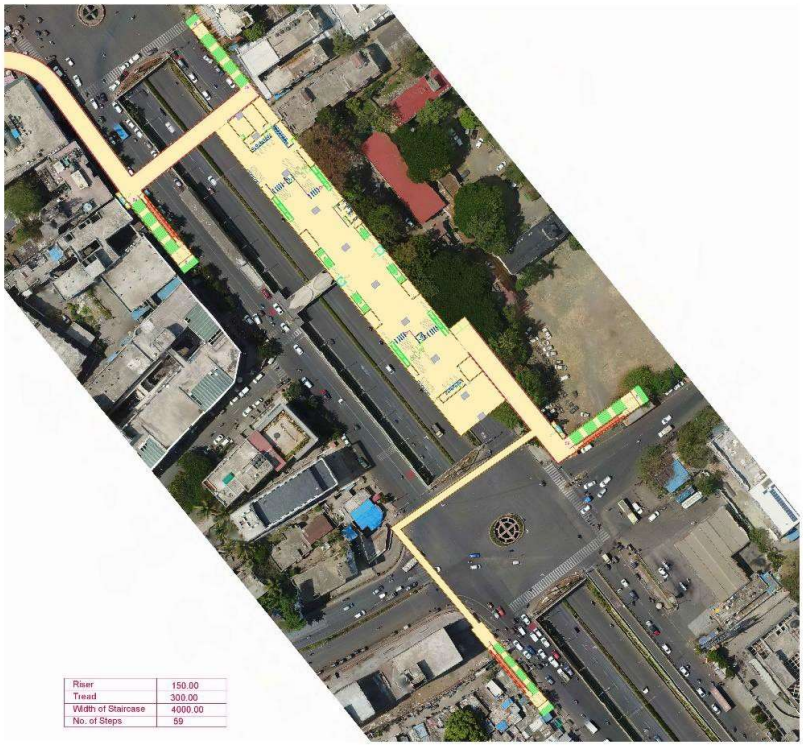
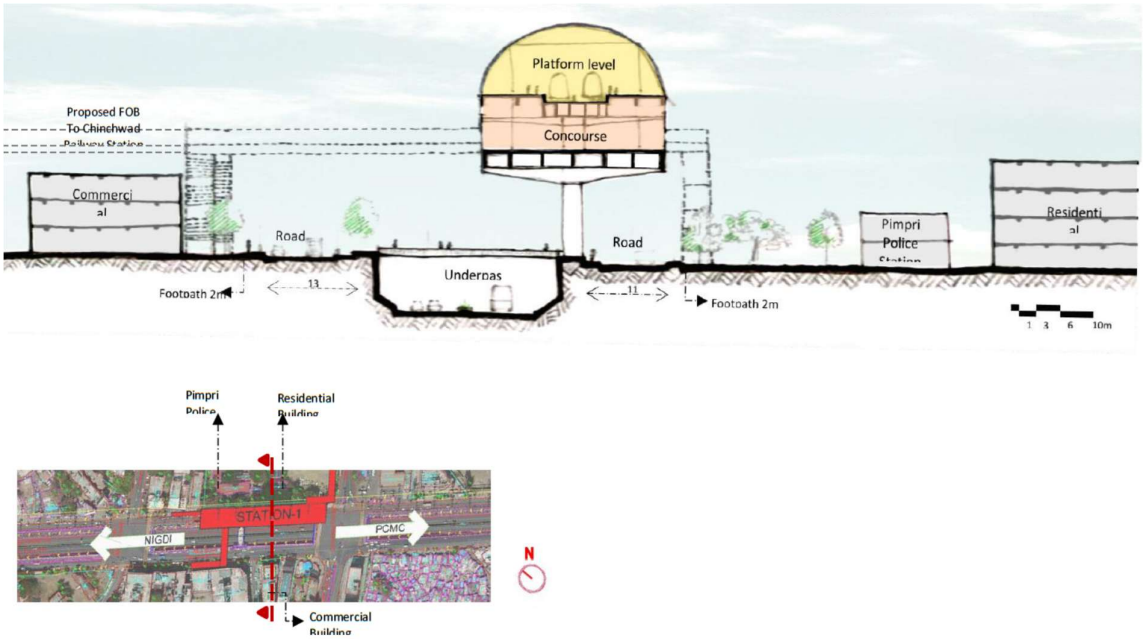


Figure 3-4: Proposed FOB from Metro Station to Railway Station

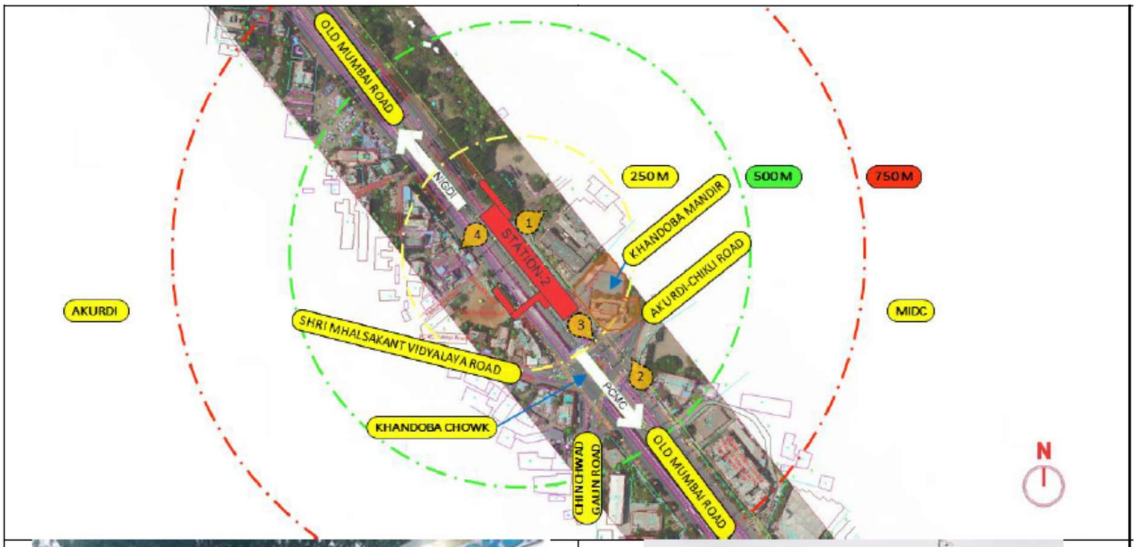
Figure 3-5: Cross-section at Chinchwad Station



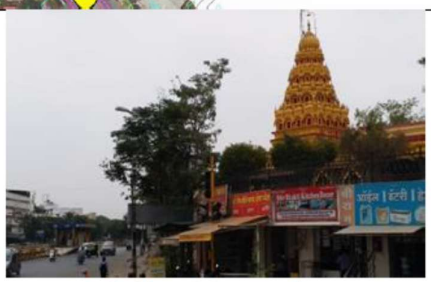
Station 2 (Akurdi)

STATION INTRODUCTION: it is an elevated station proposed on the Old Mumbai Road near Khandoba Chowk. The major roads connecting the station are Akurdi – Chikhli Road, Chinchwad Gaon Road, Shri Mhalsakant Vidyalaya Road. The station provides dispersal connectivity to public, semi-public and the residential areas of Akurdi and MIDC.	
ISSUES & CONCERNS	**POTENTIAL FOR IMPROVEMENT**
● Lack of pedestrian facilities like footpath, ● Chaotic operations of Tempo services; ● Huge encroachments of the road space.	● Dedicated non-motorized modes friendly facilities like footpath and cycle stands. ● Planning of dispersal activities through feeder modes will cater to a larger catchment. ● Removal of encroachments and optimal usage of ROW.

Figure 3-6: Some photographs of Proposed site - Akurdi Station



1. Entry gate of Force factory.



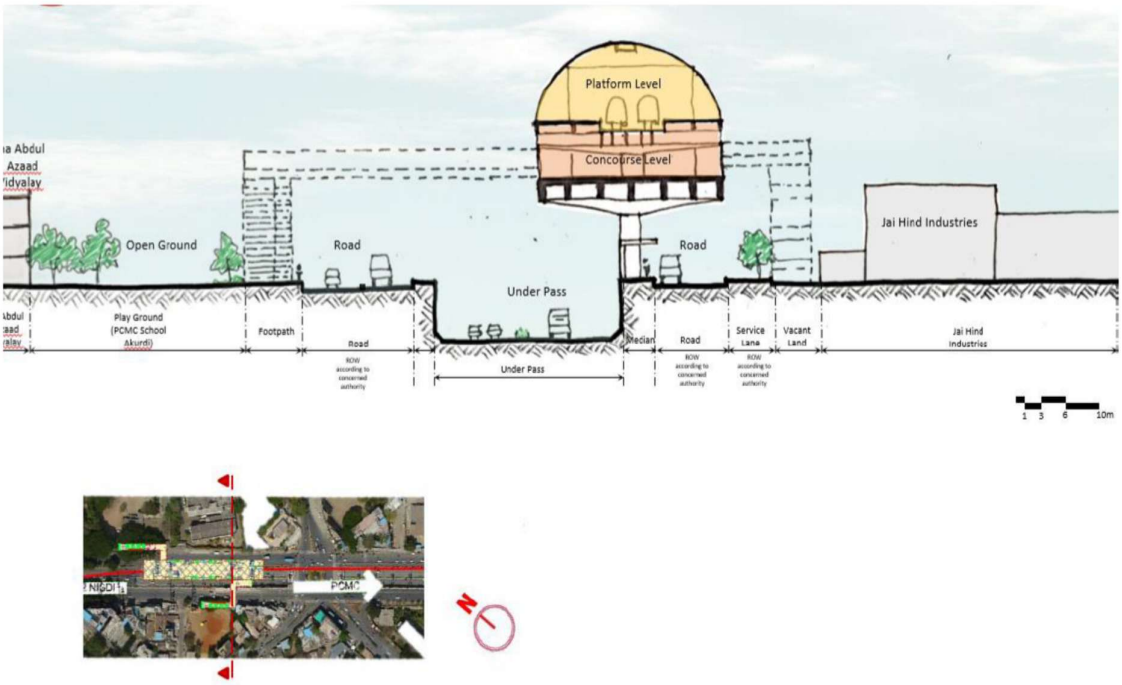
2. Khandoba temple.

3. Vulnerable Pedestrians – No pedestrian facilities existent.

4. Commercial area along the road.

Figure 3-7: Entry/Exit at Akurdi Station

Figure 3-8: Road Cross-section at Akurdi station



Station 3 (Nigdi)

STATION INTRODUCTION: it is an elevated station proposed on the Old Mumbai Road near Bhakti Shakti Udyan. Public Development area is also proposed above this station. The major roads connecting the station are Nigdi – Chikhli Road, Ankush Borhade Marg. The station provides dispersal connectivity to the residential areas of Nigdi, Appu Ghar, Bhakti Shakti Udyan and PMPML Bus Depot.	
ISSUES & CONCERN	**POTENTIAL FOR IMPROVEMENT**
● Lack of pedestrian facilities like footpath ● Chaotic operations of Tempo services ● Huge encroachments of the road space	● Dedicated non-motorized modes pedestrian friendly facilities like footpath and cycle stands. ● Planning of dispersal activities through feeder modes will cater to a larger catchment. ● Removal of encroachments and optimal usage of ROW

Figure 3-9: Some photographs of Proposed Site - Nigdi Station

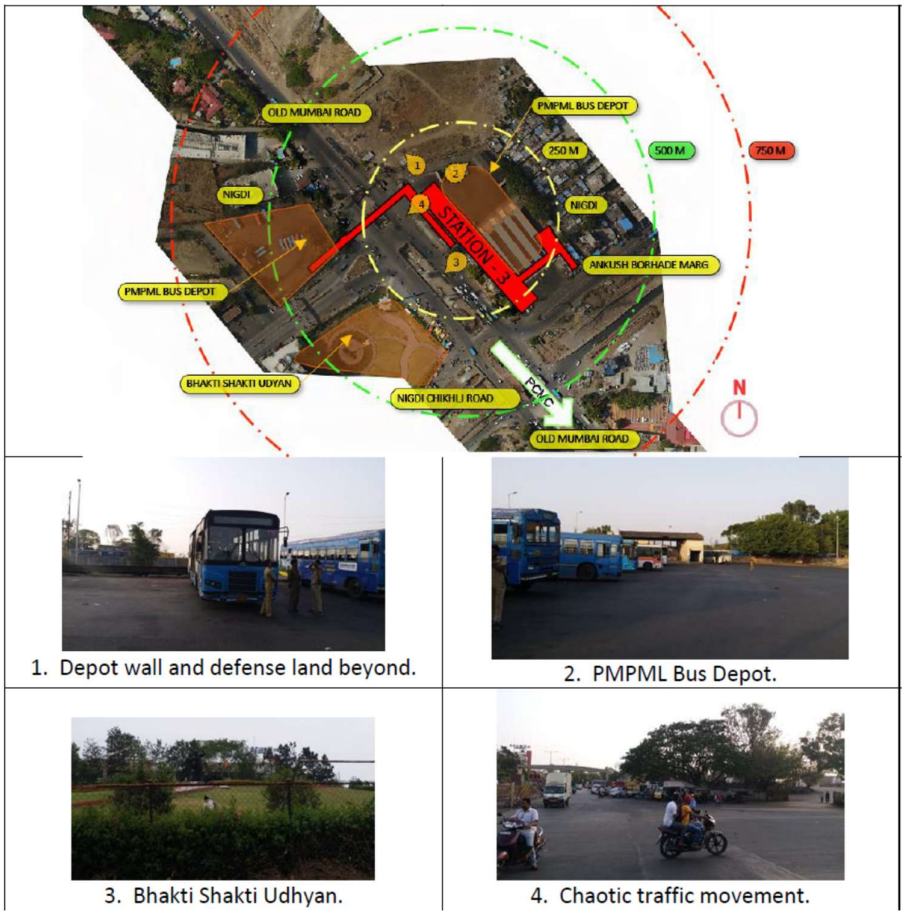


Figure 3-10: Entry/Exit at Nigdi station

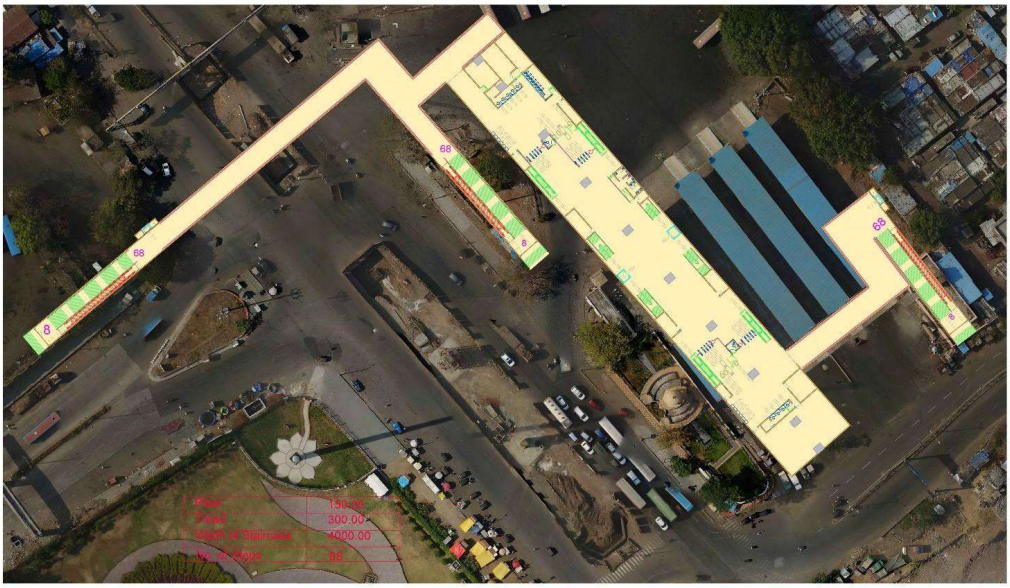


Figure 3-11: Proposed skywalk at Nigdi station

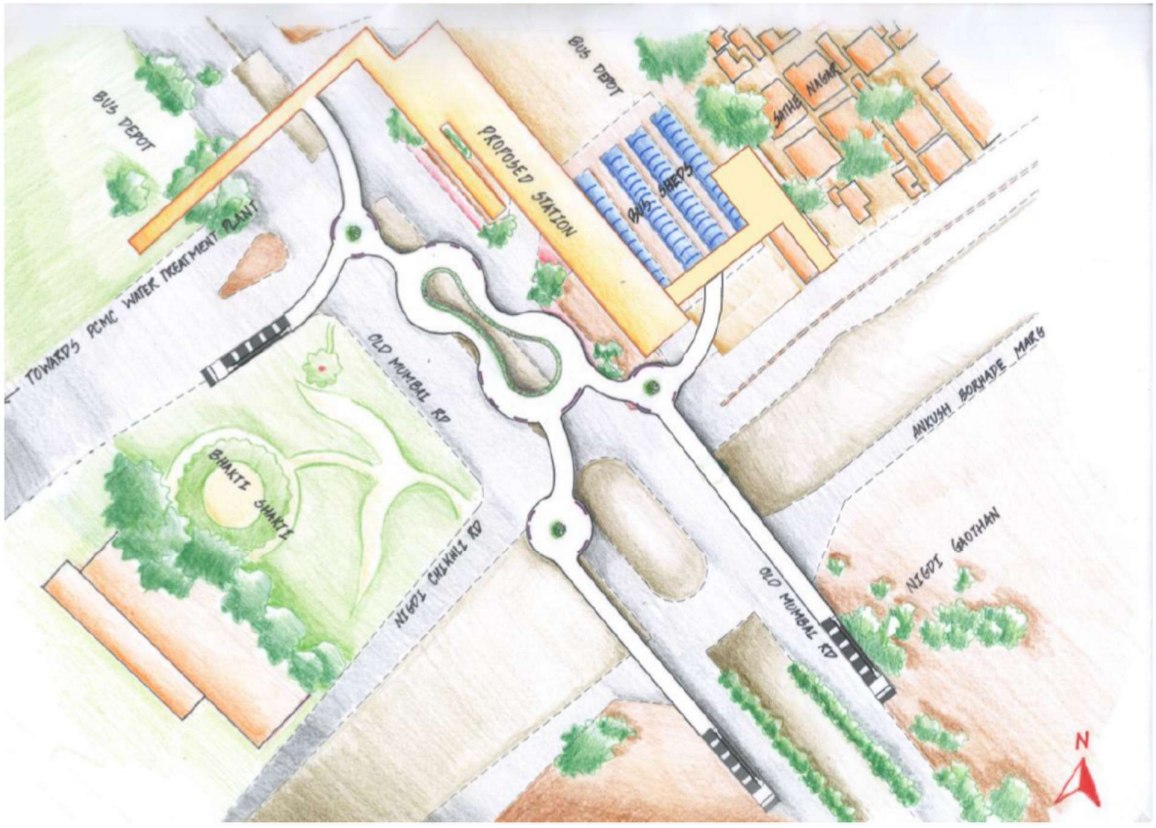
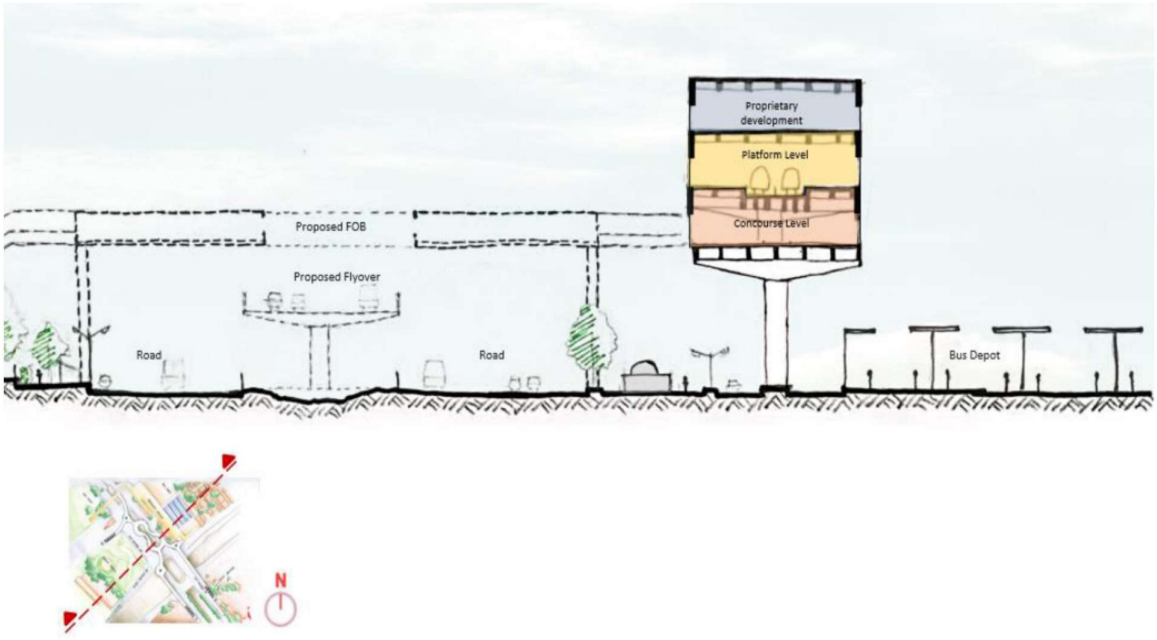


Figure 3-12: Road Cross-section at Nigdi station



Planning Parameters

139. The basic design of any station is based on Peak Hour loads. Single mode of authorization (token/card/ticket), which shall conform to the already existing Metro corridor of Line 1 of Phase 1, and would suffice to travel to any destination within the existing and proposed metro network shall be used.

The Station planning is dependent on the following factors:

- Ingress/egress and the boarding/alighting requirements.
- Structural requirements.
- Flexibility in design to allow stations to respond to site specific requirements.
- Station utilities like – Ventilation system
    - Firefighting system
    - Water supply & Sewage requirements
    - Other requirements
- Provisions for future expansions, if any.

140. A good station design comprises of adequate movement spaces from the station entrance to the platform and vice versa in a more logical way.

Passengers experience

141. One of the main objectives of station planning and design is to maximize passengers experience. This is done by ensuring at stations:

- **Attractiveness**: The station experience shall be positive;
- **Integration with urban realm**: The station will be well integrated with the existing street and its surroundings;
- **Intermodal integration**: Design will integrate the station entries with other modes of transport;
- **Passengers-oriented**: Patrons shall experience a simple system, easy to use and accessible;

- **Comfort**: The station atmosphere will be comfortable;
- **Safe and secure**: The station will be provided with sufficient safety features

Salient Features of a Typical Station

- Station entrances are located with particular reference to passenger catchment points which includes buses, IPTs, pick/drop by private modes.
- Following criterion have been considered while planning the stations
  - Sizing of station passenger facilities.
  - Stipulated design standards
  - Emergency evacuation
  - Passenger circulation, comfort, ease of use, safety and security.
  - Accommodation of BOH areas.
  - Electrical and Mechanical Plant and equipment space requirements.
- Concourse/Mezzanine shall form the link between streets and Platforms, all the passenger amenities are provided at this level.
- Plant room, operational rooms and offices are provided in the non-public areas of the station.
- The platform level shall be designed in a way to cater for the emergency scenario as well as to operate in normal conditions.
- The Ancillary spaces like DG, bore well pump house, water tanks (UG/overhead) must be preferably located at Ground level.

3. Signalling and Telecommunication

142. **Signalling system.** The signalling system shall provide the means of an efficient train control ensuring safety in train movements. It assists in optimization of metro infrastructure investment and running of efficient train services on the network. **Table 3-3** below shows the standards that have been adopted with regard to the Signalling system. Communication based Train Control (CBTC) System with adequate safety level of CENELEC SIL-4 (Safety Integrity Level) that permits an operational headway of 90 seconds with continuous automatic train control, shall be installed.

Table 3-3: Standards Proposed to be Adopted for Signalling System

Description	Standards
CBTC System	IEEE 1474.1
Interlocking	Computer Based Interlocking (CBI) adopted for station having switches and crossing shall be Hot Standby system with object controller conforming to SIL4 level of CENELEC standards EN 50126, EN 50128 and EN 50129.
Operation of Points	With Direct current 110V D.C. point machines or 380 volts 3 phase, 50 Hz. AC point machines.
Signals at Stations with point & crossings	Line Side signals to protect the points (switches). LED type signals for reliability and reduced maintenance cost.
UPS (uninterrupted power at stations as well as for OCC)	For Signalling and Telecommunications
Train protection system	Automatic Train Protection system.
Train Describer System	Automatic Train Supervision system. Movement of all trains to be logged on to a central computer and displayed on workstations in the Operational Control Centre and at the SCR. Remote control of stations from the OCC.
Redundancy for TP/Train Describer	Redundant Train borne equipment and ATS equipment at OCC.
Cables	Outdoor cables will be steel armoured as far as possible.
Fail Safe Principles	SIL-4 safety levels as per CENELEC standard for signal

Description	Standards
	application.
Immunity to External Interface	All data transmission on telecom cables/OFC/Radio. All Signalling and telecom cables will be separated from power cables. CENELEC standards to be implemented for EMC.
Train Working under emergency	Running on site with line side signal with speed automatically restricted between 15-25 kmph.
Environmental Conditions	Air-conditioners for all equipment rooms.
Maintenance philosophy	Philosophy of continuous monitoring of system status and preventive & corrective maintenance of Signalling equipment's shall be followed. Card / module / sub-system level replacement shall be done in the field and repairs under taken in the central laboratory/manufacturer's premises.

143. **Telecommunication system.** The telecommunication system acts as communication backbone for signalling and other systems and provides telecommunication services to meet operational and administrative requirements of metro network. The proposed telecom system and transmission media will have following sub-systems:

(i) IP, GE based Transmission System
(ii) Telephone Exchange
(iii) Mobile Radio Communication System
(iv) Public Address System (PAS)
(v) Centralized Clock System
(vi) Passenger Information Display System
(vii) Close Circuit Television (CCTV)
(viii) Central Voice Recording System (CVRS) and
(ix) Supervisory Control and Data Acquisition (SCADA) System
(x) Wi-Fi Services
(xi) LED Display Walls

4. Power Supply and Traction

144. For Traction System, it is standard practice in India to follow and to adopt 25 KV single phase AC Traction. In addition, it has the following merits:

- Lower initial cost;
- Lower operating and maintenance cost as in case of 25 KV ac traction the regeneration is up-to 30% and the line losses are around 0.5% in comparison to D.C. losses up-to 6 – 7%;
- A.C. system poses lesser Fire hazards as current levels are much lower than DC system.
- No Stray current problems and hence the corrosion is controlled.

145. As this is an extension of existing line, system with existing design or compatibility shall be used.

146. The power requirements of a metro system are determined by peak-hour demands of power for traction and auxiliary applications. Broad estimation of auxiliary and traction power demand is made based on the following requirements:

- Specific energy consumption of rolling stock – 70 KWhr/1000 GTKM;
- Regeneration by rolling stock – 30%;
- Elevated station load – For Year 2023, 2033, 2043 and 2053 – 300 kW load is considered
- Underground station load – initially Year 2023 and 2033 - 2000 kW, which will increase to 2500 kW in the year 2043 and 2053;

- Depot auxiliary load - initially Year 2023 and 2033 - 2000 KW, which will increase to 2500 KW in the year 2043 and 2053.

147. Keeping in view of the above norms, power demand estimation for the complete corridors is given in **Table 3-4**:.

Table 3-4: Total Power Demand for complete Corridor (Nigdi to Swargate)

Corridor	Year	2023	2033	2043	2053
PCMC-NIGDI Route Length – 4.413 km, Number of Stations – 4 (Elevated – 4)	Traction	0.7 MVA	0.9 MVA	1.0 MVA	1.1 MVA
	Auxiliary	1.1 MVA	1.1 MVA	1.1 MVA	1.1 MVA
PCMC-SWARGATE Route Length – 17.8 km, Number of Stations – 14 (Elevated – 9, Underground - 5)	Traction	6.5 MVA	8 MVA	9.2 MVA	9.5 MVA
	Auxiliary	18.2 MVA	18.8 MVA	21.9 MVA	21.9 MVA
Total Power Demand (NIGDI-SWARGATE)	**Traction**	**7.2 MVA**	**8.9 MVA**	**10.2 MVA**	**10.6 MVA**
	Auxiliary	**19.3 MVA**	**19.9 MVA**	**23 MVA**	**23 MVA**

1. **Sources of power supply.** Two sources of power supply are there along the corridor one is 220kV Chinchwad SS near PCMC and other is 132 kV Ganesh khind SS near agriculture college.

2. **Auxiliary supply arrangements and standby power supply.** Existing power supply arrangement at depot shall be considered for the extension line also, as in the existing line, the Auxiliary sub-stations (ASS) are envisaged to be provided at each station (1 ASS for elevated station) for stepping down 33 kV supply to 415 V for auxiliary applications. No extra ASS is required in depot for the extension line as the existing depot ASS can cater the 2.5 MW load in year 2053. The station ASS's will be located at mezzanine or platform level inside a room. The auxiliary load requirements have been assessed at 200kW for elevated / at-grade stations which is likely to increase up to 500 kW in the year 2053. In order to meet the requirement of auxiliary power, two dry type cast resin transformers (33/0.415kV) of 500 kVA capacity are proposed to be installed at the elevated stations (one transformer as standby) and two transformers of 2.5 MVA at Depot ASS.

3. However, in the unlikely event of simultaneous tripping of all the input powers sources or grid failure to avoid interruption of power supply to stations as well as trains, as stand by DG set of 500 KV capacity will be installed at each station to cater the auxiliary load. Low-sulphur fuel will be used for D.G. sets, equipment, and vehicles during both operation and construction. This measure aims to reduce emissions and minimize environmental impact. Concerning the fuel to be used for the DG sets, as well as for any other equipment during both operation and construction, it will adhere to low sulphur content specifications in accordance with applicable environmental standards.

4. **Solar energy harnessing system.** The roof top on the elevated stations of Pune metro corridors and the different sheds and buildings of the depot viz. Stabling, Inspection and Heavy Repair Shed, Administrative Building, DCC/OCC Building etc is proposed to be used for SPV installation at suitable orientation and inclination to optimize the solar energy potential. The roof of the sheds should be south facing to maximize the Solar power generation in depot. The solar power would be used locally to the extent of load in the building and the generation over and above the requirement of the building would be fed into the grid.

5. The average raw sunshine available which can be harnessed for the power generation depends on the geometrical coordinates of the place. The intensity of solar radiation varies with time of the day. The combined effect of these factors and the additional complication of the wobble of the seasons is that the average raw power of sunshine per square meter of south-facing roof in India is roughly 100 to 120W/m2. Based on the solar radiation intensity in the city of Pune, the peak solar power generation of Pune Metro corridor is expected to be about 200 kWp for the elevated stations and about 2000kWp for maintenance depot.

6. It is proposed that the solar PV installation for Pune metro shall be done on the basis of RESCO model which is also being followed by other metros in India. In the RESCO model, the MAHA Metro shall sublet the rooftop to the project developer who will be responsible for the solar PV installation. The power shall be purchased by MAHA metro on the basis of the unit rate specified by Power Purchase Agreement (PPA)

5. Permanent Way

148. Choice of Gauge: Standard Gauge (1435mm) is generally adopted for metro railways world- over. During the last decade, most of the new metros, constructed in various cities of the world have gone for Standard Gauge even though the national gauge for main-lines in some of the cases was different from Standard Gauge.

149. **Track Structure:** Track on Metro Systems is subjected to intensive usage with very little time for day-to-day maintenance. Thus, it is imperative that the track structure selected for Metro systems should be long lasting and requires minimum maintenance and at the same time, ensure highest level of safety, reliability and comfort, with minimum noise and vibrations. The track has been proposed keeping the above philosophy.

6. Rolling Stock

150. Rolling Stock proposed for the corridor will be similar to Phase-1. The specifications of the rolling stock and its procurement may be decided on the basis of the project implementation mechanism. The important criteria for selection of rolling stock are as under:

- Proven equipment with high reliability
- Passenger safety feature
- Energy efficiency
- Light weight equipment and coach body
- Optimized scheduled speed
- Aesthetically pleasing Interior and Exterior
- Low Life cycle cost
- Flexibility to meet increase in traffic demand

151. The controlling criteria are reliability, low energy consumption, lightweight and high efficiency leading to lower annualized cost of service

7. Fare Collection System

152. Mass Rapid Transit Systems handle a large number of passengers. Ticket issue and fare collection play a vital role in the efficient and proper operation of the system. To achieve this objective, ticketing system shall be simple, easy to use/operate, easy on accounting facilities, capable of issuing single/multiple journey tickets, amenable for quick fare changes and require overall lesser manpower. Automatic fare collection system meets these requirements.

153. Keeping in view Metro Railways Automatic Fare Collection System and the fact that Contactless card/ token technology proves to be cheaper than magnetic technology in life

cycle cost due to reduced maintenance as it has less wear and tear and is less prone to dusty environment, computer based automatic fare collection system with contactless smart token/card type ticketing is obvious choice.

154. The proposed system shall be compatible with the existing Pune Metro Phase-I system for seamless operation & maintenance.

155. The System shall be capable for open loop transactions as well to further integrate the mobility solution with the advancements in technology and to allow for seamless transition from dedicated cards to common multi-use stored value fare media that can be used for financial transactions such as making purchases at shops etc. as well as a fare media in the system.

156. To accommodate the same, the system shall conform to the following standards as a minimum:

- EMV (Euro MasterCard Visa)
- PCI-DSS (Payment card Industry / Data Security Standard)
- ISO-IEC 14443

157. The system shall be of open architecture to allow for the integration of multiple fare products and shall be capable of interfacing with cards from different vendors. Additionally, the system shall not be proprietary as far as possible to allow multiple types of fare media from multiple sources to be integrated into the system.

158. The proposed system shall offer high fare revenue protection and minimize fare revenue evasion and fare related fraudulent activities. The system shall be capable of detecting any irregularity and allow the authority to take action to correct the same.

8. Labour Camp

159. During execution of the project, manpower will be needed for various project activities. During construction phase, about 500 people are estimated to be employed, while in post-construction phase, about 150 people will be employed for operation and maintenance of the system. In addition to these, more people would be indirectly employed for allied activities.

160. The workers' camps will be developed by contractors as and where required. The accommodation, sanitation & other facilities required at camps shall be governed by Country labour laws as well as international standards like IFC/EBRD, Workers Accommodation: Processes and Standards (ifc.org). These clauses are part of the civil contract works and will be obligatory to the contractors.

161. The governing part of the above-mentioned clauses are included in the Safety, Health & Environment Manual and Environmental & Social Management Plan (ESMP). These are the project specific documents that will be approved by the Funding Agencies and also part of contract document. Following common facilities are to be broadly provided at the workers' camp as per IDC/EBRD, Workers Accommodation: Processes and Standards (ifc.org.):

(i) Room/dormitory facilities
   a. Ventilation & Light
   b. Water
   c. Bed arrangement & storage facilities
(ii) Sanitary and toilet facilities,
   a. Toilet facilities
   b. Waste water & Solid waste
   c. Bathrooms & other sanitary facilities
(iii) Canteen, cooking and laundry facilities
(iv) Ensuring good nutrition and food safety
(v) Leisure, social and telecommunication facilities

(vi) Medical facilities
   a. First Aid
   b. Other medical
(vii) Security of worker's accommodation
(viii) Workers' rights

162. Additionally, gender-specific facilities for women workers, if deployed by the contractors for construction work (depending on the number of women workers employed) shall broadly be divided into the following categories:

(i) Day crèche facility, as required
(ii) Separate bathing & toilet arrangements,
(iii) Separate access to female toilets,
(iv) Medical facilities in emergency cases,
(v) Job Security,
(vi) Safe lighting at work place and worker's colony,
(vii) Capacity development programs.

163. Community based specific policies/procedures and facilitieat Talwade and Talegaon, on approval by Maha Metro. Criteria to be used for site selection and management of labour camp, construction yards, batching plant, construction waste disposal area etc. have outlined and attached as an **Annexure-8**. In case the existing casting yards will be used, an environment audit of the used casting yards needs to be conducted and submitted to PIU/EIB for review as per EIB E&S Policy (2022) requirements for existing facilities.

164. Prior to the start of the works the environmental baseline at the casting yards will be established, based on the pollutants that can be expected from the works at site. Contractor will be required to submit an Environmental Management and Restoration Plan to GC/Maha-Metro. Environmental monitoring will be carried out monthly at all casting yards, which will be ensured by the contractor in the monthly environment monitoring reports. The casting yard site will be restored in its original state by the Contractor, after completion of works, proving that the works have not led to any pollution at the sites.

165. The monitoring & reporting will comprise of three-layer system which includes the Contractor, General Consultant and Maha Metro. The contractors have contractual binding to have Workers Welfare Officers Safety Managers and Environmental Managers, who will form the main execution team, with specific qualifications and experience as mentioned in the SHE Manual. Chief Safety Expert and Team of General Consultant shall be in a supervising and monitoring role in the project execution, while Maha Metro will review the works executed by Contractors & GC.

166. Contractors will have an efficient grievance redressal mechanism (GRM) in place. Regular reporting shall be ensured by the contractors in specific reporting formats. Monthly reporting shall be setup to ensure the timely monitoring and reform requirement.

C. CONSTRUCTION ACTIVITIES & METHODOLOGY

167. The choice of superstructure has to be made keeping in view the ease of constructability and the maximum standardization of the form-work for wide span ranges. Following types of superstructures have been considered

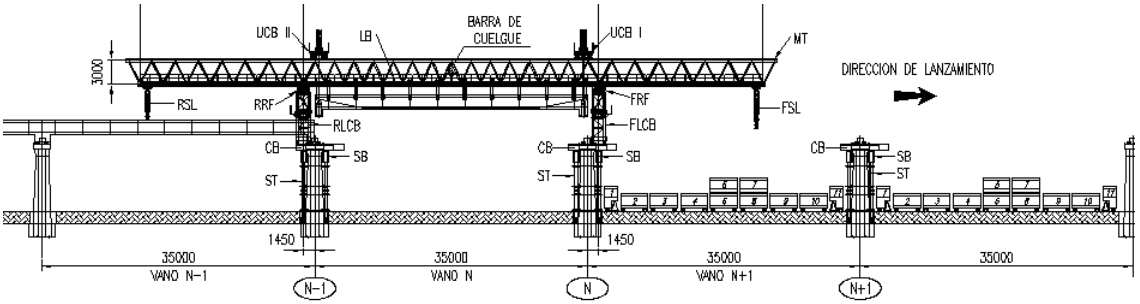
a. Precast Post tension segmental box girder

168. This essentially consists of precast segmental construction with external pre-stressing and dries joints and is by far the most preferred technique in fast track projects. In such construction, the pre-stressing is placed outside the structural concrete (but inside the box) and protected with high density polyethylene tubes which are grouted with special wax or cement. The match cast joints at the interface of two segments are provided with shear keys

as in traditional segmental construction. However, epoxy is dispensed with because water tight seal at the segment joints is not required in association with external tendons. The Photo and schematic arrangement is shown as **Figure 3-13** and **Figure 3-14**.

Figure 3-13: Launching Girder – Precast segmental Box Girder Construction

Figure 3-14: Launching Girder – Precast Segmental Box Girder Construction



169. Construction of elevated alignment involves following type of constructions: -

(i) **Sub-structure:** Two broad categories of sub-structure i.e. Pile Foundation and Open foundation are considered for Metro Systems. For heavy / medium loads and weathered loose / soft / filled up upper strata, Pile foundation systems are proposed. This requires lesser space and time for excavation. At locations where, hard strata / rock are available close to ground level, open foundations may be adopted. Columns on Open / Pile foundations with pier cap at top of columns. Alternatively, Portal arrangement is provided at certain locations. Substructure such as open foundation, pile, pile caps, columns, station structure, earth retaining structures will be cast-in-situ.

(ii) **Superstructure:** By segmental construction of whole unit construction. Box segments are most common type of segmental construction. I-Girder and U-girder are most common type of non-segmental construction methods where the structural element for whole span length is pre-cast and launched in position. Casting yard is required for casting of precast structural segments and other precast units like U-girder, I-Girder etc. The construction yard has arrangement for casting beds, curing and stacking area, batching plant with storage facilities for aggregates and cement, site testing laboratories, reinforcement steel yard and fabrication yard etc. An area of about 2.5 Ha to 3 Ha is required for each construction yard.

170. **Construction of elevated stations.** Elevated stations over the road are proposed for elevated stretches of all four alignments. Sub-structure for the elevated station portion will also be similar to that of viaduct and will be carried out in the same manner. To reduce physical and visual impact of the elevated station, stations have been made transparent with minimum walls on the sides.

171. **Pre-engineering building.** The stations are provided with roofing supported by pre-engineering building **(**PEB) structures which is fabricated in workshop and erected component-wise. The PEB structures allows for different shapes & sizes to be erected on which the roofing is normally of steel / polycarbonate sheet. The PEB structures also supports the system requirement such as OHE & Solar panels etc.

172. **General construction work practice.** As all the alignments are passing over existing road network, the construction work will be executed mainly on the road. The construction work will be carried out within a width of 4.5 meter either side from the road median and enclosures of 2-meter height barricades shall be provided on both sides. The temporary / short term impact anticipated during construction work includes dust formation, emissions from construction vehicles and noise due to construction activities. Implementation of efficient environment and social management plan (ESMP) at site will control the pollution to the maximum extent possible. The workers' camp will be located outside the urban area mostly at / near the Casting Yard locations and will be in purview of environmental monitoring.

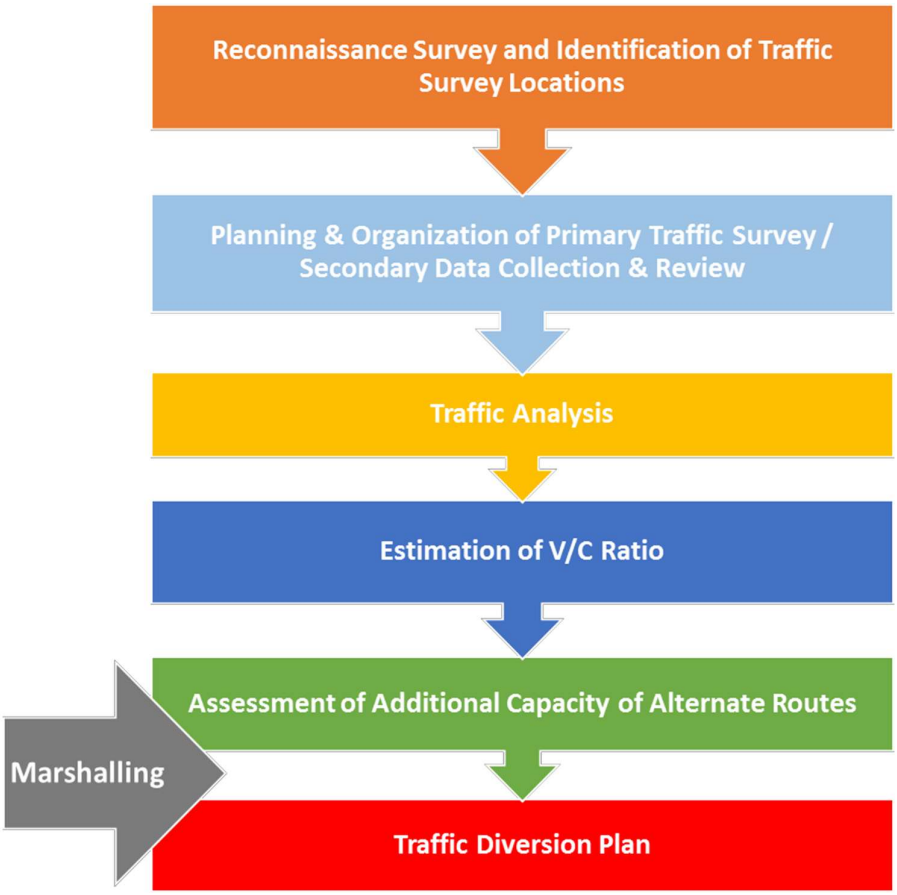
173. During construction of the project, workers shall be engaged by the contractors. The accommodation, sanitation & other facilities required at camps shall be governed by Country labour laws. These clauses are part of the civil contract works and will be obligatory to the contractors. The contractors have to provide a plan with yard layout including sewage and drainage systems, access roads, first aid facilities, etc., to be approved by Maha Metro before establishment.

174. **Traffic management plan during construction.** The aim of the traffic management measures is to relieve, wherever possible, or minimize the (short term) disruption to normal traffic likely to be caused by the construction works of the metro. The traffic management measures would need to cope, in safety, with all aspects of traffic. The typical traffic diversion plans have been prepared based on two scenarios as under:

Scenario 1: Two way at stations
Scenario 2: One way at stations

175. The traffic will be diverted on both sides or one side depending upon the available ROW near the proposed station, during construction. Appropriate traffic management measures should be adopted like relocation of bus stops, junction improvement measures, road geometric improvements, installation of traffic signage, barricading the construction area and road carriageway, etc. A broad methodology for preparing the traffic diversion plans is shown in **Figure 3-15**.

Figure 3-15: Broad methodology for preparing the traffic diversion plans



176. In order to retain satisfactory levels of traffic flow during the construction period; following measures must be taken by the contractors:

(i) Warn the road user clearly and sufficiently in advance.
(ii) Provide safe and clearly marked lanes for guiding road users.
(iii) Provide safe and clearly marked buffer and work zones
(iv) The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.
(v) Deployment of traffic marshals at all traffic diversion locations

177. No new quarry will be proposed for the Project requirements only existing, live, licensed quarries will be used as sources of aggregates. It will be ensured the aggregates procured during construction stage will be from the authorized or licensed suppliers

178. The sources of construction materials are available in ample way in the vicinity of Pune city. Environmental impacts from such activities are dust pollution due to loading & unloading and during transport of materials. Vehicles delivering materials will be covered to reduce spills and dust blowing off the load. (Material to be obtained from third party Query)

179. **Location of Casting Yards / Batching Plants** as per the contract conditions, land required for casting yards for casting of girders, Talawade and Talegaonetc. is to be arranged by the prospective contractors. The PCMC to Nigdi is basically an extension of Phase 1.

180. Contractors can use the same casting yards or may establish an alternate casting yard at Talwade and Talegaon, on approval by Maha Metro. Criteria to be used for site selection

and management of labour camp, construction yards, batching plant, construction waste disposal area etc. have outlined and attached as an **Annexure-8**. In case the existing casting yards will be used, an environment audit of the used casting yards needs to be conducted and submitted to PIU/EIB for review as per EIB E&S Policy (2022) requirements for existing facilities.

181. Prior to the start of the works the environmental baseline at the casting yards will be established, based on the pollutants that can be expected from the works at site. Contractor will be required to submit an Environmental Management and Restoration Plan to GC/Maha-Metro. Environmental monitoring will be carried out monthly at all casting yards, which will be ensured by the contractor in the monthly environment monitoring reports. The casting yard site will be restored in its original state by the Contractor, after completion of works, proving that the works have not led to any pollution at the sites.

D. IMPLEMENTATION PLAN & CONSTRUCTION SCHEDULE

1. Project Implementation Plan

182. The appointment of interim and general consultants may be initiated for project management including preparation of tender documents – as soon as DPR is approved by Government of Maharashtra (GoM), and Maha Metro. The possible dates of important milestones are given in **Table 3-5**.

Table 3-5: Proposed Project Implementation Plan

S. No.	Tasks	Timelines	Status (Feb 2025)
1	Approval of DPR by GoM	September 2021	-
2	Final Approval by GoI	November 2021	October 2023
3	Packaging & Invitation of Bids	January 2022	December 2023
4	Commencement of Civil Works	February 2022	March 2024
5	Commencement of Operation	April 2025	July 2027

2. Implementation Structure

183. Effective institutional arrangements are needed to enable the metro project to be implemented without any loss of time and cost over-run. The Government of Maharashtra has created a Special Purpose Vehicle (SPV) for implementing the Pune Metro Rail Project Phase 1. This SPV named as "NMRCL" was incorporated on 18th February, 2015 under the Companies Act and subsequently the name was changed to Maharashtra Metro Rail Corporation on 22nd January, 2017. It is a 50:50 jointly owned company of GoI and GoM responsible for implementation of all metro projects in the state of Maharashtra outside Mumbai Metropolitan region including Pune Metro Rail project phase 1 and the current extension PCMC to Nigdi.

E. DETAILED PROJECT COST ESTIMATE

184. **Capital cost estimate.** In order to arrive at realistic cost of various items, costs of the project have been derived from similar executed project in similar scenario in India. Rates are also adopted based on Report for Benchmarking for cost estimation of Metro Rail Projects issued by MoHUA, GoI in February, 2019.

Table 3-6: Detailed Cost Estimates

S. No.	Item	Amount (INR Cr)
1	Alignment & Formation	163.28
2	Station Buildings	

a	Cost of civil structure (Including cost of one FOB)	80.68
b	E&M Cost (Including Lift and Escalator)	24.00
3	Maintenance Depot	12.88
4	P-Way for main line and depot	29.13
5	Traction and Power Supply	33.10
6	Signalling	27.92
7	Telecommunication	13.50
8	Rolling Stock	120.00
9	Multi Modal Integration	9.00
10	Cost of Security	1.11
11	Environment cost	1.79
12	Utility Shifting	26.48
13	**Total Cost at FY 2019 price level (Excluding Land, R&R, General Charges, Contingencies, Central & State Taxes)**	**542.86**
14	General Charges @ 5%	27.14
15	Contingencies @ 3 % on Sr. No.13 i.e. Basic Cost	16.29
16	**Total Cost at FY 2019 price levels incl. General**	**586.29**
17	Central and State Taxes @ FY 2019 Price Level	79.28
18	**Total Cost incl. General Charges, Contingencies, Central and state Taxes @ FY '19 Price Levels (Excl. Land and R&R)**	**665.57**
19	Land	72.81
20	R&R	41.62
21	**Total Cost incl. General Charges, Contingencies,**	**780.00**
22	Escalation at 5 % per annum on the above (S. No: 21)	107.66
23	**Total Completion Cost incl. Land and R&R Costs**	**887.66**
24	Interest During Construction (IDC)	11.02
25	**Total Completion cost including IDC**	**898.68**
26	PPP component (AFC)	11.50
27	**Total Completion Cost**	**910.18**

F. ASSOCIATED FACILITIES

185. As per EIBs E&S Policy (2022) Associated facilities are those which are

i. assets and facilities directly owned or managed by the promoter that relate to the project activities to be financed,
ii. supporting activities, assets and facilities owned or under the control of parties contracted for the operation of the promoter's business or for the completion of the project (such as contractors);
iii. associated facilities or businesses that are not funded by the EIB as part of the project and may be separate legal entities yet whose viability and existence depend exclusively on the project or whose goods and services are essential for the successful operation of the project.

186. The PMRP Phase 1 which is already under operation in some sections and nearly completing construction in others, constitutes one of the main Associated Facilities to this project. Many of the components of PMRP Phase 1 including the two maintenance depots at Hill View Park and at Range Hill are planned on being used for the proposed PCMC-Nigdi (Phase-1 Extension).

187. **Maintenance depots.** It has been planned to use the already existing depots at Hill View Park and at Range Hill for the proposed PCMC-Nigdi (Phase-1 Extension). Both existing depots have infrastructure to maintain the rakes with necessary facilities viz. stabling lines, scheduled inspection lines, workshop for overhaul, unscheduled maintenance including major repairs, wheel profiling, heavy interior/under frame/roof cleaning etc. for the rolling stock operational on the corridor as well as maintenance facilities for Civil – track, buildings, water supply; Electrical – Traction, E&M; Signalling & Telecomm.; Automatic Fare Collection etc. The major infrastructure facilities at both Depot are respectively summarized in **Table 3-7** and **Table 3-8**.

Table 3-7: Infrastructure Facilities: Hill Park View Depot

Facility	Existing	Proposed
Stabling Lines	3 lines of 6 car length	3 lines of 6 car length
Inspection Lines	3 lines of 3 car length	
Workshop Lines	2 lines of 3 car length	

Table 3-8: Infrastructure Facilities: Range Hill Depot

Facility	Existing	Proposed
Stabling Lines	3 lines of 6 car length	8 lines of 6 car length
Inspection Lines	3 lines of 3 car length	
Workshop Lines	2 lines of 3 car length	

188. The construction and operation of the PCMC to Nigdi (Phase-1 Extension) will require power and water from existing electricity grid and water supply system. Electricity is required for operation of Metro system for running of trains, station services (e.g. lighting, lifts, escalators, signalling & telecom, firefighting etc. and workshops, depots within premises of metro system). The power requirements of a metro system are determined by peak-hour demands of power for traction and auxiliary applications. These existing grid substations and water supply network are being operated and managed by respective agencies under full compliance with state and local policies and regulatory frameworks.

Chapter 4: ENVIRONMENTAL AND SOCIAL BASELINE DATA

A. INTRODUCTION

189. The baseline status of environmental quality in the vicinity of project site serves as a basis for identification and prediction of impact. This chapter illustrates the description of existing environmental status of the study area with reference to the prominent environmental attributes. The data were collected from both primary and secondary sources.

190. Field monitoring was done for primary data collection of various environment components such as air quality, water quality, soil quality, noise & vibration. Also, secondary data such as micrometeorology, flora and fauna, socio-economics, hydro-geological data, traffic study etc. was collected from authenticated sources was used as a guideline and reference material. The entire data has been collected through actual physical surveys and observations, literature surveys, interaction with locals, government agencies and departments.

191. Baseline studies began with site visits and reconnaissance survey in the study area. Monitoring locations fixed for the primary data collection on the basis of environmental setting, meteorology and potential probable impacts of the project. Required secondary data was obtained from various Government agencies and research paper etc.

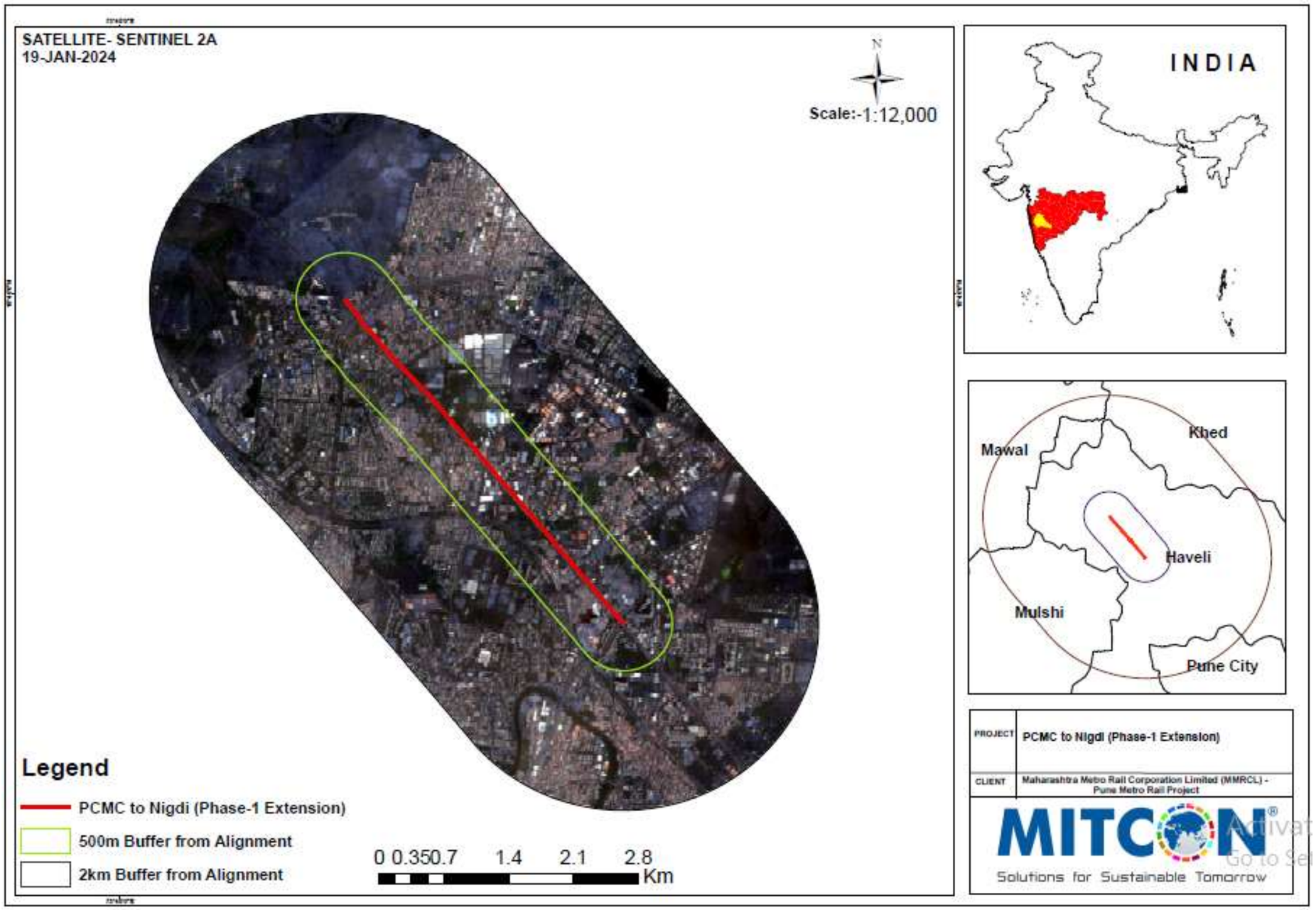
B. DATA COLLECTION METHODOLOGY

192. One reconnaissance visits were conducted to Pune Metro Rail Project PCMC to Nigdi (Phase-1 Extension) on 5th July, 2024 and Baseline survey was conducted in July 2024. During the visits, sampling sites were identified and finalized for monitoring of environmental parameters.

193. The study Area for the proposed project has been divided into three parts, viz. 500m radial distance around each alignment is designated as the Core Project Study area, while 2 km radial distance around each alignment is considered as Buffer Project Study Area. Satellite maps showing locations of the PCMC to Nigdi (Phase-1 Extension) along with Core and Buffer study areas around each alignment, are presented as **Figure 4-1**.

194. As a requirement of the ESIA process, primary baseline data for prominent environmental attributes like ambient air, noise, water (groundwater and surface water), soil, data on socio-economics at the Project corridors, as well as within 'Core and Buffer Study Areas' were collected through surveys and data on ecology & biodiversity (terrestrial, aquatic and riparian) was collected through field monitoring conducted in July 2024.

Figure 4-1: Satellite map of the PCMC to Nigdi (Phase-1 Extension) showing Project Study area



C. ENVIRONMENTAL PARAMETERS

195. Details of environmental parameters that were monitored and respective frequency of monitoring are presented in **Table 4-1**.

Table 4-1: Environmental Parameters and Frequency of Monitoring

Components	Parameters	Frequency	Methodology adopted
Meteorology	Wind Speed & Wind Direction, Temperature, Relative Humidity and Rainfall	Secondary data like average annual meteorological data was collected from IMD – Pune	IMD data Pune
Ambient Air Quality	As per the NAAQS dated 16th November 2009: $PM_{2.5}$, PM_{10}, SO_2, NO_X, CO	Ambient air quality samples are monitored at 6 locations for 24 hours once during the study period. Sampling locations were chosen such that 3 each were crosswind and downwind of the alignment, respectively.	PM_{10} / $PM_{2.5}$: Gravimetric method SO_2: Modified West and Gaeke Method. (IS: 5182, Part II) NOx: Jacobs and Hochheiser Method. (IS 5182 Part VI) CO: IS: 5182 (Part-X) & CPCB Guidelines
Ambient Noise	Noise levels in dB(A)	Continuous 24 – hourly monitoring at 6 locations once during the study period.	IS: 4954 as adopted by CPCB.
Vibration		Continuous 24 – hourly monitoring at 8 sensitive receptor locations once during the study period.	
Water quality	Physical, Chemical and Biological parameters.	Sampling was done once during the study period at 4 locations for groundwater quality and 3 locations for surface water quality.	Standard methods for Examination of Water and Wastewater' published by American Public Health Association (APHA)
Soil	Physico-chemical parameters as per BIS standards	Sampling at 5 locations in the project study area during the study period.	BIS specifications
Land use pattern	Land use for different categories	500 m radius, based on data published in Primary Census Abstract and satellite imagery Sentinel 2A.	Toposheets and Satellite imagery
Geology and Hydrogeology	Lithological types, drainage basins, etc.	Field observations in study area and from secondary data from authenticated sources like GSI, SoI, etc.	Authenticated published data.
Ecology	Flora & Fauna within study area (Terrestrial & Aquatic)	Field survey conducted in 10 km Study area, once during the study period and secondary data. Actual tree count survey of trees likely to be affected along the PCMC to Nigdi (Phase 1 Extension)	Listing of floral and faunal species.
Socio-economic Data	Socio-economic characteristics of the local population in the Study Area.	Based on data collected from the year 2011 Census Abstract and actual random consultations with locals.	Public consultation.

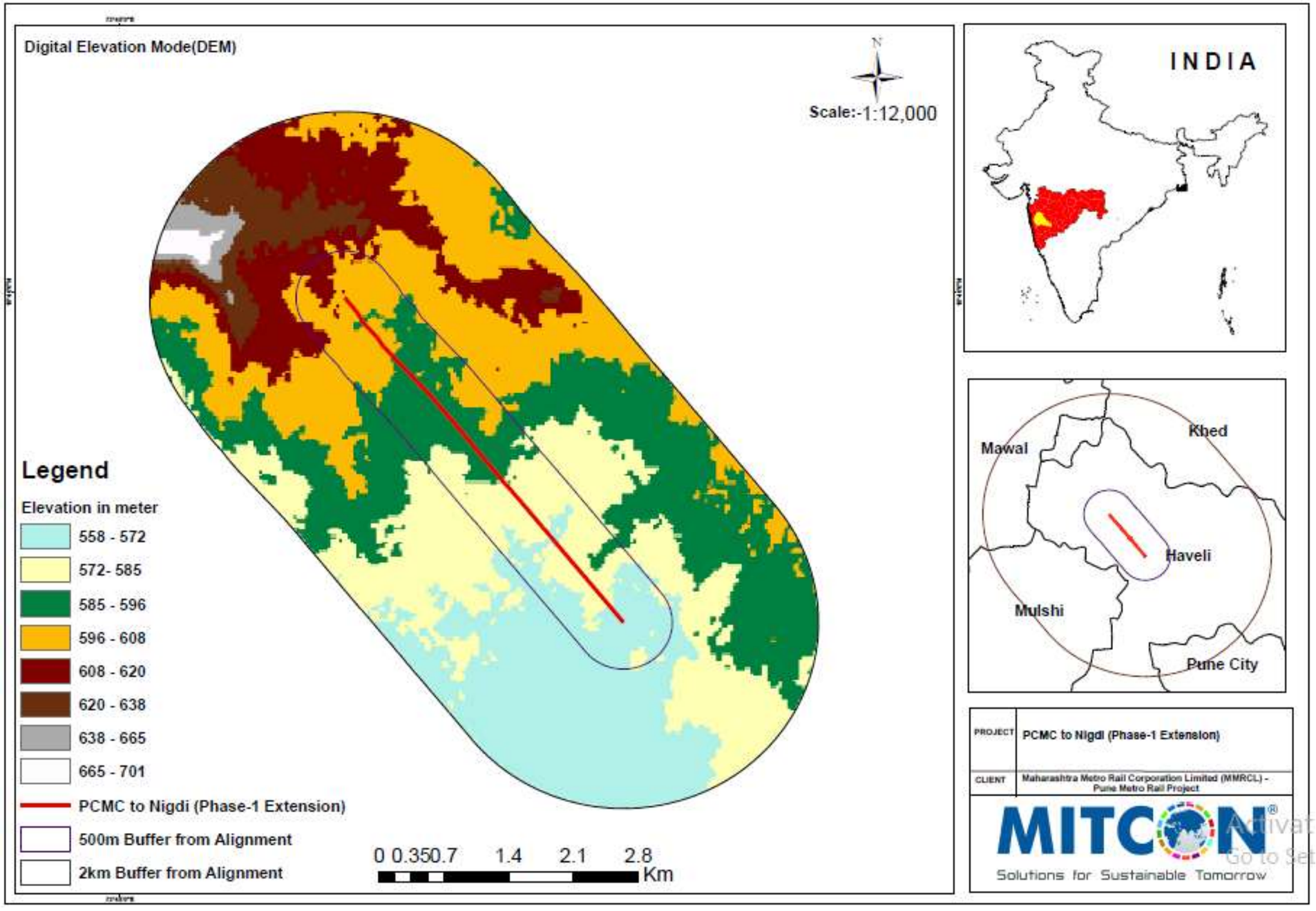
D. PHYSICAL / LAND ENVIRONMENT

1. Physiography and Geomorphology

196. The district, part of the Western Ghats and Deccan Plateau, is divided into three distinct belts: (1) The western belt, 16 to 31 km east of Sahyadri, characterized by rugged terrain with deep valleys and intersecting hill ranges; (2) The central belt, extending 30 km east of the western belt, marked by small hills, valleys, and large spurs forming plateaux; and (3) The eastern belt, featuring rolling topography with low hills gradually transitioning into plains with broader valleys. These features give rise to four major landforms: hills and Ghats, foothills, plateaux, and plains.

197. Digital Elevation Modelling (DEM) maps of the Core and Buffer study areas of the PCMC- Nigdi alignment, is presented as **Figure 4-2**.

Figure 4-2: DEM of the Core and Buffer study areas of PCMC to Nigdi (Phase-1 Extension)



2. Geology

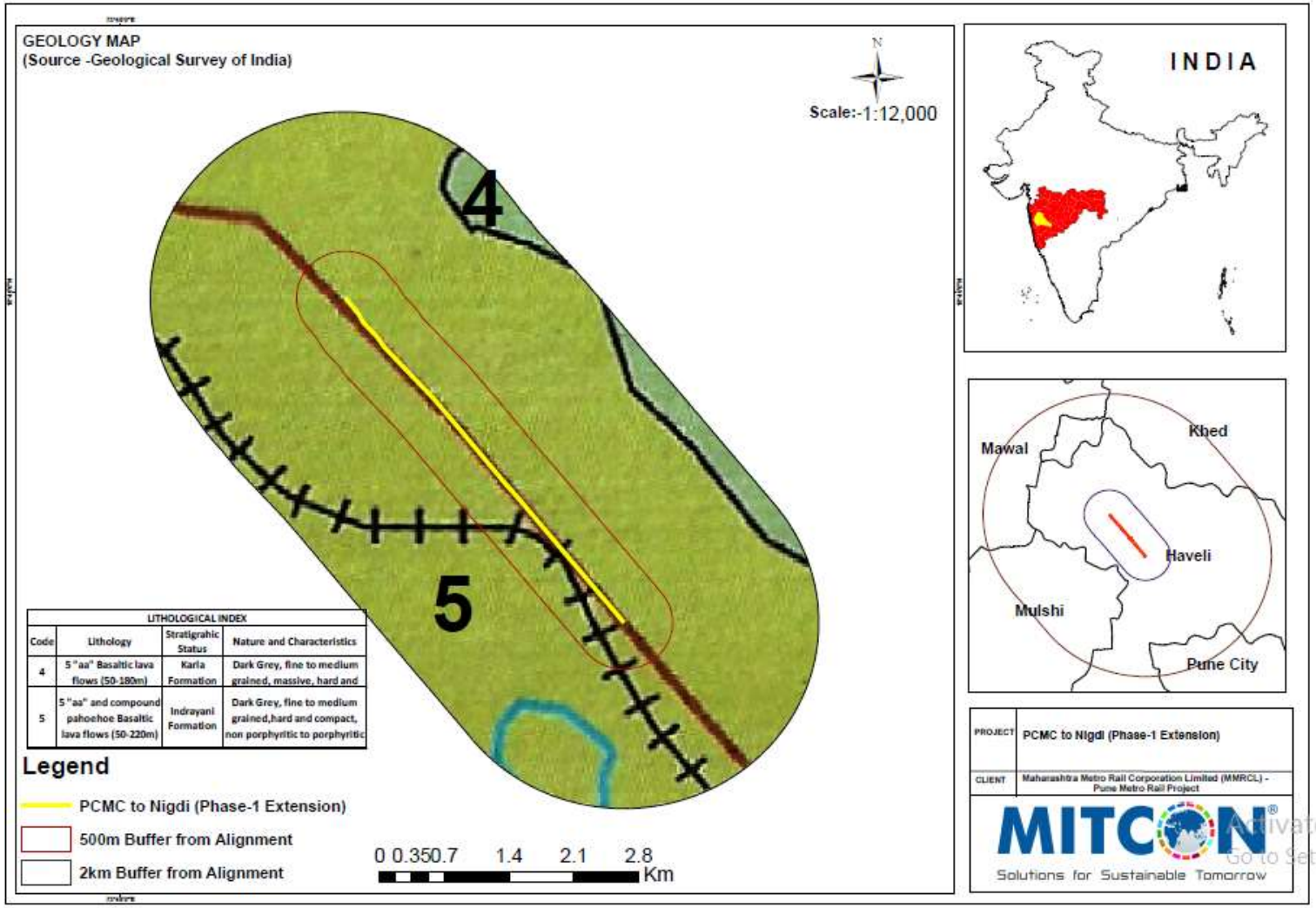
198. Almost the entire district is underlain by Deccan Volcanic Basalts belonging to Sahyadri Group of Upper Cretaceous to Eocene age, comprises of various lava flows, which can be classified in the field into two types as simple and compound flows. The compound flows occur at lower elevations whereas the simple flows are confined to the elevation above 680 m. The compound flows although vesicular and amygdaloidal in nature, hard and compact in their middle sections. They are fractured and jointed, and show moderate degree of weathering at places. Each individual lava flow consists of lower massive part becoming vesicular /amygdaloidal towards top, ranges in their individual thickness from a few centimetres to tens of meters. The flows have wide variation in colour and texture especially when they are amygdaloidal in nature with secondary mineral infillings such as Zeolites, calcite, and Agate and Chalcedony etc. The red /green/black bole beds constituting the marker horizons separating the two flows were discontinuous and generally inconsistent. The basalts are intruded by dykes and are found commonly in pahoehoe flows in the area. The generalised stratigraphy of Pune district is shown as **Table 4-2** and map showing geological formations in the PCMC to Nigdi project study area (500m radius around the alignment) is shown as **Figure 4-3**.

Table 4-2: Generalized Stratigraphy of Pune District18

Age	Group	Sub-group	Formation	Thickness (m)	Lithology
Quaternary (Recent to Sub-recent) (> 1 mya)	Sahyadri Group (Deccan Trap Super Group)	--	Alluvium	(Various)	Poorly sorted arenaceous to rudaceous sediments (sand, silt & clay)
Upper Cretaceous to Eocene (30-60 mya)		Diveghat	Purandargad	300	Deccan Trap basalt with intertrappeans: Simple flows, aphyric to plagioclase micro-phyric
			Diveghat	350	Deccan Trap basalt with intertrappeans: Simple / Aa flows, aphyric
		Lonavala	Karla	250	Deccan Trap basalt with intertrappeans: Fine-grained, aphyric, 'Pahoehoe' flows.
			Indrayani	125	Deccan Trap basalt with Intertrappeans: a thick succession of 'Aa' flows - Aphyric to sparsely phyric
		Kalsubai	Upper and Lower Ratangad	250	Deccan Trap basalts: compound 'Pahoehoe' flows and Megacryst lava flows

[18] *Source: CGWB - Aquifer Maps and Ground Water Management Plan, Pune District, Maharashtra (2018).*

Figure 4-3: Geology of Project Study Area for PCMC to Nigdi alignment as per GSI – Pune DRM



199. Deccan basalts are hydro geologically in-homogeneous rocks. The weathered and jointed / fractured parts of the rock, as also permeable inter-flow beds constitute the zone of ground water storage and flow. The existence of multiple aquifers is characteristic of basalt and exhibits wide variation in the joint/fracture intensity. The yields of well is function of the permeability and transmissivity of aquifer and it depends upon the degree of weathering and topographic setting of the aquifer. Due to wide variation in secondary openings, the potential areas for ground water are generally localized. In general, ground water occurs under phreatic/unconfined to semi-confined conditions in basalts. Two Aquifer systems have been delineated: Aquifer I from 9 to 30 m (Weathered /Jointed Basalt); and Aquifer II from 48 to 175 m (Jointed/fractured basalt). Shallow Aquifer generally tapped by the dug wells of 9 to 30 m depth, have water levels ranging from 2.1 to 25.0 m BGL and yield varies from 10 to 100 m3/day. The deeper Aquifer is being tapped by bore-wells with depth ranging from 50 to 180 m BGL and the water level from 6 to 45 m BGL.

3. Soils

200. 'Soil' means the uppermost layer of the earth's crust, which contains the organic as well as mineral matter necessary for the growth of plants. There are five types of soils found in Pune district as described below:

(i) **Laterite Soil:** Predominantly found in the western parts of the district, particularly in the Sahyadri hills and adjacent areas. This soil is rich in iron and aluminium but is generally poor in organic matter and nutrients, making it less fertile**.**

(ii) **Red Soil:** Commonly found in the hilly and plateau regions. Red soils are well-drained, slightly acidic, and rich in iron, but they are low in nitrogen, phosphorus, and organic matter.

(iii) **Black Soil (Regur Soil):** Found mainly in the eastern parts of the district. This soil is clayey, deep, and has good water retention capacity, making it ideal for growing crops like cotton, sugarcane, and sorghum. It is rich in minerals like calcium carbonate, magnesium, potash, and lime but has poor nitrogen content.

(iv) **Alluvial Soil:** Found in the river valleys, particularly along the banks of rivers like Bhima, Ghod, and Nira. This soil is fertile, with a good mix of sand, silt, and clay, making it suitable for diverse agricultural activities.

(v) **Brownish Soil:** Present in the plains and low-lying areas. This soil type has moderate fertility and is used for growing crops such as cereals, pulses, and oilseeds.

(a) Methodology

201. Soil sampling was undertaken to ascertain the type and quality of soil present in the Project study area. Methodology followed for the same is as follows:

(i) Manual sample was collected from the surface to plough depth (0-22 cm) using hammer and container bags for collecting undisturbed top soil.

(ii) Locations such as recently fertilized farms, old bunds, marshy spots, spots near trees, compost heaps and farm sheds, etc. were avoided.

(iii) Each collected Sample was a uniformly thick 2 cm slice of soil from the exposed soil face from a V-shaped hole dug in the ground.

(b) Locations & Frequency of Monitoring

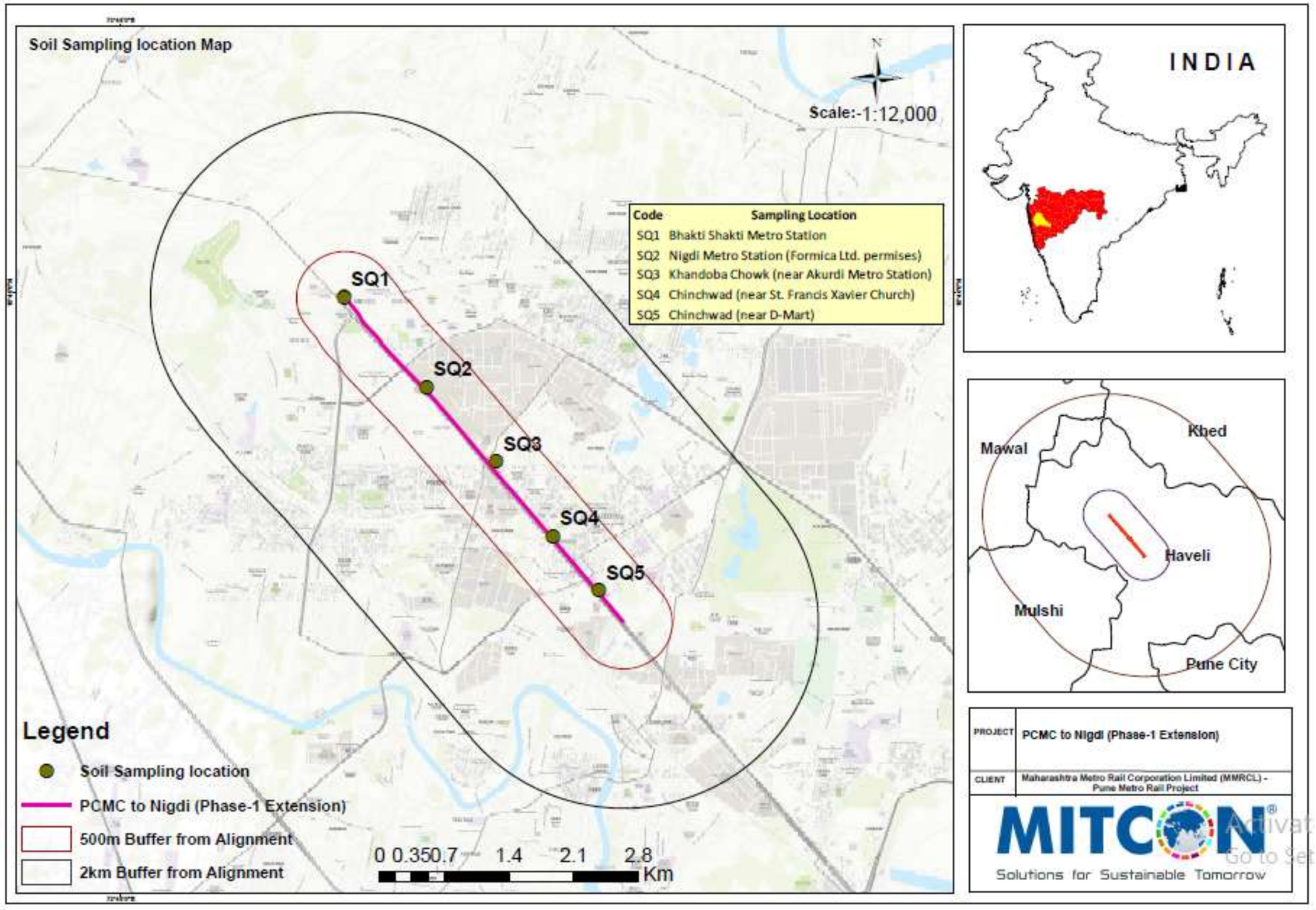
Soil samples were collected once from 5 different locations within the study area, as shown in **Table 4-3**. The locations are taken at proposed PCMC to Nigdi stations, chosen randomly, so as to provide a representative of the soils present in the project study area. **Figure 4-4.** Soil Sampling location Map shown in **Figure 4-5**

Table 4-3: Soil Sampling Locations for PCMC to Nigdi (Phase-1 Extension)

Sampling Code	Sampling Location	Latitude	Longitude
S1	Bhakti Shakti Metro Station	18°39'58.26"N	73°46'18.10"E
S2	Nigdi Metro Station	18°39'26.71"N	73°46'46.94"E
S3	Khandoba Chowk	18°39'0.73"N	73°47'11.41"E
S4	Chinchwad	18°38'34.59"N	73°47'31.24"E
S5	Chinchwad	18°38'15.76"N	73°47'47.34"E

Figure 4-4: Photographs of Soil Sampling

Figure 4-5: Soil sampling locations for PCMC to Nigdi (Phase-1 Extension)



(c) Soil Sampling Results

202. **Soil** analysis results of all 5 soil samples collected in the project area are comparatively summarized in **Table 4-4**. Detailed results of Soil sampling are given as **Annexure-4**.

Table 4-4: Results of Soil Sampling in PCMC to Nigdi (Phase-1 Extension) Project study area

Sample Code	Parameter	Texture	Percentage of Different Components			Soil Moisture	Bulk Density	Water Holding Capacity	Organic Carbon	Calcium (as Ca)	Magnesium (as Mg)	Available Nitrogen	Phosphorous (as P)	Potassium (as K)	Sodium Absorption Ratio
			Sand	Silt	Clay										
	Station **Units**	-	%	%	%	%	gm/cm$_2$	%	%	mg/kg	mg/kg	kg/ha	kg/ha	kg/ha	-
S1	Bhakti Shakti Metro Station	Clay	18	25	57	15.54	1.14	45.4	0.18	80.2	45.44	91.52	13.24	101.52	1.35
S2	Nigdi Metro Station	Sandy Loam	30	20	50	24.02	1.19	41.6	0.14	65.12	50.27	110.28	15.24	106.28	1.49
S3	Khandoba Chowk	Clay	24	25	41	18.42	1.18	55.16	0.16	89.18	41.16	87.28	10.15	120.44	1.57
S4	Chinchwad (near St. Francis Xavier Church)	Loam	22	30	48	19.16	1.15	51.16	0.24	91.52	39.83	92.58	8.52	115.16	1.45
S5	Chinchwad (near D-Mart)	Sandy	30	25	45	12.42	1.18	58.4	0.32	83.24	42.14	90.25	5.25	91.25	1.37
	Average Value / Range	-	-	-	-	12.42 to 24.02	1.17	50.34	0.21	65.12 to 91.52	39.83 to 50.27	87.28 to 110.28	5.25 to 15.24	91.25 to 120.44	1.45
	Standard soil classification	-	-	-	-	-	-	-	Less to very less	Very low	-	good	very less	very less	Low Sodium

(d) Inferences of Soil Sampling

203. The soil sample analyses results were compared with Bureau of Indian Standards (BIS) Conclusions from Soil sampling in the Study area during study period are summarised below:

Sr.No.	Parameter	Range
1	Soil Moisture (%)	12.42 – 24.02
2	Water Holding Capacity (%)	41.6 – 58.4
3	Organic Carbon (%)	0.14 – 0.32
4	Nitrogen (N) (kg/ha)	87.28 – 110.28
5	Phosphorus (P) (kg/ha)	5.25 – 15.24
6	Potassium (K) (kg/ha)	91.25 – 120.44

The soil sample analysis aimed to determine the presence of contamination. Based on the results, contamination was not found in the soil. Overall, the analysis indicates that the soil quality is poor for agriculture.

4. Land Use and/or Land Cover

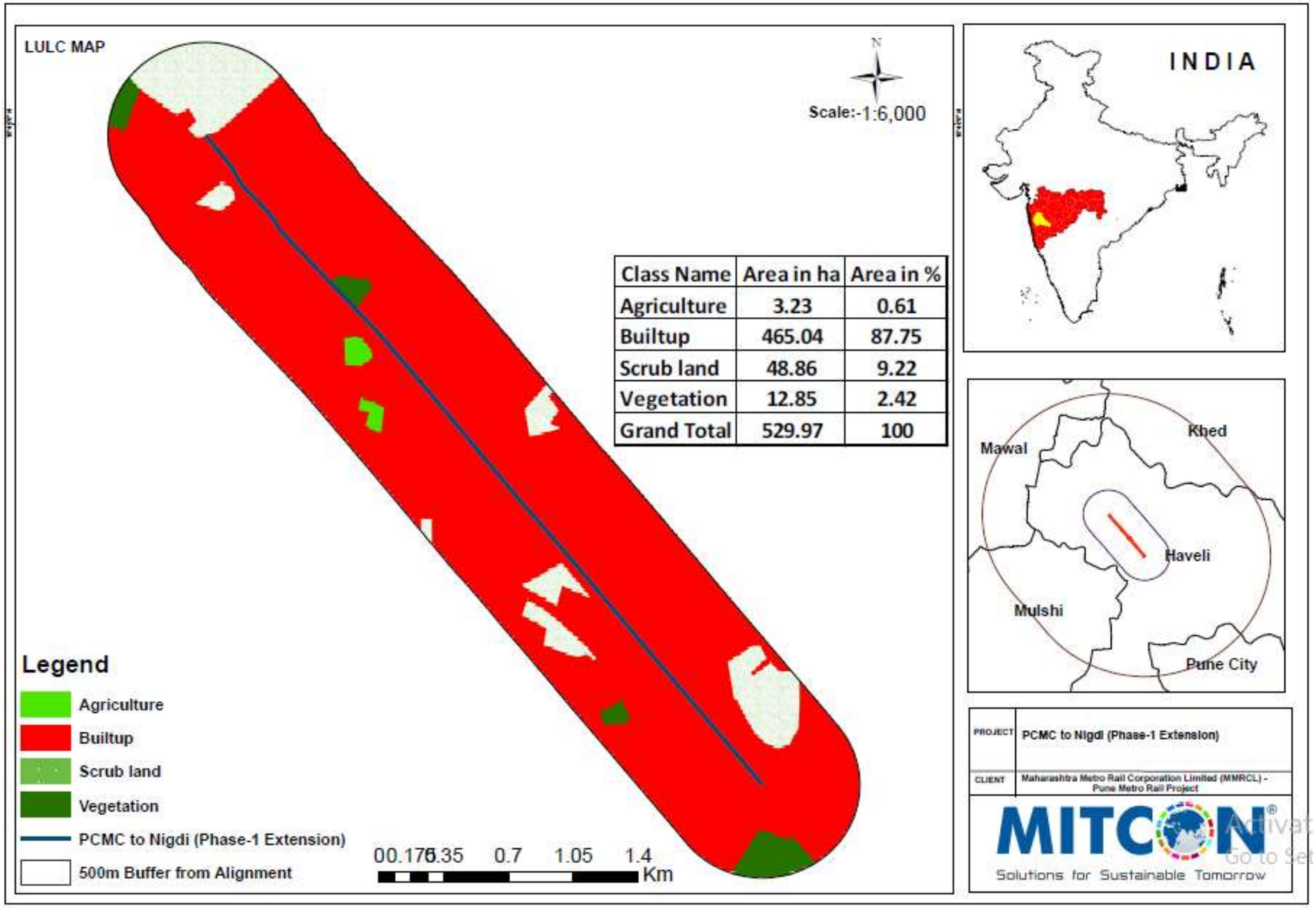
204. Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change, or maintain it. Land cover is the observed (bio-) physical cover on the earth's surface.

205. Land use/land cover for 500 m radius around the project alignment were delineated based on the Landsat ETM+ satellite data; the Land use / Land cover classes are categorized based on ground truthing and site visit. Land is classified as vegetation, barren land, built-up area, water bodies, etc. classes. Land use of the study areas varies, and is predominantly built-up urban area (87.75%) which includes, residential, commercial, mixed-use structures also comprising sensitive receptors like schools, hospitals, religious establishments, etc, as seen from **Table 4-5**. Land Use in the alignment is shown in **Figure 4-6**.

Table 4-5: Land Use in the Study Area (Cumulative)

Sr. No.	Classes	Area in Ha.	Area in %
1	Agricultural land	3.23	0.61
2	Built-up	465.04	87.75
3	Scrubland	48.86	9.22
4	Vegetation	12.85	2.42
Total		**529.97**	**100.00**

Figure 4-6: Land Use / Land Cover in 500 m Core Study Area PCMC – Nigdi (Phase-1 Extension)



5. Natural Hazards

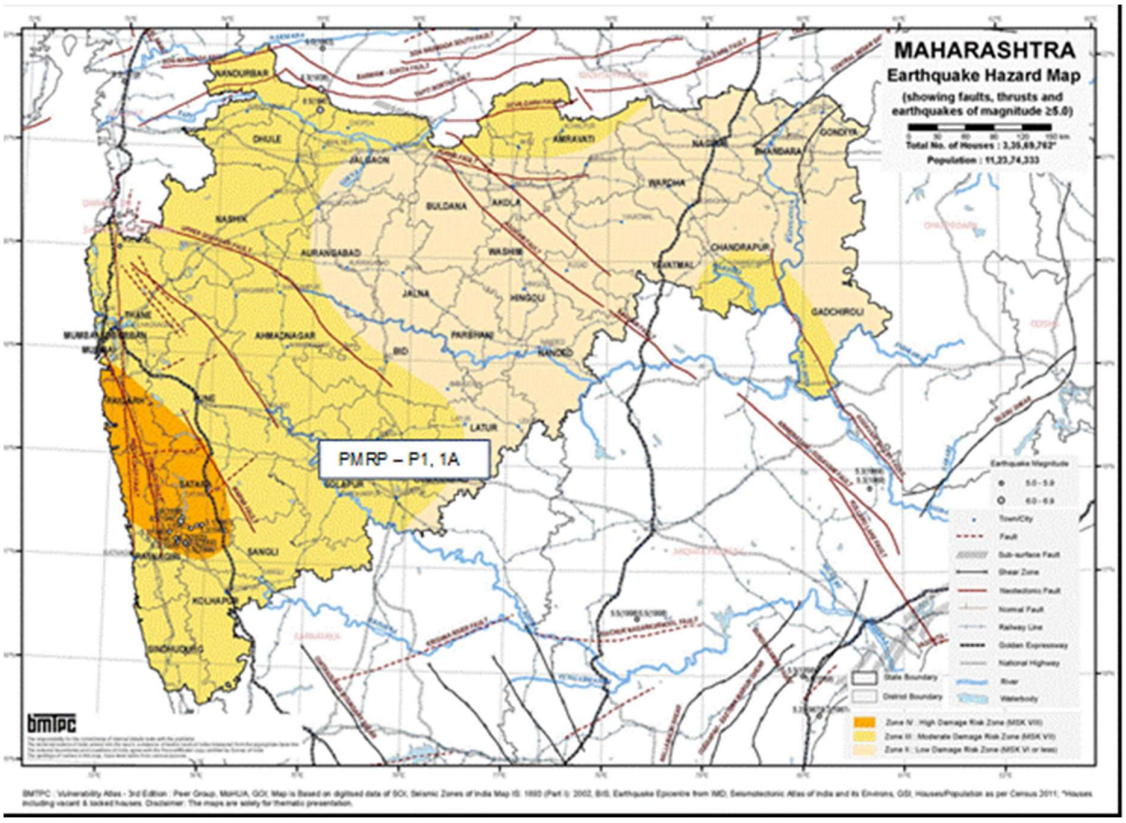
206. The district of Pune is prone to water related disasters like floods and droughts, as there are many perennial rivers flowing through the district. In addition, the uncontrolled residential and increased industrial development has worsened the floods events in the district. The existing physical infrastructure and social attributes have made the population vulnerable to urban floods.

207. Vulnerabilities to disaster / emergencies of chemical and biological, radiological and nuclear origin are also increasing due to expansion of industrial zone at the outskirt of the city at the same time rapid urbanization is moving towards the industrial clusters and these cluster are becoming the part of city thus leading the people vulnerable due to various hazards.

(a) Seismicity

208. Bureau of Indian Standards (BIS) has prepared a seismic zoning map of India based on tectonic features and records of past earthquakes. **Figure 4-7** shows the approximate project location marked on BMTPC Earthquake hazard map of Maharashtra state, showing location of Project site in Zone-III i.e. Moderate Damage Risk Zone (MSK VII).

Figure 4-7: BMTPC Earthquake Hazard Map of Maharashtra[19]



E. AMBIENT ENVIRONMENT

1. Meteorology

[19] *Source: Building Materials & Technology Promotion Council (BMTPC) Vulnerability Atlas (3rd Edition) / Hazard Maps of India*

209. Micro-meteorological data within the study area during the air quality survey period is an indispensable part of air pollution studies. The meteorological data recorded during the monitoring period is a useful tool for the interpretation of the baseline condition as well as for the input to predictive models for air quality dispersion.

(a) Methodology

210. The methodology adopted for monitoring surface metrological observations is as per the standard norms laid down by Bureau of Indian Standards, and the India Meteorological Department (IMD). The Regional Meteorological Centre – Indian Meteorological Department (RMC - IMD) in Pune is located at Shivaji Nagar, Pune. Secondary data was obtained from IMD Pune and is presented in this report.

(b) Average Meteorological Condition at IMD – Pune

211. The daily mean maximum & minimum temperature, monthly lowest minimum & highest maximum temperature, the total monthly rainfall, number of rainy days, mean wind speed and predominant wind direction

212. Sample was collected from Indian Meteorological Department, Ministry of Earth Sciences, GoI. The average of this meteorological data based on Climatological Normal (1981-2010) for the IMD Regional Meteorological Centre (RMC) at Pune) is presented in **Table 4-6**:

Table 4-6: Average of Meteorological Data from RMC – IMD Pune[20]

Location: In the compound of the Meteorological Office building at Shivajinagar, Agricultural College farm Pune. Wind instruments on terrace of the building; exposure good. (Latitude: 18°32'N, Longitude: 73°51'E) **Elevation:** 559 m above MSL							
Month	**Temperature (°C)**		**Relative Humidity (%)**		**Mean wind speed (Kmph)**	**Pre-dominant Wind Direction**	**Precipitation (mm)**
	Highest	**Lowest**	**Morning**	**Evening**			
January	35.3	1.7	85	34	2.5	W	1.1
February	38.9	3.9	72	26	3.2	W	0.3
March	42.8	7.2	55	21	4	W	2.2
April	43.3	10.6	48	24	5.4	W	8.5
May	43.3	13.8	59	37	8.5	W	26.8
June	41.7	17	77	66	9.1	W	173.4
July	36	18.9	83	76	9.2	W	181.4
August	35	17.2	86	79	8.2	W	145.2
September	36.1	13.2	84	73	5.4	W	146.1
October	37.8	9.4	79	53	2.9	W	86.3
November	36.1	4.6	76	43	2.7	N	25
December	35	3.3	82	39	2.5	N	7
Annual Total or Mean	**43.3**	**1.7**	**74**	**47**	**5.3**	**W**	**803**

213. The Annual Wind-rose has been obtained from IMD Pune and shown as **Figure 4-8** and Daily Average Meteorological data (Climatological Norm) for Pune i.e. Temperature, Rainfall and Relative Humidity are shown as **Figure 4-9**.

[20] *Source: GOI, Ministry of Earth Sciences, IMD, Climatological Tables 1981-2010*

Figure 4-8: Annual Wind-rose – Pune[21]

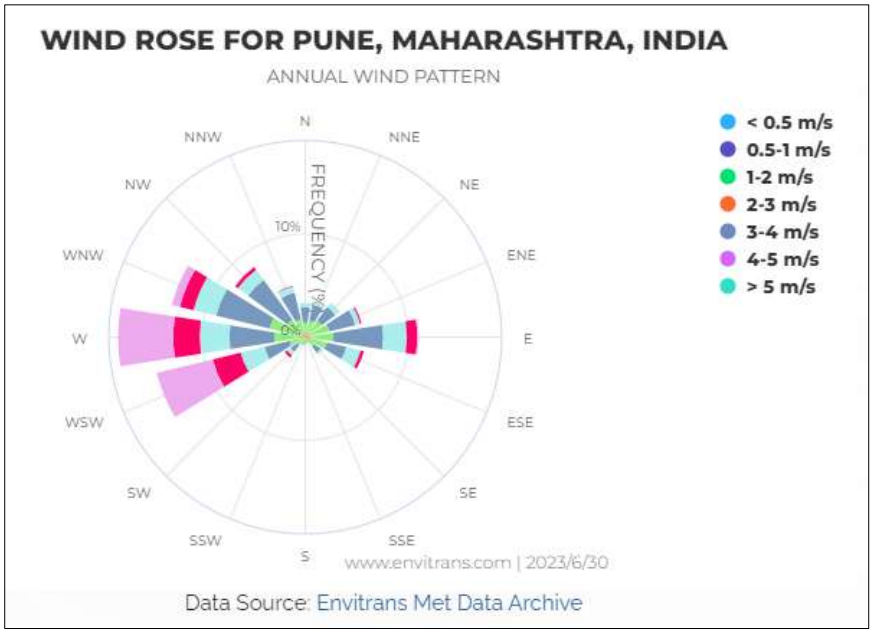
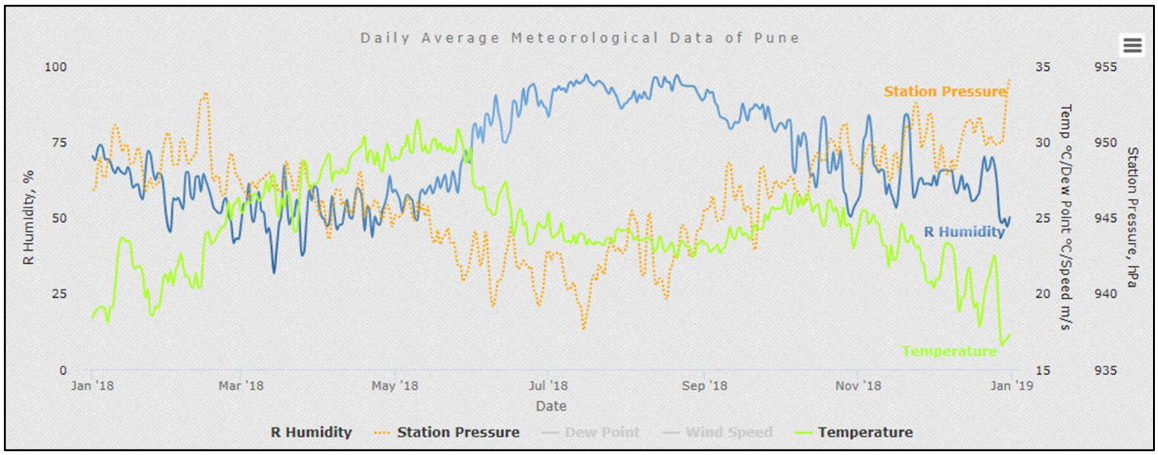


Figure 4-9: Climatological Norm at Pune[22]



2. Ambient Air Environment

214. Air quality is an important parameter of the baseline environment and its study is an indispensable tool for planning further development in the adjoining areas of the project. The extant air quality was studied to assess the current status of the same and to check the air quality status of the region vis-à-vis the air quality standards prescribed by the Central Pollution Control Board.

(a) Methodology (Criteria for choice of Parameters for Air monitoring)

215. The Air Quality Index monitored in India comprises Particulate matter, carbon monoxide, sulphur dioxide, nitrogen dioxide, ammonia, lead and ozone. The US EPA list of criteria pollutants comprises all of the above except ammonia. As per WHO, concentrations of nitrogen dioxide are often strongly correlated with those of other toxic pollutants, and because it is easier to measure, it is often used as a surrogate for the pollutant mixture as a whole. Wide adverse effects of particulate matter (PM) are observed in both short-term and long-term

[21] *Source: Indian Climate portal by envitrans – Pune Wind Pattern [https://www.indianclimate.com/wind-data.php]*
[22] *Source: Indian Climate portal by envitrans – Pune Wind Pattern [https://www.indianclimate.com/wind-data.php].*

exposures. It is possible to derive a quantitative relationship between the concentration of the pollutant as monitored in ambient air and specific health outcomes (usually mortality).

216. The biggest source of lead in air is petrol and mining: neither of them are present in Pune and so lead was not measured. Ammonia was not measured because it is highly reactive making it difficult for monitoring instruments to capture it; uncertainty surrounding sources; the gas can have a very short life span. Ozone is a secondary pollutant resulting from action of nitrogen oxides and VOCs; nitrogen oxides are measured as dioxide and therefore ozone was not measured.

217. The sampling and analysis of ambient air quality parameters was carried out as per the procedures detailed in relevant Parts of IS-5182 (Indian Standards for Ambient Air Quality Parameters).

218. The following air pollution parameters were monitored and measured by sampling:
(i) Particulate Matter less than 10µm (PM_{10})
(ii) Particulate Matter less than 2.5µm (PM2.5)
(iii) Sulphur dioxide (SO_2)
(iv) Oxides of nitrogen (NO_X)
(v) Carbon monoxide (CO)

(b) Techniques for Measurement

219. The ambient air quality monitoring was undertaken once in the study period at all the proposed PCMC to Nigdi (Phase-1 Extension) station locations the alignment. One set of 24-hour average samples were thus collected continuously at each of these locations. Measurement techniques used for Air quality analysis are presented in **Table 4-7**:.

Table 4-7: Measurement Techniques

Parameter	Monitoring Equipment	Analytical Method	Minimum Detectable limit	Technical Protocol
$PM_{2.5}$	Fine Dust Sampler	CPCB Guidelines for the measurement of Ambient Air pollutant Vol. I, 2011	10 µg/m^3	Gravimetric method
PM_{10}	Fine Dust Sampler	IS 5182 (Part 23) :2006, RA-2012	10 µg/m^3	Gravimetric method
SO_2	Gaseous sampler	IS 5182 (Part II) : 2001, RA-2012	5 µg/m^3	Improved West and Geake method
NO_x	Gaseous sampler	IS 5182 (Part VI) : 2006, RA-2012	5 µg/m^3	Modified Jacob and Hochheiser method
CO	CO meter	IS: 5182 (Part-X) & CPCB Guidelines	-	Non-Dispersive Infra-Red (NDIR) spectroscopy

(c) Sampling Period, Frequency and Parameters

220. Ambient air quality monitoring was conducted at a total of 6 locations in the project study area for 24 hours. Location maps showing Air sampling locations for PCMC – Nigdi (Phase-1 extension), is presented as **Figure 4-10**:. The monitoring locations have been selected primarily based on the predominant wind direction. The other factors considered while selection of the monitoring stations include accessibility, location of receptors and availability of power. Justification for selection of the locations for ambient Air quality monitoring in the Project Study area is summarised in **Table 4-8**:, while details of the same are given in Table **4-9**:.

Table 4-8: Justification for selection of AAQ locations for PCMC – Nigdi (Phase-1 Extension)

AAQ	Crosswind	Downwind

locations	Locations	Locations
6	3	3

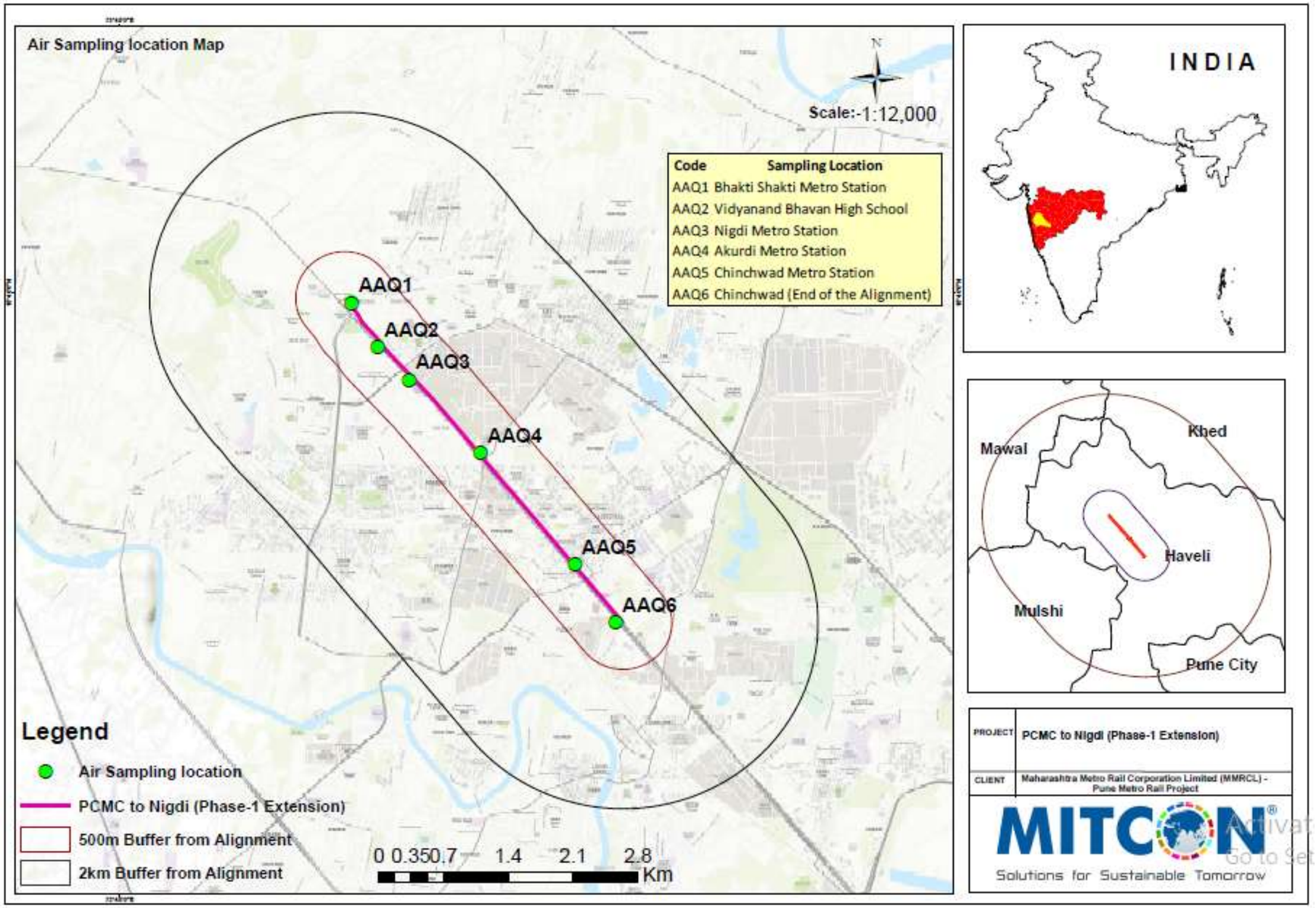
Table 4-9: Ambient Air Quality Stations monitored in Project Study Area

Sampling Code	Sampling Location	Type of Sample	Latitude	Longitude	Wind type#
AAQ.1	Bhakti Shakti Metro Station	Residential	18°39'56.20"N	73°46'21.07"E	CW
AAQ.2	Vidyanand Bhavan High School	Silent	18°39'40.79"N	73°46'30.10"E	CW
AAQ.3	Nigdi Metro Station	Residential	18°39'29.32"N	73°46'41.02"E	DW
AAQ.4	Akurdi Metro Station	Commercial	18°39'3.78"N	73°47'6.15"E	DW
AAQ.5	Chinchwad Metro Station	Commercial	18°38'24.82"N	73°.15"E	DW
AAQ 6	Chinchwad (End of the Alignment)	Commercial	18˚38’04.61‘’ N	73˚47’56.11‘’ E	CW

DW – Down-wind; CW – Cross-wind

Figure 4-10: Photographs taken during Air-sampling in the Project Study Area

Figure 4-11: Air Monitoring Locations for PCMC – Nigdi (Phase-1 extensions)



(d) Ambient Air Quality Results

221. The air pollutants emitted by point and non-point sources are transported, dispersed or concentrated by meteorological and topographical conditions. **Table 4-10**: shows a summary of the analytical results of Air Quality monitoring samples gathered in the Project Study Area. Detailed results of all parameters analysed are given in **Annexure-2**.

Table 4-10: Summary of Results of Ambient Air Quality monitoring

Sampling Location	$PM_{2.5}$ (60 µg/m^3)	PM_{10} (100 µg/m^3)	SO_2 (80 µg/m^3)	NO_X (80 µg/m^3)	CO (2 mg/m^3)
AAQ1	32.85	78.65	17.54	24.85	0.74
AAQ2	10.54	42.14	≤ 10	16.47	0.02
AAQ3	22.5	64.87	15.46	21.33	0.86
AAQ4	28.46	73.84	18.84	24.76	1.17
AAQ5	32.85	77.42	21.87	27.45	1.54
AAQ6	20.13	55.84	13.74	20.65	0.54

222. 24-hour air quality monitoring results indicates that all parameters were within the permissible level of National Ambient Air Quality Standards (NAAQS). However, both PM10 and PM2.5 as well as NOx exceed the WHO guidelines and the WBG-EHS guidelines and SO_2 exceed the WBG-EHS guidelines. The measured parameters were compared with the NAAQS laid down by CPCB, the WHO guidelines (2021 AQGs) as well as the WBG-EHS limits for ambient air quality (2007) as given **in Table 4-11**:.

Table 4-11: National and International Ambient Air Quality Standards

Pollutant, Unit	Time Weighted Average	Concentration in Ambient Air[23]		WHO Guidelines (2021 AQGs)[24]	WBG-EHS Guidelines (2007)[25]
		Industrial, Residential, Rural, and Other Areas	Ecologically Sensitive Area (notified by Central Government)		
Sulphur dioxide (SO_2), µg/m^3	Annual **24 hours**	50 **80**	20 80	- **40**	**20**
Nitrogen dioxide (NO_2), µg/m^3	Annual **24 hours** 1 hour	40 **80**	30 80	10 **25**	 200
Particulate matter (<10 µm) or PM_{10}, µg/m^3	Annual **24 hours**	60 **100**	60 100	15 **45**	**50**
Particulate matter (< 2.5 µm) or $PM_{2.5}$, µg/m^3	Annual **24 hours**	40 **60**	40 60	5 **15**	**25**
Carbon monoxide or CO, mg/m^3	24 hours **8 hours** 1 hour	- **2** 4	- 2 4	4 **-** -	

3. Ambient Noise

(a) Methodology

223. The methodology adopted for Noise Monitoring is outlined below:

(i) Ambient Noise is collected by continuous noise sampler (Lutron make, model

[23] *Source: CPCB guidelines for AAQM (National Ambient Air Quality Standards or NAAQS, 2009)*

[24] *Source: WHO Global Air Quality Guidelines (AQGs) 2021 [https://documents1.worldbank.org/curated/en/157871484635724258/pdf/112110-WP-Final-General-EHS-Guidelines.pdfhttps://iris.who.int/bitstream/handle/10665/345329/9789240034228-eng.pdf?sequence=1]*

[25] *Source: WBG (IFC) General EHS Guidelines: Air Emissions And Ambient Air Quality (April 2007). [https://documents1.worldbank.org/curated/en/157871484635724258/pdf/112110-WP-Final-General-EHS-Guidelines.pdf].*

SL-4033SD). The data collected is continuous 24-hourly data.

(ii) The instrument is mounted on a tripod which is placed around 2m from ground level in residential / commercial areas and sensitive receptors near to the project alignments, where available.

(iii) The noise measurement instrument is continuously supervised during the monitoring period (24 hours at each location).

(iv) In case of extraneous noise conditions like honking from passing vehicles, adverse meteorological conditions, if any, etc., the "Pause" function on the instrument can be used to exclude any such extra noise.

224. The noise monitoring locations are identified on the basis of following considerations:

(i) **Source.** The proximity of the settlement areas / sensitive receptors to the Project alignments. The closer the settlement areas / sensitive receptors are the severe would be the impact.

(ii) **Path.** The meteorology and the wind flow affect the impact on the receiver. The impact is higher during night time and lower in the daytime (for the same intensity produced by source). Likewise, the impact is high during inversion conditions or on locations lying at the downwind of the alignment.

(iii) **Receiver.** The impact is higher if the receiver is considered to be sensitive w.r.t the NAAQ Standards for noise. Sensitive receptors identified for PMRP Phase I Noise level assessment include hospitals, schools and colleges.

(b) Sampling Period, Frequency and Parameters

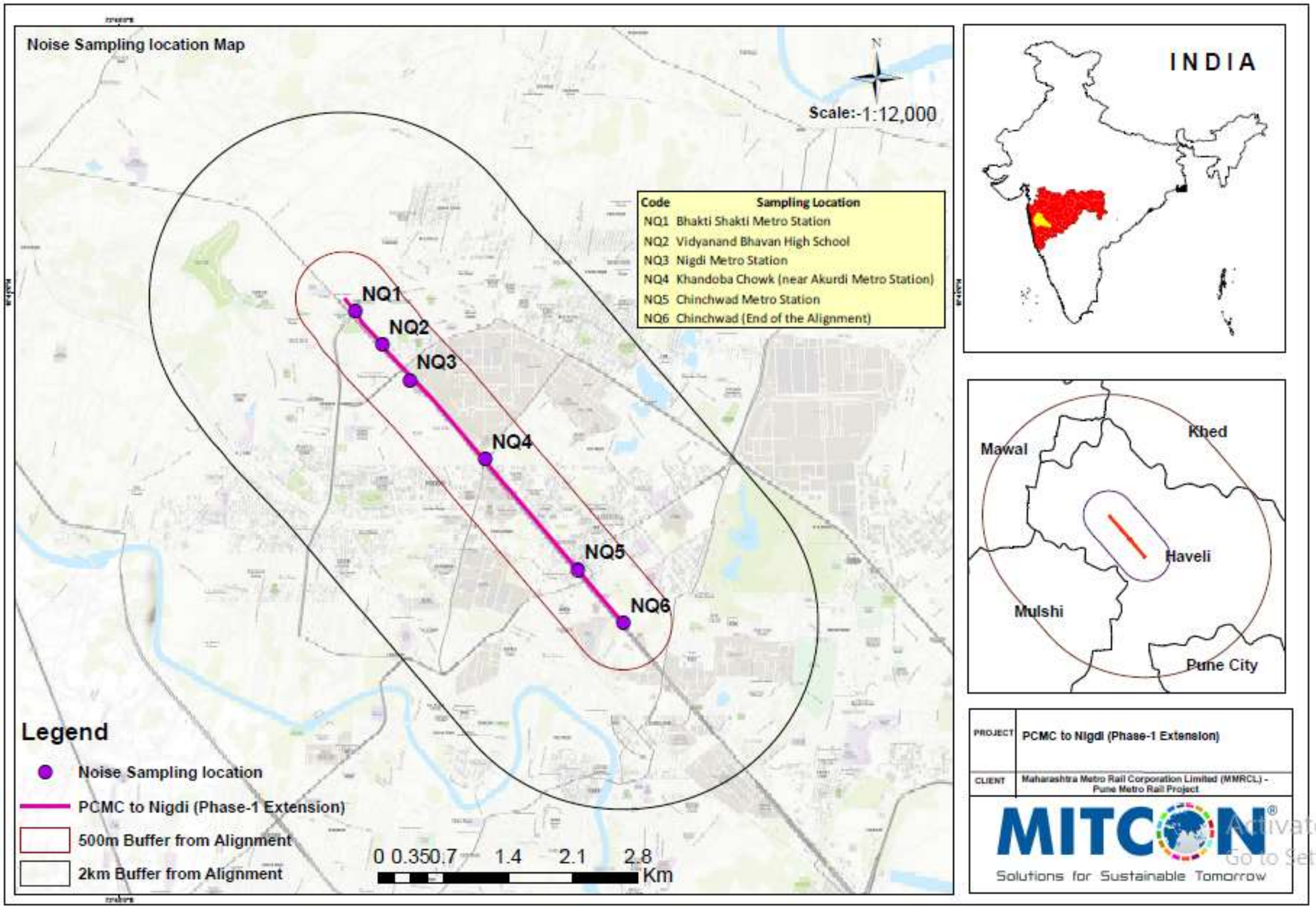
225. Ambient noise levels were monitored at 6 locations, identified during preliminary baseline survey within the study area, as shown in **Table 4-12**. Some of the photographs taken during noise monitoring in the Study area are shown as **Figure 4-12**. Noise sampling locations for PCMC to Nigdi (Phase-1 Extension) is shown as **Figure 4-13**.

Table 4-12: Noise Monitoring Sampling Locations of PCMC to Nigdi (Phase-1 Extension)

Sampling Code	Sampling Location	Significance / Zone	Latitude	Longitude
NQ1	Bhakti Shakti Metro Station	PCMC to Nigdi proposed station / Commercial	18°39'53.42"N	73°46'22.31"E
NQ2	Vidyanand Bhawan High School (Near)	PCMC to Nigdi proposed station / Silent	18°39'41.66"N	73°46'31.81"E
NQ3	Nigdi Metro Station	PCMC to Nigdi proposed station / Commercial	18°39'29.31"N	73°46'41.38"E
NQ4	Khandoba Chowk	PCMC to Nigdi proposed station / Commercial	18°39'1.73"N	73°47'7.72"E
NQ5	Chinchwad Metro Station	PCMC to Nigdi proposed station / Commercial	18°38'22.95"N	73°47'40.19"E
NQ6	Chinchwad (End of Alignment)	PCMC to Nigdi proposed station / Commercial	18°38'4.61"N	73°47'56.11"E

Figure 4-12: Some Photographs taken during Noise Monitoring in the Study Area

Figure 4-13: Noise Monitoring Sampling Locations for PCMC – Nigdi (Phase-1 Extension)



(c) Noise Quality Sampling Results

226. Ambient Noise levels in the Project Study Area were measured by digital Noise meter. Summary of the results of Noise monitoring carried out in the Project Study area are given in **Table 4-13**:.

Table 4-13: Summary of Noise Monitoring Results for PCMC to Nigdi (Phase-1 Extension)

Sample No.	Locations (Village)	Significance/ Category of Area / Zone	24 hourly Average Noise Level Values [in L_{eq} dB (A)]	
			Day	Night
NQ1	Bhakti Shakti Metro Station	Proposed Station / Commercial	64.7	46.7
NQ2	Vidyanand Bhawan High School (Near)	Sensitive Receptors (School) / Silent	41.5	38.5
NQ3	Nigdi Metro Station	Proposed Station / Commercial	63.8	53.4
NQ4	Khandoba Chowk	Commercial	62.7	43.5
NQ5	Chinchwad Metro Station	Proposed Station / Commercial	64.4	52.8
NQ6	Chinchwad (End of Alignment)	Commercial	63.4	53.7

(d) Inferences

227. The Noise monitoring results of the sampling locations are found to be within the prescribed standards (shown **in Table 4-14**). CPCB limits, which are more stringent for Commercial, Residential and Silence zones, while WBG-EHS limits for Industrial zones are used or comparing the baseline values.

Table 4-14: Guidelines/Standards with respect to Noise

Area Code	Category	CPCB Limits[26] in dB(A) Leq		WBG-EHS Limits[27] in LAeq dB	
		Day Time*	Night Time*	Day Time##	Night Time##
A	Industrial Area	75	70	**70**	**70**
B	Commercial Area	**65**	**55**	70	70
C	Residential Area	**55**	**45**	55	45
D	Silence Zone**	**50**	**40**	-	-

Note:

- ** **Day time** shall mean 6.00 a.m. to 10.00 p.m. and **Night time** shall mean from 10.00 p.m. to 6.00.a.m. as per The Noise Pollution (Regulation and Control) Rules, 2000 – CPCB guidelines. Day- and Night-times in the presented data are considered as per CPCB Guidelines*
- *## World Bank Group (WBG) EHS Guidelines - define day time as 7.00 a.m. to 10 p.m.*
- ***Silence zone is defined as an area comprising not less than 100 meters around hospitals, educational institutions, Courts of law and religious places or any others declared as such*
- *Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.*
- *dB(A) L_{eq} denotes the time weighted average of the level of sound in decibels on scale A.*

[26] *Source: CPCB guidelines for AAQM (National Ambient Air Quality Standards or NAAQS, 2009).*

[27] *Source: WBG (IFC) General EHS Guidelines: Environmental Noise Management (April 2007). [https://www.ifc.org/content/dam/ifc/doc/2000/2007-general-ehs-guidelines-noise-en.pdf]*

4. Vibration Analysis

(a) Methodology

228. Construction and operation of the metro generate vibrations from equipment during construction and wheel-rail interaction during operation. Following the completion of the detailed design, a vibration assessment was carried out for sensitive receptors—including educational, medical, and other fragile buildings—located within a 62-meter screening distance on either side of the alignment. This distance is based on the Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment Manual (2018) for Category 2 receptors, which is a standard threshold for assessing potential vibration impacts. The findings from this assessment have guided the development of mitigation measures to ensure vibration levels remain within acceptable limits throughout the project.

229. Vibration consists of rapidly fluctuating motions of the particles without any net movement. It is common to describe vibration levels in terms of velocity, which represents the instantaneous speed at a point on the object that is displaced. Vibrations are transmitted from the source to the ground and propagate through the ground to the receiver. Vibration amplitudes are usually expressed as either Peak Particle Velocity (PPV) or the Root Mean Square (RMS) velocity. PPV is used to evaluate the potential for building damage, and is defined as the maximum instantaneous peak of the vibration signal. PPV is not considered the appropriate measurement for evaluating the human response to vibration as it is typically used for construction noise monitoring. RMS is used to evaluate human response, since it takes some time for the human body to respond to vibration signals. The standard measurable units for velocity are in mm/s. Measuring the PPV is mostly used for representation of vibration when the pressure wave passes through the particles.

(b) Sampling Period, Frequency, and Parameters

230. The vibration measurement has been carried out at 8 locations (identified sensitive receptors) located near the alignments as shown **Table 4-15**, using portable Vibration Meter 2040. At each location vibration measurement was carried out for 15-20 minutes continuously during peak period of traffic. Measurement was taken in accordance with applicable standards IS11724 and international standards ISO 2372:1974, VDE 2056 of BS 4675 which specify the manner in which mechanical vibrations are to be measured. Some photographs taken during vibration monitoring in the Study area are shown as **Figure 4-14**. Sampling locations taken for Vibration monitoring, at PCMC to Nigdi (Phase-1 Extension), **Figure 4-15**

Table 4-15: Vibration Sampling Locations of PCMC to Nigdi (Phase-1 Extension)

Sampling Code	Sampling Location	Significance	Latitude	Longitude
VB1	Bhakti Shakti Metro Station	Metro Station	18°39'55.09"N	73°46'20.46"E
VB2	Vidyanand Bhavan High School	Sensitive Receptor - Educational	18°39'40.58"N	73°46'30.32"E
VB3	Diwan Hospital Pune	Sensitive Receptor - Healthcare	18°39'35.73"N	73°46'38.20"E
VB4	Star Hospital, Akurdi	Sensitive Receptor - Healthcare	18°39'6.87"N	73°47'0.86"E
VB5	Khandoba Mandir / Akurdi Metro Station	PCR - Temple	18°39'2.70"N	73°47'7.01"E
VB6	Aegis Multispeciality Hospital	Sensitive Receptor - Healthcare	18°38'56.35"N	73°47'12.56"E
VB7	Chinchwad Metro Station	Metro Station /	18°38'20.83"N	73°47'42.50"E

Sampling Code	Sampling Location	Significance	Latitude	Longitude
	/ Shri Mahalaxmi Aai temple	PCR - Temple		
VB8	Hanuman Mandir, Chinchwad (End of Alignment)	PCR - Temple	18°38'5.48"N	73°47'56.08"E

Figure 4-14: Some Photographs taken during Vibration Monitoring in the Study Area

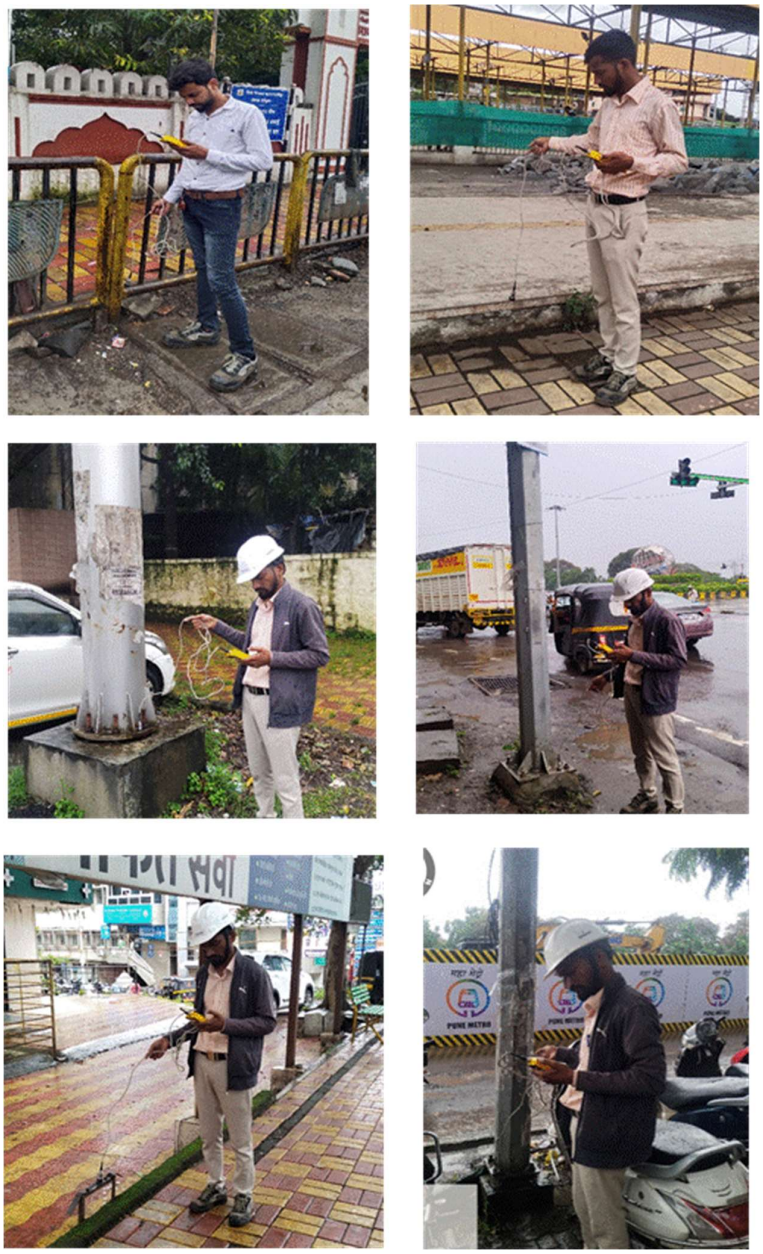
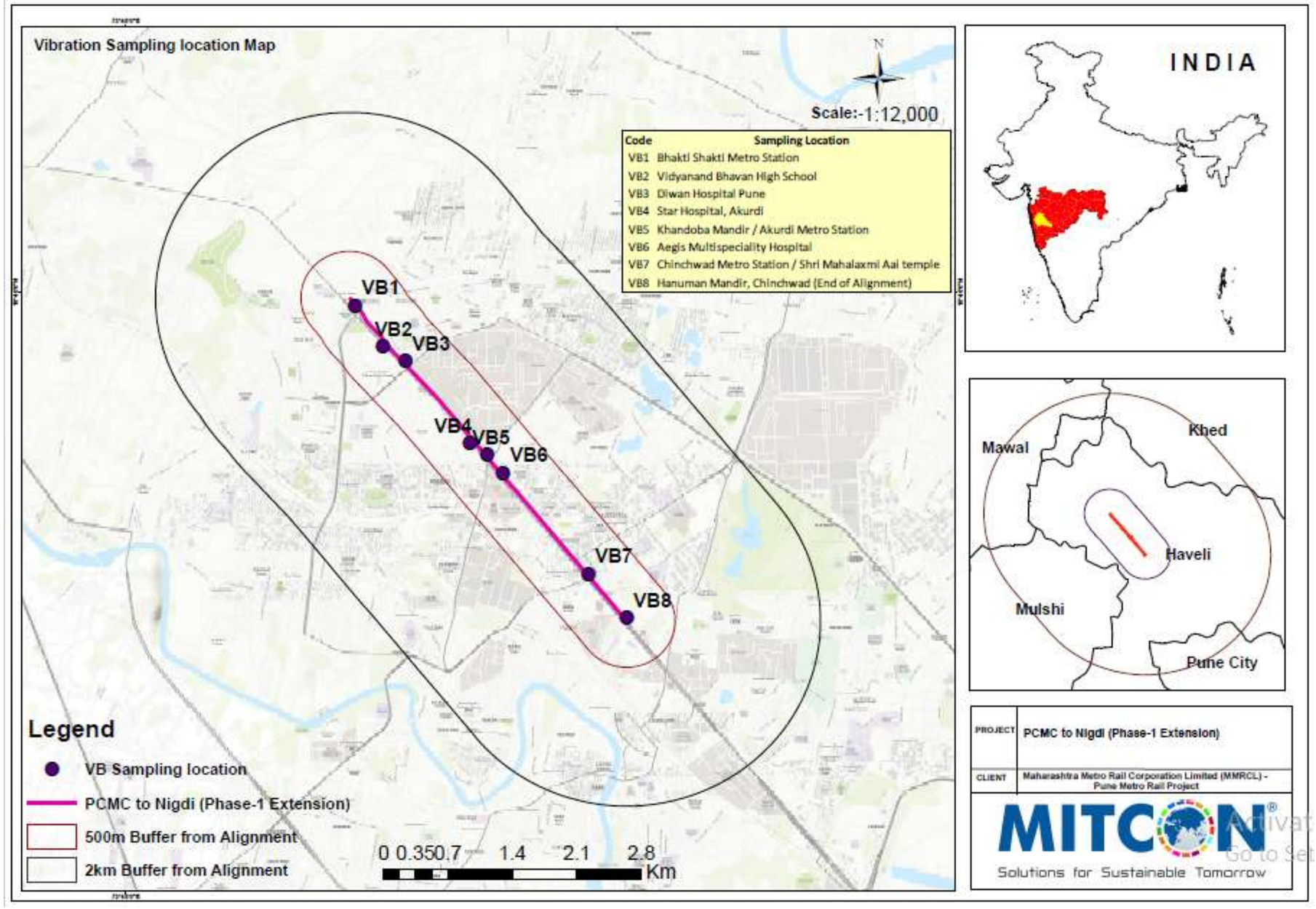


Figure 4-15: Vibration Sampling Locations for PCMC to Nigdi (Phase-1 Extension)



(c) Vibration Sampling Results

231. All structures are built with sturdy materials, so vibrations are unlikely to cause any cracks. As such, the risk of cracks or structural issues due to typical levels of vibration is minimal. The induced ground vibration levels measured are summarized in **Table 4-16**.

Table 4-16: Baseline Vibration levels along PCMC to Nigdi (Phase-1 Extension)

Sampling Code	Sampling Location	PPV (Maximum) in mm/s
VB1	Bhakti Shakti Metro Station	0.8
VB2	Vidyanand Bhavan High School	0.5
VB3	Diwan Hospital Pune	0.4
VB4	Star Hospital, Akurdi	0.5
VB5	Khandoba Mandir / Akurdi Metro Station	0.1
VB6	Aegis Multispeciality Hospital	0.6
VB7	Chinchwad Metro Station / Shri Mahalaxmi Aai temple	0.3
VB8	Hanuman Mandir, Chinchwad (End of Alignment)	0.3

232. The observed levels at all 8 locations are well below the building vibration damage criteria for construction relevant to structures existing at those location (level of PPV 5 mm/sec has been mentioned in ESMP as the permissible upper level to be maintained by the contractor during construction, as per the guidelines of the Central Institute of Mining and Fuel Research (CMFRI or CMRI) w.r.t. Vibration as shown in **Table 4-17**. The measured levels are also below limits set by Directorate General of Mines Safety (DGMS), GoI as shown in **Table 4-18** (which are more relevant for blasting during construction). Other pertinent National and International standards, such as those by the Metro Rail Transit System Guidelines for Noise and Vibrations, (RDSO) India, September 2015 (**Table 4-19**) based on the FTA Transit Noise and Vibration Impact Manual, September 2018, the Caltrans Guidelines for Vibration Damage Potential Threshold Criteria given in the Transportation and Construction Vibration Guidance Manual, Caltrans, September 2013 (**Table 4-20**) and the Human Response to typical levels of Ground-Borne Vibration (**Figure 4-16**) given in the FTA Transit Noise and Vibration Impact Manual, September 2018 (**Figure 4-17**) are also provided for reference.

Table 4-17: CMFRI guidelines w.r.t. Vibration[28]

Type of structures	PPV (mm/s)	
	<24 Hz	>24 Hz
Domestic houses, dry-wall interior, construction structures with Cemented, bridge	5.0	10.0
Industrial buildings, steel or reinforced concrete Structures	12.5	25.5
Object of historical importance, very sensitive Structures, more than 50 years old construction and Structures in poor state condition	2.0	5.0
IS 14881:2001		
Soil, weathered or soft conditions : 70 mm/s		
Hard rock conditions : 100 mm/s		

Table 4-18: Directorate General of Mines Safety (DGMS) guidelines w.r.t. Vibration29

Type of structure	Vibration (mm/s) for dominant excitation frequency, Hz*		
	< 8Hz	8-25Hz	>25Hz
(A) Buildings / structures not belonging to the owner			
Domestic houses/structures (kuccha, bricks &	5	10	15

[28] *Source: Central Institute of Mining and Fuel Research (CMFRI) guidelines w.r.t. Vibration (Dhar et al, 1993)*
[29] *Source: DGMS (Tech) (S&T) Circular No. 7 of 1997.*

cement)			
Industrial building	10	20	25
Objects of historical importance & sensitive Structures	2	5	10
(B) Buildings belonging to the owner with limited span of life			
Domestic houses/structures	10	15	20
Industrial buildings	15	25	50

* PPV = 2πfA, in which f = frequency (Hz) and A = displacement (mm)

Table 4-19: Recommended Criteria for Ground-borne Vibration & Noise for General Assessment30

Land use category	Ground-borne Vibration Impact Levels (VdB ref=25.4μ mm/s)	Ground-borne Noise Impact Levels (dB ref 20 μ Pa)
Category 1: Buildings where vibration would interfere with interior operations	65 VdB	N/A*
Category 2: Residences and buildings where people normally sleep	72 VdB	35 dBA
Category 3: Institutional land uses with primarily day time use	75 VdB	40 dBA
Vibration sensitive equipment is not sensitive to ground-borne noise		

Table 4-20: Caltrans Guidelines for Vibration Damage Potential Threshold Criteria31

	Maximum PPV (in/sec)	
Structure and Condition	**Transient Sources**	**Continuous/Frequent Intermittent Sources**
Extremely fragile historic buildings, ruins, ancient monuments	0.12	0.08
Fragile buildings	0.2	0.1
Historic and some old buildings	0.5	0.25
Older residential structures	0.5	0.3
New residential structures	1.0	0.5
Modern industrial/commercial buildings	2.0	0.5

Note: Transient sources create a single isolated vibration event, such as blasting or drop balls. Continuous/frequent intermittent sources include impact pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment.

[30] *Source: Metro Rail Transit System Guidelines for Noise and Vibrations, RDSO India, Sept 2015.*
[31] *Source: Transportation and Construction Vibration Guidance Manual, Caltrans, Sept 2013.*

Figure 4-16: Human Response to typical levels of Ground-Borne Vibration (GBV)32

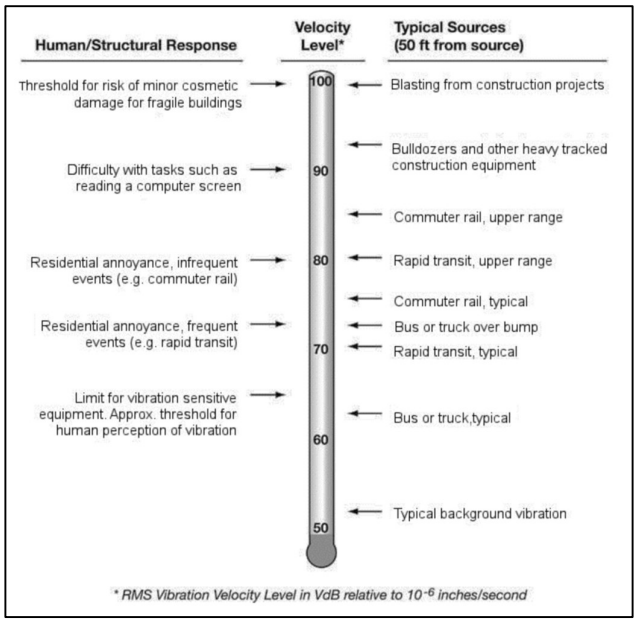


Figure 4-17: GBV and GBN Impact Criteria for General Assessment33

Land Use Category	GBV Impact Levels (VdB re 1 micro-inch /sec)			GBN Impact Levels (dB re 20 micro Pascals)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB[4]	65 VdB[4]	65 VdB[4]	N/A[4]	N/A[4]	N/A[4]
Category 2: Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

Notes:
1. "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
2. "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.
3. "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.
4. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.
5. Vibration-sensitive equipment is generally not sensitive to ground-borne noise.

** GBV = Ground-borne Vibration; GBN = Ground-borne Noise*

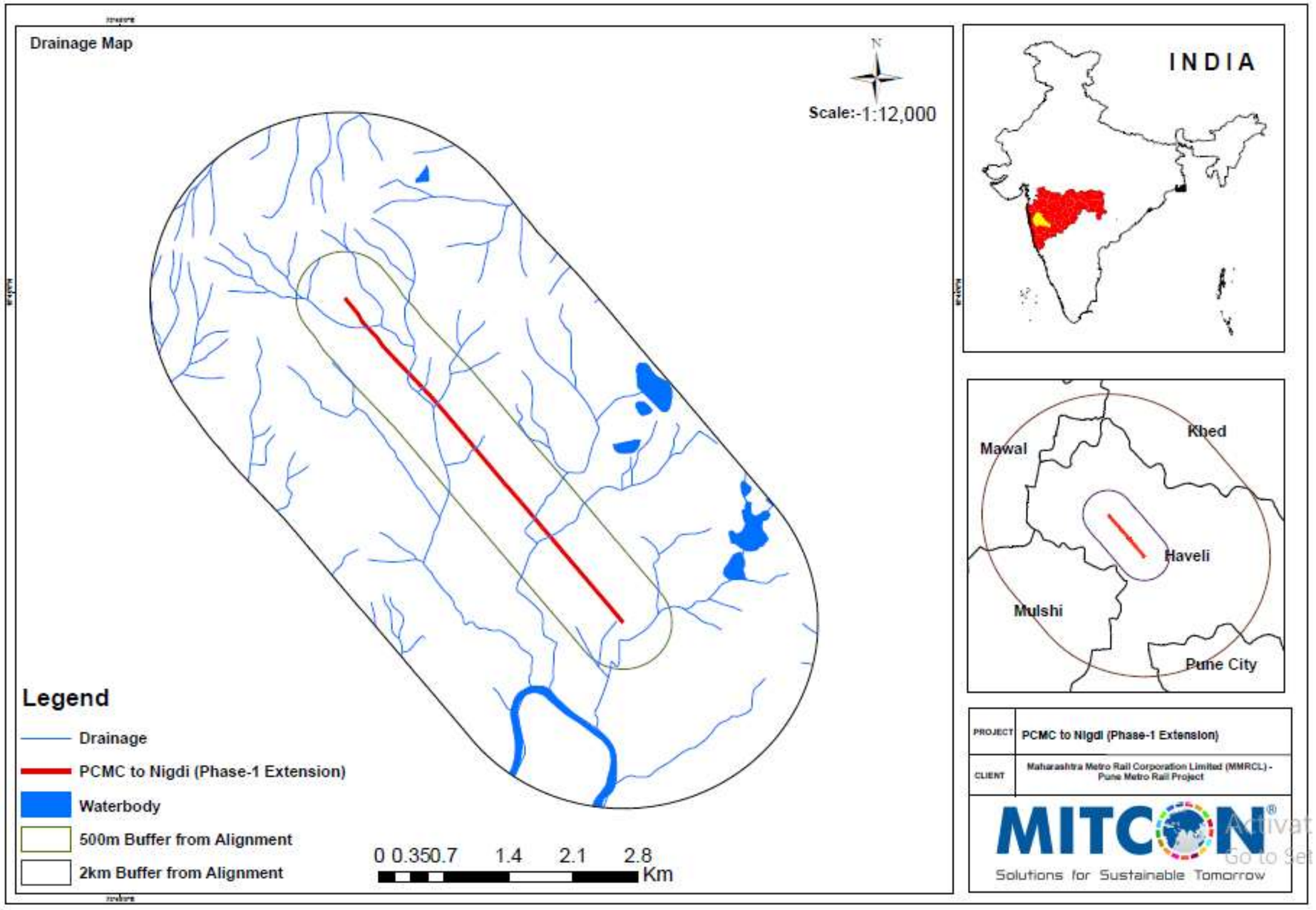
F. WATER ENVIRONMENT

1. Hydrology / Drainage

233. The district has three major drainage systems: (i) Bhima-Ghod, with the Bhima River (355 km) and Ghod River (196 km); (ii) Mula-Mutha, covering 242 km; and (iii) Nira, with a total length of 231 km. Pawana River is nearest to the Alignment lying at distance of 1 km due South west of proposed Chinchwad Metro Station. Indrayani River 5.15 km due East from Bhakti Shakti proposed metro station. Other significant rivers include Andhra, Karna, Shivganga, Pushpavati. The semi-dendritic drainage pattern is dense, and the district is divided into 71 watersheds based on geomorphology and drainage. Drainage pattern in 500m radius around the alignment is shown in **Figure 4-18**.

[32] *Source: FTA Transit Noise and Vibration Impact Manual, September 2018.*
[33] *Source: Transit Noise and Vibration Impact Assessment, US FTA, May 2006 and Transit Noise and Vibration Impact Assessment Manual, Federal Transit Administration, September 2018*

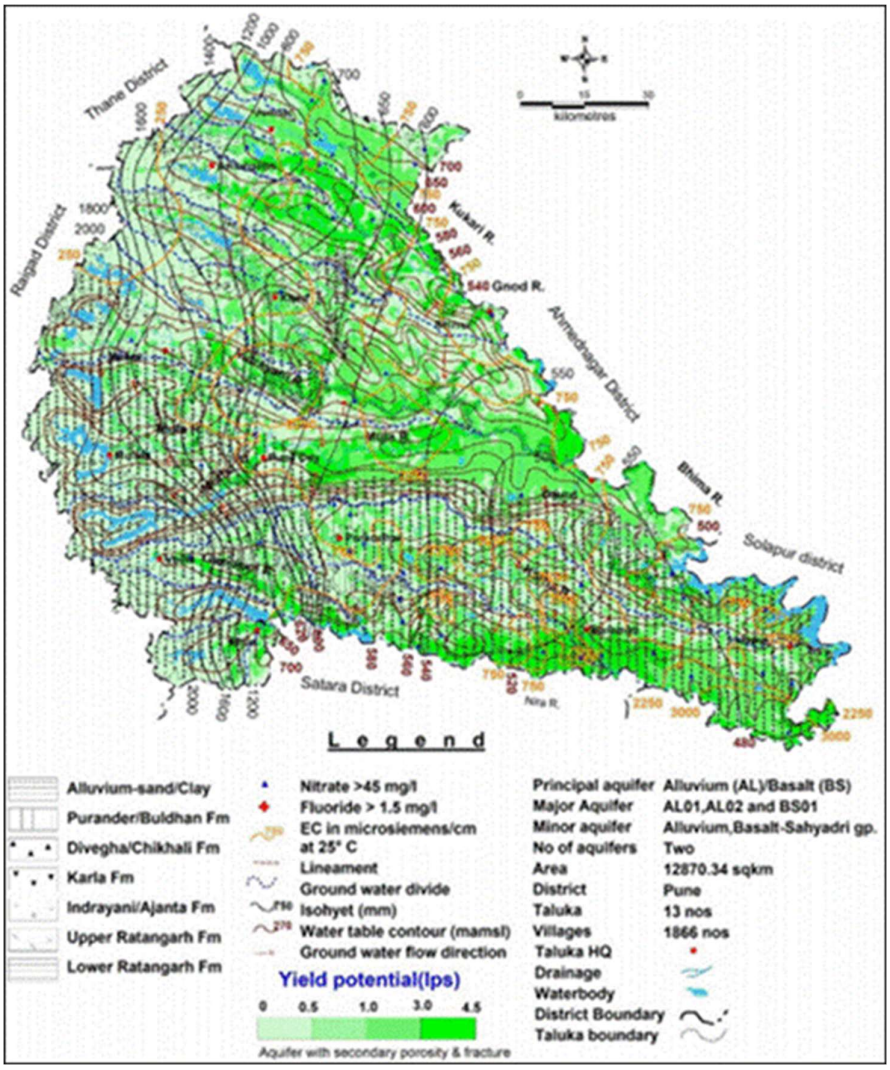
Figure 4-18: Drainage Pattern in 2km study area of PCMC to Nigdi (Phase-1 Extension)



2. Hydrogeology and Groundwater[34]

234. Alluvium and Basalt aquifers are the main aquifers in the district. Two aquifer Systems in Basalt and one shallow aquifer in Alluvium (limed to river banks) are found to be prevailing in the district. Deccan Trap Basalt of upper Cretaceous to lower Eocene age is the major rock formation in the district, whereas only a very narrow belt confined to the banks of rivers is underlain by Recent Alluvium. A map depicting hydrogeological features of Pune district is presented in **Figure 4-19**. In Alluvial deposits, inter pore spaces constitutes the potential water bearing zones and prevalence of sand and gravels renders them a high degree of porosity and permeability and make them a potential ground water reservoir. However, alluvium occurrence is restricted to narrow belts along the banks of major river courses and has limited depth. The older Alluvium, which is more clayey with thin horizons of sand and silt, forms a comparatively lesser potential aquifer. Ground water in Alluvium occurs mostly under water table and also under semi-confined to confined conditions in certain places. Shallow Aquifer occurs from 2 to 32 m BGL depth with shallow water levels. The yield varies from 50-300 m3/day.

Figure 4-19: Hydrogeology of Pune District



[34] *Source: CGWB Report on Aquifer Mapping and Management of Ground Water Resources in Ambegaon, Baramati, Indapur, Junnar And Purandar Blocks, Pune District, Maharashtra*

(a) Groundwater bearing Formations

235. **Deccan Trap Basalts:** Almost the entire district is underlain by Deccan Volcanic Basalts belonging to Sahyadri Group of Upper Cretaceous to Eocene age, comprises of various lava flows, which can be classified in the field into two types as simple and compound flows. The compound flows occur at lower elevations whereas the simple flows are confined to the elevation above 680 m. The compound flows although vesicular and amygdaloidal in nature, hard and compact in their middle sections. They are fractured and jointed, and show moderate degree of weathering at places. Each individual lava flow consists of lower massive part becoming vesicular /amygdaloidal towards top, ranges in their individual thickness from a few centimetres to tens of meters. The flows have wide variation in colour and texture especially when they are amygdaloidal in nature with secondary mineral infillings such as Zeolites, calcite, and Agate and Chalcedony etc. The red /green/black bole beds constituting the marker horizons separating the two flows were discontinuous and generally inconsistent. The basalts are intruded by dykes and are found commonly in pahoehoe flows in the area. The dykes vary in thickness from one or two meters to as much as 10 meters and extend for long distances. The dykes display the joints parallel to the walls, at right angle to the walls besides horizontal ones, with chilled margins. The dykes act as barrier or as water conduits / pathways for the movement of groundwater flow depending on intensity of fracturing in the dyke rock. The location and orientation of the dykes with respect to the groundwater flow are very important.

236. **Alluvium**: Alluvium, belonging to the Quaternary period forms a very productive aquifer in the district. The alluvial deposits are restricted as narrow belts along the banks of major river courses like Bhima and their tributaries. The alluvium occurs in patches in paleo-depressions. These shallow alluvium deposits comprise of loose or semi-consolidated medium to coarse grained sands, gravels, fine silt with admixture of clays resting directly on the massive, weathered or amygdaloidal zones of the basaltic lava flows.

(b) Water Level Scenario:

237. In Pune District, the water table varies from 480 m amsl in south-eastern part of the area to about 700 m amsl in Northwest of study area, near river Bhima. The overall ground water movement in the area is from west to southeast and tends to flow towards surface drainages. It has been observed that the ground water flow direction follows the drainage and topography of the area. This indicates the topographic control for the ground water movement. The water level scenario in the district is shown below:

Pre-monsoon Depth to Water Level (May-2017)	: 0.90 to 30.35 m BGL
Post-monsoon Depth to Water Level (Nov.-2017)	: Ground level to 25.20 m BGL
Pre-monsoon Water Level Trend (2008-2017)	: Rise: 0.0001 to 0.750 m/year
	: Fall: 0.0116 to 0.42 m/year
Post-monsoon Water Level Trend (2008-2017)	: Rise: 0.0012 to 1.588 m/year
	: Fall: 0.0028 to 0.6992 m/year

(c) Major Ground Water Problems and Issues:

238. About 50 % area of Pune district falls under the ‘Rain Shadow’ zone. Long-term rainfall data analyses reveal that the eastern-, southern-, south-eastern, central- and north-central parts of the district around Indapur, Baramati, Jujuri, Daund, Talegaon Dhamdhare, Alandi, Shirur and Bhor talukas, covering about 50% geographical area, experiences drought conditions. Therefore, these areas are classified as ‘Drought Prone Areas’. Decadal pre-monsoon water level trend (2008-17) reveals that by and large, during pre-monsoon periods, 65 % of the area and during post monsoon periods, about 68 % of the area shows fall in water levels. Falling trend of water level is observed in major parts of Pune City, Haveli, Khed, Junnar, Daund, Indapur, Baramati, Purandhar, Bhor, Velhe, Mulsi and Maval Talukas of the

district.

(d) Groundwater Prospects & Block Categorisation:

239. The prominent hill ranges, isolated hillocks, undulation etc. give rise to higher run off conditions in the district. The predominance of hard rock formation in the form of basaltic lava flows facilitates the run off rather than natural recharge due to the poor ground water storage and transmission capabilities. As such ground water development in the region is low to moderate. Most of the dug wells become dry during peak summer. The bore wells range in depth from 45 to 90 m BGL and have been drilled in most of the villages in the district.

3. Water Quality Analyses

240. The development of any region is dependent on the availability of sufficient water resources, as developmental activities require water for construction, domestic and other purposes. Water environment consists of water availability in the form of surface- and ground water resources, its quality and use (both present and intended). The water resources in the PCMC to Nigdi project study area broadly fall into following categories:

(i) Surface Water resources: Rivers/ Lakes.
(ii) Ground Water resources: Dug Wells (open and covered) / Bore wells / Hand pumps.

241. Surface Water and Groundwater quality within 2 Km radius of the PCMC to Nigdi buffer zone, as well as along the alignments, has been studied for assessing the water environment and to evaluate the anticipated impact of the proposed project.

242. Water quality of the project area may get affected due to various factors like sedimentation & deposition of natural organic material, nutrients, bacteria & toxic substances, etc. Study of the water environment is essential in preparation of ESIA for identification of critical issues including planning the mitigation measures with a view to have optimum use of the water resources. Assessment of baseline data of the Water environment (both surface- and ground-water) in a study area includes:

(i) Identification of surface water sources
(ii) Identification of ground water sources
(iii) Collection of water samples
(iv) Analysing water samples for physico-chemical and biological parameters
(v) In this context, 4 groundwater samples and 3 surface water samples were collected from the study area for analysis of existing water quality in the area.
(vi) The criteria for selection of sites for water sampling was based on the following rationale:
(vii) To characterize the groundwater in the study area in terms of location, behaviour, and quality.
(viii) To identify potential effects of road construction and operation activities on groundwater regime of the area and any potential effects of groundwater quality on road construction and integrity.
(ix) To identify measures to avoid, mitigate and manage any potential effects including any relevant design features of the road or techniques for construction.
(x) To identify residual effects of Project construction and operation activities on groundwater in the project area.

243. The surface and ground water quality of the project area may get affected due to various factors like sedimentation & deposition of natural organic material, nutrients, bacteria & toxic substances, etc. These contaminants can contribute to water by either point or non-

point sources. Point sources contribute contaminants from a discrete site, such as the outflow from a pipe, ditch, well, leakages in storage lagoons, storage of solid waste, etc. These sources can be controlled by treatment at or before the point of discharge. Non-point sources, on the other hand include the atmosphere, agricultural areas, golf courses, residential developments, roads, parking lots, and contributions from groundwater along lengthy reaches of streams.

(a) Monitoring Stations for Water Quality Assessment

244. Water quality sampling was carried out in the month of July 2024. During the study period, few surface water bodies were found within the project study area i.e. in 2 km radius of the alignment.

245. The details of sampling locations for Surface water and Groundwater samples are shown in **Table 4-21** and **Table 4-22,** respectively. Sampling locations for Surface water samples for PCMC to Nigdi (Phase-1 Extension) depicted in **Figure 4-20** while those for Ground water samples are shown in **Figure 4-21.**

Table 4-21: Monitoring Stations for Surface Water Quality Assessment

Sampling Code	Sampling Location / Type	Latitude	Longitude
SW1	Lake at LIG Colony, Nigdi	18°39'23.19"N	73°46'14.59"E
SW2	Bird Valley Lake (South)	18°39'17.19"N	73°48'2.29"E
SW3	Pavana river (D/S)	18°37'38.63"N	73°47'32.86"E

Table 4-22: Monitoring Stations for Ground Water Quality Assessment

Sampling Code	Sampling Location
GW 1	Bhakti Shakti Metro Station
GW 2	Nigdi Metro Station
GW 3	Akurdi Metro Station
GW 4	Chinchwad Metro Station

Figure 4-20: Surface Water monitoring locations for PCMC to Nigdi (Phase-1 Extension)

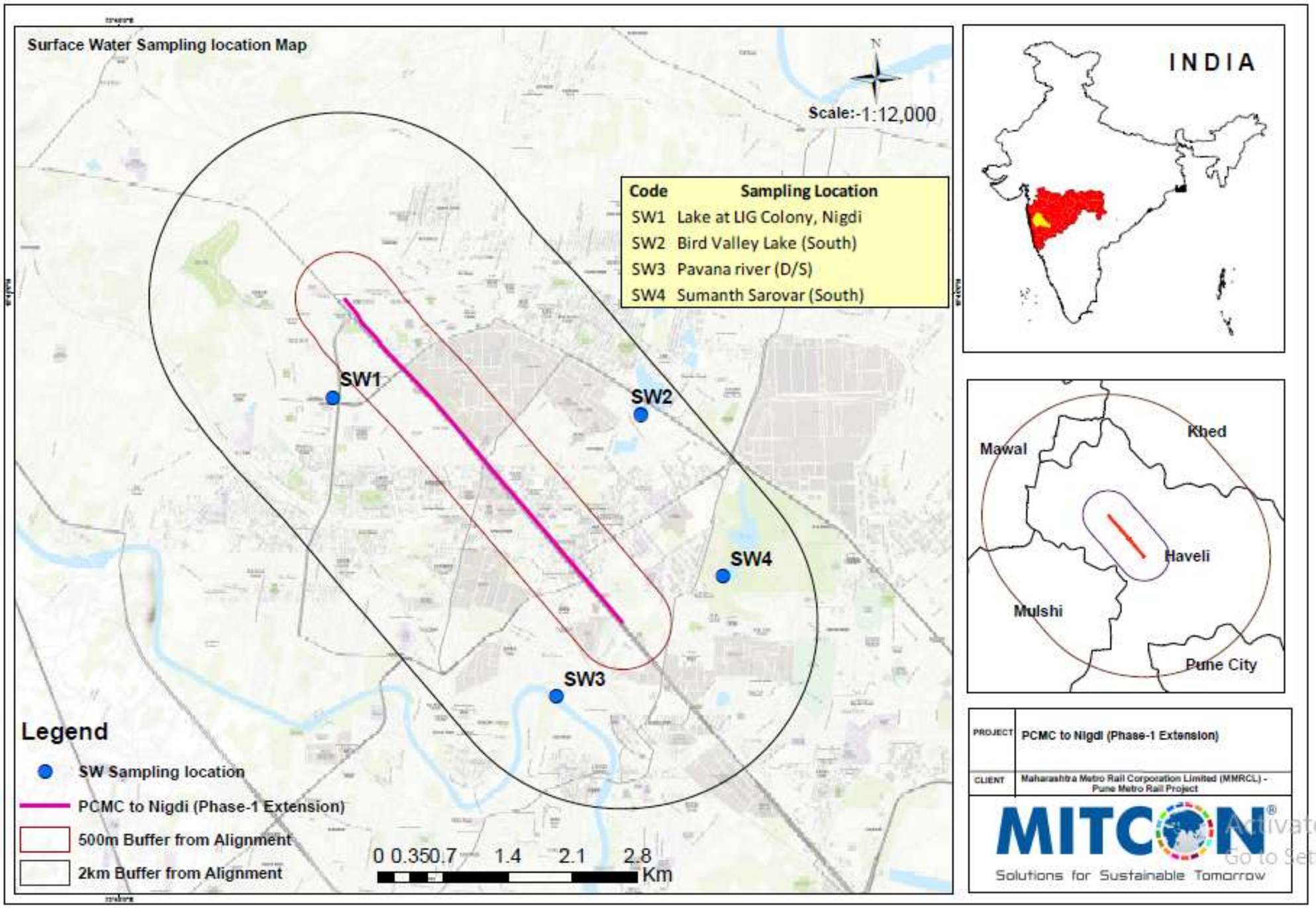
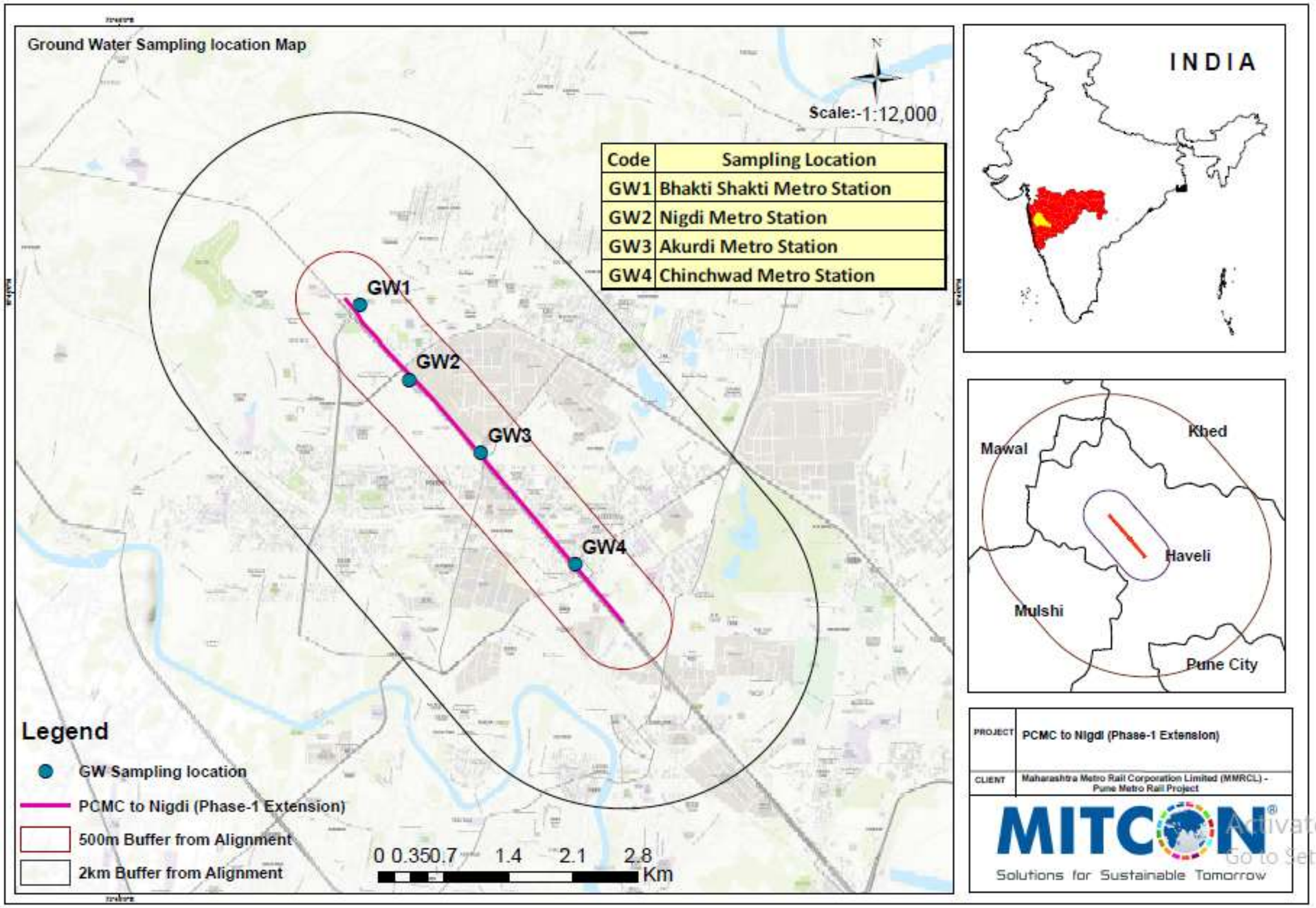


Figure 4-21: Groundwater monitoring locations for PCMC to Nigdi (Phase-1 Extension)



246. Some photographs taken during surface and groundwater quality, in the study area are presented in **Figure 4-22** and **Figure 4-23** respectively.

Figure 4-22: Some Photographs Showing Surface Water Quality Monitoring

Figure 4-23: Photographs Showing Groundwater Quality Monitoring

(b) Water Quality Analyses Results

247. Summary of the results of important Surface Water quality & Groundwater quality parameters are given in **Table 4-23** and **Table 4-24**, respectively. Detailed results of all parameters analysed are given in **Annexure-3**.

Table 4-23: Summary of Surface Water Quality Analyses for PCMC to Nigdi (Phase-1 Extension)

Sample Code	Potability	Chemical										Bacteriological	
	Parameter	pH at 25 °C	Electrical Conductivity at 25 °C	Total Dissolved Solids	Total Solids	Total Hardness as $CaCO_3$	Chloride as Cl^-	Fluoride as F	BOD	COD	Dissolved Oxygen	Total Coliforms	E-coli
	Units	-	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	Per 100 ml	Per 100 ml
SW1	Lake at LIG Colony, Nigdi	7.27	248.46	143	149	71.14	10.15	<0.1	7	13	4.5	Present	Absent
SW2	Bird Valley Lake (South)	7.18	414.2	289	301	137.89	12.68	<0.1	10	32	4	Present	Present
SW3	Pavana river (D/S)	7.18	341.5	185	193	95.78	14.56	<0.1	9	27	4.3	Present	Present

Designated Best Use Water Quality Criteria:		
Drinking water source without conventional treatment but after disinfection	A	Total coliforms less than 50 MPN/100ml; pH between 6.5 and 8.5; DO 6 mg/ or more; BOD 2 mg/l or less
Outdoor bathing (organised)	B	Total coliforms less than 500 MPN/100ml; pH between 6.5 and 8.5; DO 5 mg/ or more; BOD 3 mg/l or less
Drinking water source after conventional treatment and disinfection	C	Total coliforms less than 5000 MPN/100ml; pH between 6 and 9; DO 4 mg/ or more; BOD 3 mg/l or less
Propagation of wildlife and fisheries	D	pH between 6.5 and 8.5; DO 4 mg/l or more; Free ammonia (as N) 1.2 mg/l or less
Irrigation, industrial cooling, controlled waste disposal	E	pH between 6 and 8.5; EC max. 2250 µS/cm; Sodium absorption ratio max. 26; Boron max. 2 mg/l

Table 4-24: Summary of Groundwater Quality Analyses for PCMC to Nigdi (Phase-1 Extension)

Sample Code	Potability	Chemical							Bacteriological	
	Parameter	pH at 25 °C	Electrical Conductivity at 25 °C	Total Dissolved Solids	Total suspended Solids	Total Hardness as $CaCO_3$	Chloride as Cl^-	Fluoride as F	Total Coliforms	E-coli
	Units	-	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	Per 100 ml	Per 100 ml
	IS:10500:2012 Required Standards	6.50 to 8.50	N.S.	≤ 500	N. S	≤ 200	≤ 250	≤ 1.0	Absent	Absent
GW 1	Bhakti Shakti Metro Station	7.45	505.42	373	<5	165.14	21.57	<0.1	Absent	Absent
GW 2	Nigdi Metro Station	7.32	643.2	383	<5	174.52	42.16	<0.1	Absent	Absent
GW3	Akurdi Metro Station	7.34	583.9	391	<5	189.25	48.25	<00.1	Absent	Absent
GW4	Chinchwad Metro Station	7.39	396.8	195	<5	98.13	22.42	<0.1	Absent	Absent

(c) Water Quality Inferences

248. For any water body to function adequately in satisfying the desired use, it must have corresponding degree of purity. Drinking water should be of highest purity. Each water use has specific quality need. Therefore, to set the standard for the desire quality of a water body, it is essential to identify the uses of water in that water body. In India, the CPCB has developed a concept of designated best use (see **Table 4-24**). According to this, out of the several uses of water of a particular body, the use which demands highest quality is termed its designated best use.

(i) The surface water samples analysed from various locations within the Project Study Area indicate varying levels of water quality. For instance, the lake at LIG Colony, Nigdi (Sample SW1) and Bird Valley Lake (Sample SW2) exhibit moderate levels of total dissolved solids and hardness, along with the presence of coliform bacteria, suggesting potential contamination. Similarly, the Pavana River (Sample SW3) downstream location shows comparable characteristics, with the presence of coliforms and moderate concentrations of dissolved solids and hardness. These water bodies likely fall under the lower water quality classification, specifically Class "E," which is suitable for irrigation and controlled waste disposal, due to the presence of coliforms and moderate dissolved oxygen (DO) levels

(ii) The measured values for groundwater were compared with IS 10500:2012. Groundwater samples from Bhakti Shakti Metro Station (GW1), Nigdi Metro Station (GW2), Akurdi Metro Station (GW3), and Chinchwad Metro Station (GW4) were compared with the IS 10500:2012 standards. The analyses show that most chemical parameters, such as pH, electrical conductivity, and total dissolved solids, are within permissible limits, though there are exceedances in total hardness in some cases.

G. ECOLOGY AND BIODIVERSITY

1. Introduction and Study Area

249. An ecological study is essential to understand the impact due to project development activities on flora and fauna of the area. The proposed Project alignment does not pass through any reserve / protected forest in its entire stretch. Moreover, no protected areas / environmentally sensitive areas are found in the Indirect or Secondary Influence zone (10 km radial distance around the alignment). Following was carried out as part of the detailed ecology and biodiversity study for proposed project.

(i) **Vegetation Study.**
  (a) Listing of floral diversity
  (b) Listing of affected trees

(ii) **Faunal Study.** 10 km from alignment as per guidelines of MoEF&CC.

(iii) **Habitat Analysis Study.** 2 km buffer study area around each of the four alignments

2. Period of Studies

250. Ecology and Biodiversity studies were carried out from July to August 2024. The avian studies were conducted during the dawn and dusk period, the nocturnal studies during the night and the mammalian & butterfly studies were conducted during various period of the day. **Table 4-25** gives the study period for all the ecological studies carried out.

Table 4-25: Summary of the Ecological Studies Carried Out

Sl. No.	Type of Study / Faunal Class	Particulars	Methods	Sampling (Month)
1	Floral		Listing and Affected count due to proposed alignment	July 2024 & August 2024
2	Mammals	Terrestrial	Listing	July 2024 & August 2024
3	Birds	Terrestrial and Aquatic	Listing & Visual Encounter Survey	July 2024 & August 2024
4	Reptiles	Terrestrial and Aquatic	Listing & Visual Encounter Survey	
5	Amphibians	-	Listing & Visual Encounter Survey	
6	Insects	Butterfly and Dragonfly	Listing	
7	Fishes	-	Listing, Market Survey & Discussion with Local fishermen	
8	Riparian & Aquatic ecology	Floral & faunal	Listing	July 2024 & August 2024

3. Approach & Methodologies of the Studies

(a) Approach to the Study

251. Data collection on the status of flora and fauna in the project study area are mandatory and a primary requirement of ESIA studies. EB study was carried as per guidelines of MoEF&CC, CPCB, World Bank & EIB. Type, location and characteristics of sensitive flora and fauna were studied. Studies on both terrestrial and aquatic ecology was carried out as described in this section.

(b) Methodology for Floral Studies

(i) Affected tree species were identified due to proposed alignment with GBH & GPS locations

(ii) Individual species were identified including trees, shrubs, herbs & climbers by observing the species randomly from the study area (i.e., 500) m radius form the alignments).

(c) Methodology for Aquatic Ecology Study

252. **Aquatic Flora.** Listing of aquatic floral diversity has been carried at various locations by random Sampling Method.

253. **Aquatic Fauna**

A. Fish Survey

254. Listing of fish diversity through market survey and consultations with fishermen has been carried out. Local fishermen were visited and discussion regarding the presence of fishes in the local ponds/Nallahs/streams/river was done. Also, discussion was carried out with the fish vendors regarding species found in the local ponds. Photographs of local fish varieties

were taken.

(d) Methodology for Terrestrial Faunal Studies

255. Information has been gathered through the following sources:

(i) Desktop Study
   a. Scientific Literature search for biodiversity & ecological studies in the project region, on websites;

(ii) Field Study
   a. In absence of detailed secondary data availability within the project direct influence area, Primary Ecological & biodiversity surveys / studies have been conducted to collect up-to-date baseline data.

(iii) Discussions and meetings with following stakeholders
   a. Local Community
   b. Fishermen

(e) Methodology for Faunal Field Studies

256. For carrying out faunal surveys, sites were chosen based on the available access and to cover entire 10 km radius around proposed alignments.

257. Visual Encounter Survey Method: The survey to understand the presence of fauna like Mammals / Birds / Reptiles / Amphibians / Butterflies / Insects in the project area has been carried out using Visual Encounter Survey Method at various locations around the proposed alignments.

(f) Gardens in the PCMC

258. The nearest gardens from the proposed alignments has been identified and marked on google. List of gardens in the study area is also enumerated (**Table 4-37)**

4. Floral Studies

259. Summary of the Floral Diversity found in the Project study area is given as follows:

Floral Diversity	• A total of 258 trees are likely to be affected during construction of the Project, of which 104 are at the station entry-exit portals and the remaning 154 are along the road medians (alignment) • 448 species (211 trees, 110 Herbs, 69 Shrubs, 58 climbers) found in the Project study area.

(a) Trees likely to be affected

260. Trees likely to be affected Metro Line. About 258 trees will be affected due to site construction activities along the Pimpri to Nigdi proposed Metro alignment (104 at the proposed station entry-exit portals, and 154 along the alignment). Girth-wise summary of all trees likely to be affected along the entire project alignment is presented as **Table 4-26** (154 trees) and **Table 4-27** (104 trees), while the detailed lists of the same are given in **Annexure-12**.

261. Among the 258 affected trees found along the proposed alignment, most trees exist along the road on sides and median. The predominant tree species found are *Caryota urens* L.*, Ficus benghalensis* L.*, Ficus benjamina* L.*, Ficus religiosa* L.*, Holoptelea integrifolia* (Roxb.)

Planch., *Melaleuca viminalis* subsp. *viminalis, Peltophorum pterocarpum* (DC.) Baker, *Samanea saman* (Jacq.) Merr., *Spathodea campanulata* P. Beauv., *Tabebuia pentaphylla* Hemsl., *Azadirachta indica* A. Juss., etc.

Table 4-26: Girth-wise Summary of Trees Likely to be Affected along PCMC to Nigdi Metro Line

Girth size (in cm)						Total
0 – 30	31 – 60	61 – 90	91 – 120	121 – 150	> 150	
8	52	47	28	5	14	154

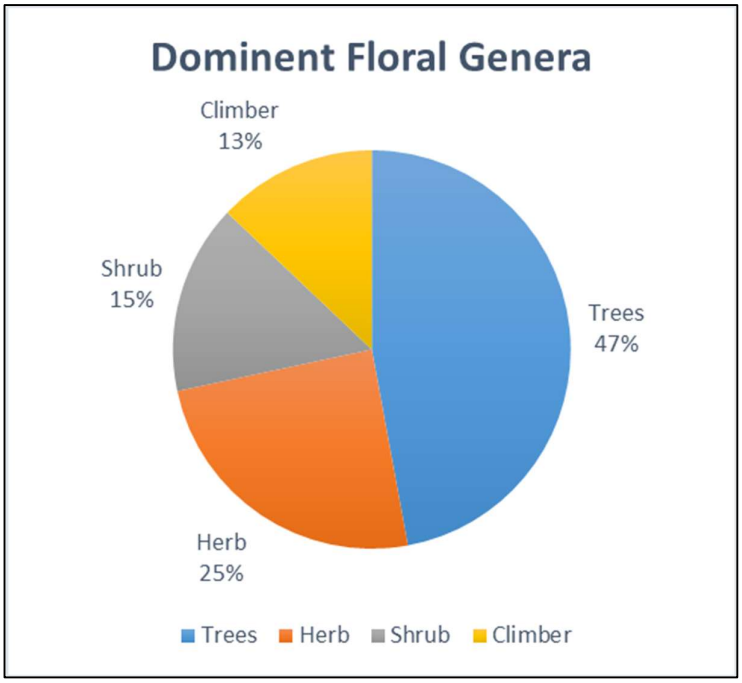
Table 4-27: Girth-wise Summary of Trees Likely to be Affected at Metro Station Entry-exit portals

Side of Alignment	Girth size (in cm)						Total
	0 – 30	31 – 60	61 – 90	91 – 120	121 – 150	> 150	
LHS	3	4	21	11	8	6	**53**
RHS	10	11	10	8	3	9	**51**
Total	**13**	**15**	**31**	**19**	**11**	**15**	**104**

(b) Floral Diversity

262. Primary data were generated by preparing a general checklist of the trees around 10 km around the proposed alignment. The study recorded overall 448 species which included 211 species of Trees, 110 species of Herbs, 69 species of Shrubs and 58 species of Climbers. Dominant genera (type of flora) found in the study area is presented graphically as **Figure 4-24:.**

Figure 4-24: Dominant genera (type of flora) found in the Project Study Area



263. As per IUCN classification, among the flora found in the project study area, two species namely *Aegle marmelos, Dalbergia melanoxylon* are categorised as Near Threatened (NT), three species namely *Khaya senegalensis, Santalum album, Saraca asoca* as Vulnerable (VU), and two species *Tectona grandis (Linn. f.), Ailanthus altissima* under Endangered (EN) category. The List of Floral Diversity in the entire study area is presented in **Table 4-28**.

Table 4-28: Floral Diversity observed in the Project Study Area

Sr.No.	Scientific Name	Common Name	Habit
Tree			
1	*Adansonia digitata L.*	African baobab	Tree
2	*Adenanthera pavonina L.*	Coral Bean Tree	Tree
3	*Aegle marmelos (L.) Correa.*	Indian Bael	Tree
4	*Ailanthus excelsa Roxb.*	Maharuk	Tree
5	*Alangium salvifolium (L.f.) Wangerin*	Sage Leaved Alangium	Tree
6	*Albizia lebbeck (L.) Benth.*	Indian Siris	Tree
7	*Albizia procera (Roxb.) Benth.*	White Siris	Tree
8	*Alstonia macrophylla Wall.ex G. Don*	Mothi Saatveen	Tree
9	*Alstonia scholaris (L.) R.Br.*	Blackboard tree	Tree
10	*Annona muricata L.*	Soursop	Tree
11	*Annona reticulata L.*	Netted Custard Apple	Tree
12	*Annona squamosa L.*	Custard Apple	Tree
13	*Antiaris toxicaria (J.F. Gmel.) Lesch.*	Upas Tree	Tree
14	*Aphanamixis polystachya (Wall.) R. Parker*	Rohituka tree	Tree
15	*Aquilaria malaccensis Lam.*	Agarwood	Tree
16	*Areca catechu L.*	Areca Palm	Tree
17	*Artocarpus altilis (Parkinson) Fosberg*	Breadfruit	Tree
18	*Artocarpus heterophyllus Lam.*	Jackfruit	Tree
19	*Averrhoa carambola L.*	Star Fruit	Tree
20	*Azadirachta indica A. Juss.*	Neem Tree	Tree
21	*Barringtonia acutangular (L.) Gaertn.*	Indian Oak	Tree
22	*Bauhinia racemosa Lam.*	Bidi leaf tree	Tree
23	*Bauhinia variegata L.*	Orchid Tree	Tree
24	*Bergera koenigii L. (Syn. Murraya koenigii (L.) Spreng.)*	Curry Tree	Tree
25	*Bixa orellana L.*	Annatto	Tree
26	*Bombax ceiba L.*	Silk Cotton Tree	Tree
27	*Boswellia serrata Roxb.*	Indian frankincense	Tree
28	*Bursera penicillata (Sesse & Moc. ex DC.) Engl.*	Torote copal	Tree
29	*Butea monosperma (Lam.) Kuntze*	Palas	Tree
30	*Callicarpa candicans (Burm.f.) Hochr.*	Beautyberry Tree.	Tree
31	*Calophyllum apetalum Willd.*	Konkan Beauty Leaf Tree	Tree
32	*Calophyllum inophyllum L.*	Ball tree	Tree
33	*Camphora officinarum Nees. (Sny. Cinnamomum camphora (L.) J. Presl.*	Camphor tree	Tree
34	*Canarium strictum Roxb.*	Black dammar	Tree
35	*Capparis grandis L. f.*	Tree Caper	Tree

Sr.No.	Scientific Name	Common Name	Habit
36	*Careya arborea Roxb.*	Wild Guava	Tree
37	*Carica papaya L.*	Papaya	Tree
38	*Caryota urens L.*	Fishtail Palm	Tree
39	*Cassia fistula L.*	Golden Shower tree	Tree
40	*Casuarina equisetifolia L.*	Whistling Pine	Tree
41	*Catunaregam spinosa (Thunb.) Tirveng.*	Mountain Pomegranate,	Tree
42	*Cedrus deodara (Roxb. ex D.Don) G.Don*	Devdar	Tree
43	*Ceiba pentandra (L.) Gaertn.*	Kadop Tree	Tree
44	*Cinnamomum tamala (Buch. -Ham.) T. Nees & C.H. Eberm*	Indian Bay Leaf	Tree
45	*Cinnamomum verum J. Presl*	True cinnamon tree	Tree
46	*Citrus aurantium L.*	Sweet Orange	Tree
47	*Citrus limon L. Osbeck*	Lemon	Tree
48	*Citrus medica L.*	Citron	Tree
49	*Commiphora caudata (Wight & Arn.) Engl.*	South-Indian Commiphora	Tree
50	*Cordia dichotoma G. Forst.*	Indian cherry	Tree
51	*Cordia myxa L.*	Assyrian plum	Tree
52	*Cordia sebestena L.*	Scarlet Cordia	Tree
53	*Cordia sinensis Lam.*	Long-Leaf Cordia	Tree
54	*Couroupita guianensis Aubl.*	Cannon Ball Tree	Tree
55	*Crateva magna (Lour.) DC.*	Large Garlic Pear	Tree
56	*Crescentia cujete L.*	Jicaro,	Tree
57	*Cycas revoluta Thunb.*	Japanese Sago Palm	Tree
58	*Dalbergia latifolia Roxb.*	Black Rosewood	Tree
59	*Dalbergia melanoxylon Guill. & Perr.*	African Blackwood	Tree
60	*Dalbergia sissoo Roxb.ex DC*	Indian Rosewood	Tree
61	*Dichrostachys cinerea (L.) Wight & Arn.*	Sickle Bush	Tree
62	*Dillenia indica L.*	Elephant Apple	Tree
63	*Diospyros blancoi A.DC.*	Butter Fruit	Tree
64	*Diospyros ebenum J. Koenig ex Retz.*	Indian Ebony	Tree
65	*Diospyros malabarica (Desr.) Kostel.*	Gaub	Tree
66	*Dolichandrone falcata (Wall.Ex DC.) |Seem*	Medhshingi	Tree
67	*Donella lanceolata (Blume) Aubrev.*	Star Apple	Tree
68	*Ehretia aspera Willd.*	Chamror	Tree
69	*Ehretia laevis Sieber ex A.DC.*	Chamror	Tree
70	*Elaeocarpus serratus L.(Syn. Elaeocarpus angustifolius Wight)*	Ceylon Olive	Tree
71	*Erythrina × bidwillii Lindl.*	Coral Bean Tree	Tree
72	*Erythrina stricta Roxb.*	Indian Coral Tree	Tree
73	*Erythrina variegata L.*	Lenten tree	Tree

Sr.No.	Scientific Name	Common Name	Habit
74	*Eucalyptus globulus Labill.*	Eucalyptus	Tree
75	*Euphorbia antiquorum L.*	Triangular Spurge	Tree
76	*Euphorbia tirucalli L.*	Pencil Tree	Tree
77	*Ficus benghalensis L.*	Banyan	Tree
78	*Ficus krishnae C. DC. (Syn. Ficus benghalensis L. var. krishnae)*	Krishna Fig	Tree
79	*Ficus lacor Buch. -Ham.*	Java Fig	Tree
80	*Ficus longifolia Schott*	narrow leaf fig	Tree
81	*Ficus racemosa L.*	Cluster fig	Tree
82	*Ficus religiosa L.*	Pipul Tree	Tree
83	*Ficus tinctoria subsp. gibbosa (Blume) Corner*	Dye Fig	Tree
84	*Firmiana colorata (Roxb.) R. Br.*	Scarlet Sterculia	Tree
85	*Flacourtia ramontchi L'Hér.*	Indian plum	Tree
86	*Garcinia indica (Thouars) Choisy*	Kokum	Tree
87	*Garcinia xanthochymus Hook.f. ex T. Anderson*	Mysore Gamboge	Tree
88	*Garuga pinnata Roxb.*	Garuga,	Tree
89	*Gliricidia sepium (Jacq.) Kunth*	Gliricidia	Tree
90	*Gmelina arborea Roxb.ex Sm.*	Gamhar	Tree
91	*Grevillea robusta A. Cunn. ex R.Br.*	Silver oak	Tree
92	*Grewia tiliifolia Vahl*	Dhaman	Tree
93	*Helicteres isora L.*	East-Indian screw tree	Tree
94	*Heterophragma quadriloculare (Roxb.) K. Schum.*	Waras	Tree
95	*Holarrhena pubescens Wall.ex G. Don*	Indrajao	Tree
96	*Holigarna arnottiana Hook.f.*	Black Varnish Tree	Tree
97	*Holigarna grahamii (Wight) Kurz*	Blistering Varnish Tree	Tree
98	*Holoptelea integrifolia (Roxb.) Planch.*	Indian Elm	Tree
99	*Hydnocarpus pentandrus (Buch. -Ham.) Oken*	Jangli Almond	Tree
100	*Jatropha curcas L.*	Physic Nut	Tree
101	*Khaya senegalensis (Desv.) A. Juss*	African Mahogany	Tree
102	*Kigelia africana (Lamk.) Benth.*	Sausage Tree	Tree
103	*Knema attenuata (Wall. ex Hook.f. & Thomson) Warb.*	Wild Nutmeg	Tree
104	*Lagerstroemia speciosa (L.) Pers.*	Pride of India	Tree
105	*Leucaena leucocephala (Lam.) de Wit*	River tamarind	Tree
106	*Limonia acidissima L.*	Wood Apple	Tree
107	*Litchi chinensis Sonn.*	Lyche	Tree
108	*Macaranga peltata (Roxb.) Mull.Arg.*	Shield-Leaf Tree	Tree
109	*Machilus glaucescens (Nees) Wight*	Large-Flowered Bay Tree	Tree

Sr.No.	Scientific Name	Common Name	Habit
110	*Madhuca indica J.F.Gmel.*	Mahua	Tree
111	*Madhuca longifolia var. latifolia (Roxb.) A. Chev.*	Indian Butter Tree	Tree
112	*Magnolia champaca (L.) Baill. ex Pierre*	Champak	Tree
113	*Magnolia liliifera (L.) Baill.*	egg magnolia	Tree
114	*Mallotus philippensis (Lam.) Müll.Arg.*	Kamala Tree	Tree
115	*Mammea suriga (Buch. -Ham. ex Roxb.) Kosterm.*	Surangi	Tree
116	*Mangifera indica L.*	Mango	Tree
117	*Manilkara hexandra (Roxb.) Dubard*	Ceylon Iron Wood	Tree
118	*Manilkara zapota (L.) P. Royen*	Chikoo	Tree
119	*Mappia nimmoniana (J. Graham) Byng & Stull*	Stinking Tree	Tree
120	*Memecylon umbellatum Burm.f.*	Ironwood tree	Tree
121	*Mesua ferrea L.*	Indian rose chestnut	Tree
122	*Miliusa tomentosa (Roxb) Finet & Gagnep*	Woolly Miliusa	Tree
123	*Millettia peguensis*	Moulmein Rosewood	Tree
124	*Mimusops elengi L.*	Spanish cherry	Tree
125	*Mitragyna parvifolia (Roxb.) Korth.*	True Kadamb	Tree
126	*Monoon longifolium (Sonn.) B. Xue & R.M.K. Saunders*	Ashok	Tree
127	*Morinda citrifolia L.*	Noni	Tree
128	*Morinda coreia Buch. -Ham. (Syn. Morinda pubescens Sm.)*	Indian Mulberry	Tree
129	*Moringa oleifera Lam.*	drumstick tree	Tree
130	*Morus alba L.*	White Mulberry	Tree
131	*Muntingia calabura L.*	Jam tree	Tree
132	*Murraya paniculata (L.) Jack*	Orange Jasmine	Tree
133	*Myristica fragrans Houtt.*	Nutmeg	Tree
134	*Neolamarckia cadamba (Roxb.) Bosser*	Kadam	Tree
135	*Nyctanthes arbor-tristis L.*	Har singa	Tree
136	*Oroxylum indicum (L.) Kurz*	Indian Trumpet Flower	Tree
137	*Pandanus odorifer (Forssk.) Kuntze*	Kewda	Tree
138	*Peltophorum pterocarpum (DC.) Backer exK. Heyne*	Copperpod	Tree
139	*Persea americana Mill.*	Avocado	Tree
140	*Phoenix dactylifera L.*	Date Palm	Tree
141	*Phoenix sylvestris (L.) Roxb.*	Wild Date Palm,	Tree
142	*Phyllanthus acidus (L.) Skeels*	Star Gooseberry	Tree
143	*Phyllanthus emblica L.*	Indian gooseberry	Tree

Sr.No.	Scientific Name	Common Name	Habit
144	*Piliostigma foveolatum (Dalzell) Thoth. (Syn. Bauhinia foveolata Dalzell)*	Pore Leaved Bauhinia	Tree
145	*Pimenta dioica (L.) Merr.*	Jamaica pepper	Tree
146	*Pithecellobium dulce (Roxb.) Benth.*	Madras Thorn	Tree
147	*Pongamia pinnata (L.) Pierre*	Pongam Tree	Tree
148	*Prosopis cineraria (L.) Druce*	Khejri Tree	Tree
149	*Prunus padus L.*	Himalayan Bird Cherry	Tree
150	*Psidium guajava L.*	Gauva	Tree
151	*Pterocarpus marsupium Roxb.*	Indian Kino Tree	Tree
152	*Pterocarpus marsupium subsp. acuminatus (Prain) Thoth.*	Indian Kino Tree	Tree
153	*Pterocarpus santalinus L.f.*	Red Sandalwood	Tree
154	*Pterospermum acerifolium (L.) Willd.*	Kanak Champa	Tree
155	*Pterospermum reticulatum Wight & Arn.*	South-Indian Kanak Champa	Tree
156	*Punica granatum L.*	Pomegranate	Tree
157	*Putranjiva roxburghii Wall.*	Lucky Bean Tree	Tree
158	*Radermachera xylocarpa (Roxb.) Roxb. ex K. Schum.*	Padri Tree	Tree
159	*Ricinus communis L.*	Castor bean	Tree
160	*Salix tetrasperma Roxb.*	Indian Willow	Tree
161	*Salvadora oleoides Decne.*	Bada Peelu	Tree
162	*Salvadora persica L.*	Toothbrush Tree	Tree
163	*Samanea saman (Jacq.) Merr.*	Monkey pod tree	Tree
164	*Santalum album L.*	Indian sandalwood	Tree
165	*Sapindus mukorossi Gaertn.*	Indian soapberry	Tree
166	*Saraca asoca (Roxb.) W.J.de Wilde*	Sita Ashok	Tree
167	*Schleichera oleosa (Lour.) Oken*	kusum Tree	Tree
168	*Semecarpus anacardium L.f.*	dhobi nut tree	Tree
169	*Senegalia catechu (L.f.) P. J. H. Hurter & Mabb.*	Black Cutch Tree	Tree
170	*Senegalia chundra (Roxb. ex Rottler) Maslin*	Red Cutch Tree	Tree
171	*Senegalia polyacantha (Willd.) Seigler & Ebinger*	White Thorn	Tree
172	*Sesbania grandiflora (L.) Poir.*	Agati	Tree
173	*Shorea robusta C.F. Gaertn.*	Sal	Tree
174	*Simarouba glauca DC.*	Paradise Tree	Tree
175	*Spathodea campanulata P. Beauv.*	African tulip tree	Tree
176	*Spondias pinnata (L. f.) Kurz*	Wild Mango	Tree
177	*Sterculia foetida L.*	Java Olive	Tree
178	*Sterculia guttata Roxb.*	Spotted Sterculia	Tree
179	*Sterculia urens Roxb.*	Indian-tragacanth	Tree

Sr.No.	Scientific Name	Common Name	Habit
180	*Stereospermum chelonoides (L.f.) DC.*	Fragrant Padri Tree	Tree
181	*Strychnos nux-vomica L.*	Nux Vomica	Tree
182	*Swietenia macrophylla King*	Big-Leaf Mahogany	Tree
183	*Symplocos racemosa Roxb.*	Lodh Tree	Tree
184	*Syzygium cumini (L.) Skeels.*	Jamun	Tree
185	*Syzygium salicifolium J. Graham*	Kath Jamun	Tree
186	*Tabernaemontana alternifolia L.*	Indian Moon-Seed	Tree
187	*Tamarindus indica L.*	Tamarind	Tree
188	*Tamilnadia uliginosa (Retz.) Tirveng. & Sastre*	Divine Jasmine	Tree
189	*Tecomella undulata (Sm.) Seem.*	Roheda	Tree
190	*Tectona grandis L.f.*	Teak	Tree
191	*Terminalia anogeissiana Gere & Boatwr.*	Axle Wood Tree	Tree
192	*Terminalia arjuna (Roxb. ex DC.) Wight & Arn.*	Arjun tree	Tree
193	*Terminalia bellirica (Gaertn.) Roxb.*	Baheda	Tree
194	*Terminalia catappa L.*	Indian Almond	Tree
195	*Terminalia chebula Retz.*	Chebulic Myrobalan	Tree
196	*Terminalia elliptica Willd.*	Black murdah	Tree
197	*Terminalia mantaly H. Perrier*	Madagascar Almond Tree	Tree
198	*Terminalia pendula (Edgew.) Gere & Boatwr. (Syn. Anogeissus pendula Edgew.)*	Buttontree	Tree
199	*Tetrameles nudiflora R.Br.*	False Hemp Tree	Tree
200	*Tetrapilus dioicus (Roxb.) L.A.S. Johnson (Syn. Olea dioica Roxb.)*	Rose Sandalwood	Tree
201	*Theobroma cacao L.*	Cacao tree	Tree
202	*Thespesia populnea (L.) Sol. ex Correa*	Indian tulip tree	Tree
203	*Trema orientale* (L.) Blume	Indian Charcoal Tree	Tree
204	*Vachellia leucophloea* (Roxb.) Maslin, Seigler & Ebinger	White Bark Acacia	Tree
205	*Vachellia nilotica* (L.) P. J. H. Hurter & Mabb.	Babool	Tree
206	*Vateria indica* L.	White Damar	Tree
207	*Vitex negundo* L.	Chaste Tree	Tree
208	*Wrightia tinctoria* (Roxb.) R.Br.	Sweet Indrajao	Tree
209	*Zanthoxylum rhetsa* (Roxb.) DC.	Indian Prickly Ash	Tree
210	*Ziziphus jujuba* Mill.	Jujube	Tree
211	*Ziziphus rugosa* Lam.	Wild Jujube	Tree
Shrub			
1	*Abutilon indicum* (L.) Sweet	Indian Mallow	Shrub
2	*Alocasia macrorrhizos* (L.) G. Don	Gaint Taro	Shrub
3	*Ardisia sonchifolia* Mez		Shrub

Sr.No.	Scientific Name	Common Name	Habit
4	*Barleria cristata* var. dichotoma L.	Philippine violet	Shrub
5	*Barleria prionitis* L.	Porcupine Flower	Shrub
6	*Breynia androgyna* (L.) Chakrab. & N.P. Balakr	Star gooseberry	Shrub
7	*Bridelia retusa* (L.) A. Juss.	Cup Saucer Plant	Shrub
8	*Calotropis gigantea* (L.) W.T. Aiton	Crown Flower	Shrub
9	*Calotropis procera* (Aiton) W.T.Aiton	Giant Milkweed	Shrub
10	*Capparis zeylanica* L.	Indian caper	Shrub
11	*Carissa spinarum* L.	Wild Karanda	Shrub
12	*Cissus quadrangularis* L.	Veldt Grape	Shrub
13	*Citronella apogon* (Griseb.) R.A. Howard		Shrub
14	*Clerodendrum infortunatum* L.	Hill Glory Bower	Shrub
15	*Clerodendrum phlomidis* L.f.	Sage Glory Bower	Shrub
16	*Coffea arabica* L.	Mountain coffee,	Shrub
17	*Commiphora wightii* (Arn.) Bhandari	Indian bdellium-tree	Shrub
18	*Croton tiglium* L.	Purging Croton	Shrub
19	*Embelia tsjeriam-cottam* (Roem. & Schult.) A. DC.	Malabar Embelia	Shrub
20	*Gardenia gummifera* L.f.	Cambi gum tree	Shrub
21	*Glycosmis cochinchinensis* (Lour.) Pierre ex Engl.	Gin Berry	Shrub
22	*Glycosmis pentaphylla* (Retz.) DC.	Gin Berry	Shrub
23	*Grewia abutilifolia* Vent ex Juss.	Mallow-Leaved Crossberry	Shrub
24	*Hibiscus rosa-sinensis* L.	Chinese hibiscus	Shrub
25	*Indigofera tinctoria* L.	True Indigo	Shrub
26	*Ixora coccinea* L.	Jungle geranium	Shrub
27	*Ixora parviflora* Lam.	ixora	Shrub
28	*Jasminum sambac* (L.) Aiton	Arabian Jasmine	Shrub
29	*Lantana camara* L.	Lantana	Shrub
30	*Lawsonia inermis* L.	Heena	Shrub
31	*Maesa indica* (Roxb.) Sweet	Wild Berry	Shrub
32	*Meyna laxiflora* Robyns	Muyna	Shrub
33	*Mimosa hamata* Willd.	Hooked Mimosa	Shrub
34	*Nerium oleander* L.	Oleander	Shrub
35	*Nicotiana glauca* Graham	Tree Tobaco	Shrub
36	*Opuntia elatior* Mill.	Prickly Pear	Shrub
37	*Pelargonium graveolens* L'Her.	Rose-Scented Geranium	Shrub
38	*Pentas lanceolata* (Forssk.) Deflers	Pentas	Shrub
39	*Phyllanthus niruri* L.	gale of the wind	Shrub

Sr.No.	Scientific Name	Common Name	Habit
40	*Phyllanthus reticulatus* Poir	Black-Honey Shrub	Shrub
41	*Piper amalago* L.		Shrub
42	*Plumbago auriculata* Lam.	Plumbago	Shrub
43	*Premna corymbosa* Rottler		Shrub
44	*Premna serratifolia* L. (Syn. Premna integrifolia L.)	Headache Tree	Shrub
45	*Rauvolfia serpentina* (L.) Benth. ex Kurz	Indian Snakeroot,	Shrub
46	*Rauvolfia tetraphylla* L.	Wild Snake Root,	Shrub
47	*Rosa indica* L.	Indian Fragrant Rose	Shrub
48	*Rotheca serrata* (L.) Steane & Mabb.	Blue Fountain Bush	Shrub
49	*Scaevola taccada* (Gaertn.) Roxb.	Half Flower	Shrub
50	*Senegalia rugata* (Lam.) Britton & Rose	Shikakai	Shrub
51	*Senna tora* (L.) Roxb.	Stinking Cassia	Shrub
52	*Solanum anguivi* Lam.	Forest Bitterberry	Shrub
53	*Solanum torvum* Sw.	Turkey Berry	Shrub
54	*Spermadictyon suaveolens* Roxb.	Forest Champa	Shrub
55	*Tabernaemontana divaricata* (L.) R.Br. ex Roem. & Schult.	Crape jasmine	Shrub
56	*Vachellia farnesiana* (L.) Wight & Arn.	Mimosa bush	Shrub
57	*Vitex trifolia* L.	Three-Leaved Chaste Tree	Shrub
58	*Vitis vinifera* L.	Common Grape Vine	Shrub
59	*Woodfordia fruticosa* (L.) Kurz	Fire Flame Bush	Shrub
60	*Ziziphus oenopolia* (L.) Mill.	Jackal Jujube	Shrub
Climber			
1	*Abrus precatorius L.*	Rosary pea	Climber
2	*Argyreia nervosa (Burm.f.) Bojer*	Elephant creeper	Climber
3	*Aristolochia littoralis Parodi*	Calico Flower	Climber
4	*Artabotrys hexapetalus (L.f.) Bhandari*	Hari champa	Climber
5	*Basella alba L.*	Malabar Spinach	Climber
6	*Bridelia stipularis (L.) Blume*	Climbing Bridelia	Climber
7	*Calamus rotang L.*	Common Rattan	Climber
8	*Cardiospermum halicacabum L.*	Balloon Vine	Climber
9	*Causonis trifolia (L.) Mabb. & J. Wen*	Bush Grape,	Climber
10	*Ceropegia bulbosa Roxb.*	Bulbous Ceropegia	Climber
11	*Cestrum nocturnum L.*	Night Blooming Jasmine	Climber
12	*Clematis hedysarifolia* DC.	Konkan Clematis	Climber
13	*Clitoria ternatea* L.	Butterfly Pea	Climber
14	*Cocculus hirsutus* (L.) W. Theob.	Broom Creeper	Climber
15	*Combretum albidum* G. Don	Piluki	Climber
16	*Cryptolepis buchananii* R.Br. ex Roem. & Schult.	Wax Leaved Climber	Climber
17	*Cryptostegia grandiflora* Roxb. ex R.Br.	Rubber vine	Climber

Sr.No.	Scientific Name	Common Name	Habit
18	*Cuscuta reflexa* Roxb.	Giant Dodder	Climber
19	*Cynanchum viminale* (L.) L. Syn. *Sarcostemma viminale* (L.) R.Br.	Sacred soma	Climber
20	*Decalepis hamiltonii* Wight & Arn.	Swallow-Root	Climber
21	*Dioscorea alata* L.	Water Yam	Climber
22	*Dioscorea bulbifera* L.	Aerial yam	Climber
23	*Diplocyclos palmatus (L.)* C. Jeffrey	Marble Vine	Climber
24	*Elaeagnus latifolia* L.	South Indian Silverberry	Climber
25	*Embelia ribes* Burm.f.	Vidanga	Climber
26	*Gloriosa superba* L.	Glory Lily	Climber
27	*Guilandina bonduc* L. (Syn.	Yellow Nicker	Climber
28	*Gymnema sylvestre (Retz.)* R.Br. ex Sm.	Gurmar	Climber
29	*Hemidesmus indicus (L.)* R. Br.	Indian Sarsaparilla	Climber
30	*Ipomoea batatas (L.)* Lam.	Sweet Potato	Climber
31	*Ipomoea cairica (L.)* Sweet	Cairo Morning Glory,	Climber
32	*Jasminum auriculatum* Vahl	Juhi	Climber
33	*Leptadenia reticulata (Retz.)* Wight & Arn.	Cork Swallow-Wort	Climber
34	*Mansoa alliacea (Lam.)* A.H. Gentry	Garlic Vine	Climber
35	*Moullava spicata* (Dalzell ex Wight) Nicolson	Candy Corn Plan	Climber
36	*Mucuna pruriens (L.) DC.*	Velvet bean	Climber
37	*Operculina turpethum (L.) Silva Manso*	White day glory	Climber
38	*Passiflora edulis Sims*	Passion Fruit	Climber
39	*Passiflora foetida L.*	Stinking passionflower	Climber
40	*Passiflora incarnata L.*	Purple passionflower	Climber
41	*Pergularia daemia (Forssk.) Chiov.*	Pergularia	Climber
42	*Piper longum L.*	Long Pepper	Climber
43	*Piper nigrum L.*	Black Pepper	Climber
44	*Piper retrofractum Vahl*	Javanese long pepper	Climber
45	*Premna coriacea C. B. Clarke*	Leathery Premna	Climber
46	*Pueraria tuberosa (Roxb. ex Willd.) DC.*	Indian kudzu	Climber
47	*Salacia oblonga Wall. ex Wight & Arn.*	Oblong Leaf Salacia	Climber
48	*Salacia reticulata Wight*		Climber
49	*Solanum crispum Ruiz & Pav.*	Chilean potato vine	Climber
50	*Tinospora cordifolia (Willd.) Hook.f. & Thomson*	Gulbel	Climber
51	*Tinospora crispa (L.) Hook.f. & Thomson*	Petawali	Climber
52	*Tinospora sinensis (Lour.) Merr.*	Malabar Gulbel	Climber
53	*Tribulus terrestris L.*	Puncture Vine	Climber
54	*Uvaria concava Teijsm. & Binn.*	Many-Flowered Uvaria	Climber
55	*Vincetoxicum indicum (Burm.f.) Mabb.*	Indian Ipecac	Climber

Sr.No.	Scientific Name	Common Name	Habit
56	*Wattakaka volubilis (L.f.) Stapf*	Sneeze Wort	Climber
57	*Piper betle L.*	Betel Vine	Climber
58	*Celastrus paniculatus Willd.*	Black Oil Plant	Climber
	Herb		
1	*Achyranthes aspera L.*	Prickly Chaff Flower	Herb
2	*Acmella oleracea (L.) R.K. Jansen*	Toothache plant,	Herb
3	*Acorus calamus L.*	Sweet Flag	Herb
4	*Ageratum conyzoides L.*	White weed	Herb
5	*Allium sativum L.*	Garlic	Herb
6	*Aloe vera (L.) Burm.f.*	Aloe vera	Herb
7	*Alternanthera sessilis (L.) DC.*	Tangle Mat	Herb
8	*Alysicarpus monilifer (L.) DC.*		Herb
9	*Andrographis paniculata (Burm.f.) Nees*	Green chiretta	Herb
10	*Artemisia absinthium L.*	Common wormwood	Herb
11	*Asclepias curassavica L.*	Halad Kunku	Herb
12	*Asparagus racemosus Willd.*	Satavar	Herb
13	*Bacopa monnieri (L.) Wettst.*	Brahmi	Herb
14	*Balanites aegyptiaca (L.) Delile*	Indian thorny bamboo	Herb
15	*Bambusa bambos (L.) Voss*	Giant thorny bamboo	Herb
16	*Biophytum sensitivum (L.) DC.*	Little Tree plant	Herb
17	*Boerhavia diffusa L.*	Red Spiderling	Herb
18	*Boerhavia erecta L.*	Erect Spiderling	Herb
19	*Canna indica L.*	Indian Shot	Herb
20	*Cannabis sativa L.*	Indian hemp	Herb
21	*Caralluma adscendens (Roxb.) Haw.*	Caralluma	Herb
22	*Catharanthus roseus (L.) G. Don.*	Rosy periwinkle,	Herb
23	*Celosia argentea L.*	Silver Cockscomb,	Herb
24	*Centella asiatica (L.) Urb.*	Indian Pennywort	Herb
25	*Centratherum punctatum Cass.*	Larkdaisy	Herb
26	*Chamaecostus cuspidatus (Nees & Mart.) C.D. Specht & D.W. Stev.*	fiery costus	Herb
27	*Chlorophytum borivilianum Santapau & R.R. Fern.*	Musli	Herb
28	*Chromolaena odorata (L.) R.M. King & H. Rob.*	Bitter bush	Herb
29	*Chrysopogon zizanioides (L.) Roberty*	Khas,	Herb
30	*Coix lacryma-jobi L.*	Adlay Millet	Herb
31	*Coleus amboinicus Lour.*	Indian borage	Herb
32	*Coleus barbatus var. barbatus (Syn. Coleus forskohlii (Willd.) Briq.)*	Indian Coleus	Herb
33	*Commelina maculata Edgew.*	Spotted Dayflower	Herb
34	*Convolvulus prostratus Forssk.*	Prostrate Bindweed	Herb

Sr.No.	Scientific Name	Common Name	Habit
35	*Corchorus aestuans L.*	East Indian Mallow,	Herb
36	*Cullen corylifolium (L.) Medik.*	Hill Glory Bower	Herb
37	*Curcuma amada Roxb.*	Mango Ginger	Herb
38	*Curcuma caesia Roxb.*	Black Turmeric	Herb
39	*Curcuma longa L.*	Turmeric	Herb
40	*Curcuma zedoaria (Christm.) Roscoe*	White Turmeric	Herb
41	*Cyanthillium cinereum (L.) H.Rob.*	Little ironweed,	Herb
42	*Cymbopogon citratus (DC.) Stapf*	Lemon Grass	Herb
43	*Cymbopogon martini (Roxb.) W. Watson*	Palmarosa Grass	Herb
44	*Cymbopogon nardus (L.) Rendle*	Citronella Grass	Herb
45	*Cynodon dactylon (L.) Pers.*	Common Lawn Grass	Herb
46	*Dendrocalamus strictus (Roxb.) Nees*	Calcutta Bamboo	Herb
47	*Desmostachya bipinnata (L.) Stapf*	Daabh	Herb
48	*Digera muricata (L.) Mart.*	False Amaranth	Herb
49	*Eclipta prostrata (L.) L.*	False daisy	Herb
50	*Elettaria cardamomum (L.) Maton*	green cardamom	Herb
51	*Ensete superbum (Roxb.) Cheesman*	Rock Banana	Herb
52	*Erigeron bonariensis L.*	Hairy Fleabane	Herb
53	*Etlingera elatior (Jack) R.M.Sm.*	Torch Ginger	herb
54	*Euphorbia heterophylla L.*	Wild Poinsettia	Herb
55	*Euphorbia hirta L.*	Asthma Weed	Herb
56	*Euphorbia hypericifolia L.*	Graceful Sandmat	Herb
57	*Evolvulus alsinoides (L.) L.*	Slender dwarf morning-glory	Herb
58	*Gynura procumbens (Lour.) Merr.*	Hill Gynura	Herb
59	*Impatiens walleriana Hook.f. (Syn. Impatiens balsamina L.)*	Busy Lizzy	Herb
60	*Justicia adhatoda L.*	Malabar Nut	Herb
61	*Kaempferia galanga L.*	Aromatic Ginger	Herb
62	*Kalanchoe olivacea Dalzell*	Indian Kalanchoe	Herb
63	*Kalanchoe pinnata (Lam.) Pers.*	Air Plant	Herb
64	*Martynia annua L.*	Tiger's Claw	Herb
65	*Mecardonia procumbens (Mill.) Small*	Baby Jump Up	Herb
66	*Mentha × piperita L.*	Pepper mint	Herb
67	*Mentha arvensis L.*	Wild Mint	Herb
68	*Mimosa pudica L.*	Touch-me-not	Herb
69	*Musa × paradisiaca L.*	Banana	Herb
70	*Musa balbisiana Colla*	Wild Banana	Herb
71	*Nigella sativa L.*	Black Seed	Herb
72	*Ocimum americanum L.*	Hoary Basil	Herb
73	*Ocimum basilicum L.*	Basil	Herb

Sr.No.	Scientific Name	Common Name	Habit
74	*Ocimum gratissimum L.*	African Basil	Herb
75	*Ocimum kilimandscharicum Gurke*	Campho Basil	Herb
76	*Ocimum tenuiflorum L.*	Holy Basil	Herb
77	*Oldenlandia corymbosa L.*	Corymb Diamond Flower	Herb
78	*Origanum majorana L.*	Marjoram	Herb
79	*Oxalis corniculata L.*	Creeping Wood Sorrel,	Herb
80	*Pandanus amaryllifolius Roxb. ex Lindl.*	Basmati Plant,	Herb
81	*Phyllanthus amarus Schum. & Thonn.*	Carry Me Seed	Herb
82	*Pleurolobus gangeticus (L.) J.St.-Hil. ex H. Ohashi & K. Ohashi (Syn. Desmodium gangeticum (L.) DC.)*	Sal Leaved Desmodium	Herb
83	*Plumbago indica L.*	Plumbago	Herb
84	*Plumbago zeylanica L.*	Chitrak	Herb
85	*Pogostemon cablin (Blanco) Benth.*	Patchouli	Herb
86	*Pogostemon parviflorus Benth.*	Small-Flowered Shrub-Mint	Herb
87	*Portulaca oleracea L.*	Purslane	Herb
88	*Premna resinosa (Hochst.) Schauer*	Resinous Premna	Herb
89	*Senna occidentalis (L.) Link*	Coffee Senna	Herb
90	*Senna uniflora (Mill.) H.S. Irwin & Barneby*	Oneleaf Senna	Herb
91	*Sesamum indicum L.*	Sesame	Herb
92	*Sida acuta Burm.f.*	Common Wireweed	Herb
93	*Sida cordifolia L.*	Heart-Leaf Sida	Herb
94	*Solanum nigrum L.*	Black nightshade	Herb
95	*Solanum virginianum L.*	Thorny Nightshade	Herb
96	*Sphaeranthus africanus L.*	African Globe Thistle	Herb
97	*Stevia rebaudiana (Bertoni) Bertoni*	Stevia	Herb
98	*Tectaria cicutaria (L.) Copel.*	button fern	Herb
99	*Tephrosia purpurea (L.) Pers.*	Common Tephrosia	Herb
100	*Trianthema portulacastrum L.*	Desert Horse Purslane	Herb
101	*Trichodesma indicum (L.) Sm.*	Indian Borage	Herb
102	*Tridax procumbens L.*	Tridax Daisy	Herb
103	*Typha angustifolia L.*	Lesser Indian Reedmace	Herb
104	*Uraria picta (Jacq.) Desv. ex DC.*	Dabra	Herb
105	*Withania somnifera (L.) Dunal*	Ashwagandha	Herb
106	*Xanthium strumarium L.*	Common Cocklebur	Herb
107	*Zingiber officinale Roscoe*	Ginger	Herb
108	*Glycyrrhiza glabra L.*	Licorice	Herb
109	*Ruta graveolens L.*	common rue	Herb
110	*Saccharum officinarum L.*	Sugarcane	Herb

5. Faunal Studies

264. The baseline faunal surveys were carried out in July 2024 via visual encounters & available secondary data etc. as detailed out in the methodology section. A total of 237 various faunal species, as summarised in **Table 4-29**, including 8 species of mammals, 91 species of birds, 5 species of Amphibian, 4 species of Reptiles, 21 species of butterflies 32 species of Moth, 9 species of dragonfly, 67 species of Fish have been observed / recorded during the study.

Table 4-29: Faunal Community of Study Area

Sl	Type (Class) of Fauna	Total Number of Species observed / recorded
1	Mammal	8
2	Avian species	91
3	Amphibian	5
4	Reptial	4
5	Butterfly	21
6	Moth	32
7	Dragonfly	9
8	Fishes	67
Total		**237**

(a) Mammals Diversity

265. Total 8 Mammal species recorded during the study period, while list of Mammal species found in study area is given in **Table 4-30**.

Table 4-30: Checklist of Mammal Diversity

Sl	Zoological Name	Family	Common Name	IUCN Status	IWPA Status
1	*Pteropus giganteus giganteus (Briinnich)*	Pteropodidae	Indian Flying Fox	LC	Schedule II
2	*Presbytis entellus*	Cercopithecidae	Common Langur	Not Enlisted	Not Enlisted
3	*Lepus nigricollis*	Ochotonidae	Indian Hare	LC	Schedule II
4	*Vulpes bengalensis*	Canidae	Indian Fox	LC	Schedule I
5	*Canis lupus Sykes*	Canidae	Wolf	LC	Schedule 1
6	*Funambulus palmarum Linn*	Scuiridae	Three Striped Palm Squirrel	LC	
7	*Herpestes edwardsi Geoffray*	Viverridae	Common Mongoose	LC	
8	*Sus scrofa*	Suidae	Wild Boar	LC	Schedule II

(b) Avifaunal Diversity

266. Total 91 bird species found in study Area. Bird diversity represented as IUCN Status is depicted in **Figure 4-25** while list of bird species found in and around Pune city is given in **Table 4-31**.

Figure 4-25: Bird Diversity - IUCN Status

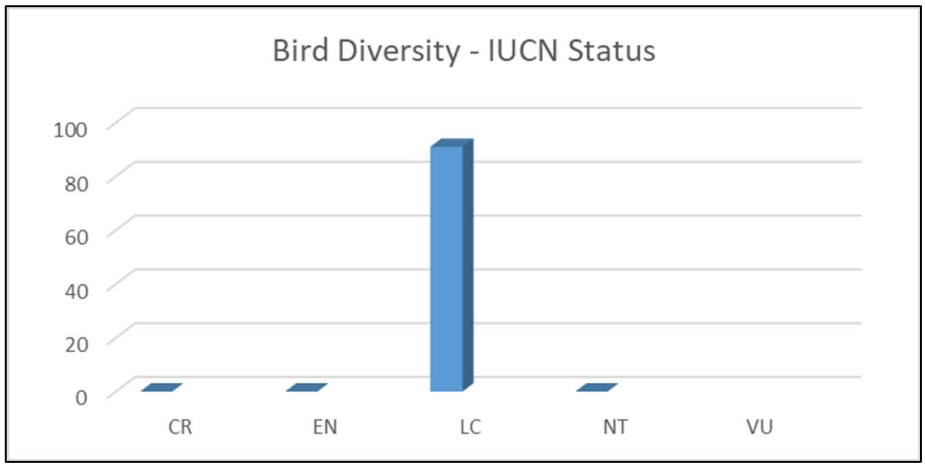


Table 4-31: Avian Diversity of Study area

Sr no	Family	Scientific name	Common name	IUCN	IWPA 1972
1	Podicipedidae	*Tachybaptus ruficollis* (Pallas, 1764)	Little Grebe	LC	Sch II
2	Columbidae	*Columba livia* (J.F. Gmelin, 1789)	Rock Pigeon	LC	Sch II
3	Columbidae	*Streptopelia chinensis* (Scopoli, 1786)	Spotted Dove	LC	Sch II
4	Columbidae	*Streptopelia senegalensis* (Linnaeus, 1766)	Laughing Dove	LC	Sch II
5	Columbidae	*Treron phoenicopterus* (Latham, 1790)	Yellow-footed green pigeon	LC	Sch II
6	Apodidae	*Cypsiurus balasiensis* (J.E. Gray, 1829)	Asian palm swift	LC	Sch II
7	Apodidae	*Apus affinis* (J.E. Gray, 1830)	Little Swift	LC	Sch II
8	Cuculidae	*Centropus sinensis* (Stephens, 1815)	Greater Coucal	LC	Sch II
9	Cuculidae	*Clamator jacobinus* (Boddaert, 1783)	Pied Cuckoo	LC	Sch II
10	Cuculidae	*Eudynamysscolopaceus* (Linnaeus, 1758)	Asian Coucal	LC	Sch II
11	Cuculidae	*Cacomantis merulinus* (Scopoli, 1786)	Plaintive cuckoo	LC	Sch II
12	Cuculidae	*Hierococcyx varius* (Vahl, 1797)	Common hawk cuckoo	LC	Sch II
13	Rallidae	*Amaurornisphoenicurus* (Pennant, 1769)	White-Breasted Waterhen	LC	Sch II
14	Ardeidae	*Ardeola grayii* (Sykes, 1832)	Indian Pond Heron	LC	Sch II
15	Ardeidae	*Bubulcus ibis* (Linnaeus, 1758)	Cattle Egret	LC	Sch II
16	Charadriidae	*Charadrius dubius* (Scopoli, 1786)	Little Ring Plover	LC	Sch II
17	Charadriidae	*Vanellus indicus* (Boddaert, 1783)	Red-Wattled Lapwing	LC	Sch II
18	Charadriidae	*Vanellus malabaricus* (Boddaert, 1783)	Yellow-Wattled Lapwing	LC	Sch II
19	Rostratulidae	*Rostratula benghalensis* (Linnaeus, 1758)	Greater-painted snipe	LC	Sch II

Sr no	Family	Scientific name	Common name	IUCN	IWPA 1972
20	Jacanidae	*Hydrophasianus chirurgus* (Scopoli, 1786)	Pheasant-tailed jacana	LC	Sch II
21	Scolopacidae	*Tringa glareola* (Linnaeus, 1758)	Wood Sandpiper	LC	Sch II
22	Scolopacidae	*Actitis hypoleucos* (Linnaeus, 1758)	Common sandpiper	LC	Sch II
23	Scolopacidae	*Tringa nebularia* (Gunnerus, 1767)	Common greenshank	LC	Sch II
24	Scolopacidae	*Gallinagogallinago* (Linnaeus, 1758)	Common snipe	LC	Sch II
25	Turnicidae	*Turnix suscitator* (J.F. Gmelin, 1789)	Barred buttonquail	LC	Sch II
26	Accipitridae	*Accipiter badius* (J.F. Gmelin, 1788)	Shikra	LC	Sch I
27	Accipitridae	*Milvus migrans* (Boddaert, 1783)	Black kite	LC	Sch II
28	Strigidae	*Athene brama* (Temminck, 1821)	Spotted owlet	LC	Sch II
29	Bucerotidae	*Ocyceros birostris* (Scopoli, 1786)	Indian grey hornbill	LC	Sch II
30	Upupidae	*Upupaepops* (Linnaeus, 1758)	Eurasian hoopoe	LC	Sch II
31	Picidae	*Dendrocoposmahrattensis* (Latham, 1801)	Yellow-crowned woodpecker	LC	Sch II
32	Ramphastidae	*Psilopogon haemacephalus*	Coppersmith barbet	LC	Sch II
33	Meropidae	*Merops orientalis* (Latham, 1801)	Asian green bee-eater	LC	Sch II
34	Coraciidae	*Coracias benghalensis* (Linnaeus, 1758)	Indian roller	LC	Sch II
35	Alcedinidae	*Halcyon smyrnensis* (Linnaeus, 1758)	White-throated kingfisher	LC	Sch II
36	Falconidae	*Falco tinnunculus* (Linnaeus, 1758)	Common kestrel	LC	Sch I
37	Psittaculidae	*Psittacula cyanocephala* (Linnaeus, 1766)	Plum-headed parakeet	LC	Sch II
38	Psittaculidae	*Psittacula krameri* (Scopoli, 1769)	Rose-ringed parakeet	LC	Sch II
39	Campephagidae	*Pericrocotuscinnamomeus* (Linnaeus)	Small minivet	LC	Sch I
40	Campephagidae	*Coracina javensis* (Horsfield, 1821)	Large Cuckooshrike	LC	Sch II
41	Vangidae	*Tephrodornis pondicerianus* (J.F. Gmelin)	Common Woodshrike	LC	Sch II
42	Oriolidae	*Oriolus oriolus* (Linnaeus, 1758)	Eurasian Golden Oriole	LC	Sch II
43	Aegithinidae	*Aegithina tiphia* (Linnaeus, 1758)	Common iora	LC	Sch II
44	Dicruridae	*Dicrurus macrocercus* (Vieillot, 1817)	Black Drongo	LC	Sch II
45	Laniidae	*Lanius vittatus* (Valenciennes 1826)	Bay-backed shrike	LC	Sch II
46	Laniidae	*Lanius schach* (Linnaeus, 1758)	Long-tailed shrike	LC	Sch II
47	Corvidae	*Dendrocitta vagabunda* (Latham, 1790)	Rufous treepie	LC	Sch II
48	Corvidae	*Corvus splendens* (Vieillot, 1817)	House crow	LC	Sch II

Sr no	Family	Scientific name	Common name	IUCN	IWPA 1972
49	Corvidae	*Corvus macrorhynchos* (Wagler, 1827)	Large-billed crow	LC	Sch II
50	Nectariniidae	*Leptocomazeylonica* (Linnaeus, 1766)	Purple-rumped sunbird	LC	Sch II
51	Nectariniidae	*Cinnyris asiaticus* (Latham, 1790)	Purple Sunbird	LC	Sch II
52	Ploceidae	*Ploceus philippinus* (Linnaeus, 1766)	Baya weaver	LC	Sch II
53	Estrildidae	*Euodice malabarica* (Linnaeus, 1758)	Indian silverbill	LC	Sch II
54	Estrildidae	*Lonchura punctulata* (Linnaeus, 1758)	Scaly-breasted munia	LC	Sch II
55	Passeridae	*Passer domesticus* (Linnaeus, 1758)	House Sparrow	LC	Sch II
56	Motacillidae	*Anthus rufulus* (Vieillot, 1818)	Paddyfield pipet	LC	Sch II
57	Motacillidae	*Motacilla cinerea* (Tunstall, 1771)	Grey Wagtail	LC	Sch II
58	Motacillidae	*Motacilla citreola* (Pallas, 1776)	Citrine Wagtail	LC	Sch II
59	Motacillidae	*Motacilla alba* (Linnaeus, 1758)	White Wagtail	LC	Sch II
60	Motacillidae	*Motacilla maderaspatensis* (J.F. Gmelin)	White-browed Wagtail	LC	Sch II
61	Motacillidae	*Motacilla flava* (Linnaeus, 1758)	Yellow Wagtail	LC	Sch II
62	Fringillidae	*Carpodacus erythrinus erythrinus*	Common Rosefinch	LC	Sch II
63	Paridae	*Parus cinereus* (Vieillot, 1818)	Cinerious Tit	LC	Sch II
64	Paridae	*Machlolophus xanthogenys* (Vigors, 1831)	Yellow tit	LC	Sch II
65	Sylviidae	*Sylvia hortensis* (Gmelin, 1789)	Western Orphean warbler	LC	Sch II
66	Sylviidae	*Curruca curruca* (Linnaeus, 1758)	Lesser whitethroat	LC	Sch II
67	Alaudidae	*Ammomanesphoenicura* (Franklin, 1831)	Rufous tailed lark	LC	Sch II
68	Alaudidae	*Eremopterixgriseus* (Scopoli, 1786)	Ashy-crowned sparrow-lark	LC	Sch II
69	Alaudidae	*Mirafra erythroptera* (Blyth, 1845)	Indian bush lark	LC	Sch II
70	Cisticolidae	*Prinia socialis* (Sykes, 1832)	Ashy prinia	LC	Sch II
71	Cisticolidae	*Prinia inornata* (Sykes, 1832)	Plain Prinia	LC	Sch II
72	Cisticolidae	*Orthotomussutorius* (Pennant, 1769)	Common Tailorbird	LC	Sch II
73	Hirundinidae	*Cecropis daurica* (Laxmann, 1769)	Red-Rumped Swallow	LC	Sch II
74	Hirundinidae	*Hirundo smithii* (Leach, 1818)	Wire tailed Swallow	LC	Sch II
75	Hirundinidae	*Ptyonoprognerupestris* (Scopoli, 1769)	Eurasian crag martin	LC	Sch II
76	Hirundinidae	*Ptyonoprogneconcolor* (Sykes, 1832)	Dusky crag martin	LC	Sch II
77	Pycnonotidae	*Pycnonotus jocosus* (Linnaeus, 1758)	Red-whiskerd Bulbul	LC	Sch II
78	Pycnonotidae	*Pycnonotus cafer* (Linnaeus, 1766)	Red vented Bulbul	LC	Sch II

Sr no	Family	Scientific name	Common name	IUCN	IWPA 1972
79	Pycnonotidae	*Pycnonotus luteolus* (Lesson, 1841)	White-browed Bulbul	LC	Sch II
80	Sylviidae	*Chrysomma sinense* (J.F. Gmelin, 1789)	Yellow-eyed Babbler	LC	Sch II
81	Zosteropidae	*Zosterops palpebrosus* (Temminck,1824)	Indian White eye	LC	Sch II
82	Leiothrichidae	*Argya malcolmi* (Sykes, 1832)	Large grey Babbler	LC	Sch II
83	Sturnidae	*Pastor roseus* (Linnaeus, 1758)	Rosy Starling	LC	Sch II
84	Sturnidae	*Sturnia pagodarum* (J.F. Gmelin, 1789)	Brahminy starling	LC	Sch II
85	Sturnidae	*Acridotheres tristis* (Linnaeus, 1766)	Common Myna	LC	Sch II
86	Muscicapidae	*Saxicoloidesfulicatus* (Linnaeus, 1766)	Indian robin	LC	Sch II
87	Muscicapidae	*Copsychus saularis* (Linnaeus, 1758)	Oriental magpie robin	LC	Sch II
88	Muscicapidae	*Cyornis tickelliae* (Blyth, 1843)	Tickells Blue Flycatcher	LC	Sch II
89	Muscicapidae	*Phoenicurus ochruros* (S.G. Gmelin, 1774)	Black redstart	LC	Sch II
90	Muscicapidae	*Monticola solitarius* (Linnaeus, 1758)	Blue rock thrush	LC	Sch II
91	Galliforms	*Pavo cristatus*	Indian Peafowl	LC	Sch II

(c) Herpetofauna Diversity

267. 9 species of Herpetofauna faunal species has been recorded in study area and listed in **Table 4-32**.

Table 4-32: Herpetofauna Diversity in Study Area

Sl	Zoological Name	Common Name	Family	IUCN Status	IWPA 1972
1	*Duttaphrynus melanostictus* (Schneider, 1799)	Asian common Toad	Bufonidae	LC	-
2	*Euphlyctis cyanophlyctis*	Indian Skipper Frog	Dicroglossidae	LC	Sch II
3	*Hoplobatrachus tigerinus*	Indian Bull Frog	Dicroglossidae	LC	-
4	*Zakerana sp.*		Dicroglossidae	LC	-
5	*Microhyla ornata*	Ornate Microhylid	Microhylidae	LC	-
6	*Xenochrophis piscator*	Checkered kellback	Colubridae	LC	-
7	*Naja naja*	Indian Cobra	Elapid	LC	Sch I
8	*Daboia russelii*	Russell's viper	Viperidae	LC	Sch I
9	*Ptyas mucosa*	Oriental Rat Snake	Colubrid	LC	Sch I

(d) Butterfly & Moth Diversity

268. Total 21 species butterflies and 32 species of Moth were recorded in the study area as given in **Table 4-33** and **Table 4-34.**

Table 4-33: Butterfly Diversity

Sr no	Phylum	Family name	Scientific name	Common name	IUCN	IWPA 1972
1	Arthropoda	Nymphalidae	*Euploea core*	Common Crow	LC	-

Sr no	Phylum	Family name	Scientific name	Common name	IUCN	IWPA 1972
2	Arthropoda	Popilionidae	*Papilio polymnestor*	Blue Mormon	NL	-
3	Arthropoda	Lycaenidae	*Tajuria jehana*	Indian Plain Blue royal	NL	-
4	Arthropoda	Nymphalidae	*Tirumala liamniace*	Blue Tiger	NL	-
5	Arthropoda	Pieridae	*Pieris rapae*	Cabbage White	NL	-
6	Arthropoda	Nymphalidae	*Junonia iphita*	Chocalate Pancy	NL	-
7	Arthropoda	Nymphalidae	*Hypolimnas misippus*	Danaid eggfly	Sch II	Sch II
8	Arthropoda	Lycaenidae	*Zizina labradus*	Common Glass blue	NL	-
9	Arthropoda	Pieridae	*Eurema hecabe*	Common Glass Yellow	LC	-
10	Arthropoda	Popilionidae	*Papilo polytes*	Common Mormon	NL	-
11	Arthropoda	Pieridae	*Cepora nerissa*	Common Gull	NL	-
12	Arthropoda	Nymphalidae	*Neptis hylas*	Common Sailor	NL	-
13	Arthropoda	Pieridae	*Delias eucharis*	Common Jezebel	NL	-
14	Arthropoda	Nymphalidae	*Jenonia lemonia*	Lemon pansy	NL	-
15	Arthropoda	Nymphalidae	*Dannus plexippus*	Monarch Butterfly	NL	-
16	Arthropoda	Pieridae	*Lxias marianne*	Orange white tip	NL	-
17	Arthropoda	Nymphalidae	*Melanitis jeda*	Common Evening Brown	NL	-
18	Arthropoda	Pieridae	*Leptosia nina*	Psyche	NL	-
19	Arthropoda	Lycaenidae	*Telicada nyseus*	Red Pierot	NL	-
20	Arthropoda	Papilionidae	*Graphium agamemnon*	Tailed Jay	NL	-
21	Arthropoda	Nymphalidae	*Acraea terpsicore*	Tawny Coster	NL	-

Table 4-34: Moth Diversity in Study Area

Sr No	Phylum	Family	Species
1	Arthropoda	Bombycidae	*Trilocha varians*
2	Arthropoda	Crambidae	*Eoophyla sejunctalis*
3	Arthropoda	Crambidae	*Parapoynx stagnalis*
4	Arthropoda	Crambidae	*Hendecasis duplifascialis*
5	Arthropoda	Crambidae	*Pyraustaphoenicealis*
6	Arthropoda	Crambidae	*Paliga machoeralis*
7	Arthropoda	Crambidae	*Haritalodes derogata*
8	Arthropoda	Crambidae	*Lygropia distorta*
9	Arthropoda	Crambidae	*Nosophora euryterminalis*

Sr No	Phylum	Family	Species
10	Arthropoda	Crambidae	*Eurrhyparodes bracteolalis*
11	Arthropoda	Crambidae	*Herpetogramma licarsisalis*
12	Arthropoda	Crambidae	*Hydriris ornatalis*
13	Arthropoda	Crambidae	*Lamprosema commixta*
14	Arthropoda	Crambidae	*Hymenia perspectalis*
15	Arthropoda	Crambidae	*Spoladea recurvalis*
16	Arthropoda	Crambidae	*Cirrhochrista brizoalis*
17	Arthropoda	Crambidae	*Conogethespunctiferalis*
18	Arthropoda	Crambidae	*Diaphania indica*
19	Arthropoda	Crambidae	*Endocrossis /lavibasalis*
20	Arthropoda	Crambidae	*Glyphodes bivitralis*
21	Arthropoda	Crambidae	*Glyphodes onychinalis*
22	Arthropoda	Crambidae	*Marucavitrata*
23	Arthropoda	Crambidae	*Omiodes indicata*
24	Arthropoda	Crambidae	*Poliobotys ablactalis*
25	Arthropoda	Crambidae	*Synclera traducalis*
26	Arthropoda	Crambidae	*Talangasexpunctalis*
27	Arthropoda	Crambidae	*Tyspanodes linealis*
28	Arthropoda	Crambidae	*Sameodescancellalis*
29	Arthropoda	Crambidae	*Cnaphalocrocis medinalis*
30	Arthropoda	Crambidae	*Cnaphalocrocis poeyalis*
31	Arthropoda	Crambidae	*Chabula acamasalis*
32	Arthropoda	Crambidae	*Nausinoe geometralis*

(e) Damselfly Diversity

269. Total 9 species of dragonflies were recorded within the study area as presented in **Table 4-35**.

Table 4-35: Dragonfly and Damsel-fly Diversity of Pune

Sr no	Phylum	Family name	Species (scientific name)	IUCN Status
1	Arthropoda	Libellulidae	*Orthetrumpruinosum* (L)	-
2	Arthropoda	Libellulidae	*Tramea limbata* (L)	LC
3	Arthropoda	Libellulidae	*Trithemis festiva* (L)	LC
4	Arthropoda	Libellulidae	*Bradinopyga geminate* (L)	LC
5	Arthropoda	Libellulidae	*Orthetrum glaucaum* (L)	-
6	Arthropoda	Libellulidae	*Diplocodes triviolis* (L)	-
7	Arthropoda	Libellulidae	*Orthetum caledonicum* (L)	-
8	Arthropoda	Libellulidae	*Orthetrum sabina* (L)	LC
9	Arthropoda	Libellulidae	*Trithemis aurora* (L)	LC

(f) Fish Diversity

270. As per secondary data available, some authors have recorded 59 species of freshwater fish in the Indrayani River[35] and 22 species of freshwater fish in the Pavna River[36] belonging to 18 families. Pawana River is nearest to the Alignment lying at distance of 1 km due South west of proposed Chinchwad Metro Station. Indrayani River 5.15 km due East from Bhakti Shakti proposed metro station.List of fish diversity from the Study area is given as **Table**

[35] *Neelesh Dahanukar, Mandar Paingankar, Rupesh N. Raut & Sanjay S. Kharat, Fish fauna of Indrayani River, northern Western Ghats, India, Journal of Threatened taxa, 4(1): 2310–2317*

[36] *Muley D. V. and Patil I. M., A Study of Water Quality and Fish Diversity of Pauna River, Maharashtra, J.Aqua.Biol.Vol. 21(1). 2006; 68-75.*

4-36.

Table 4-36: List of Fish diversity in nearby waterbodies

Sr No	Family/Species	Indrayani River	Pavna River	Abundance	IUCN status
	Notopteridae				
1	*Notopterus notopterus* (Pallas, 1769)	+	+	C	LC
	Cyprinidae				
2	*Catla catla* (Hamilton, 1822)	+		M	
3	*Cirrhinus fulungee* (Sykes, 1839)	+		C	LC
4	*Cirrhinus reba* (Hamilton, 1822)	+	+	C	LC
5	*Cirrhinus mrigala* (Hamilton, 1822)	+		M	
6	*Cyprinus carpio* (Linnaeus, 1758)	+		M	
7	*Gonoproktopterus curmuca* (Hamilton, 1807)	+		A	EN
8	*Labeo ariza* (Hamilton, 1807)	+		R	LC
9	*Labeo boggut* (Sykes, 1839)	+	+	R	LC
10	*Labeo calbasu* (Hamilton, 1822)	+	+	M	LC
11	*Labeo porcellus* (Heckel, 1844)	+		R	LC
12	*Labeo rohita* (Hamilton, 1822)	+		M	LC
13	*Osteobrama cotio peninsularis* (Silas, 1952)	+		M	LC
14	*Osteobrama neilli* (Day, 1873)	+		R	LC
15	*Osteobrama vigorsii* (Sykes, 1839)	+		C	LC
16	*Puntius amphibious*	+		A	DD
17	*Puntius conchonius* (Hamilton, 1822)	+		R	LC
18	*Puntius Kolus*		+		-
19	*Puntius thomassi*		+		-
20	*Puntius jerdoni* (Day, 1870)	+	+	R	LC
21	*Puntius sarana subnasutus*	+	+	M	LC
22	*Puntius sophore* (Hamilton, 1822)	+	+	A	LC
23	*Puntius ticto* (Hamilton, 1822)	+	+	A	LC
24	*Rohtee ogilbii* (Sykes, 1839)	+	+	M	LC
25	*Amblypharyngodon mola*	+		A	LC
26	*Tor mosal*		+		DD
27	*Salmostoma phulo phulo*		+		-
28	*Salmophasia balookee* (Sykes, 1839)	+		M	LC
29	*Salmophasia boopis* (Day, 1874)	+		A	LC
30	*Salmophasia novacula*	+		C	LC
31	*Devario aequipinnatus*	+		C	LC
32	*Rasbora daniconius* (Hamilton, 1822)	+	+	A	LC
33	*Rasbora rasbora*		+		LC
34	*Crossocheilus cf. latius*	+		C	LC
35	*Osteobrama vigorsii*		+		LC

Sr No	Family/Species	Indrayani River	Pavna River	Abundance	IUCN status
36	*Garra mullya* (Sykes, 1839)	+	+	A	LC
	Parapsilorhynchidae				
37	*Parapsilorhynchus tentaculatus*	+		M	LC
	Balitoridae				
38	*Acanthocobitis mooreh* (Sykes, 1839)	+		M	LC
39	*Oreonectes evezardi* (Day, 1872)	+		M	LC
40	*Nemachilichthys rueppelli*	+	+	M	LC
41	*Noemacheilus anguilla*	+		M	LC
42	*Schistura denisoni* (Day, 1867)	+		C	LC
	Cobitidae				
43	*Lepidocephalichthys thermalis*	+		A	LC
	Bagridae				
44	*Mystus cavasius*		+		LC
45	*Mystus bleekeri* (Day, 1877)	+	+	M	LC
46	*Aorichthys seengala*		+		-
47	*Mystus seengtee* (Sykes, 1839)	+		C	LC
48	*Mystus malabaricus* (Jerdon, 1849)	+		M	NT
49	*Rita gogra* (Sykes, 1839)	+		M	LC
50	*Sperata seenghala* (Sykes, 1839)	+		M	LC
	Siluridae				
51	*Ompok bimaculatus* (Bloch, 1794)	+	+	C	NT
52	*Wallago attu* (Bloch & Schneider, 1801)	+	+	R	NT
	Schilbeidae				
53	*Neotropius khavalchor* (Kulkarni, 1952)	+		R	DD
	Sisoridae				
54	*Glyptothorax poonaensis* (Hora, 1938)	+		R	EN
	Claridae				
55	*Clarias gariepinus* (Burchell, 1822)	+	+	M	LC
	Heteropneustidae				
56	*Heteropneustes fossilis* (Bloch, 1794)	+		M	LC
	Belonidae				
57	*Xenentodon cancila* (Hamilton, 1822)	+		M	LC
	Poeciliidae				
58	*Poecilia reticulata* (Peters, 1859)	+		A	LC
	Ambassidae				
59	*Chanda nama* (Hamilton, 1822)	+		C	LC
60	*Parambassis ranga* (Hamilton, 1822)	+		M	LC
	Cichlidae				
61	*Oreochromis mossambicus*	+	+	A	VU

Sr No	Family/Species	Indrayani River	Pavna River	Abundance	IUCN status
	Gobiidae				
62	*Glossogobius giuris* (Hamilton, 1822)	+	+	C	LC
	Channidae				
63	*Channa marulius* (Hamilton, 1822)	+	+	M	LC
64	*Channa punctata* (Bloch, 1793)	+	+	C	LC
	Mastecembalidae				
65	*Mastacembelus armatus*	+	+	C	LC
	Belontiidae				
66	*Xenetodon cancila* (Hamilton)		+		-
	Centropomidae				
67	*Pseudabassis ranga*		+		-

6. Gardens

271. There are several parks in Pune locality. Most of the gardens are well maintained with beautiful arrangement of trees, shrubs & climbers with all the aspects. There are around 39 gardens present near the project site but none is getting impacted by the project work. The list of gardens in and around the study area is as **Table 4-37**.

Table 4-37: List of Gardens nearest to Alignment

Code	Name of Garden	Distance	Direction	Latitude	Longitude
1	Shankar Shetty Park	125m	E	18°38'39.14"N	73°47'32.55"E
2	Bhakti-Shakti Garden	40m	W	18°39'51.78"N	73°46'17.45"E
3	Maharana Pratap Garden	35m	E	18°39'34.73"N	73°46'39.29"E

7. Protected Areas/Zoos

List of nearest protected areas / zoo is given in **Table 4-38**.

Table 4-38: List of Nearest Zoo

Sr. No	Protected Areas	District	Distance from nearest point on the Alignment
1	Nisargakavi Bahinabai Chaudhari Zoo	Pune	1.85 km

272. Most of the water bodies, especially near urban or residential areas, are found to be polluted at different levels because of anthropogenic activities.

H. SOCIO ECONOMIC ENVIRONMENT

273. The growth of any economy is dependent on various factors which include availability of natural resources, presence of feasible climatic conditions, skilled man-power, infrastructural support and a steady orientation and research towards growth and development. A vast range of developmental projects have been carried out in the country. Their sole purpose has been improving the living conditions of the citizens.

274. All developmental activities are primarily centred on human development. However, when a country needs to grow in terms of its industrial and technological standing, infrastructural development is necessary. Infrastructure ranges from providing resources to employing sets of skilled manpower for obtaining the desired results. All these elements when

balanced at an international level bring about global development. At a local level when such activities are being scoped, socio-economic surveys play an important role. They not only emphasize the individual standing of a community but also delineate the possible socio-economic outcomes of any project. They include all the elements, from the conditions of the people living in that area to their working status. When developmental activities are about to occur in any area the socio-economic standing of the locality comes to the forefront.

275. In order to study the socio-economic aspects of the communities living in and around proposed project, the required data has been collected, primarily in the form of socio-economic surveys conducted in the Project Study Area.

276. The possible direct and indirect positive impacts of the project are listed below.

(i) The immediate benefits of the PCMC to Nigdi project will come in the form of employment opportunities for those who are engaged as wage laborer, petty contractor, and suppliers of raw materials.
(ii) The mass transport under PCMC to Nigdi will encourage the people to shift from their private vehicles to public transport thereby resulting into lesser vehicles on the road contributing to reduction in traffic congestion, pollution, and accidents.
(iii) Due to PCMC to Nigdi metro alignment, there will be improved linkage between the sub-urban areas to Pune city thereby providing wider work and business opportunities. People can travel from Pune city to industrial zones like Chakan MIDC, Tathawade MIDC etc. to work.
(iv) This will also help people to get faster access to essential services like school, health center, public distribution system etc.

277. The possible adverse impacts of the PCMC to Nigdi (Phase-1 Extension) project are:
(i) Loss of Private land: Despite efforts to minimize the resettlement impact some Private land will be acquired for Phase-I project under the direct purchase policy.
(ii) Loss of Common Property Resource (CPR): A very small number of CPR will be impacted due to metro station construction
(iii) Loss of livelihood: Temporary loss of livelihood is anticipated for the non-titled holder due to relocation to outside the project of impact.

278. Apart from this, secondary data was gathered from publications of the Census Department, Government of India (2011 Census), and other authenticated sources, as presented in the following sections.

1. Demographic Features of PCMC

279. Development of the Pimpri-Chinchwad Municipal Corporation dates back to the establishment of industries such as Bajaj Auto and Telco, in the middle of the 20th century. The establishment of the Pimpri-Chinchwad New Town Development Authority (PCNTDA) in the 1980s helped the development of residential colonies in the 1990s to an extent. With the booming IT and ITeS sector in neighbouring Pune in the 1990's, Pimpri-Chinchwad has seen large scale development of residential areas.

280. Demography of Pune District is controlled by socio-economic and environmental conditions. According to the 2011 census, Pune District comprising of 14 tehsils had a population of 9429408 and Pune city had a population of 1727692. The Sex ratio of 833 per 1000 male in urban area. Average literacy rate was 77.77% from which, male literacy was 56.68% and female literacy was 41.31%. Working population of Pune (15–59 yrs. age category) was 39.17%. Demographics of Pune City is presented in **Table 4-39**.

Table 4-39: Demographics of Pune City

Indicators	Values
Population (2011 Census)	1727692
Male	942533
Female	785159
Total Number of Households	427356
Working population (15-59)	676832
Total Literacy	1343658
Male Literacy	56.68%
Female Literacy	43.31%

281. The Pune district covers a total area of about 15643 sq. km. of which Pune city accounts for 181 sq. km. (1.15%). PCMC city is governed by Pimpri Chinchwad Municipal Corporation (PCMC) which comes under Pimpri Chinchwad Region. As per the 2011 census, population of Pune city is 1727692 of which male and female are 942533 and 785159 respectively.

A. Population

282. The current estimate population (average population based on Arithmetical Increase Method, Incremental Increase Method & Geometrical Method) of Pune city in 2024 is 4264399. The last census was conducted in 2011 and the schedule census for Pune city in 2021 was postponed due to COVID-19 epidemic. The current estimates of Pune city are based on past growth rate.

Year	Population
2024	3080099
2011	1727692
2001	1012472
1991	517083

Caste-wise population. Schedule Caste (SC) constitutes 419396 while Schedule Tribe (ST) were 34025 of total population of Pune, as given below:

Caste	Total	Male	Female
Scheduled Caste (SC)	273810	142281	131529
Scheduled Tribe (ST)	36535	19621	16914

B. Education

283. PCMC is a major education hub in India. There are two types of schools in the city; PCMC (Government) run schools and private schools run by trusts. These schools are governed by either of the following boards: Maharashtra State Board of Secondary and Higher Secondary Education, Central Board for Secondary Education (CBSE), Indian Certificate of Secondary Education (CBSC) and The International Baccalaureate (IB).

284. Total literates in PCMC are 77.77% of which 56.68% are males while 43.31%are females.

C. Employment

285. In Pimpri Chinchwad Municipal Corporation (PCMC), total population is 1727692, out of these individuals were engaged in work activities. 629863 of workers describe their work as Main Work (Employment or Earning more than 6 Months) while 46969 were involved in marginal activity providing livelihood for less than 6 months, 5868 were cultivators (owner or co-owner) while 4455 were agricultural labourers and 11973 working in household industries.

The details are given below:

Type of Workers	Total	Male	Female
Main Workers	629863	521922	107941
Cultivators	5868	4597	1271
Agriculture Laborer	4455	3109	1346
Household Industries	11973	7518	4455
Other Workers	607567	506698	100869
Marginal Workers	46969	31617	15352
Non-Working	1050860	388994	661866

2. Utilities and households

286. Large number of sub-surface, surface- and overhead- utility services viz. sewers, water mains, storm water drains, gas pipe lines, telephone/ communication cables, Overhead power transmission lines, power cables, traffic signals, etc. exists all along the proposed alignment. These utility services are essential and have to be maintained in working order during different stages of construction, by temporary/permanent diversions and relocation or by supporting in position. Any interruption to these will have serious repercussions on the most sensitive suburban services and direct impact on the public besides set back in construction and project implementation schedule & costs. Therefore, meticulous detailed survey and planning will be required to protect / divert the utility services. Accordingly, overhead utilities were identified during physical survey of at the DPR stage itself. Moreover, liaison with concerned utility owners was made for identification and mapping of various underground utilities. No trenching / GPR survey etc. was conducted for underground utilities.

287. The PCMC to Nigdi (Phase-1 Extension) will be mostly running through the urban area at an elevated level. The alignment will need to negotiate underground water pipelines, sewage pipelines, underground telecommunication cables, elevated power lines, sewage pipelines, etc. which are all perpendicular as well as parallel to the alignment. The alignments will also cross storm water drains in some locations, which are not considered part of Utilities.

288. PCMC to Nigdi (Phase-1 Extension) alignment passes a number of educational and medical institutions located within 100 m from the alignment centre. Exact details of these sensitive receptors including their coordinates and distance to the alignment can be found in **Annexure-7**. None of the sensitive receptors will be directly impacted by the project alignments, since the piers and viaducts are all planned on the median of the existing road or on the service road.

3. Physical Cultural Resources

289. Physical Cultural Resource/s (PCR/s) is/are defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Physical cultural resources may be located in urban or rural settings and may be above or below ground or under water. Their cultural interest may be at the local, provincial, national, or international level.[37]

290. Examples of PCR are: (i) human-made objects such as buildings of architectural or historical interest, religious buildings, and historic roads, bridges, and walls; (ii) natural sites and landscapes such as paleontological sites, natural landscapes of outstanding aesthetic quality, and wellsprings and wells of spiritual significance; (iii) combined human-made and

[37] *Source: Campbell, Ian (2009) - Physical cultural resources safeguard policy: guidebook (English). Washington, D.C.: World Bank Group. [http://documents.worldbank.org/curated/en/520411468149683036/Physical-cultural-resources-safeguard-policy-guidebook]*

natural features such as cave paintings, sites used for religious or social functions, and places of pilgrimage; and (iv) movable objects such as paintings, religious artefacts and antiquities such as coins and seals. Other examples of PCR include sites used for religious or social functions such as weddings, funerals or other traditional community activities, etc.

291. No known protected archaeological monuments/sites nor heritage assets are located on or along the proposed alignment.

292. List of all the resources of religious and cultural nature, and community resources are located within 100-150m from the PCMC to Nigdi (Phase-1 Extension) alignment which are presented in **Annexure-7** (List of Sensitive Receptors)

4. Socio-Economic Profile of the PAPs

293. In order to study the socio-economic aspects of the communities living in and around proposed Pune metro extension line of Phase-I, the required data has been collected, primarily in the form of socio- economic surveys conducted in the Project Study Area.

294. Along with the census data collection, data on demographic and socio-economic profile of the PAPs along with 9 other stockholders from community were collected for their social mapping and understanding of the standard of living. The following section describes the socio-economic profile of 34 affected Families including the tenants in the structures.

(a) Number of Project Affected Persons (PAPs)

295. There are 115 individual PAPs in total being affected by the project, which includes 67 (58.26%) male and 48 (41.74%) female. The average family size is 3.4 and the sex ratio among the PAPs is 716. The details of PAPs being affected in the project are presented in the **Table-4-40**.

Table-4-40: Number PAPs[38]

Sr. No.	Categories of PAPs	No. of Persons	%
1	Male	67	58.26
2	Female	48	41.74
Total		**115**	**100**

(b) Social Categories of the PAPs

296. The social stratification of all the affected Families including tenants in the project area indicates dominance of Scheduled Caste (SC) population with 11 (32.35%) Families followed by 10 (29.41%) general Caste Population and other backward caste (OBC) population with 08 (23.53%) Families. There is no Scheduled Tribe (ST) family affected under the project. The details of social grouping in the project area are presented in the **Table-4-41**.

Table-4-41: Social Categories of PAPs

Sl. No.	Description of the Caste	No. of Families	%
1	Scheduled Caste	11	32.35
2	Other Backward Caste	08	23.53
3	General Caste	10	29.41
4	Other/No Response/Entity	05	14.71
Total		**34**	**100**

[38] *Source: Census Survey, 2024*

(c) Religious Categories of the PAPs

297. Majority of displaced persons belong to Hindu religion, (76.47%), Muslim (8.82%) and others (14.71). The religious categories of PAPs are given below in **Table-4-42**.

Table-4-42: Religious Categories of PAPs

Sl. No.	Description of the Religion	No. of Families	%
1	Hindu	26	76.47
2	Muslim	3	8.82
3	Others	5	14.71
Total		**34**	**100**

(d) Vulnerable PAPs in the Project

298. According to project census survey there are 13 Families excluding tenants enumerated as vulnerable Families. In this project vulnerable group includes 09 SC Families, 3 women headed Families (WHH) 1 differently abled household. The vulnerable household details are presented in the **Table-4-43**.

Table-4-43: Vulnerable Categories of PAPs

Sl. No.	Vulnerability Type	No. of Families	%
1	Scheduled Caste Families	9	69.23
2	Women Headed Families	3	23.08
3	Families headed Differently Abled Person	1	7.69
Total		**13**	**100**

(e) Annual Income Level of the PAPs

299. There are 16 Families (47.06%) having an average annual income below Rs. 242,000 (average per capita income of the State). The survey reveals that 4 (11.76%) Families are earning above Rs. 242,000 and below 300,000; and 14 (41.18%) Families were reported to be earning more than Rs. 300,000 per year. The average income level of Families in the project area is summarized in the **Table-4-44**.

Table-4-44: Income Level of PAPs[39]

Sl. No.	Level of Income	No. of Families	%
1	Up to 242,000	16	47.06
2	Above 242,000 and Below 300,000	4	11.76
3	Above 300,000	14	41.18
Total		**34**	**100**

(f) Educational Status of PAPs

300. The educational status of PAPs reveals that there are 3.67% who are illiterate. Among the PAPs, 40.36% are matric and 14.69% are graduate This data excludes the children below 6 years. The gender segregated details of educational status of PAPs are presented in the **Table-4-45**.

Table-4-45: Educational Status of PAPs

Sl. No	Educational Status of APs	Male	Female	Total	%
1	Illiterate	0	4	4	3.67
2	Literate	3	3	6	5.5
3	Up to middle	20	8	28	25.69

[39] *Source: Census Survey, 2024*

4	Below matric	5	6	11	10.09
5	Matric	27	17	44	40.36
6	Graduate	9	7	16	14.69
Total		**64**	**45**	**109**	**100**

(g) Occupational Status of PAPs

301. The occupational pattern of PAPs excluding children below 6 years, student, housewife and unemployed, reveals that 70.31% PAPs is engaged in business activities. Among other categories, 9.38% engaged in service, 18.75% are labourer and 1.56% are professionals. Affected persons' livelihoods are not primarily land based. The details of occupational status of PAPs are summarized in **Table-4-46**.

Table-4-46: Occupational Status of PAPs

Sl No	Occupational Status of PAPs	Male	Female	Total	%
1	Service	6	0	6	9.38
2	Business	33	12	45	70.31
3	Labour	8	4	12	18.75
4	Professional	1	0	1	1.56
Total		**48**	**16**	**64**	**100**

302. **Status of School Going Children** as per the sample socio-economic survey of the total Families, 18 children are currently going to school and colleges of various standards. As presented in **Table-4-47**.

Table-4-47: School Going Status of Children

Sl. No.	Education	No of Children	%
1	Primary School (up to Class V)	4	22,22
2	Middle School (Class VI - VIII)	3	16.67
3	Secondary School (Class IX - X)	5	27.78
4	Higher Secondary (Class XI - XII)	2	11.11
5	College	3	16.67
6	University	1	5.5
Total		**18**	**100**

303. **Source of Income for the PAP.** Out of 34 surveyed Families, 11 (66.13%) are earning their livelihoods from commercial activities, as it is the main contributors to their livelihoods. Provision for assistance to rebuild the commercial activities are included in the entitlement matrix. Among others, 10 (9.68%) are in service as details are given in following **Table-4-48**.

Table-4-48: Major Sources of Income by Surveyed Families

Sl. No.	Source of Income	Number	%
1	Commercial	11	66.13
2	Service (Pvt./Govt.)	10	9.68
3	Remittance (money order, etc.)	1	3.23
4	Others	1	20.97
TOTAL		**23**	**100.00**[40]

304. **Decision Making.** Women were asked about their role in decision-making on financial and social matters of the household. It was revealed that 95.65% of Families, women have always had a role in the financial and 100% in social decision-making process.

[40] *Source: Sample Socio-economic Survey, 2024*

Chapter 5: ANTICIPATED IMPACTS AND MITIGATION MEASURES

A. METHODOLOGY

305. The methodology of assessing environmental impacts due to the project involved clear identification of the environmental components that will be impacted, the type of impacts, the assessment area where the impacts will be felt and defining the criteria for assessing the significance of each type of impact. After defining these aspects, a screening of project impacts during design and pre-construction (D) stage, construction (C) stage and operation (O) stage of the project was carried out to identify the minor, moderate and major impacts. This would guide development of mitigation measures and ensure that residual impacts are minimized to the maximum extent possible.

306. The Social Impact Assessment (SIA) methodology included a screening/reconnaissance survey during the inception phase using the corridor alignment map, followed by a census and baseline socio-economic survey of potentially affected households based on plot data provided by Maha Metro. This helped document the population, assets, and livelihoods at risk, with a cut-off date of 18th June 2024 for non-title holders. A census-based socio-economic survey established a baseline for assessing impacts on income, assets, cultural networks, and common property resources. Additionally, public consultations and focus group discussions were held to incorporate community feedback into the Social Impact Management Plan (SIMP).

B. IDENTIFICATION OF ENVIRONMENTAL COMPONENTS

307. The identification of environmental components impacted by the project, involves identifying Valued Environmental Components (VEC) of the physical, biological, and human environments, that are at risk of being impacted by the project. The VECs for this project which are based on the collected environmental baseline data include:

(i) Physical environment – air quality and greenhouse gas emissions, land and soil, surface water quality and quantity, and groundwater quality and quantity;
(ii) Biological environment – terrestrial and aquatic vegetation, mammals, avifauna, and ecologically important areas;
(iii) Social environment – private land and buildings, public infrastructure including utility structures, noise and vibration levels, cultural / heritage buildings, and occupational health and safety for the construction workers and local community living within the vicinity of the project area.

308. **Type of impact on the VECs.** The type of impact can be described as:

(i) **Positive**: Improvement in the quality of the VECs because of the project;
(ii) **Negative**: Degradation or reduction in the quality of the VECs because of the project;
(iii) **Neutral**: No noticeable change in VECs.

309. **Area of impact assessment.** The area covered for assessing direct project impacts includes:

(i) Core Study Area of 500 m radial distance around each of the proposed alignments was studied for **Direct Impacts**;
(ii) In addition, Buffer Study area of 2 km around each of the proposed alignment was studied for **Indirect impacts**.
(iii) Sensitive receptors in an area of 100 meter on either side of the proposed alignments;

310. **Significance of impacts.** The assessment of the significance of the impacts on the VECs requires understanding the sensitivity of each VEC within the project context; the

duration of impact; the extent of impact, the intensity of impact and the likelihood of impact. The following sections elaborate these.

311. **Sensitivity of VEC.** The sensitivity of a VEC can be determined by the existing conditions of the VEC within the project area and existence of important VEC's within the project areas. Sensitivity of each VEC is described as high, medium or low as described below.

(i) **Low.** No environmentally important areas (such as protected areas, natural or critical habitat areas, heritage sites, places of worship etc.) are located within the direct and indirect impact zone. The quality of existing conditions of VECs is good or fair;

(ii) **Medium.** There are one or more environmentally important areas within the indirect impact zone of the project area. The quality of existing conditions of VECs is good or fair;

(iii) **High.** There are one or more environmentally important areas within the direct impact zone of the project area. The quality of existing conditions of the VECs is poor or degraded (such as poor air quality, high noise levels, poor water quality), which makes the VEC highly susceptible to further deterioration.

312. Based on baseline conditions in the project area and sensitivity criteria, the level of sensitivity of each VEC is provided in **Table 5-1**.

Table 5-1: Sensitivity of VECs in the project area

Sr. No.	Valued Environmental Components (VECs)	Sensitivity Level	Remarks
1.0	**Physical Environment**		
1.1	Air Quality	High	During the baseline survey value of PM2.5 and PM10 ranges between 10.54 to 32.85 µg/m^3 and 42.14 to 78.65 µg/m^3 respectively, whereas SO_2 and NOx values vary between 13.74 to 21.87 µg/m^3 and 16.47 to 27.45 µg/m^3 respectively. CO values vary between 0.02 to 1.54 mg/m^3.
1.2	GHG Emission	Medium	Vehicular emission in the construction phase is expected to be the main source of GHG pollution.
1.3	Surface Water quality	Medium	Water quality of the surface waters in the project area is sub-par due to high to moderate levels of organic and inorganic matter.
1.4	Groundwater quality	Medium	Water quality of the groundwater in the project area is moderate
1.5	Groundwater quantity	Safe Zone	PCMC is not facing major groundwater shortages
1.6	Land degradation and pollution	Medium	The project alignment is following the median of the existing roads which pass mainly through residential and commercial areas
2.0	**Biological Environment**		
2.1	Trees, terrestrial and aquatic vegetation	High	A total of 258 trees (12 species) are likely to be affected in the construction of the four project alignments.
2.2	Terrestrial fauna (mammals, birds, insects)	Low	No nesting / roosting sites were observed in vicinity of the proposed alignments (especially on trees likely to be affected) during the survey
2.3	Ecologically important areas	Low	There are no Protected / Eco-sensitive areas located within 2 km radial distance around the PCMC to Nigdi alignment. *However,*

Sr. No.	Valued Environmental Components (VECs)	Sensitivity Level	Remarks
			Nisargakavi Bahinabai Chaudhari Zoo is located at 1.85 km from the alignment)
3.0	**Social Environment**		
3.1	Private land and buildings	Medium	Approximately 21 households will be affected, and approx. 677.88 m^2 of private land needs to be acquired
3.2	Public property / infrastructure / utility structures	Medium	The alignment will cross sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, traffic signals, roadside lights, footbridges etc.
3.3	Noise	High	The ambient noise levels in general meet the CPCB and WHO limits, except at a few locations. However, some residential buildings and sensitive receptors are close to the proposed alignments.
3.4	Vibration	Medium	There are several structures located near the proposed alignments. Regular traffic such as buses and trucks on the existing roads add to vibration levels. However, vibration analyses show that all levels are within National and International Limits
3.5	Occupational Health & Safety	Medium	All construction activities will be carried out in accordance with established occupational health and safety standards. Appropriate measures will be implemented to minimize risks to workers, including the use of personal protective equipment (PPE), regular safety training, and site supervision to ensure a safe working environment.
3.6	Public health and safety	Medium	Public health and safety measures include traffic management plans, dust and noise control, proper waste disposal, and clear signage to minimize risks to the community during project activities.
3.7	Physical Cultural Resources (PCR)	Low	There are very few religious places/sensitive receptors located close to the alignment (within 150m on either side)

313. **Duration of the impact**: Duration means the time dimension of the impact on the VECs. The terms permanent, temporary and short-lived are used to describe the duration of impact:

(i) **Short-lived:** The impact disappears promptly;
(ii) **Temporary:** The impact is felt during one project activity or, at most, during the construction period of the project;
(iii) **Permanent:** The impacts are felt throughout the life of the infrastructure.

314. **Extent of impact:** The extent of impact entails the spatial scale of impact on one or more of the VECs. The terms PMRC (Pune Metro Rail Corporation), local and on-site are used to describe the area of impact:

(i) **On-site:** The impact is felt within the direct impact zone;

(ii) **Local:** The impact is felt within the indirect impact zone;
(iii) **NMA:** The impact is felt beyond the indirect impact zone.

315. **Intensity of impact**: The intensity or seriousness of an impact entails understanding the repercussion or risks posed by the impact. This is a subjective criterion which is defined as high, medium or low as below:

(i) **High:** The severity of impact is high if grave repercussions are expected as a result of the impact due to any of the following or similar situations: the impact will be felt by a large number of people or receptors; the receptors are highly sensitive; the impacts will cause serious health issues; there is already a history of complaints from the project area and people have raised significant concerns during public consultation; some of the VEC in the project area already severely degraded and maybe further worsened by the project; there will be a significant change in one or more VEC because of the project;
(ii) **Medium:** The severity of impact is medium due to any of the following or similar situations: the impact will be felt by a small number of people; some receptors are affected but they are not sensitive; the impact will not cause serious health issues; some concerns were raised during public consultations, but they were not significant; there will be minor changes in one or more VEC because of the project;
(iii) **Low:** The severity of impact is low due to any of the following or similar situations: the impact will not be felt by anyone; no or limited receptors are affected; no concerns were raised during public consultations; there will be no noticeable changes in one or more VEC because of the project.

316. Based on the sensitivity of the VEC and the rating of duration, extent, intensity of impact as described above and bearing in mind the likelihood of occurrence of the impact, the overall significance of each impact was classified as major, moderate or minor as demonstrated in **Table 5-2**.

Table 5-2: Criteria for Rating the Significance of Adverse Impacts

Significance	VEC Sensitivity	Duration	Extent	Intensity
Minor	Medium or Low	Short-lived or Temporary	Limited, Local or Regional	Low
	Low	Permanent	Limited	Low
Moderate	High or Medium	Temporary	Limited, Local or Regional	Medium
	Medium	Permanent	Limited	Medium
Major	High	Permanent or Temporary	Limited, Local or Regional	High
	High or Medium	Permanent	Local or Regional	Medium

C. SCREENING OF IMPACTS

317. Based on the rating criteria provided in **Table 5-2,** environmental impacts anticipated during the project design and pre-construction (D) stage, construction (C) stage and operation (O) stage were screened for their level of significance as demonstrated in **Table 5-3** below. If for example, the sensitivity of a VEC is considered high as per **Table 5-1** and a large number of people will be permanently affected on a regional scale, the impact will be considered highly significant. On the other hand, if a VEC is medium sensitive and only a few receptors will be temporarily affected on a localized scale, the significance of the impact will be minor. The screening was carried out for impacts that are expected without mitigation. Hence, it guided the identification of impacts that need mitigation and clearly point out significant / major negative impacts that need to be prioritized for mitigation.

318. The significance of each environmental impact or project activity is indicated in the cells in the second to last column of **Table 5-3**, while the last column shows the significance of anticipated residual impacts after mitigation. Red indicates a major negative impact, orange indicates a moderate negative impact; yellow indicates a minor negative impact and green indicates a positive impact. The following section discusses the details of impacts on each of the VECs in line with the identification of major, moderate, and minor impacts in the screening matrix. Major impacts have been given priority for identification of mitigation measures to ensure that residual impacts are minimized to the extent possible.

Table 5-3: Screening of Environmental & Social Impacts

Sl	Parameter	Adverse Impacts												Significance before mitigation	Residual impacts after mitigation
		Duration			Extent			Intensity / Risk			Likelihood				
		S	T	P	O	L	R	L	M	H	U	L	D		
A.	**Impacts due to Location and Design (Pre-Construction)**														
1	Degradation of surface water quality due to sewage discharge			*	*			*				*		Moderate	Minimal -ve
2	Use of surface water for stations			*		*		*			*			Moderate	Minimal -ve
3	Degradation of groundwater quality due to location of stations and inclusion of sewage treatment			*		*			*		*			Minor	Neutral
4	Location of construction yards		*		*				*				*	Minor	Minimal -ve
5	Location of muck disposal sites			*	*			*					*	Moderate	Minimal -ve
6	Location of project alignment in areas with vegetation and trees.			*	*				*		*			Minor	Minimal -ve
7	Impact of height of viaduct and lighting on birds			*		*		*				*		Moderate	Minimal -ve
8	Transfer of 4848.34 sq.m government land and acquisition of 677.88 sq.m private land			*		*			*				*	Minor	Minimal -ve
9	Aesthetic impact: Limited reduction with proposed sleek structures			*		*				*		*		Moderate	Minimal -ve
10	Metro noise adds to baseline noise which is already high. Significant reduction with proposed design features			*	*					*		*		Major	Moderate –ve

Sl	Parameter	Adverse Impacts												Significance before mitigation	Residual impacts after mitigation
		Duration			Extent			Intensity / Risk			Likelihood				
		S	T	P	O	L	R	L	M	H	U	L	D		
11	Metro vibration adds to baseline vibration level. Limited reduction with proposed design features			*	*			*				*		Major	Minimal -ve
12	Design of Health and Safety features in stations and trains for construction workers and operating staff			*	*				*				*	Moderate	Moderate –ve
13	Safety risks due to flooding and earthquakes			*	*			*			*			Minor	Minimal –ve
14	Transmission of communicable diseases including HIV/AIDS, Covid-19, etc.			*	*					*	*			Moderate	Minimal –ve
15	Possible impact on religious or cultural buildings / structures within 100 meters of the alignment			*		*			*		*			Minor	Neutral
16	Increased energy demand from grid, causing additional GHG emissions			*			*	*					*	Moderate	Minimal –ve
B.	**Impacts due to Project Construction**														
1	Sourcing of construction material; Emissions from machinery and vehicles; site operations; operations in construction yard; dumping at muck and waste disposal sites		*		*				*				*	Major	Minimal -ve
2	Degradation of surface- and ground-water quality due to run-off and waste water from		*		*			*				*		Moderate	Minimal –ve

Sl	Parameter	Adverse Impacts												Significance before mitigation	Residual impacts after mitigation
		Duration			Extent			Intensity / Risk			Likelihood				
		S	T	P	O	L	R	L	M	H	U	L	D		
	construction sites, construction yards, waste disposal sites, Labour camps, drainage changes due to C&D waste disposal sites, siltation of water bodies														
3	Use of surface water for construction purposes			*		*			*		*			Moderate	Neutral
4	Reduction of ground water quantity due to dewatering activities	*			*			*			*			Moderate	Neutral
5	Soil erosion due to site clearing and levelling		*		*			*			*			Minor	Minimal –ve
6	Soil pollution due to various activities at construction yards, C&D and hazardous waste disposal sites		*			*			*				*	Moderate	Minimal –ve
7	Removal of 258 trees, damage to maintained trees and bushes			*	*				*				*	Moderate	Moderate –ve
8	Impact on avifauna due to height of viaduct, construction noise and vibration and lighting			*	*			*					*	Moderate	Neutral
9	Diversions of utility services and possible outages		*			*		*				*		Moderate	Neutral
10	Traffic diversions		*		*					*			*	Moderate	Minimal –ve
11	Temporary use of land for construction, Labour camps and traffic detours		*		*				*				*	Moderate	Neutral
12	Noise and Vibration due to operation of construction		*		*				*				*	Major	Minimal –ve

Sl	Parameter	Adverse Impacts												Significance before mitigation	Residual impacts after mitigation
		Duration			Extent			Intensity / Risk			Likelihood				
		S	T	P	O	L	R	L	M	H	U	L	D		
	equipment and vehicular movement														
13	Impacts due to possible poor conditions in Labour camp, working at height and with heavy machinery, risk of transmission of communicable diseases including Covid-19		*		*			*			*			Moderate	Moderate –ve
14	Public exposure to traffic, noise, vibrations, dust and communicable diseases including Covid-19		*		*				*			*		Moderate	Minimal –ve
15	Chance finds of objects of physical or cultural value		*		*			*			*			Minor	Neutral
C.	**Impacts due to Project Operation**														
1	Degradation of water quality due to sewerage discharge			*		*			*		*			Minor	Minimal –ve
2	Increased water demand from public water supply			*		*			*		*			Moderate	Minimal –ve
3	Land degradation due to insufficient waste management			*	*			*			*			Moderate	Neutral
4	Noise due to metro operations			*	*				*				*	Major	Minimal –ve
5	Vibration due to metro operations			*	*			*					*	Major	Minimal –ve
6	Accidents, electromagnetic interference, exposure to electromagnetic radiation and communicable diseases		*			*			*			*		Moderate	Minimal –ve
D.	**Positive Impacts during Operation phase**														

Sl	Parameter	Adverse Impacts												Significance before mitigation	Residual impacts after mitigation
		Duration			Extent			Intensity / Risk			Likelihood				
		S	T	P	O	L	R	L	M	H	U	L	D		
1	Reduced air pollution due to modal shift towards public transport			*			*			*			*	-	Major +ve
2	More efficient and environmentally friendly movement of people			*		*				*			*	-	Major +ve
3	Groundwater recharge due to rainwater harvesting			*			*			*			*	-	Major +ve
4	Growth of compensated trees			*		*				*			*	-	Moderate +ve
5	Economic opportunities			*		*				*		*		-	Moderate +ve

Note:

Impact: +ve = positive; -ve = negative

Duration: S = Short-lived; T = Temporary; P = Permanent

Extent: O = On-site; L = Local; R: Regional (Pimpri Chinchwad Municipal Area)

Intensity: L = Low; M = Medium; H = High

Likelihood: U: Unlikely; L: Likely; D: Definite

: positive impact; : minor negative impact; : moderate negative impact; : major negative impact;

D. IMPACTS PRIOR TO MITIGATION

319. **Table 5-3** shows that during the pre-construction phase the most significant impacts (before mitigation) to be expected are:

(i) Degradation of surface water quality due to sewage discharge (Moderate)
(ii) Use of surface water for stations (Moderate)
(iii) Location of muck disposal sites (Moderate)
(iv) Impact of height of viaduct and lighting on birds (Moderate)
(v) Aesthetic impact due to location and design (Moderate);
(vi) Noise impact due to choices in design (Major);
(vii) Vibration impact due to choices in design (Major);
(viii) Design of Health and Safety features in stations and trains for construction workers and operating staff (Moderate)
(ix) Impact on Health and Safety due to communicable diseases such as Covid-19 (Moderate)
(x) Increased energy demand from grid, causing additional GHG emissions (Moderate)

320. During construction phase the following impacts are of major significance:

(i) Impact on air quality due to emissions from machinery, vehicles and site operations, and due to sourcing of construction material (Major);
(ii) Impact due to increased noise and vibration from construction equipment (Major)
(iii) Degradation of surface- and ground-water quality due to run-off and waste water (Moderate);
(iv) Impact due to use of surface water for construction and dewatering of groundwater, if any (Moderate);
(v) Soil pollution due to various activities at construction yards, C&D and hazardous waste disposal sites (Moderate);
(vi) Impact due to removal of trees during construction phase (Moderate);
(vii) Impact due to diversions of Utility services and traffic diversions (Moderate);
(viii) Impact on land due to temporary use of land for construction, Labour camps and due to dumping at excavate and waste disposal sites (Moderate);
(ix) Impacts due to possible violation of Occupational Health & Safety norms at construction sites, labour camps, etc. (Moderate);
(x) Impact due to public exposure to traffic, noise, vibrations, dust and communicable diseases (Moderate).

321. During the operational phase the only major impact that can be expected is an increase in noise and vibration due to operation of the metro.

322. Additionally, various positive impacts are also anticipated due to construction / operation of the metro like:

(i) Reduced air pollution due to modal shift towards public transport;
(ii) More efficient and environmentally friendly movement of people;
(iii) Groundwater recharge due to rainwater harvesting;
(iv) Plantation of compensatory afforestation;
(v) Creation of Economic opportunities.

E. ANTICIPATED IMPACTS AND MITIGATION MEASURES

323. In the following Sections, the identified impacts on each of the VECs are described including the measures that will be taken to mitigate these impacts. If the expected impacts cannot be mitigated completely the residual impact is described including its significance.

1. Air Quality

324. A major benefit of metro is reduction in ambient air pollution and greenhouse gases with consequent costs of health and accidents due to shift of passengers from usage of current road-based modes. Based on number of daily vehicle kilometre reduction, daily reduction in fuel (diesel and petrol) consumption has been estimated.

325. **Impacts.** Air pollution will be caused at construction sites during excavation, demolition, operation of construction equipment, blasting in rock; on routes of transportation of construction material, precast elements, excavated material and waste; at construction yards during aggregate crushing / screening, construction material and precast elements; at disposal sites during disposal of waste and excavated material. Emissions from DG sets, emissions from fuel and other hazardous chemicals are other sources of pollution. Open burning of solid waste and solid fuel in labour camps could cause air pollution. The pollution is in terms of fugitive dust and particulate and chemical emissions from trucks. Air pollution from road-based vehicles, especially particulate matter, is found to cause diseases of brain, heart, lungs and kidneys.

326. Trucks are required to transport raw material to casting yards and Ready-Mix Concrete (RMC) plants; from pre-cast yards and batching plants to construction site and between construction site and excavate and waste disposal site. The estimate of air pollution impacts is based on vehicle km of truck movement to transport precast elements and material from construction yard and earth from site to disposal location for typical leads.

327. **Mitigation.** Contractor's transport vehicles and other equipment will conform to emission standards. The Contractor will carry out periodical checks and undertake remedial measures including replacement, if required, so as to operate within permissible norms.

328. Procedure for truck maintenance, including selection of service providers considering environmental aspects, application of Low-Sulphur fuel, no idling of trucks, routine maintenance (including assurance of proper engine operations related to emissions and noise), and disposal of used oil and other fluids, batteries, and tyres etc.

329. DG sets compliant with emission standards will be used.

330. The following dust protection methods will be used:
    (i) Dust screens during excavation and demolition near sensitive receptors
    (ii) Dust filters atop cement silos
    (iii) Wet suppression for aggregate crushing and screening.
    (iv) Good quality project roads with added petroleum emulsions and adhesives, speed control, traffic control.
    (v) Material of specifications as per contract will be procured by Contractor from Government-approved quarries

331. The Contractor will ensure that trucks carrying loads of sand and aggregate required in construction being transported to construction yards are covered and loaded with sufficient free - board to avoid spills--within the largest compartment of tanker truck. Transportation will be scheduled by time and route to minimize air pollution in inhabited (homes or workplaces or sensitive receptors such as schools, hospitals) areas.

332. The Contractor will ensure that all trucks carrying loose C&D waste will be covered and loaded with sufficient free - board to avoid spills through the tailboard or sideboards. Transportation of C&D waste (muck) will be scheduled by time and route to minimize air pollution in habitat areas. Disposal of Hazardous waste will be done by licensed vendors at sites pre-approved independent of the project. Contractor will ensure that the vendor transports the waste with due care to avoid escape of fumes or spillage en route.

333. Temporary storage will be maintained by the Contractor at all times until the excavate

is re-utilized for backfilling and C&D waste is evacuated from site. Dust control activities will continue even during any work stoppage. Soil erosion by runoff will be controlled by installing proper drainage systems using contour information. It is suggested to avoid bringing soil from outside the project boundary and to use the excavated mounds for filling low lying area where it is necessary.

334. The Contractor will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt.
Construction yards with aggregate crushing and screening, pre-casting, material and fuel storage and GC plants as well as excavate/waste disposal sites will be located away from inhabited or ecologically sensitive areas.

335. Labour residing in camps will be provided with LPG fuel for cooking. Burning of waste or other unwanted materials will not be allowed on site or at labour camps.

336. Prediction of impacts on air environment in Operation phases of the project has been carried out by employing a mathematical model. Impact during construction phase will be due to excavation & pilling operation for construction of piers and due to vehicle movement for transportation of excavated material if any. Thus, impact of the same will be limited and temporarily in nature, hence it was not considered for air quality modelling. In the present case, AERMOD (10.2.1) dispersion model based on steady state Gaussian plume dispersion, designed for multiple point sources for short term has been used for predicting the ground level concentrations. The computations deal with major pollutants like Sulphur dioxide and Suspended Particulate Matter and Oxides of Nitrogen.

337. The air quality modelling study for the proposed facility was conducted using the AERMOD dispersion model to evaluate the ambient air quality and predict the incremental impacts from project operations. The baseline ambient air quality data was collected from six monitoring locations, strategically chosen based on wind patterns, proximity to sensitive receptors, and potential downwind and crosswind impacts.

338. Key parameters, including PM_{10}, SO_2 and NOx, were analysed, and all observed values were within the permissible limits set by the Central Pollution Control Board (CPCB). The operation of diesel generator (DG) sets, modelled under worst-case scenarios, indicated negligible incremental concentrations for all monitored pollutants. The cumulative concentration levels, including baseline and incremental impacts, remained well below regulatory thresholds at all receptor locations.

339. The study concludes that the project operations are unlikely to cause significant adverse impacts on ambient air quality. Nevertheless, the proposed mitigation measures, such as the installation of efficient air pollution control equipment and regular maintenance of DG sets, are recommended to ensure sustained compliance with environmental standards

340. The air pollution modelling carried out represents the worst case and normal operating scenarios for metro. Analysis of data is completed and a summary of the conclusions drawn from the predicted incremental Ground Level Concentrations (GLCs) is provided in **Annexure-6** of this report.

341. **Residual Impact.** Through modal shift from fossil-fuel driven transport to metro the air quality will be positively impacted. The magnitude of the beneficial impact of metro will increase with increasing ridership. For a more efficient movement of people the alignment will be designed with a smaller number of curves and a curve radius better than minimum value. Stations will be designed with optimal platform and concourse space as per standard planning and design codes. Integration of metro with other modes especially walk, public transport and intermediate public transport (hired modes) is found to increase ridership and lessen congestion inside and outside the stations. Residual impact is non-significant.

342. **Impact Significance**

- Design and pre-construction stage – major positive
- Construction stage – major negative
- Operation stage – major positive
- Residual Impact after Mitigation – major positive

2. Noise

343. Baseline noise is within permissible limitsat all monitored locations.

344. **Impact due to Construction Phase.** Noise will be generated from equipment during construction and wheel-rail interactions during operation phase. The major sources of noise during construction phase are operation of various types of construction equipment. Permitted number of impacts (example piling) at various noise levels is prescribed under Model Rules of the Factories Act, 1948. Actual noise from construction equipment (Lmax) measured at 50 feet distance[41] ranged from 76 dB(A) to 84 dB(A); vibratory pile driver at 101 dB(A). The average / typical noise levels generated by various types of construction equipment are given in **Table 5-4** while actual noise generated by various construction equipment is summarised in **Table 5-5.**

Table 5-4: Average Noise Levels Generated by Various Construction Equipment[42]

Equipment	Typical Noise Level (dBA) at 50 ft from source
Air Compressor	81
Backhoe	80
Ballast Equalizer	82
Ballast Tamper	83
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Concrete Vibrator	76
Crane Derrick	88
Crane Mobile	83
Dozer	85
Generator	81
Grader	85
Impact Wrench	85
Jack Hammer	88
Loader	85
Paver	89
Pile Driver (Sonic)	96
Pneumatic Tool	85
Pump	76
Rock Drill	98
Roller	74
Scraper	89
Shovel	82
Truck	88

Table 5-5: Actual Noise Levels Generated by Various Construction Equipment[43]

Equipment	Actual Lmax Noise Level (dBA) at 50 ft from source
Auger drill rig *	84

[41] *Construction Noise Handbook August 2006, FHWA, USA*
[42] *Source: FTA Transit Noise and Vibration Guidance Handbook, May 2006*
[43] *Source: Construction Noise Handbook, US FHWA, Aug 2006*

Compressor *	78
Dump truck *	76
Excavator *	81
Flat bed truck *	74
Front end loader *	79
Vibratory Pile driver *	101
Press Pile	70
Batching Plant	90
Booster pump	80

345. During construction phase, there will be significant increase in vehicular movement for transportation of construction material. Additionally, there will be noise from the usual traffic with possible traffic congestion due to traffic diversions. During construction phase, the increase in vehicular movement is expected to be up to a maximum of 5 to 6 trucks/hour.

346. The effect of high noise levels on the operating personnel has to be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 85 dB(A) affects the hearing acuity of the workers/operators and hence, should be avoided. To prevent these effects, WBG-EHS recommended that the exposure period of affected persons is limited (**Table 5-6**).

Table 5-6: Maximum Exposure Periods Specified by WBG-EHS guidelines

Maximum equivalent continuous Noise level dB(A)	**Unprotected exposure period per day for 8 hrs./day and 5 days/week[44]**
85	8
88	4
91	2
94	1
97	½
100	¼
103	No exposure permitted at or above this level

347. **Mitigation Measures.** During construction various measures such as noise mufflers, enclosures, low-noise equipment and temporary noise barriers will reduce noise. Vehicles and construction equipment will be in good state of maintenance, where feasible of low noise design, fitted with noise mufflers. Other mitigation measures to be taken are:

(i) At all locations, auger piling will be carried out in place of mechanical (by driven) piling which will generate less noise than mechanical piling [around 70-75 dB(A)]. Also, 2m high barricade of GI sheet will be installed on all sides of piling operations. This will effectively cut down noise levels by 10-15 dB (A). Piling operations will be restricted during day time hours only

(ii) Noisy construction activities will be enclosed by use of transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities;

(iii) RCC pumps will be covered from all sides. Bends and excessive head will be avoided;

(iv) If needed, construction traffic will be confined to certain routes (based on infrastructure capacity) or restricted to certain off -peak hours (that is, to reduce noise pollution at night or to avoid commuting and school hours during the day);

(v) Local residents and shop owners will be informed about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement;

[44] *Although hearing protection is preferred for any period of noise exposure in excess of 85 dB(A), an equivalent level of protection can be obtained, but less easily managed, by limiting the duration of noise exposure. For every 3 dB(A) increase in sound levels, the 'allowed' exposure period or duration should be reduced by 50 percent*

(vi) Noise monitoring is required during construction, including field observations and measurements.

348. Exposure of workers to high noise levels will be minimized by measures such as the following:

(i) Personal protective equipment such as passive or active ear-muffs
(ii) Use of electric instead of diesel-powered equipment
(iii) Use of hydraulic tools instead of pneumatic tools
(iv) Acoustic enclosures for noise generating construction equipment like DG sets
(v) Scheduling work to avoid simultaneous activities that generates high noise levels
(vi) Job rotation where feasible
(vii) Sound-proof control rooms
(viii) Automation of equipment and machineries, wherever possible.

349. **Impact during Operation Phase:** During the operation phase the main source of noise will be from running of metro trains, particularly the noise radiated from train operations and track structures. Airborne noise is radiated from at-grade and elevated structures, while ground-borne noise and vibration are of primary concern in underground operations.

350. In the context of rapid rail transit, noise levels exhibit distinct variations: when trains traverse viaducts (elevated) at a speed of 50 mph (i.e around 80kmph), the noise level at a distance of 15 m from the tracks registers at 85 dB (A); a corresponding value of 80 dB (A) is observed at ground level, while rail transit at stations yields a noise level of 65 dB (A). The primary noise source arises from the movement of metro trains, with the dominant contributors being the noise emanating from train operations and track structures. However, since an average (schedule) speed of 32-34 kmph (around 20-21 mph) will be adopted, significantly lower noise levels will be generated throughout the operation phase of PCMC to Nigdi.

351. To estimate the operational noise level, the internationally recognized noise modelling software 'SoundPLAN' version 9.0 has been utilized. The Environmental noise propagation methodology adopted, and the equations used within the SoundPLAN model are based on the ISO 9613 'Acoustics – Attenuation of Sound during Propagation Outdoors' (ISO, 1996) and Railway noise using FTA/FRA- HSGT:2005.

352. Using SoundPlan 9.0, the calculation options that were selected for this project provided a balance between accuracy of noise assessment and time to complete the computation. The required inputs for modeling of Noise were collected from Maharashtra Metro Rail Corporation Limited (MMRCL) and presented in **Table 5-7** below. As mentioned earlier, in addition to the FTA/FRA-HSGT (2005) standards that were applied, the following options were adopted:

- The maximum and minimum distance between any two stations is 3.2km and 600m, respectively. Both of which are in line 1A.
- The metro train service timing for all routes is 6:00 AM till midnight, i.e. 18 hours per day.
- The scheduled speed on all the routes is 34 kmph
- The maximum acceleration and deceleration shall be 1.0 m/s2 and 1.1 m/s2
- Assessment: Day, Night, Ldn
- Emission time slices: 6-22, 22-6
- Reflection order: 3

Table 5-7: Features of rolling stock and track

Parameter	Detail
Unit	3 car basic unit DMC+TMC+DMC
DMC dimension	21.64x2.9x3.9 (LxBxH)

TMC dimension	21.34x2.9x3.9 (LxBxH)
Maximum coach length	22.6m
Axle Load	≤ 16T or 157Kn
Number of axles	4
Normal braking system	Regenerative
Braking type	Disc brakes
Wheel diameter	860mm (assumption)
Track Gauge	1435mm
Track base	Ballast-less track with elastic and absorbent fittings
Rail joints	Minimum spacing (assumption)

353. **Noise Emission Sources:** Noise radiated from train operations and track structures generally constitute the major noise sources. Airborne noise is radiated from at-grade and elevated structures, while ground-borne noise is of primary concern in underground operations. Basic sources of wayside airborne noise are:

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

354. Predicted noise levels for the project area were modelled in accordance with the FTA guidelines. Predicted future noise levels in the project area were based on existing measured sound levels and future daily transit operations.

- **Ground Elevation and Digital Ground Model**: The ground elevation data was taken from Google Earth to generate Digital Ground Model.
- **Superstructure**: The viaduct has pre-stressed concrete "Box" shaped Girders/Double U-Girder on a Single pier with pile / Open foundations. It is assumed that the viaduct side wall height is 750mm and will act as a noise wall. For elevated viaducts, the rail level is 11.16m AGL, whereas it is 0.75m AGL for at-grade stations. All the stations are elevated
- **Rail Elevation**: The rail elevations from the engineering vertical profiles were used to establish the absolute and relative height of the railway every 11.16 meters.
- **Building Location and Heights:** Building locations were taken from Open Street Map and Google Maps while the building heights were extrapolated from the number of floors as observed from field survey.

355. **Noise Modelling Studies:** Noise modelling studies for PMRP Phase I Project for operation phase have been carried out, and a brief summary of the findings is presented below.

356. The noise from the operation of the metro is within the permissible limits of CPCB and do not exceed +3 dB(A) of the existing ambient noise levels except at one sensitive receptor along the alignment where noise levels are not within permissible limits and exceeding the +3 dB(A) during night time. However, there is no activity at this sensitive receptor during night time and metro will not be operational during whole night. Therefore, no mitigation measures are required at these receptors. Findings of the Noise modelling analysis carried out are summarised in **Table 5-8** below, while detailed Noise modelling Study is attached as **Annexure-14** of this ESIA report.

Table 5-8: Summary of Noise Modelling Studies

Name of Receptor	Land use Category as per CPCB	Baseline Noise Levels, dB(A)	Projected Noise Levels, dB(A)	Increase over Baseline Noise Levels,	Noise Levels after installation of Noise Barriers	Central Pollution Control Board Noise

						dB(A)		dB(A)		Standards (dBA)
		Day time	Night time	Day time	Night time	Day time	Night time	Day time	Night time	
Bhakti Shakti Metro Station	Proposed Station/ Commercial	64.7	46.7	65.2	47.8	0.5	1.1	64.9	45.3	Day: 65 Night: 55
Vidyanand Bhawan High School (Near)	Sensitive Receptors (School)/ Silent	41.5	38.5	44.3	42.2	2.8	**3.7**	42.1	39.7	Day: 50 Night: 40
Nigdi Metro Station	Proposed Station/ Commercial	63.8	53.4	64.9	54.7	1.1	1.3	62.7	52.2	Day: 65 Night: 55
Khandoba Chowk	Commercial	62.7	43.5	63.8	45.1	1.1	1.6	62.6	42.6	Day: 65 Night: 55
Chinchwad Metro Station	Proposed Station/ Commercial	64.4	52.8	66.5	53.8	2.1	1	63.9	51.3	Day: 65 Night: 55
Chinchwad (End of Alignment)	Commercial	63.4	53.7	64.1	54.9	0.7	1.2	61.9	52.4	Day: 65 Night: 55

357. **Embedded Measures.** The ballast-less track supported on two layers of rubber pads will reduce track noise and ground vibrations. In addition, providing skirting of coach shell covering the wheel will screen any noise coming from the rail wheel interaction as of propagating beyond the viaduct. Screening of noise can be ensured by providing parabolic noise barriers on each side of the track along the curved portion of the viaduct and at identified sections during operation.

358. In order to verify the predicted noise levels, the ESMP provides for noise monitoring during the first three years of operation.

359. **Residual impact.** The residual impacts due to metro operation will be negligible. Suitable mitigation measures like noise barrier will be proposed at affected locations, if any identified at a later stage during construction / operation.

360. **Impact Significance:**

- Design and pre-construction stage – major negative
- Construction stage – major negative
- Operation stage – major negative
- Residual Impact after Mitigation – negligible

3. Vibration

361. . Construction and operation of metro will cause vibration from equipment during construction and wheel-rail interaction during operation. As part of this ESIA, a general vibration and annoyance assessment for operational phase has been carried out. The vibration assessment required as a prolonged annoyance has been carried out based on the methodology proposed by the Federal Transit Administration of USA in the Transit Noise and Vibration Guidance Handbook, 2006. The vibration induced during the operational phase is based on the US Federal Transit Administrations methodology to create a ground-borne

vibration prediction model to assess metro operation related vibration into buildings. The assessment also followed the "Metro Rail Transit System. Guidelines for Noise and Vibrations" elaborated by CT-38 Track Design Directorate, Research Designs and Standards Organisation (RDSO), Ministry of Railways of India.

362. **Impact** During Construction Phase: Based on the general vibration assessment, pile drivers (impact or sonic), clam shovel drops, and vibratory rollers are identified as the primary sources of construction-related vibration. Pile driving, in particular, can affect structures up to 40 metres away and cause perceptible annoyance up to 100 metres, depending on receptor sensitivity and building type. However, a review of the alignment confirms that very few sensitive receptors / residential structures fall within these critical distances. As such, vibration levels are expected to remain within internationally accepted limits (e.g., DIN 4150-3, ISO 4866) for structural safety and human comfort. Nevertheless, vibration monitoring will be undertaken during construction, especially near any newly emerging receptors, and mitigation measures—such as temporary barriers or adjustments in construction methods—will be implemented, where required.ed.

363. Pile driving for viaduct piers and buildings generate vibrations. Apart from distance from the alignment, soil, age and condition of buildings adjacent to the alignment determines extent of damage to such buildings due to vibration. Continuous effect of vibration on the buildings can cause damage to buildings. **Figure 5-1** provides typical PPV values at 25 ft. for several types of construction machinery as per the FTA, 2018.

364. Vibration from pile driving can be calculated with the following equation (FTA, 2018):

$PPV_{Impact\ Pile\ Driver} = PPV_{Ref}\ (25/D)^{1.5}$

Where, PPV_{Ref} = 0.644 in/sec (for a typical pile driver at 25 ft.)

D = distance (from pile driver to the receiver in ft.)

365. Based on this equation a typical engineered concrete or masonry building is potentially at risk if it is located within 22 meter of the pile driving works.

Figure 5-1: Vibration source levels for construction equipment (FTA) [45]

Equipment		PPV at 25 ft, in/sec	Approximate Lv* at 25 ft
Pile Driver (impact)	upper range	1.518	112
	typical	0.644	104
Pile Driver (sonic)	upper range	0.734	105
	typical	0.17	93
Clam shovel drop (slurry wall)		0.202	94
Hydromill (slurry wall)	in soil	0.008	66
	in rock	0.017	75
Vibratory Roller		0.21	94
Hoe Ram		0.089	87
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58

* RMS velocity in decibels, VdB re 1 micro-in/sec

366. **Impact** During Operational Phase: In operation phase, a maximum distance of 29 m will be affected if 80 kmph design speed and masonry building structures are considered. This distance will be reduced to 10 m if 32 kmph scheduled speed is considered. As a feature of design, track fittings during operation will reduce vibration. Vibration during operation of the metro could cause annoyance and disturbance to daily living of residents and workers along the alignment. Vibration could damage fragile and old buildings over a period of time.

367. During operation vibration is found to be higher with higher speeds and lower with heavier transit structure.

[45] *Source: FTA Transit Noise and Vibration Impact Manual, September 2018.*

368. Vibration modelling for the proposed PCMC to Nigdi has been carried out, and the detailed report of the same is attached as **Annexure-11** of this ESIA Report.

369. **Mitigation.** The design will include vibration reducing features such as, but not limited to ballast less track structure supported on two layers of rubber pads, resilient mounting and dampers and welded rails. Construction activities will be scheduled such that demolition, earthmoving and ground-impacting operations do not occur in the same time period. At locations where the alignment is close to sensitive structures, the contractor shall prepare a monitoring scheme prior to carrying out construction at such locations. Also, vibration mitigation measures will be implemented. Vibratory Rollers will be avoided near sensitive structures.

370. The contractor will prepare a mitigation plan and implement the same during the final design and construction phase of the project. This scheme will include:

(i) Monitoring requirements for vibrations at regular intervals throughout the construction period; Pre-construction structural integrity inspections of sensitive structures.
(ii) Information dissemination about the construction method, probable effects, quality control measures and precautions to be used.
(iii) vibration monitoring plan during final design and the implementation of a compliance monitoring program during construction.

371. Damping treatments, localized stiffening or mass addition at the receptors to reduce post-construction vibration. Wave-impeding blocks (WIP), subgrade stiffening and wave barriers are effective measures of interrupting the propagation of waves through the soil.
Visual inspections of pre-identified buildings at risk of damage caused by vibrations during construction will be done so as to serve as baseline to monitor progression of building damage if any. The visual inspections will be done in attendance of the owner of the building and will be recorded. Cast-in-situ piling will be deployed so as to reduce vibration.

372. In the case of vibrations from road traffic and pile driving, very deep barriers (in excess of 10 m) will be constructed to reduce vibration. In-ground barriers are trenches that are either left open or filled with a material (such as polymer slurry or concrete) that has stiffness or density significantly different from that of the surrounding soil. However, trenches may be too costly for situations involving houses. They could perhaps be justified for larger buildings with strict vibration limits, such as operating theatres of hospitals or high-tech factories with sensitive processes. An economical alternative to trenches in a residential area could be a row of lime or cement piles of diameter 0.5 m to 1 m and a depth of 15 m in the right-of-way adjacent to the road. However, the effectiveness of such pile-walls has not yet been demonstrated[46]. Measures will be decided upon forecast of vibration during the Visual inspections of pre-identified buildings at risk of damage caused by vibrations during construction, as mentioned above.

373. Detailed vibration modelling is needed if sensitive receptors are located within the reported distances from the track in order to determine if the negative impacts can be fully mitigated through the following mitigation measures:

(i) Ballasted tie-welded track with elastic steel fastenings and plastic or rubber absorbing pad will reduce noise and vibration levels. Surface irregularities on the wheel and rail will be minimized by good maintenance of wheel and rail condition.
(ii) Elastic pad between seat of the rail and the track slab as well as between track slab and the superstructure beneath it will reduce vibration will be installed to reduce transmission of vibration from the track and superstructure. Using floating

[46] *Source: NRC-CNRC Construction Technology Update No. 39, 2000, Vibrations in Buildings by Osama Hunaidi and A review on the effects of earth borne vibrations and the mitigation measures, BOO Hyun Nam et al, IJR International Journal of Railway, Sept 2013.*

slab and high resilience fasteners to reduce the vibration at the point of emission.

374. **Residual impact**. The residual impact is considered minimal negative.

375. **Impact Significance**

- Design and pre-construction stage – major negative
- Construction stage – major negative
- Operation stage – moderate negative
- Residual Impact after Mitigation – minimal negative

4. Hydrology / Drainage

376. **Impact.** The construction of infrastructure projects like a metro system, including the construction of piers, can have various impacts on hydrology and surface water bodies. These impacts can be both positive and negative, and they depend on various factors including the design and construction of the project, as well as the local environmental conditions.

377. The construction of metro piers, stations, and tracks often leads to an increase in impervious surfaces such as concrete and asphalt. This can result in increased surface runoff and reduced infiltration of rainwater into the soil. As a result, there may be more storm-water entering local water bodies, which can lead to increased erosion and potential water quality issues.

378. Metro Construction may alter the natural drainage patterns of the area. New drainage systems may be installed to manage storm-water, which could change the flow of water in the area. This alteration can have implications for local streams, rivers, and wetlands. Pollutants which include sediment, construction materials, chemicals, and oils etc. can be introduced into nearby surface water bodies through surface run-off. Proper erosion and sediment control measures shall be put in place to mitigate these impacts, if required.

379. Piling and excavation activities during construction can temporarily lower the water table in the vicinity of the metro construction. Mitigation measures like construction of retention ponds or wetlands to manage storm-water, the use of permeable pavement in station areas, and the implementation of best management practices for erosion and sediment control measures shall be recommended wherever required.

380. **Mitigation.** Anticipated impacts of pier construction will be mitigated by construction of Phase 1 extension metro piers parallel (adjacent) to the piers of existing bridges on downstream side so as to avoid obstruction / conflict of water flows. Work will be executed by providing suitable cofferdams for foundations / sub-structures.

381. **Embedded measures.** The following Flood Control Measures are embedded in the Project Design of Stations:

(i) All entrances extending to street level shall be protected against flooding. This protection shall include provision of minimum but appropriate number of steps and/or ramps to landing, considering minimum required height and/ or flood gates. The design of such protection shall be achieved according to the proper study of flood history record and topographical survey data.

(ii) Where required for flood protection the stair well on pavement entrances shall be surrounded by a solid balustrade 900 mm high. At sites not affected by flooding alternative entrance envelopes can be proposed.

(iii) Flood protection, as required for all standard station entrances shall be provided. Any incidental water, shall be similarly catered for.

382. **Impact Significance**

- Design and pre-construction stage – neutral

- Construction stage – minor negative
- Operation stage – minor negative
- Residual Impact after Mitigation – neutral

5. Surface water and Groundwater Quality

383. **Impact.** The wastewater discharged from the project during construction and operation can pollute surface water bodies and ground water if not handled and treated properly. However, as a feature of design, all stations will be connected to the municipal sewerage and therefore such water will be treated by municipal authorities as per norms before discharge into surface water bodies. The stations will therefore have an impact on the amount of sewage to be treated throughout the operational phase and, in case of insufficient treatment, indirectly have an impact on the water quality. In case of poor maintenance of the sewage system leakages might start to occur, thus impacting the quality of ground water. If the drainage capacity of the existing sewerage system is inadequate to handle the additional sewage the risk of localized flooding emerges.

384. Waste construction materials and hazardous waste from construction sites; used water from the RMC plant; water used for dust suppression at aggregate crushers are sources of pollution of surface water bodies or groundwater. Sewage from labour camp can also pollute surface water bodies or groundwater. Groundwater which seeps into excavations can get contaminated by chemicals used in construction and consequently pollute groundwater outside the excavations upon dewatering. Hazardous waste would mainly arise from the maintenance of equipment which may include used engine oils, hydraulic fluids, waste fuel, spent mineral oil/cleaning fluids from mechanical machinery, scrap batteries or spent acid/alkali, spent solvents etc. Percolation / leaching of toxic substances at C&D waste disposal sites and hazardous waste disposal sites can pollute water.

385. **Mitigation**. As per design the stations will be connected to the municipal sewerage system. Prior to commencement of the works contractor will verify with the municipal authorities if the existing sewerage capacity is adequate to handle the extra sewage or if additional works on the existing sewerage system are necessary. This in order to prevent uncontrolled discharge of sewage into the environment.

386. In order to detect any leaks in the sewer system as soon as possible during the operational phase, regular visual inspections of the terrain surrounding the stations will be carried out. If subsidence of the ground is observed the sewer must be excavated for inspection and repairs when necessary.

387. Sedimentation ponds of adequate size and capacity will be built for the treatment of discharges from the batching plants and the crushing plants to allow the sediments to settle. Final discharges from the sedimentation ponds will comply with the National standards for wastewater. The settled sediments will be periodically removed and will be disposed of at the designated spoil disposal sites.

388. At the campsites wastewater treatment facilities will be constructed (e.g., septic tank and soak pit and site drainage) to avoid spillage of wastewater into surface water or groundwater.

389. Equipment/vehicle repair/maintenance and re-fuelling areas will be confined to areas in construction sites designed to contain spilled lubricants and fuels. Such areas will be equipped with a concrete perimeter and drainage system leading to an oil/grease-water separator that will be regularly skimmed of oil to prevent spilled oil/grease being discharged to the ground surface.

390. Management and storage of fuel, waste oil, and hazardous substances will be planned in accordance with the World Bank Group's Environmental, Health and Safety General

Guidelines on Hazardous Materials Management. This includes the use of appropriate secondary containment structures capable of containing the larger of 110 % of the largest tank or 25% of the combined tank volumes in areas with above-ground tanks with a total storage volume equal or greater than 1,000 liters. Fuel storage tanks need to be placed under roofs and on concrete slabs with berms or dikes to contain spills in a secured covered area.

391. Spill clean-up equipment (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances will be maintained on-site. Should any accidental spills occur, immediate clean-up will be undertaken, and all clean-up materials will be stored in a secure area for further disposal. Disposal of such will be undertaken by a waste management company contracted by the Contractors. The waste management company must have the required licenses to transport and dispose of any hazardous waste before any such waste is removed from the site. The Contractors will keep copies of the company's licenses and provide waste transfer manifests at their camp site for routine inspection by the engineer.

392. **Residual impact.** Although waste water let into the sewers will be treated by municipal authorities to general effluent standards before discharge into surface water or groundwater, minimal negative impact on receiving bodies might occur in case of insufficient treatment. The stations will have an impact on the amount of sewage to be treated throughout the operational phase and, in case of insufficient treatment, indirectly have an impact on the water quality. Temporary leakages of the sewerage at the stations cannot be ruled out completely. Therefore, a minimal negative residual impact will exist.

393. **Impact Significance:**

- Design and pre-construction stage – moderate negative
- Construction stage – moderate negative
- Operation stage – minor negative
- Residual Impact after Mitigation – minimal negative

6. Surface water and Groundwater Quantity

394. **Impact.** Water consumption during construction shall be about 22.5 KLD for PCMC to Nigdi. Dewatering necessary for pile foundation construction will lead to a decrease in ground water quantity. Water demand at stations during operation is estimated at 6.75 KLD and will be met through municipal water supply, thus impacting the availability of this commodity.

395. **Mitigation**. Stations of proposed project will be connected to the municipal water supply system; there will be no direct use of surface water. However, since City is partly depending on surface water for its water needs, the water use of the stations will impact the quantity of surface water indirectly to a certain extent.

396. As a design feature adequate nos. of rainwater harvesting structures are being proposed at each of the elevated stations and this will be implemented as an environmental conservation measure, to conserve and augment the storage of groundwater. Regular inspection and maintenance of the rainwater harvesting system will be required in order to let it function effectively.

397. Water for dust suppression (sprinkling) and tire washing will be sourced from surface runoff when possible. Used water from tyre washing will be collected, subjected to precipitation and re-used. Groundwater will not be used. Water for curing of concrete will be sourced from municipal supply, surface runoff or water from dewatering. Water for concrete batching plant and labour camps will be sourced from treated municipal water.

398. Waste water from construction yards, sites and labour camps that cannot be used for dust suppression or tyre washing will be discharged into public sewers after precipitation; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water.

399. **Residual impact.** Rainwater harvesting will be implemented to recharge groundwater. Since no groundwater will be extracted for the project the residual impact on groundwater quantity is high positive. Since City is majorly dependent on surface water for its water needs, the use of municipal water at the stations will impact the quantity of surface water indirectly to a certain extent. This commodity cannot be completely mitigated through rainwater harvesting. A minimal negative residual impact on surface water quantity will therefore remain.

400. **Impact Significance:**

- Design and pre-construction stage – minor negative
- Construction stage – moderate negative
- Operation stage – minor negative
- Residual Impact after Mitigation – minimal negative (surface water) major positive (groundwater)

7. Land degradation

401. **Impact.** Construction yards with aggregate crushing and screening, pre-casting, material and fuel storage and ready-mix concrete plants and sites for disposal of C&D waste and disposal of surplus excavated soil can cause topography-related drainage changes, pollution of air, water and soil. Metro construction is a material intensive activity. Huge quantity of different construction materials will be required for construction of elevated metro and stations, leading to depletion in construction material at source.

402. Quarry operations are independently regulated activities and outside the purview of the project proponent. It is, nonetheless, appropriate to consider the environmental implications in selection of quarry sources since poorly run operations create dust problems, contribute noise pollution, ignore safety of their employees, or cause the loss of natural resources. So, the construction material will be sourced only from legalized and approved quarries that are in full compliance with environmental and other applicable regulations and have an outstanding environmental track record. Opening of a new quarry specifically for proposed project is not foreseen under this ESIA.

403. Construction activities cause degradation of land in terms of loss of topsoil and pollution. Fertile topsoil which is removed during demolition, site levelling and excavation, if not securely preserved, could be washed off due to surface runoff or be lost as fugitive dust. Soil contaminants include heavy metals and Persistent Organic Pollutants (POPs) (due to processes pre-dating the metro construction activities); Polycyclic Aromatic Hydrocarbons (PAHs) (from exhaust of construction vehicles, equipment, DG sets) and mineral oils (from leakages and spillages).

404. Soil pollution and changes in local water drainage patterns could result from dumping of surplus excavated soil and C&D waste. Hazardous waste will be taken away by licensed vendors who will be responsible for due disposal at pre-approved sites.

405. **Mitigation.** Construction yards will be located at least 500 m away from habitations and at least 1 km away from environmentally or ecologically sensitive area, if any. Selection of the sites for construction yards, batching plant, casting yard and waste disposal sites will follow the criteria for site selection, as laid down in **Annexure-8** of this ESIA-ESMP report and Maha Metro's SHE Manual (**Annexure-10)**, with the final location and layout of the sites. Locations will be approved by Maha Metro and funding agencies before construction commences, in consultation with Municipal Authorities. Hazardous waste will be taken away by licensed vendors who will be responsible for due disposal at sites pre-approved independent of the project. The contractor will provide a plan with construction yard layout including batching plant, sewage and drainage system, provisions of precipitation tanks, access road, first aid facilities etc., to be approved by Maha Metro and the funding agencies before establishment.

406. C&D waste is part of solid waste that results from land clearing, excavation, construction, demolition, remodelling and repair of structures, roads and utilities. C&D waste has the potential to save natural resources (stone, river sand, soil etc.) and energy, occupying significant space at landfill sites and its presence impedes processing of bio-degradable waste as well as recyclable waste. C&D waste generated from metro construction has potential use after processing and grading. The contractor will segregate and temporarily store the C&D waste till he transports and disposes it at sites approved by MPCB, Maha Metro for the project. Disposal of waste should follow good practice and some level of screening should be conducted. Normal construction waste can go to existing facilities conform to national systems, however when large scale spoil disposal will take place in specific designated locations this will need to be carefully managed.

407. Material will be stabilized by watering or other accepted dust suppression techniques. The excavated soil and C&D waste (muck) will be filled in the dumping site in layers and compacted mechanically. Suitable slopes will be maintained on the stockpile. Once the filling is complete, it will be protected by low walls, provided with a layer of good earth on the top and covered with vegetation. A disposal plan will be prepared by Contractor, which will be approved by Maha Metro.

408. The contractor will ensure that hazardous wastes from construction activity and equipment are labelled, recorded, stored in impermeable containment and for periods not exceeding mandated periods and, in a manner, suitable for handling storage and transport. The contractor will maintain a record of sale, transfer, storage of such waste and make these records available for inspection. The contractor will get Authorized Recyclers to transport and dispose Hazardous Waste, under intimation to the Project Authority.

409. Sites for disposal of surplus excavated soil and C&D waste will be decided by Maha Metro before start of construction in consultation with MPCB and Pimpari Chinchwad Municipal Corporation. The sites will be located away from residential areas, water bodies and ecologically sensitive locations as to avoid pollution and disruption of natural drainage. Disposal of hazardous waste will be done by licensed vendors at pre-approved sites independent of the project.

410. Non-hazardous solid waste generated in stations will be collected on a regular basis and transported to local municipal bins for onward disposal to disposal site by municipality. Regular inspection and maintenance of the waste collection system will be required in order to let it function effectively.

411. **Residual impact**. Metro construction will inevitably lead to depletion in construction material at source, the residual impact is considered to be minimal negative.

412. Since it will take some time for soil to settle after the construction works a minimal negative residual impact for soil erosion might exist. Although contractor has to take every effort to prevent contamination of construction yards and muck disposal sites, a certain degree of pollution cannot be ruled out. Construction yards and muck disposal sites could also cause a change in drainage patterns around the sites. Therefore, a minimal negative residual impact exists, especially if the contractor's liability for any pollution that has arisen is insufficiently covered.

413. **Impact Significance**

- Design and pre-construction stage – minor negative
- Construction stage – moderate negative
- Operation stage – neutral
- Residual Impact after Mitigation – minimal negative

8. Flora

414. **Impact.** The alignment has been chosen in such a way that loss of trees and other vegetation is minimized as much as possible. However, Total 258 Trees (12 species) are likely to be affected due to proposed alignments. 1 of these trees to be cut are from an endangered species (*Saraca asoca* (Roxb), Wild). With removal of these trees, the process for CO_2 sequestration will get affected as follows:

(i) Total number of Trees affected: 258
(ii) Decrease in CO_2 absorption due to loss of 258 trees (@ 20 kg per tree per year): 5.16 tons/year
(iii) Decrease in Oxygen production due to tree loss of 258 trees (@ 110 kg per tree per year): 28.38 tons/year

415. The only significant long-term ecological impact of the project will be due to the loss of the 258 trees as mentioned above. Mitigation and enhancement measures proposed under the project to address this risk and ensure no net loss of biodiversity include implementation of a robust compensatory afforestation program including habitat improvement activities. The compensatory afforestation program includes planting of adequate no. of trees as per the PCMC Tree authority guidelines. There will be no net loss of biodiversty because of the project.

416. Fugitive dust from construction yards, construction sites; particulate pollutants and dust from trucks hauling construction material, segments and waste soil and C&D waste disposal sites will be deposited on leaves thus impacting vegetation growth. Construction activities also have the potential to cause physical damage to trees and vegetation nearby the construction sites.

417. **Mitigation**. The loss of trees will be compensated through planting of 10 saplings for each tree felled. Location for compensatory plantation will be decided by Maha Metro in consultation with owner of the land as well as the State Forest Department such that displacement does not become necessary. Depending on the chosen location, the Maharashtra Forest Department or the Pimpri Chinchwad Municipal Corporation will be responsible for the conservation and management of the trees. It is found that about 258 trees are likely to be lost in the project under line and stations, hence to compensate the same adequate no. of plants fulfilling the PCMC Tree authority guideline will be planted. Native plant species and miscellaneous indigenous tree species are recommended for plantation. For the Endangered species (*Saraca asoca*, Roxb Wild)), saplings of the same species will be planted. The saplings will be planted on government land pockets located along the project. The saplings will be monitored for their survival for three years. Re-plantation shall be taken up every year with new saplings where saplings fail to survive.

418. Efforts will be made to minimize the cutting of trees by transplantation of the young trees when possible. Transplantation will be done in coordination with Maharashtra Forest Department. After completion of construction of the metro, Maha Metro will plant saplings in the road median: this re-planting is not in scope of works of the construction contractor.

419. Tree cutting and felling will be done only if the tree is in the way of construction and only after receiving clearance from Maha Metro and competent Authorities. No damage will be caused to trees during construction activities other than the trees marked for felling. Vegetative cover will be maintained as much as reasonably possible. Wherever excavations are made in the ground near the roots of trees that need to be maintained, appropriate measures will be taken to prevent exposed soil from drying out and causing damage to the tree and its roots.

420. To avoid negative impact on herbaceous vegetation along the waterways encountered along the alignments, vehicle & construction machinery movement will be restricted to designated roads. Similarly, dumping of muck, excessive site clearance, levelling etc. in the river/nallah basin will be avoided. No Excavated material will be stored near river/nallah

basins. Vegetation clearing by chemicals / herbicides will not be permitted and workers will be briefed about do's and don'ts. Sedimentation of storm water will be minimized by avoiding stockpiling of excavated material. Portable sanitation, treatment and disposal facility will be provided at construction site.

421. **Residual impact.** Although contractor has to take every effort not to damage trees and vegetation that needs to be maintained, the risk of damage to the vegetation cannot be ruled out completely. Since restoration of the vegetative cover will take some time a minimal negative residual impact will exist. Compensatory plantation will be done in a ratio of 10 saplings against each tree felled. Compensatory saplings will take time to mature, therefore the short-term residual impact of tree cutting will be minimal negative. Once the saplings have matured the residual impact will be positive.

422. **Impact Significance**

- Design and pre-construction stage – moderate negative
- Construction stage – moderate negative
- Operation stage – neutral
- Residual Impact after Mitigation – minimal negative (short term) to positive long term

9. Fauna

423. The alignment does not pass through ecologically sensitive areas. However, Nisaragakavi Bahinabai Chaudhari Zoo is located within 2 km radius from the alignment. Construction yards and waste disposal sites will not be located near sensitive areas.

424. **Impact.** The elevated project does not impede movement of terrestrial fauna; however, the elevated metro could intercept flight paths of birds.

425. **Mitigation.** With measures to minimize dust, noise and vibration during construction in place no additional measures with regard to fauna will be necessary. Lighting at stations will be kept to the minimum and of frequencies and brightness which do not affect bird behaviour.

426. **Residual impact.** The impact of noise & vibration and lighting on birds will be accentuated by the height of elevated structure. Since there are no endangered species present the residual impact will be minimal negative.

427. **Impact Significance**

- Design and pre-construction stage – neutral
- Construction stage – minor negative
- Operation stage – neutral
- Residual Impact after Mitigation – minimal negative

10. Socio Economics

428. **Impacts at different stages of the Project Cycle:** can be anticipated majorly at three different levels- during Pre-Construction, Construction and Operational stages. The intensity of social impacts will depend on and relate closely to the stages of the project cycle. The below **Table 5-9** gives a summary of the same, as per the separate SIA study carried out for the project.

Table 5-9: Impacts at different stages of project cycle

Sl No	*Stages*	*Possible Impacts*

1	*Design Stage*	• Interruption in the delivery of services • Land Speculation
2	*Construction Stage*	• Displacement and relocation of NTH • Influx of migrant construction workforce • Temporary Land requirement • Health impacts on those who lives close to the construction site • Traffic diversions and risk to existing structures • Dust generation • Noise pollution
3	*Operational Stage*	• Reduction in employment opportunities compared to the construction phase • Impact on Elderly and Differently Abled people in terms of accessibility and use of services

(a) Community Health and Safety

429. **Impacts.** Minor health risks due to initial site preparation activities and interactions with the community are envisaged. Besides this, during construction phase of the project there is high risk of communicable diseases (e.g., HIV/AIDS and STIs) from an influx of 500 workers. Increased road safety concerns due to construction vehicles (20–30 trucks daily). There will be minimal health risks & improved health outcomes due to reduced air pollution and better transportation access during operational phase.

430. **Mitigation.** To mitigate the risk of communicable diseases, baseline health surveys will be conducted in the preconstruction phase to assess prevailing health conditions, followed by health awareness campaigns targeting at least 80% of the affected population. Road safety concerns will be managed through traffic control measures such as enforced speed limits and designated pedestrian crossings. No significant mitigation is required during the operational phase, as health impacts are expected to be positive.

431. **Residual Impact:**

- Construction: Moderate with mitigation.
- Operation: Positive, with better access to healthcare facilities and reduced accident rates.

(b) Traffic Impacts

432. **Impacts.** Slight increase in traffic from equipment transport (5–10 vehicles/day) is envisaged during pre-construction phase. During construction phase moderate traffic congestion can occur due to an influx of 20–30 construction vehicles/day. Appropriate traffic diversions to cater to the increased vehicle influx shall be provided. During operation phase there will be positive impact on traffic congestion due to efficient metro services.

433. **Mitigation.** Designated unloading areas/ casting yard & batching plant have been proposed so that there will be minimal impact on traffic and reduced road obstruction. Deployment of appropriate number of traffic marshals at critical points has been proposed during construction phase along with appropriate road signage, speed breakers etc. Traffic diversions whenever necessary will be provided by the contractor to manage traffic.

434. **Residual Impact:**

- **Construction:** Minor delays.
- **Operation:** Positive, with an estimated 30% reduction in road traffic.

(c) Employment

435. **Impacts.** The project is expected to generate employment for around 500 skilled/unskilled labourers during construction phase and a large skilled work force is required to operate and maintain the system during operation phase.

436. **Mitigation.** Prioritize employment generation for local population, targeting at least 50% local employment. Skill-building programs for affected community members, including women to be implemented. During operational phase conduct annual performance evaluations and training sessions for Maha Metro Staff.

437. **Residual Impact.**
- Construction: Positive.
- Operation: Strongly positive.

(d) **Private Structures Affected**

438. **Impacts:** Due to the proposed project, 28 structures, owned by 21 families will be affected. Among these, 06 structures are owned by 06 legal titleholders (Commercial/shops), 18 structures are owned by 11 families having license from Municipality and 4 structures by 4 squatters. There are only 3 mobile vendors found during the survey who are having license, apart from that no mobile vendors were found without license in the survey. The details of loss of structures presented in the **Table-5-10**.

Table-5-10: Ownership Status of Affected Private Structures

Sl. No.	Ownership Status	No. of Structure	No. of Families
1	Legal Titleholder (Commercial/shops)	6	6
4	License from Municipality (kiosks 5, shops 8, Mobile vendor 3, 1 small eatery, 1 Shop shed)	18	11
5	Squatters	4	4
Total		**28**	**21**[47]

439. As per census survey, out of 21 Families losing their structures in the project, 04 Families are losing 04 residential structures,04 families are losing 11 commercial structures (shops) ,03 families losing 03 commercial structure (mobile vendors), 01 family losing 01 commercial structure (eatery), 05 families losing 05 commercial structure (kiosk), 02 are losing 02 other commercial structures (One staff Quarter and one labour house) and 02 are losing 02 other types of private structures i.e. boundary walls. The details of structures and number of displaced Families are given in the **Table-5-11**.

Table-5-11: Type of Loss of Private Structures

Sl. No.	Type of Structure	No. of Structure	No. of Families
1	Residential Structure TH	00	00
2	Residential Structure – Squatters (NTH)	04	04
3	Commercial Structure- Shop	11	04
4	Commercial Structure- Mobile Vendor	03	03
5	Commercial Structure- Eatery	01	01
6	Commercial structure- Kiosk	05	05
7	Other Commercial Structure – Staff quarter and Labour house (TH)	02	02

[47] Source: Census Survey, 2024

8	Other Private Structure- Boundary Wall (TH)	02	02
Total		**28**	21

440. The usage of various structures being affected in the project are presented in **Table 5-12** The physical and economical displacement under the project will mainly result in loss of residential and commercial structures. Other private structures like boundary wall affected under the Project will not result in physical displacement.

Table 5-12: Usage of Affected Private Structures

Sl. No.	Type of Structures	No. of Structure	No. of Families
	Residential		
1	House (NTH)	04	04
62	Boundary Wall (TH)	02	02
3	**Commercial**		
4	Shops- owner (TH)	02	02
5	Shops- Tenants (Formal rent agreement)	10	03
6	Small Eatery (Licensed)	01	01
7	Kiosk (Licensed)	05	05
8	Tenant in kiosk (Licensed)	01	01
9	Other Commercial -(Staff quarter and Labour house) (TH)	02	02
10	Other commercial- Licensed (Shop front Shed only) TH	01	01
Total		**28**	**21**[48]

441. The structures being affected in the project are of various types by construction such as temporary, semi-permanent and permanent nature. This categorization is based on inventory of structures as part of social impact assessment which will be further verified and evaluated during implementation by concerned government department. Out of 26 main structures belongs to both TH and NTH, 15 structures are of temporary in nature, 8 structures are of semi-permanent nature and 3 structures are of permanent nature. The type of constructions of the affected structures are given in the **Table-5-13**.

Table-5-13: Type of Construction of the Private Structures

Sl. No.	Type of Structures	Temporary (Kutcha)	Semi-Permanent (Semi-Pucca)	Permanent (Pucca)	Total
1	Residential	4 (NTH)	0	0	4
2	Commercial	11	8	3	22
Total		15	8	3	26

442. The land acquisition for the project will affect 08 titleholder Families and the area of acquisition will be a total of 677.875 square meters. All the land to be acquired under the project is being used for commercial purpose only. The details are presented in **Table-5-14**.

Table-5-14: Land Use Details of Affected Land

Sl. No.	Land Use Type	Affected Families	Area (Sq. m)
1	Residential	00	0.00
2	Commercial	08	677.88
Total		**08**	**677.88**

[48] *Source: Census Survey, 2024*

443. **Mitigation. (Relocation Strategy).** All the structures affected under the project as per provisions made in the entitlement matrix will be eligible for the following:

(i) Compensation for structure will be paid at the replacement cost as per RFCTLARR Act 2013,
(ii) One-time Resettlement allowance per affected families
(iii) Shifting assistance to all displaced structures,
(iv) Right to salvage materials from structure and other assets with no deductions from replacement value

444. In addition to the above-mentioned entitlements, to help the PAPs losing structures and relocating themselves, following relocation strategy will be adopted in the project:

(i) Maha Metro shall conduct consultations with PAPs and will establish linkages to suitable government rehabilitation schemes.
(ii) At least 60 days advance notice before demolition of structure.
(iii) Their dismantled structures materials will not be confiscated, and they will not pay any fine or suffer any sanction.
(iv) Maha Metro during the RAP implementation will assist PAPs during verification of assets and will provide necessary counselling on payment of compensation and assistance.
(v) Ensuring a smooth transition (during the part or full relocation of the PAPs), helping the PAPs to take salvaged materials and shift.
(vi) In close consultation with the PAPs, Maha Metro will fix the shifting dates agreed with the PAPs in writing and the arrangements desired by the AFs with respect to their entitlements.
(vii) During the economic relocation of families losing commercial structures and Maha Metro will ensure that after relocation the livelihood of economically affected families has been restored to the pre-project level through provisions of livelihood restoration measures as per the Entitlement Matrix (including alternate livelihood training, linkage to government schemes, access to credit and services).

445. **Impact Significance:**

- Design and pre-construction stage – minor negative
- Construction stage – moderate negative
- Operation stage – minor negative
- Residual Impact after Mitigation – minimal negative

(e) Public Property / Infrastructure / Utility Services

446. **Impact:** Project are planned to run elevated majorly on the medians of existing roads. The alignment will cross sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, traffic signals, roadside lights, footbridges etc. These utilities / services are essential and have to be maintained in working order during different stages of construction by temporary / permanent diversions or by supporting in position. The Organizations / Departments responsible for concerned utility services are reported in **Table 5-15**.

Table 5-15: Organizations Responsible for Utilities and Services

SN	Organization/ Department	Utility/Services
1	Maharashtra Public Works Department	Roads and bridges other than National Highways
2	Pimpri Chinchwad Municipal Corporation	City roads and bridges, including hydrants and fountains etc., Roads, surface water drains, nallahs, sewer lines, streetlights, etc.

SN	Organization/ Department	Utility/Services
		Water and sewage treatment plants, pumping stations sewerage and drainage lines; water mains and their service lines
3	National Highway Authority of India (NHAI)	Roads and bridges on National Highways
4	Indian Railways	Railway crossings, subways, signals, bridges, stations etc.
5	BSNL (OFC and Telephone Cables)	Tele cables, junction boxes, telephone posts, O.H lines
6	Airtel, Vodafone, Idea, Jio, etc.	Telecommunications cables, junction boxes, telephone posts, etc.
7	Power Grid Corporation of India Ltd.	HT towers, cables
8	Maharashtra State Electricity Corporation Limited (MSEB)	HT/other overhead Power lines

447. During construction period, complete/partial traffic diversions on road will be required, as most of the construction activities are along the road. As the alignment runs along centre of existing roads, traffic originating from and destined to locations along this section of road will need to be diverted through internal roads. Further, traffic will move on a lesser width of road due to barricading of metro work zone along the road median. This will cause congestion leading to air pollution, fuel consumption, safety risks and passenger time loss due to decreased average speed of movement.

448. In case of shifting of utilities and temporary traffic diversions, it might be necessary to temporarily use land outside of the construction zone.

449. The construction and operation of the project may lead to significant disruptions in community accessibility across the road. Communities could face physical separation, affecting daily movement for work, education, healthcare, and social interaction. Access to essential public services like schools and markets may be hindered, and longer detours can increase travel time and transportation costs. The absence of safe crossings could raise safety risks for pedestrians and cyclists. Roadside vendors may experience reduced foot traffic, impacting livelihoods, while the social fabric of neighbourhoods may weaken due to restricted mobility. Additionally, construction activities may temporarily block access routes, causing inconvenience and confusion.

450. **Mitigation.** The alignment of the metro will negotiate a number of utilities which will have to be maintained in working order during construction. They may require temporary or permanent diversion subject to their depth, details such as piling configuration or span of viaduct, utility protection measures, etc. In case public utilities are required to be shifted to private land in exceptional circumstances, then adequate compensation will be made by Maha Metro to the property owner on the same principles as temporary land acquisition. Following completion of construction of metro, such utilities shall be rehabilitated on public land.

451. To address the impacts caused due to loss of access from one side of the road to the other, pedestrian underpasses, footbridges, and well-marked crosswalks shall be integrated into the project design to ensure safe and convenient access. Traffic calming measures, dedicated pedestrian and bicycle lanes, and signalized crossings can enhance safety. Temporary access routes and advance communication during construction will help minimize disruption. Roadside vendors should be relocated to suitable vending zones and provided with livelihood restoration support. Active community engagement is essential to understand local mobility patterns and maintain social connectivity through inclusive planning and infrastructure.

452. Prior to the start of excavation, the contractor will perform a ground survey to confirm

location of pipelines and other utilities after which detailed design consultant will revise, where necessary, spans and pile arrangement to ensure that pier foundations do not interfere with major underground utilities.

453. Where the alignment cannot be fine-tuned to avoid conflict with utilities, permanent diversions will be done before commencement of work on the pertinent section; temporary diversions can be done before or during construction. Plans for diversion or relocation of any utilities along with hazard studies if required will be prepared by the Contractor in consultation with and approval of respective utility agencies before finalization of time schedule of metro construction works. Preferably they will have to be diverted by the agencies themselves.

454. In order to retain satisfactory levels of traffic flow during the construction period, traffic management and engineering measures will be taken. They can be road widening, traffic segregation, one-way movements, traffic diversions, acquisition of service lanes, etc. Barricading of road space for construction is required along the central median of the road on viaduct and edge of road right of way at stations. To minimise traffic delays, segmental construction will be employed. Maintenance of diverted roads in good working condition to avoid slow down and congestion will be a prerequisite during construction period.

455. The following traffic management guidelines will form basis of procedures to be adopted by contractor to ensure the safe and efficient movement of traffic and also to ensure the safety of workmen at construction sites. The Contractor will develop detailed traffic management plans consistent with the Indian Guidelines on Traffic Management in work zones (IRC:SP:55-2014), prior to mobilization for respective sections with site-specific plans.

(i) High visibility reflective jackets to construction workers;
(ii) Signage to warn the road user clearly and sufficiently in advance;
(iii) Safe and clearly marked lanes and buffer and work zones for guiding road users and workers;
(iv) The primary traffic control devices used in work zones will include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights;
(v) Advance traffic updates/ information for users of affected roads;
(vi) Traffic diversion due to temporary road closures;
(vii) At congested sections, temporary traffic coordinators will be engaged to facilitate the traffic management;
(viii) Focus will be on ensuring safe access to properties, passage to pedestrians, parking;
(ix) Construction traffic moving from construction yards to construction sites and from construction sites to soil/waste disposal areas may be confined to certain routes (based on infrastructure capacity) or restricted to certain off -peak hours so to reduce noise pollution at night or to avoid commuting and school hours during the day; and
(x) If necessary, bus service and other public and private transport services in the area should be improved to meet residents' transportation needs.

456. **Residual impact**. After construction all utilities will be fully functional and temporary traffic diversions will no longer be necessary. Therefore, no residual impact will exist after completion of construction.

457. **Impact Significance:**

- Design and pre-construction stage – moderate negative
- Construction stage – moderate negative
- Operation stage – neutral
- Residual Impact after Mitigation – none

(f) Physical Cultural Resources (PCR)

458. No known protected archaeological monuments / sites or heritage assets are located

on the project.

459. The project will implement, where required, chance finds procedure contained in ESS8 of WBG ESF and EIB's Standard 10 (Cultural Heritage) and which includes a requirement to notify relevant authorities of found objects or sites; to fence-off the area of finds or sites to avoid further disturbance; to conduct an assessment of found objects or sites by cultural heritage experts; to identify and implement actions consistent with the requirements of this ESS and national law; and to train project personnel and project workers on chance find procedures.

460. The contractor shall comply with Federation Internationale des Ingenieurs-Conseils (FIDIC- The International Federation of Consulting Engineers) Section 4.24 on Fossils**.** The contractor will document all findings, including maintaining a chain of custody, which will be validated by the Construction Supervision Consultant (CSC)**,** while expert verification will be conducted by the Archaeology Department. In the event of a chance find, temporary work stoppage in the immediate area shall be enforced for up to 72 hours to allow the on-site representative of the Archaeology Department to assess the discovery and provide necessary instructions. However, construction activities in adjacent areas shall continue as per the detailed design.

461. **Residual impact.** Since no PCRs are located within the project's direct zone of impact no residual impact is expected.

462. **Impact Significance:**

- Design and pre-construction stage – neutral
- Construction stage – minor negative
- Operation stage – neutral
- Residual Impact after Mitigation – none

(g) Intensity of Impact in the Project

463. In addition to the various types of impact on land and non-land assets as discussed above the intensity of impacts, the data has been analysed and provided in **Table-5-16** and **Table-5-17**. below. Further during the implementation, the viability of partially affected structures will be assessed by qualified engineers from the concerned department in consultation with the PAPs and the compensation will be paid for the entire structures as required. **Table-5-16** shows that out of 8 families only one family is losing above 25% up to 50% and rest 7 families are losing below 20% of land. **Table-5-17** shows that 17 families are losing more than 50% of the structures.

Table-5-16: Intensity of Impact on Land

Sl. No.	Scale of Impact	No. of Families & No of Plots	%
1	Up to 10%	5 families losing 6 plots	62.5
2	Above 10% and up to 25%	2 families losing 2 plots	25
3	Above 25% and up to 50%	1 family 1 plot	12.5
4	Above 50% and Below 100%	0	0
Total		**8**	**100**[49]

Table-5-17: Intensity of Impact on Structure

Sl. No.	Scale of Impact	No. of Structure & No. of Family	%
1	Below 25%	03 (2 families)	10.71
2	Above 25% to 50%	02 (2 families)	7.14
3	Above 50% to 75%	01 (1 family)	3.57

[49] *Source: Census Survey, 2024*

4	Above 75% to 100%	22 (16 families)	78.57
Total		**28**	**100**

464. **Mitigation**. Affected persons and will be paid cash compensation at market rates for land and structures, compensation for loss of livelihood and rehabilitation benefits as per the Resettlement Action Plan (Sept 2024).

465. **Residual impact:** Involuntary Resettlement is small in magnitude, project affected people will be duly compensated and a R&R plan will be implemented. The residual impact will therefore be minimal negative.

466. **Impact Significance:**

- Design and pre-construction stage – moderate negative
- Construction stage – moderate negative
- Operation stage – neutral / positive
- Residual Impact after Mitigation – minimal negative

(h) Resettlement Impact on PAPs

467. **Impact.** As per the Land Acquisition Plan (LAP) prepared for proposed Project and R&R survey conducted, 5579.13 square meters of land needs to be acquired permanently for the proposed alignment. The analysis of land acquisition requirement for the project shows that out of total land required for the project is 677.875 square meters (12.15%) is private land, 4848.343 square meters (86.90%) is government land and 52.907 square meters (0.95%) is religious land. Out of 17 land plots, 8 plots owned by 8 families (private), 7 plots owned by Government and 2 belongs to religious community. The government land required by the project will be transferred to Maha Metro and the private, religious and community land will be acquired by Maha Metro. The land acquisition requirement for the project is presented in the **Table-5-18**.

Table-5-18: Details of Land Acquisition Requirement

Sl. No.	Type of Ownership	Unit	No of Plots	Area (in Sqm.)	%
1	Private Revenue	8	8	677.87	12.15
2	Government	7	7	4848.34	86.90
3	Religious	2	2	52.92	0.95
Total		**17**	**17**	**5579.13**	**100**[50]

Note: The unit in the Table-above refers to the number of impacted entities including private (Families), government, religious and community etc.

468. In addition to the above-mentioned permanent land acquisition, 493.73 square meters of land will be temporarily utilized for the Project. Among 493.73 square meters, 305.31 square meters is privately owned and rest of the 188.42 square meters of land is owned by Government. The land proposed to be taken under lease (both privately owned and government owned) are currently vacant and not under any agricultural, residential or commercial use. The temporary land will be obtained from private owners through administration of a lease agreement and appropriate compensation/rent will be paid on mutual agreement. The cost of lease/rent for the private land is included under the budget of this resettlement plan.

469. Based on the above requirement, the project impact assessed through project census survey includes loss of land, loss of non-land assets, loss of trees and loss of livelihoods. Other than this, common properties resources (CPR) including religious/community owned land and assets are also found to be affected by the proposed project. It is confirmed that the land to be rented (both privately owned and government owned) is not under any agricultural

[50] Source: Land Acquisition Report and Census Survey 2024

use and does not involve the presence of squatters or tenants. As such, no impacts from temporary land acquisition are expected.

470. A project census survey was carried out to identify the persons who would be affected and/or displaced by the project and to make an inventory of their assets that would be lost due to the project, which would be the basis of calculation of compensation. The census survey of proposed PCMC- Nigdi corridor was carried out in between 18 June - 1 July, 2024. It was found that a total of 34 Families would be affected by this project. Among the affected Families, 6 (17.65%) Families are losing both land and structures, 15 (44.12%) Families are losing only structures, 2 (5.88%) Families are losing only commercial land and 11 (32.35%) Families includes tenants in commercial establishments (i.e., livelihood not land-based). There are no employee or seasonal workers/ helpers found in the commercial structures, either the commercial units are run by the owner or tenant themselves or their family members help them in running the business. In case any employee is identified during implementation he or she will be compensated by the titleholder who will be compensated two and half times of the market rate as per the Entitlement Matrix. The details are being provided in the **Table-5-19.**

Table-5-19: Land Acquisition and Resettlement Impacts

Sl. No.	Category of Loss	Impact on Land and Structure	No. of Family	%
1	Land with Structure (Commercial) owned by Titleholders	6 commercial land plots with 6 commercial structures/shop (1 labour house, 1 staff quarter, 3 Shops, 1 boundary wall)	6	18
2	Only residential Structure (Squatters)	4 structures - 4 residential structures	4	11
3	Commercial space owned by non-titled license holder	10 commercial all license holders (1 small eatery, 1 shop shed, 7 food outlets, 1 clothes shop)	3	9
4	Only Land owned by Titleholders	02 land plots (Commercial-Shopping mall and private school land only)	2	6
5	Owners of licensed kiosks	5 licensed kiosks	5	15
6	Mobile vendors	3 licensed mobile vendors (mobile carts on wheels)	3	9
7	Commercial - Tenants	11 structures (incl. 1 licensed kioks, 7 licensed shops, 3 TH shops, 0 other structures)	11	32
Total		**34**	**34**	**100**[51]

471. The start date of project census survey i.e. 18th June 2024 is the cut-off date for non-titleholders who will be eligible for compensation and assistance under the project. For titleholders, the date of notification of intended acquisition (Section 11) as per the provisions of RFCTLARR Act 2013, and/or the date of 1st notification by Land Purchase Policy of Maharashtra will be treated as the cut-off date. The findings and magnitude of impacts are discussed in the following sections.

472. **Mitigation.** In view of the layout design of proposed extension section of Phase-I project prepared by the DPR Consultant, the census survey was undertaken in June 2024. Based on the proposed layout and census survey, the nature of social impacts identified in the project mainly comprise of following impacts.

- Permanent loss of land
- Loss of temporary commercial structures (Kiosk/Mobile vendors)

[51] Source: Census Survey, 202

- Loss of private trees

473. Major part of the alignment runs along the central verge of the roads. Therefore, it disturbs the people to the minimum. However, there may be some impacts on the people living in the vicinity of the alignment and passing through the roads of the alignment since there would be barricading to provide space for working.

474. The RAP is prepared to address the social issues in the project area or along the project corridor such as impact on private / common / business/ cultural properties and on the people residing or doing business/ work in the area. Project affected area includes the area in which property/assets would be affected or from where land would be acquired for the project. The RAP captures all social impacts resulted from the Project including involuntary resettlement impacts and the management plan will be prepared in the form of RAP.

475. During FGDs / Public and individual consultation it was found that the affected families are aware of the project and loss of their land. They demanded adequate compensation for affected assets will mitigate the negative impact. Hence, providing fair cash compensation to the affected households will be the suitable measure for mitigation of impacts. Thereby, the cash compensation will be provided through Direct Purchase Method under Maharashtra Government's GR No: Misc. 03/2015/C.N.34/A-2 (May 12, 2015, and September 30, 2015)

476. Maha Metro will provide adequate and appropriate cash compensation at full replacement cost for lost land and structures including eligible relocation assistance to the titleholders. Compensation will be paid to the non-titleholders for the loss of assets other than land, such as dwellings and also for other improvements to the land, at full replacement cost.

477. Despite being a linear project and efforts made to minimize the resettlement impacts, the proposed project will affect residential and commercial structures as a result of which both physical and economic displacement will arise and therefore need for relocation is envisaged in the project. Efforts are made through various provisions in this resettlement plan to mitigate negative social impacts on displaced persons and communities by supporting relocation of affected Families and by restoration of income to national minimum standard.

(i) Loss of Livelihoods in the Project

478. **Impact.** The affected livelihoods are not primarily land-based and the livelihood losses are mostly due to loss of commercial structures such as beauty kits store, tea stall, pan shop, small eateries, ice-cream shop, other provisional stores. As per the census survey, out of total 24 families, 13 families losing livelihoods, which includes 13 owners of commercial structures and 11 tenants doing business activity in the impacted structures. There is no residential, commercial structure and employees affected under the project. The commercial units identified are small and operated by the owners themselves and family members. The details of impact on livelihoods in the project are presented in the **Table-5-20**.

Table-5-20: Impact on Livelihoods

Sl. No.	Category of Impact	No. of Family	%
1	Owners of Commercial Structure	13	83.33
2	Commercial Tenant	11	16.67
Total		**24**	**100**

479. **Mitigation.** The project impacts reveal that due to loss of commercial structures and business, 24 Families will experience loss of their livelihood out of which, 13 owners of commercial structures, 11 tenants doing business activity, will be losing their livelihood due to the project. Income loses due to loss of commercial structures and other livelihood loss will be supported by providing skill up-gradation/ training to the eligible PAPs.

480. The proposed Pune metro rail phase 1 extension project will have some impact on the livelihoods of PAPs. Hence, it is the responsibility of Maha Metro as the owner of the project

to provide adequate provisions for restoration of livelihood of the affected families. The focus of restoration of livelihood will be to ensure that the PAPs are able to at least "regain their previous living standards". Restoration of pre-project levels of income is an important part of rehabilitating individuals, families, and socio-economic and cultural systems in project affected areas. The basic objective of income restoration activities is that no project-affected person would be worse off than before the project.

481. In this project 4 Families are losing more than 50% of their residential structures and considered as fully displaced and need relocation. There are 13 Families losing more than 50% of their commercial structures are considered as economically displaced. In addition, 2 Families losing their other structures like boundary wall are considered as not displaced. Other 2 families losing two commercial structures i.e. labour house and staff quarter are considered as not displaced as the owner (private company) will be shifting the labour house to a different location and the staff quarter to a different staff quarter. All the structures affected under the project will be assessed for their viability by the concerned public works department (PWD) and accordingly compensated or relocated during the implementation.

(j) Loss of Community Property Resources

482. **Impact.** In terms of community property resources (CPR), 10 structures used by local community are identified to be affected under the project. The types of affected CPRs are presented in the **Table-5-21**. CPRs will be compensated either by cash compensation at replacement cost to the community (registered trust, society or village committee as appropriate) or reconstruction of the community structure at a new location in consultation with the affected community. Based on the census survey, it is confirmed that none of the CPR loss will result in livelihood loss of any person.

Table-5-21: Impact on CPR

Sl. No.	Type of Structure/s	No. of Structure/s
1	Temple (Dattatreya temple)	1
2	Other Religious (Chabutra, Shed) (Sri Krishna Temple)	3
3	Bus Stop (PMPML- Pune Mahanagr Paribhan Mahamandal Limited)	2
4	Boundary/ shed etc. (Chinchwad Police Station)	1
5	Traffic Police booth	1
6	Bus terminal shed (PMPML)	2
Total		**10**

Note: (*) two cattle sheds have been identified inside the Shri Krishna temple campus itself. They are used to provide shelter and food for cows. These sheds will be shifted behind the temple in the same premise and are therefore not considered displaced.

483. **Mitigation.** There are 10 common property resource to be affected under the project. The CPR will be compensated either by cash compensation at replacement cost to the community (registered trust, society or village committee as appropriate) or reconstruction/ re-establishment/ relocation of the community structure in consultation with the affected community. For CPR with religious significance, traditional ceremonies will be observed during relocation.

(k) Project Entitlement and Budget Provision

484. The entitlement matrix proposed for this project has adequate provisions for restoration of livelihood of the affected communities. The focus of restoration of livelihoods is to ensure that the PAPs are able to at least regain their pre-project living standards. To restore and enhance the economic conditions of the PAPs, various assistances are incorporated in the Entitlement Matrix. Maha Metro will play a proactive role to mobilize eligible PAPs to get some vocational skills training. The special training program should be conducted with the help of departments concerned of Govt. of Maharashtra which is actively working for specific livelihood schemes in the locality. Additional consultation with PAPs and other stakeholders will be

conducted and a training needs assessment will be carried out by Maha Metro to refine the required livelihood restoration measures.

485. **Compensation for Land:** The calculation of compensation for land is based on the findings of inventory of loss of land, assessment of latest market rate for the year 2024-25, as published by Department of Registration and Stamp, Government of Maharashtra. The multiplication factor and solatium are also considered as per the requirement of RFCTLARR Act.

486. **Compensation for Structures for Titleholders (TH):** The cost of main structure is calculated as per the minimum guidance value (i.e. market value updated on a yearly basis) issued by Department of Registration and Stamp, Government of Maharashtra. The cost of boundary wall is estimated as per the market assessment survey. The multiplication factor and solatium for the structures belong to titleholders is also considered as per the requirement of RFCTLARR Act.

487. **Compensation for Structures Non-titleholders (NTH):** The impacts on various types of structures belong to non-titleholders' compensation calculated is based on the market assessment, which will be finalized by the Government approved value to be appointed by Maha Metro during implementation.

488. **Estimation of R&R Assistances:** R&R assistances like shifting allowance, resettlement allowance, livelihood allowance, vulnerability allowance etc. calculated as per the approved entitlement matrix provided under this RAP.

489. The resettlement cost estimate for this project includes eligible compensation, resettlement assistance and support cost for RAP implementation. The support cost, which includes staffing requirement, monitoring and reporting during project implementation and other administrative expenses are part of the overall project cost. The total R&R budget for the estimated project RAP implementation is Rs.217.52 million.

490. The cost related to resettlement will be borne by the Maha Metro. The Maha Metro will ensure allocation of funds and availability of resources for smooth implementation of the project R&R activities. In the case of assistance and other rehabilitation measures, Maha-Metro will directly pay the money or any other assistance as stated in the RAP to PAPs.

(l) Project Impact on Indigenous People

491. As per the Census of India 2011, Schedule Tribe (ST) Families in Pune is 3.37% of the total population of the city. Since the project alignment is falling mostly in urban area, the presence of ST population is less. In this project no ST is identified among the PAPs hence no impact on the ST Families.

(m) Project Impact on Women

492. **Impact.** The Metro rail project will bring great benefits to women and girls. Direct benefits include a decrease in travel time and an increase in reliable and convenient transport service. Indirect benefits include improved access to products and services, including social services such as health, education, as well as other government services. During construction, operation and maintenance of this metro project women will also benefit from the increased employment opportunities. However, construction of metro rail may also lead to potential negative impacts such as the spread of STIs (sexually transmitted infections) and road safety issues. Potential negative impacts will be addressed through community awareness sessions. In addition, the contractor will also carry out HIV/AIDS awareness program among worker camps and nearby community as mandated in their contract. As per the findings of consultation with women group, the perceived benefits from the projects includes:

(i) Improved access to social facilities like health, education
(ii) Increase in income generating activities
(iii) Frequent, safe and affordable transport

(iv) Management of emergency situation
(v) Improved community relations
(vi) Increased frequency of health workers, extension worker's visits
(vii) Improved access to market
(viii) Increased Leisure time
(ix) Reduced time spent on transportation of goods and services

493. During the consultation process the women apart from loss of assets, could not easily articulate the negative impacts. However, along with the loss of assets the following negative impacts were also recorded:

(i) Loss of assets as a result of the metro rail construction
(ii) Preference to men as wage labour over women during construction
(iii) Discrimination in wage payment
(iv) More dependence of mechanized techniques in metro rail construction likely to have very little opportunity for women as labourers

494. There are 3 women headed Families (WHH) affected in the project. The negative impacts of the project on female-headed Families will be taken up on a case-to-case basis and assistance to these Families will be treated on a priority basis. During disbursement of compensation and provision of assistance, priority will be given to female-headed Families. Additionally, women headed Families are considered as vulnerable and provision for additional assistance has been made in the entitlement of the RAP. Provision for equal wage and health safety facilities during the construction will be ensured by the Maha Metro.

(n) Aesthetics

495. **Impact.** The spans, columns and foundations of the metro viaduct and stations will be aligned with but structurally independent of the elevated road.

496. **Mitigation.** Sleek columns will be incorporated in the structural design as much as possible without compromising safety.

497. **Residual impact.** Notwithstanding the sleek structure, the visual impact of the elevated metro will be high and will be accentuated after any future infrastructure project is constructed. Since construction will take place in an urbanized area with a lot of concrete buildings already present the overall residual impact will be moderate negative. However, in cases where residential buildings are near the alignment the residual impact could be high negative.

498. **Impact Significance:**

- Design and pre-construction stage – moderate negative
- Construction stage – moderate negative
- Operation stage – neutral / positive
- Residual Impact after Mitigation – moderate to high negative

(o) Occupational Health and Safety

499. **Impact.** Safety and health of metro personnel can be impacted in terms of failure of equipment or operating personnel or security in stations and on trains. Proper design of health and safety features in stations and trains can reduce this impact.

500. It is estimated that about 500 persons will work during peak construction activity on site and casting yards. Estimated total population in the labour camps will be 500. The water requirement at camps will be 203 KLD, wastewater generation will be around 183 KLD & municipal solid waste generation 0.75 ton per day. This is tentative and will vary depending on the construction schedule during construction. Unclean water can cause health problems

to residents of worker camps. Problems could arise due to cultural differences between workers from outside and local residents. Construction workers are more prone to infectious diseases and lack of sanitation facilities (water supply and human waste disposal) and insect vectors. COVID-19 poses a greater hazard with a higher risk for workers in the labour camps due to proximity of living spaces of individuals and families. Sleeping and eating spaces and public conveniences will require area much higher than are as per current norms. Further, practices of personal hygiene such as hand sanitizing and face protection need to be incorporated in the psyche of the camp residents as well as local people who operate small shops at the camp. Testing, first aid, transportation and hospital facilities of a much higher order of safety will be required.

501. The following elements impact worker safety – working at heights, excavations, electrical and mechanical; gases, machinery; equipment; blasting; formwork; piling; PPE; medical facilities; firefighting; housekeeping; segment launching; batching plant; transport; security; explosives; general safety.

502. Harmful electromagnetic radiation is emitted by electrical traction and rolling stock: exposure of personnel needs to be minimized; electronic equipment needs to be immunized. Maha Metro personnel could be impacted by the effects of electromagnetic interference, electromagnetic radiation, musculoskeletal disorders (MSDs), stress and other communicable diseases.

503. Electromagnetic Interference (EMI) in metro railway can disturb electronic circuits in 3 ways:

(i) EMI in railway infrastructure like signalling caused by rolling stock: Considering the criticality of signalling, such disturbances can cause accidents and safety of staff as well as passengers.
(ii) EMI in environment caused by rolling stock: The railway can impact environment upto at least 10m from the track (Railway EMI impact on train operation and environment, A Morant etal, IEEE, Dec 2012)
(iii) EMI in rolling stock caused by environment.

504. **Mitigation.** Maha Metro has a SHE Manual in place outlining the minimum Health and Safety standards that will be required by Maha Metro during construction of the proposed PCMC to Nigdi project. Additional measures will also be put in place to complement the SHE manual or ensure that the SHE manual is aligned with international standards in terms of requirements for managing the mentioned aspects. SHE manual (including worker management and accommodation) will be updated to align with EIB standards 8 and 9 and with IFC Workers' Accommodation: Processes and Standards (ifc.org) – please refer to paras 161-164 for better understanding. Furthermore, the manual has been developed to give guidance and assistance to the respective Contractors in the development and production of their Site Health and Safety Plans, to satisfy the required H&S standards established by the Contract Conditions and the Employer's Requirements. The SHE Manual forms integral part of the bidding documents for the works to be undertaken. Construction works will be executed as laid down in the manual as applicable to PCMC to Nigdi project. The applicable sections are i) Control Document; ii) Health and Safety Manual; and iii) Environmental Management Arrangements. Control comprises: Legal requirements; standards; Contractor`s organisation and interfaces with Maha Metro; procedures to identify hazards and estimate risk, hazard mitigation measures; emergency response plan; resources; arrangements for training, inspection, communication, compliance, reporting, documentation and audit, review; complaint redressal. The Health and Safety Manual covers**:** Contractor organisation; accidents; hazards and risks; emergency preparedness plan; signage; industrial health and welfare; works - heights, excavations, electrical and mechanical; gases; machinery; equipment; blasting; formwork; piling; PPE; medical facilities; firefighting; traffic management; housekeeping; launching; batching plant; transport; security; explosives; general safety; flooding etc.

505. SHE Manual, comprising the above-mentioned sections, as mandated by Maha Metro for elevated construction are placed in **Annexure-10** to this ESIA-ESMP report. Compliance with Maha Metro SHE Manual is mandatory requirement to meet the standards, for the contractors. While complying with this SHE Manual, site-specific and construction work-specific procedures will be prepared by the Contractor and approved by Maha Metro. Hazards and requisite safety measures related to working at height are of primary focus on this project.

506. Prior to construction, necessary (temporary) living facilities for project workers will be provided by the contractor. Locations of such camps, their layout and level of facilities so as to minimize health risks will be put up for approval of Maha Metro, PCMC and Public Health Officer. The workers' camps will be developed by contractors as and where required. The accommodation, sanitation & other facilities required at camps shall be governed by Country labour laws as well as international standards like IFC/EBRD, Workers' Accommodation: Processes and Standards (ifc.org). As per Building & Other Construction Workers (BOCW Regulation of Employment and Conditions of Service) Act, 1996 the employer (Contractor) is liable to arrange for sanitation, health care facilities of labourers free of charge. Labour camps will be in full compliance of BOCW Act. Uncontaminated water will be provided for drinking, cooking and washing, health care.

507. Waste water from cooking, bathing and washing including sewage from toilets will be discharged into municipal drains. Such waste water will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water.

508. Garbage bins will be provided in the camp and regularly emptied into municipal bins. Municipal solid waste will be collected and taken away and disposed by municipality.

509. The Contractor will implement Covid-19 guidelines and Operating Procedures as part of the Contract. Residents of worker camps will be sensitized about need to implement precautions and trained in social distancing, sanitizing, avoiding groups; arrangements for thermal scanners and provision of sanitisers, face masks, gloves etc will be made by contractor. Site record of nearby hospitals will be maintained and fully equipped ambulances will be available to transport sick camp residents to hospitals. Daily disinfection of camps will be carried out.

510. The construction works will be undertaken in accordance with all applicable legislation and Indian statutory requirements and guidelines-ISO 45001:2018: Occupational Health and Safety Management System and ISO 14001-2015: Environmental Management Systems.

511. As part of medical facilities for workers, the Manual mentions support to the HIV/AIDS control agency. Measures to minimize Covid transmission will form part of the ESHS Requirements in the contract documents so as to guarantee that the Contractor will implement Covid-19 guidelines and Operating Procedures as part of the Contract.

512. In order to safeguard Maha Metro personnel during operation of the metro system, the design includes installing Automatic Train Protection and Automatic Train Supervision sub-systems, a backup power arrangement in form of DG sets and a Closed-Circuit TV for security and crowd control. Specifications and layout of equipment will be decided so as to minimise exposure of personnel to harmful electromagnetic radiation.

513. To reduce conducted or radiated emissions detailed specification and layouts of equipment e.g. power cables, rectifiers, transformer, E&M equipment etc. will be framed as per appropriate international standards. Electromagnetic Compatibility and maximum electromagnetic emission levels of whole railway system to the outside world measured at the railway boundary fence will comply with EN50121-2.

514. Musculoskeletal disorders (MSDs) and stress were identified by the industry as their

major work-related ill health issues (Position Paper on Work related stress in the rail industry, Office of Rail Regulation UK, June 2014). No such published data is available in India. MSD risk can be eliminated or minimized through product design, mechanization, appropriate handling aids, risk assessments, training and better use of specialists such as ergonomists and physiotherapists.

515. Stress can be managed at three levels of intervention:

(i) Primary level intervention: The main priority for Maha Metro will be to assess and reduce the risk of harmful levels of workplace stress from occurring. This may require action at an organisational level, for example by changes to job design, task allocation, training, and supervision.

(ii) Secondary level intervention: Good practice at the secondary level typically involves building individuals' ability to cope with stress, for example by emotional resilience training, relaxation, or mindfulness; employee assistance programmes (EAPs); 'buddying' schemes; or healthy lifestyle promotion.

(iii) Tertiary level intervention: This focuses on recovery and rehabilitation, for example trauma focussed cognitive behavioural therapy; counselling; EAPs and staged returns to support early return to work.

516. **Residual impact:** Even with SHE manuals and procedures in place the risk of workplace accidents during construction, risk of accidents due to failure in operating systems and security and risk of exposure to electromagnetic radiation will be a continuing feature, however proven technologies will ensure that the residual impact is minimal negative. During operation safety risks can be mitigated to a large extent through proper equipment, PPE's, procedures and education, however a chance remains the procedures may not always be followed in full. Therefore, a moderate negative residual impact remains.

517. **Impact Significance**

- Design and pre-construction stage – moderate negative
- Construction stage – moderate negative
- Operation stage – neutral
- Residual Impact after Mitigation – moderate negative

11. Waste Management

518. **Impact.** Estimated total population in the labour camps will be 500. The water requirement at camps will be 203 KLD, wastewater generation will be around 183 KLD & municipal solid waste generation 0.75 ton per day. Hazardous waste generated during construction and operational phase may include used oil, fuel, paints, lubricant, etc. Domestic solid waste will be generated in stations during operational phase of the project. Solid waste generated during construction includes construction and demolition (C&D) waste such as concrete debris, metal scraps, wooden formwork, packaging material, and excavated soil. In addition, municipal solid waste (MSW) from labour camps—including food waste, paper, and plastics—contributes to the overall volume. It is estimated that labour colonies will generate approximately 0.75 tonnes of MSW per day, considering a peak workforce of 500 workers.
If not managed, this waste can lead to:

- Obstruction of storm water drains,
- Contamination of land and water bodies,
- Foul odours, and
- Proliferation of disease vectors

519. Hazardous waste such as used oils, spent lubricants, diesel residues, chemical containers, batteries, and solvents are expected to be generated during equipment maintenance and operations, particularly from DG sets and construction machinery. Improper disposal can lead to soil and groundwater contamination, fire hazards, and occupational health issues.

520. **Mitigation.** Labour camps will be constructed in semi urban set-up or outskirts of the

city. At the campsites wastewater treatment facilities will be constructed (e.g., septic tank and soak pit and site drainage) to avoid spillage of wastewater into surface water or groundwater. Alternatively, a connection to the public sewer system may be realised. Sewage discharged into public sewers will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. Alternately, the contractor shall install small STP/Bio-digester for treatment of sewage from workers' camps. This treated water shall be used for gardening & sprinkling on roads. Hazardous materials (e.g. fuel, lubricants etc.), will be stored and disposed off through authorised MPCB approved vendor. Waste disposal sites and disposal management plan, temporary storage location for hazardous & other solid waste shall be monitored on regular basis. Non-hazardous solid waste generated in stations will be collected on a regular basis and transported to local municipal bins for onward disposal to disposal site by municipality. Regular inspection and maintenance of the waste collection system will be required in order to let it function effectively.

521. Mitigation for Solid waste management may include:

- Source segregation of waste into biodegradable, recyclable, and non-recyclable components.
- Composting of organic waste and handover of inert and recyclable waste to PCMC-authorized waste contractors.
- Reuse of suitable C&D material within the project (e.g., as backfill or sub-base material).
- Disposal of excess waste to designated landfill sites approved by the Maharashtra Pollution Control Board (MPCB).

522. Mitigation measures to manage hazardous wastes include the following:

- Storage of hazardous waste in labeled, leak-proof, and covered containers on impermeable surfaces.
- Regular collection by authorized handlers and disposal through registered recyclers or Treatment, Storage, and Disposal Facilities (TSDF).
- Maintenance of hazardous waste logs and registers in compliance with the Hazardous Waste Management Rules, 2016 (amended 2019).
- Onsite availability of spill containment kits and emergency response training for staff handling such materials.

523. **Residual Impact:**

- **Construction:** Moderate with mitigation.
- **Operation:** Minimal with mitigation

524. Maha Metro, through its Project Implementation Unit (PIU) and appointed General Consultant (GC), will oversee the implementation of the Waste Management Plan. The contractor will be contractually obligated to ensure full compliance with the WMP and other ESMP requirements. Periodic site inspections, waste handling audits, and compliance checks will be carried out to ensure that environmental safeguards are not compromised. Reports on waste generation, handling, and disposal will be submitted monthly for review by Maha Metro and the European Investment Bank (EIB).

12. Energy consumption

525. **Impact**. Metro is an electrical energy intensive transport system, needing power for traction, train control, depots and station facilities. Such demand will increase with increase in passenger demand over time. Demand details are given under section on operation.

526. **Mitigation.** In accordance with the GRIHA (version 2015) norms, the following measures will be implemented to a feasible degree in the stations and depots.

(i) Control annual heat gain through favourable orientation and design of facades
(ii) Site planning according to contours
(iii) Site plan designed to preserve existing vegetation/ existing water bodies / other topographical features like boulders etc.
(iv) Manage storm water on site through rainwater harvesting
(v) Mitigate heat island effect by ensuring that building surface visible to sky is shaded by trees. Ensure zero SWD (Solid Waste Disposal) post-construction by means of ground water recharge and recharge of groundwater aquifers by rainwater. The building will be designed to incorporate low ODP (Ozone Depleting Potential) materials, indoor air quality and comfort, low-VOC (Volatile Organic Compounds) paints and adhesives, reduced landscape water demand, sustainable building materials and renewable energy utilization etc.

527. **Impact Significance:**

- Design and pre-construction stage – neutral
- Construction stage – moderate negative
- Operation stage – neutral / positive
- Residual Impact after Mitigation – minimal negative

528. Construction of metro project in a city like PCMC will yield many tangible benefits such as better accessibility; reduction in atmospheric air pollution; less travel time; more comfort and improved quality of life. Some of the benefits expected from the project include:

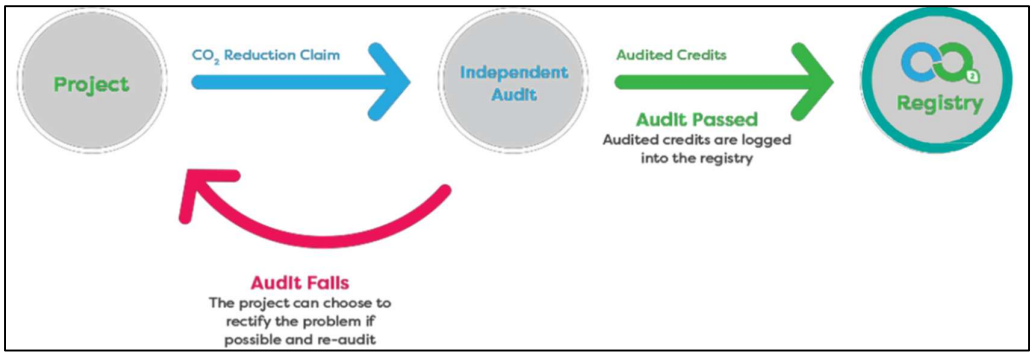
(i) **Employment Opportunities** – The project is expected to generate employment for unskilled labourers during construction phase and a large skilled work force is required to operate and maintain the system during operation phase;
(ii) **Safety** – Metro trains are largely safer, efficient and faster compared to other modes and means of transportation. Also, operation of metro trains reduces traffic congestion and chaos on at-grade roads making the roads safer and reduces the incidence of accidents;
(iii) **Reduction in Traffic Congestion and resulting Air and Noise pollution** – Proposed extension of metro network provides quick access to commuters, attracting public to use metro, thus significantly reducing traffic congestion on city roads. The reduction in traffic congestion reduces the fuel consumption and helps to conserve fuel and reduce air pollution and noise pollution on the roads;
(iv) **Increase in Green Cover** – Compensatory plantation at the rate of 10 trees for each tree being cut due to the project, will increase the green cover by the time these trees mature;
(v) **Benefits to Economy** – The project will facilitate movement of people from one end of PCMC to the other. This safe and easy movement yields benefit to growth of economic activity due to better accessibility, savings in fuel consumption, reduction on investment on road infrastructure, reduction in vehicle operating costs, savings in travel time, improvement in safety and quality of life and reduction in loss of productivity due to health disorders resulting from pollution;

F. CARBON CREDIT STUDY

1. What is Carbon Credit?

529. Carbon credits are reductions of emissions of greenhouse gases caused by a project or a product by anybody which directly or indirectly reduces or eliminates greenhouse gases. Currently, this reduction is measured in terms of Carbon dioxide or CO_2 reduced. The process for registering Carbon Credits against a project is shown in **Figure 5-2** below.

Figure 5-2: Process of Registering Carbon Credits



2. How it Works?

530. Carbon credits are bought voluntarily by companies and individuals to offset the environmental cost of their actions – which are typically measured by a verified third party and go towards funding projects in alternative energy, developing renewable resources, and other areas.

531. When companies or individuals go about their daily lives and conduct business they use energy. When this energy is derived from fossil fuels such as oil, coal and gas, it releases carbon and other greenhouse gases (GHGs) into the atmosphere. This is one of the key contributors to climate change.

532. Carbon markets provide the infrastructure for carbon trading or 'offsetting' -- the process by which businesses and individuals can be accountable for their unavoidable emissions by funding certified GHG emission reduction projects elsewhere in the world, as represented in **Figure 5-3**. Types of Carbon Credit Markets are shown in **Figure 5-4.**

Figure 5-3: How Carbon Markets work

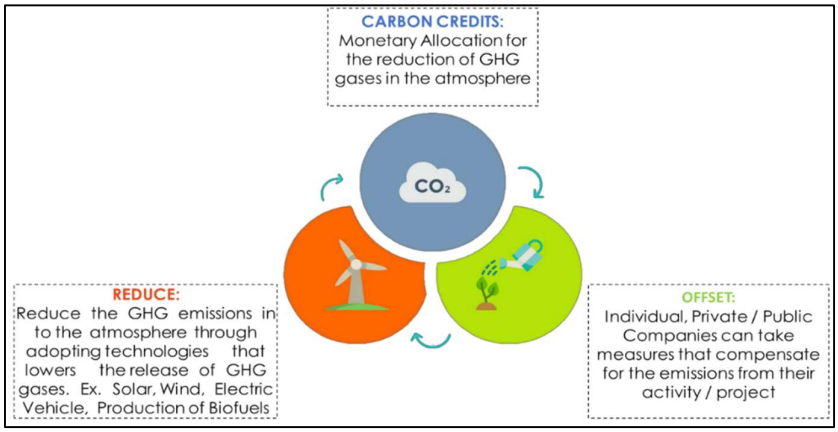
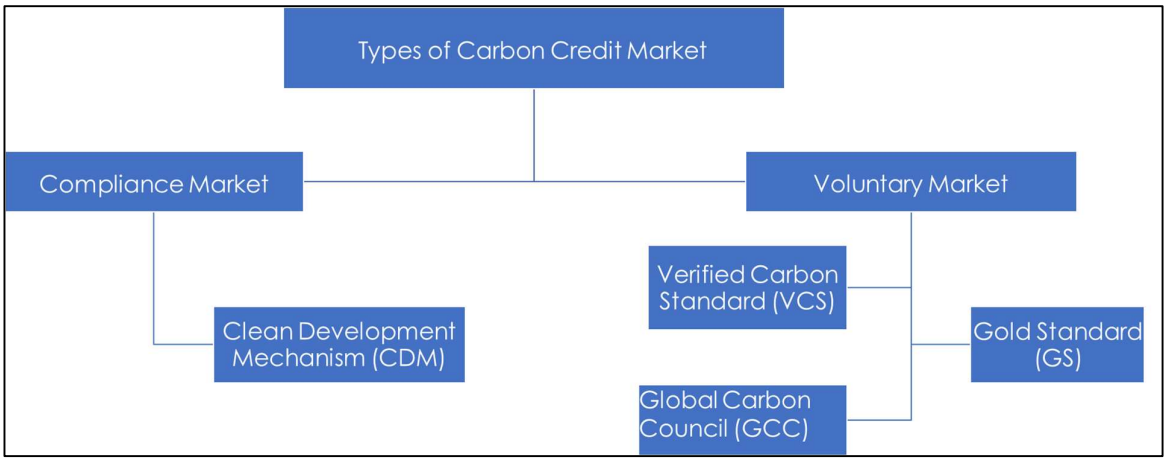


Figure 5-4: Types of Carbon Credit Markets



533. Estimating "CO_2 emission savings" of a Mass Rapid Transit System (MRTS) project shall give an opportunity to earn carbon credits under Clean Development Mechanism (CDM) of Kyoto protocol for 'Non-Annex I' countries like India. A summary of requirements and salient features of the CDM is summarised in **Table 5-22** below.

Table 5-22: Salient features of the CDM for Carbon Credits

Mechanism	CDM
What is it?	United Nations' Carbon Crediting mechanism, which is globally accepted. However, the only major buyer right now is EU.
Eligibility	A prior intimation form needs to be sent to UN within 6 months of commissioning
Timeline for registration	Approx. 1 year, subject to DNA (MoEF&CC) Meeting & Host Country Approval (HCA) Letter
Strength	Taking the project under CDM ensures that it is also recognized by UNFCCC and remains eligible in all the current and future mechanism (Paris Agreement) proposed by UNFCCC
Major Use	CDM projects are eligible to be used under compliance mechanism mainly in EU ETS.
Critique	Focus only on Emission reductions, thus Sustainable Development not captured in the current scenario.
Long Term Vision	CDM, or any other mechanism that might come up under Paris Agreement that has to decide upon latest by Dec 2021. We strongly believe it's a justified gamble to keep the projects eligible under CDM to benefit in the long run since they will the country's legal compliance structure.

3. Carbon Emission Estimation for PCMC to Nigdi (Phase-1 Extension)

534. As per the DPR (August 2021) carbon emission estimation of PCMC to Nigdi (after construction) is presented in **Table 5-23**.

Table 5-23: Carbon Emission Estimation

Treatment cost of CO2 in Rs/Ton[52]	500
Carbon (CO2) Emission - Ton /litre[53]	0.0023

[52] *Source: Appraisal Guidelines for Metro Rail Projects Proposals, 2017, MOH&UA, GOI*
[53] *Source: GHG Analysis Road Improvement, Guidance Note, World Bank Group, February 2016)*

Chapter 6: ANALYSIS OF ALTERNATIVES

A. PROJECT PURPOSE

535. Urbanization and rapid growth of vehicles population has laid severe stress on the urban transport system in Pimpri chinchwad. Increase in vehicular traffic and limited augmentation road infrastructure facilities have been observed in the city. Private modes have gained more usage due to limited public transport facilities with poor level of service.

536. In addition to the existing public transport and PCMC to Nigdi (Phase-1 Extension) received in-principle approval from the Government of Maharashtra. As part of , PCMC to Nigdi (Phase-1 Extension) project has been planned. Furthermore, the Government of Maharashtra, through the Maharashtra Metro Rail Corporation, has decided to introduce an efficient, safe, and high-capacity public transport system for the proposed project.

B. PUBLIC TRANSPORT PLAN IN CMP

537. The Comprehensive Mobility Plan (CMP) considers bus rationalization, bus augmentation and Mass Rapid Transit System (MRTS) for city of Pimpri Chinchwad. Multi Modal Hub are also proposed in CMP. Apart from physical integration fare integration, information integration is also proposed. Intelligent Transport System is considered for Pimpri Chinchwad city including AFCs, Validators, Electronic Ticket Machines, Security Access Modules etc. High and medium capacity public transport systems have also been conceived in CMP.

1. Options of Mass Transport Systems

538. Mass transport systems in cities / urban agglomerations can be broadly classified into the following 5 categories, the E & S impacts of which are summarised in **Table 6-1** below:

Table 6-1: Mass Transport Systems with their respective Environmental & Social impacts

Aspect	Environmental Impacts	Social Impacts
Normal Bus System	- Significant air and noise pollution due to diesel engines. - High carbon emissions per passenger.	- Affordable but prone to delays and overcrowding. - Lacks reliability and comfort.
Bus Rapid Transit System (BRTS)	- Moderate air and noise pollution reduction due to better traffic flow. - Encourages reduced private vehicle use.	- Improved travel times and reliability. - Limited capacity for high-density cities. - May cause displacement due to lane segregation.
Light Rail Transit System (LRT)	- Minimal air pollution as it's electric-powered. - Moderate land use compared to Metro.	- Provides efficient connectivity but limited capacity. - May require resettlement during construction.
Metro Rail System	- Zero air pollution during operation (electric-powered). - Sustainable in high-density urban areas.	- Highest passenger capacity (40,000–80,000 PHPDT). - Reliable, fast, and future-proof for growing cities. - Reduces congestion and travel time.
Regional Rail	- Low air pollution per passenger but moderate noise pollution.	- Useful for suburban connectivity but less efficient within urban cores. - May require significant land acquisition for track expansion.

539. Why Metro Rail System is the Best Alternative:

- **Environmental Advantages**: Zero emissions during operation and high energy efficiency make it the most environmentally friendly option for urban transit.
- **High Capacity**: Metro rail can accommodate the highest passenger volumes, making it suitable for rapidly growing cities.
- **Reliability**: Fully segregated tracks ensure punctuality and safety, unlike systems that share roads with other vehicles.
- **Long-term Solution**: Though capital-intensive, metro systems offer sustainable and scalable transport for future urban growth.

2. Selection of alignment and stations in CMP

540. The PMRP is constantly trying to reduce the impact of the project by minimizing the Corridor of Impact through fine tuning their design without compromising with the safety precautions. Therefore, adequate attention has been given during the feasibility and detailed design phases of the project preparation to minimize the adverse impact on land acquisition and involuntary resettlement. However, technical and engineering constraints were one of the major concerns during exploration of various alternatives, especially in relations to road safety and decreasing congestion in key sections.

541. The engineering data and typical cross-sections formed the basis of determining the land requirement at stations locations. Based on this information such as presence of buildings, trees, utility services along the project corridor, the center line of the alignment is designed so as to cause minimum disturbance / impact on people. The existing land of the road will be utilized for the construction of line viaduct and stations.

542. Attempts have been made in modifying the engineering design and alignment of Phase-I extension metro line at various locations to minimize the land acquisition, resettlement, and adverse impacts on the people in the project area.

543. Comprehensive Mobility Plan for PCMC has been prepared in 2018. Comprehensive Mobility Plan has been prepared for a planning period of 15 years with a vision for transport in PCMC to ensure that the city has a planned, best performing transport systems to address the needs and concerns of the City. The objectives of CMP are to develop specific actions in form of short, medium- and long-term improvement proposals that will achieve the transportation vision for the area. The ultimate objective of the CMP is to provide a long-term strategy for the desirable mobility pattern of the city's populace. To achieve this, the following are the main objectives:

(i) Ensure development of high-quality road in PCMC in a cost-efficient and professional manner within the specified time frame.
(ii) Improve the access to and within the PCMC area resulting in efficient traffic management.
(iii) Maximise revenue potential for the road.
(iv) Prepare long-term holistic plan for the development of the road network, making PCMC a highly connected city.

(a) CMP Vision Statement:

544. PCMC, through a Comprehensive Mobility Plan, has tried to explore and identify various steps that have to be taken towards improvement of its transportation systems with the objective of providing better quality of service to its citizens through better quality of infrastructure. The six most important pillars for ensuring Sustainable Mobility in urban areas are:

(i) Integrating Land use and Transport in Planning Process
(ii) Recognizing the use of non-motorized means of movement by introducing NMT favourable strategies

(iii) Bringing a control on movement of personal vehicles
(iv) Managing parking in the city
(v) Encouraging Public Transport System and other Sustainable modes
(vi) Directing city growth in a uniform manner with the help of better links and access roads
(vii) Sustainable Mobility however can only be ensured if the solutions are environmentally, socially and economically sustainable. To ensure that Mobility solutions for city that are sustainable and in conformity with sustainable mobility, following Goals have been formulated in the CMP:

Goal 1: Develop public transit system in conformity with the land use that is accessible, efficient and effective.

Goal 2: Ensure safety and mobility of pedestrians and cyclists by designing streets and areas that make a more desirable, liveable city for residents and visitors and support the public transport system.

Goal 3: Develop traffic and transport solutions that are economically and financially viable and environmentally sustainable for efficient and effective movement of people and goods

Goal 4: Develop a Parking System that reduces the demand for parking and need for private mode of transport and also facilitate organized parking for various types of vehicles.

545. The transport network of city is dependent on its land use. Land use and the transport network strategy development must go hand in hand. Connectivity helps in the realization of the land use planned. The land-use transport strategy developed focuses on accessibility, connectivity, and mixed land use developments to minimize private vehicle trips, encourage transit-oriented development. In the long term, the transport strategy should be based on the urban growth envisaged for the city. Transport network strategy, therefore, enables the city to take an urban form that best suits the geographical constraints of its location and also one that best supports the key social and economic activities of its residents.

546. As per the Comprehensive Mobility Plan for Pune Municipal Corporation and Pimpri - Chinchwad Municipal Corporation, the overall Per Capita Trip Rate (PCTR) observed in PMC and PCMC area was 1.33 and 1.17 respectively, while the vehicular PCTR (excluding walk) in PMC and PCMC area was 0.88 and 0.76.

547. The year 2018 is considered as the base year for the travel demand model. In 2018, the base case transport network includes buses, intermediate public transport (IPT), shared liners, out-station bus routes, existing suburban rail routes, and currently operational BRT routes.

548. For the years 2027, 2037, 2047, and 2057, the network with the project will encompass buses, IPT, shared liners, out-station bus routes, both existing and proposed suburban rail routes, as well as currently operational and proposed BRT routes. It will also feature metro lines under construction and proposed mass transit according to the Comprehensive Mobility Plan (CMP), including proposed projects such as PCMC-Nigdi (PMRP Phase 1 Extension)

3. Alternative Options for Lower Ridership Volumes

❖ **Personal Rapid Transit/ Cable Car**

549. Based on worldwide experience, Light Metro and LRT are feasible solutions for mass transit at volumes of around 5000 PHPDT or more.

550. Alternatives to Light Metro or LRT could be considered for the extension, for example monorail or various forms of Personal Rapid Transit (PRT

- **A Passenger Per Hour in Peak Direction (PPHPD) too high for the people mover option**

551. Typically, PRT vehicles are small in order to provide a personalised service, usually carrying between two and six passengers. As vehicles are small, infrastructure can be lighter in design.

552. Although larger vehicles have not so far been used for the limited examples of PRT in current operation, it might be possible to offer larger vehicles, but this would increase the size and cost of infrastructure and reduce the benefits of offering a personalised service.

553. If we assume vehicles carrying as many as 20 passengers (much larger than any application so far in the world), then 400 departures would be required in the peak hour in 2057, which does not appear feasible.

- **Monorail**

554. Monorail, a transport mode that has higher capacity than PRT but has been mainly developed for other than mass transit so far

555. Monorail can accommodate larger volumes of riders than PRT, similar to Light Metro and LRT, and at similar commercial speeds.

556. Most Monorail systems in the world have been short-distance lines, often aimed at tourists, but there are growing applications to mass transit systems (e.g. the Mumbai Monorail can accommodate over 550 passengers per train

- **Monorail, a system that has cheaper infrastructure than conventional rail-based project**

557. To be suitable for extension line, up to 11860 PHPDT would need to be accommodated by 2057 or beyond- even assuming trains of similar capacity to Mumbai monorail, this could require at least 15 departures per hour by 2047. Construction requires similar infrastructure to elevated Light Metro and LRT, although structures typically require less material compared to an equivalent Light Metro or LRT, without-turn infrastructure costs per km approximately 25% lower.

- **Monorail, a system that lacks flexibility compared to more conventional modes**

558. One major challenge is that monorail systems are less flexible than conventional Metro and LRT systems, for example switching between tracks requires additional infrastructure than with steel rails, and ride quality is lower than on steel rails. Evacuation can be more difficult/dangerous than even elevated conventional rail systems, unless adequate additional escape routes are built into the infrastructure.

- **Lack of diversity in monorail systems suppliers implying potential higher costs and risks**

559. Monorail vehicles are available from only a few suppliers, have less of a successful record of operation, and are more specialist than Light Metro or LRT vehicles. Consequently, monorail vehicles are likely to be more expensive than equivalent Light Metro or LRT vehicles, and the whole operating system would be provided by the vehicle supplier as it is bespeaking which would increase risk and potential cost.

560. Different monorail systems are not compatible with each other so that for example, a Hitachi monorail system will not run with rolling stock from another supplier. If the chosen supplier decided to end its monorail business line, then the system itself would be threatened

(no possibility to renew rolling stock notably).

561. Timelines for completing systems of similar length to that proposed for extension appear to be similar for monorail and conventional rail-based systems (e.g. Mumbai Monorail five years to opening of first section)

4. Mode Selection

562. Pune is a growing city with high potential of economic activity and population growth. Commuting for day to day business and personal reasons results in to high passenger traffic and congestion on roads. Therefore, Phase-I of Pune Metro is already approved by Government and is currently under construction phase. Following this development, there is a demand for PCMC to Nigdi (Phase-1 Extension) .

563. The objective of Mass Transportation systems should be to provide high mobility, freedom and comfort at optimum cost, keeping safety and security of passengers on high priority. Mode change over a trip should be minimized to avoid passenger discomfort. The system and technological option should be selected keeping long term demand in view.

564. Feasible alternatives (e.g. Monorail) offer limited advantages and are unlikely to be delivered any faster than Light Metro or LRT. Ensuring compatibility across the whole network should offer economies of scale (both in capital expenditure – such as sharing depots – and in operating expenditure – sharing maintenance, staff, rolling stock, etc.)

565. Considering the above factors and systems options, it is concluded that an PCMC to Nigdi (Phase-1 Extension) provides a suitable Mass Rapid Transit System (MRTS) option to public in the area of extension and beyond. It will connect public in and around the area of PCMC to Nigdi to the core area of city and can act as catalyst for further growth in this area

C. SCREENING CRITERIA FOR IDENTIFIED ALTERNATIVES

1. Goals & Objectives

566. Metro Rail Policy guidelines of MoHUA, 2017 suggests several screening criteria for Alternatives Analysis of projects. Following screening criteria have been identified for both the qualitative and quantitative evaluation:

(i) **Mobility Effects** - Primary purpose of this task is to assess the current travel demand for base year, with available future year networks and land use data as documented in CMP.

(ii) **Conceptual Engineering Effect -** Engineering effects have been analysed for civil aspects of alternatives. To refine the range of alternatives to relate the differences between options, all feasible alternatives have been compared including those as identified in CMP.

(iii) **System Effects -** The indigenous availability of rolling stock, carrying capacity, type of operation, safety, comfort, land availability for depot, are some of the core transport system related characteristics to be considered.

(iv) **Environmental Effects -** The purpose of preliminary environmental analysis is to identify environmentally sensitive areas early on, so that these areas can be avoided if possible, during design. A screening-level analysis has been conducted to determine the potential environmental impacts of each alternative identified.

(v) **Social Effects -** The analysis has been conducted to determine the potential social impacts of alternatives.

(vi) **Cost Effectiveness & Affordability -** The capital cost and annual costs associated e.g. operation & maintenance costs etc. for each alternative have been evaluated. Preliminary costs have been estimated based upon conceptual engineering for alternatives selected for evaluation.

(vii) **Financial and Economic Effects –** Financial plans, economic benefits and costs associated with the project have been identified and quantified for identification of optimum solution along with economic viability.

(viii) **Other Factors - Approval & Implementation -** The mass transport system to be introduced will require technology and set of components well established and proven so that statutory approvals and implementation of system do not result in time delays and cost implications. Established systems already in place in India will require less time for processing of approvals and would be easy to implement.

567. A scoring criterion for each of screening parameters has been developed for the initial qualitative evaluation. The following weightage has been considered as provided in **Table 6-2**.

Table 6-2: Weightage of Screening Criteria For Qualitative Evaluation

SN	Criterion	Weightage
1	Mobility Effects	**20**
2	Conceptual Civil Engineering Effect	**15**
3	System Effects	**10**
4	Environmental Effects	**15**
5	Social Effects	**5**
6	Cost Effectiveness & Affordability	**15**
7	Financial and Economic Effects	**15**
8	Approvals & Implementation	**5**
	Total	**100**

568. The alternatives are ranked based on their relative performance under each criterion. Four scoring classifications considered for each parameter are:

(i) Excellent (100%)
(ii) High (75%)
(iii) Medium (50%)
(iv) Low (25%)

2. Qualitative Evaluation of Alternatives

(a) Basis of Scoring the Screening Parameters for Quantitative Evaluation:

(i) **Mobility Effects** – Mobility effects namely travel demand and existing transport characteristics in the city influence in determining the mass transport system required. Fulfilment of projected demand in long term scenario, ease of passenger transfer, utilization factor, possibility of intermodal integration between systems and catchment area connectivity are the identified parameters. Guided systems score high in mobility effects as they offer higher carrying capacity and frequency of regulated services, better utilization in terms of more passenger-km and thus reducing congestion on roads.

(ii) **Conceptual Civil Engineering Effects** – The parameters covered are available right of way, alignment design & constructability, geotechnical characteristics, station planning & intermodal integration and requirement for utility shifting. Road based systems score high as it requires less right of way and have easy constructability than grade separated rail-based systems and BRT. Rail based systems and elevated BRT with dedicated guideway systems have impact on shifting of existing surface / underground utilities. However, Metro Rail, LRT and BRT can offer better station planning and intermodal integration opportunities.

(iii) **System Effects** – The influential parameters are interoperability with existing Metro Phase-I, passenger's safety & comfort, type of operation and indigenous availability of the system. Rail based systems and Elevated BRT are more automated in operations while normal bus system is manually operated in mixed traffic conditions. Metro rail would be the most suitable mode considering

continuity / interoperability with the Phase 1 metro system. Rail based systems offer better quality of travel and offer safe travel conditions than road-based systems. Except for LRT, other modes namely Metro, BRT and Normal bus have indigenous availability in the country.

(iv) **Environmental Effects** – The parameters considered are air & noise pollution, trees affected and management of hazardous waste. Rail based systems have been assigned better scores more than bus-based systems considering their ability to reduce pollution levels on the city roads. Grade separated Metro Rail and LRT being electrified systems play an important role in minimizing the air and noise pollution levels in the city.

(v) **Social Effects** – Normal Bus based system score high as very few structures / families are affected.

(vi) **Cost Effectiveness & Affordability** – Bus based systems are more affordable than rail-based systems due to lower capital and O&M costs per passenger-km and accordingly are assigned higher scores than metro and light rail systems. Rail based systems incur high capital cost whereas normal bus systems require comparatively less investment costs as buses share the existing roadway system with other modes. However, Metro, LRT and elevated BRT consume more construction and O&M costs as they are planned for a much higher operational period and an exclusive guideway system.

(vii) **Financial and Economic Effects** – Economic benefits and Life cycle cost of rail-based systems is much higher than road-based systems considering reduction in pollution levels, number of accidents and overall social benefits. The cost incurred in road-based systems considers fuel, operation and maintenance costs. Rail based systems on the other hand result in saving considerable travel time, provide convenient and safe travel conditions thereby resulting in optimizing overall travel cost. The rail-based systems also allow Transit Oriented Development along dedicated project which generate additional revenue for the implementing agency/development authority. Metro among rail-based systems have higher carrying capacity and offer higher economic returns than all other systems.

(viii) **Approvals and Implementation** – Road based systems and Metro score higher than LRT as these systems have set standard procedures for approvals and implementation. LRT would consume more time as it has not been introduced yet in India.

D. "DO NOTHING" SCENARIO

569. As part of the alternatives assessment, a "Do Nothing" scenario analysis has been carried out to evaluate the potential implications of proceeding with or foregoing the proposed PCMC to Nigdi (Phase-1 Extension) of the Pune Metro Rail Project. This comparative assessment is crucial to understand the environmental and social significance of the proposed project. The "Do Nothing" scenario assumes continued reliance on existing transport infrastructure, which is already under strain due to rapid urbanization, increased vehicle ownership, and inadequate public transport options. In contrast, the "With Project" scenario envisions the implementation of a sustainable, efficient, and inclusive metro system that addresses urban mobility challenges while minimizing adverse impacts through well-defined safeguard measures. The following **Table 6-3** presents a side-by-side comparison of key environmental and social aspects under both scenarios.

Table 6-3: Comparative analysis of "Do Nothing" Scenario vs. With Project Scenario

Aspect	"Do Nothing" Scenario	With Project Scenario
Air Quality	Continued deterioration due to rising number of private vehicles, resulting in higher emissions and dust levels in densely populated corridors.	Temporary air quality deterioration during construction due to dust and machinery emissions. Long-term improvement through modal shift to clean metro transport.
Noise & Vibration	High baseline noise from road traffic persists, especially	Temporary increase during construction. Controlled through

	near sensitive receptors like hospitals and schools.	equipment maintenance, restricted working hours, and noise barriers near sensitive areas.
Water Resources	Urban runoff continues to pollute surface water. Groundwater use and recharge are unregulated.	Risk of contamination during construction (dewatering, run-off). Mitigated via proper drainage planning, sediment traps, and regulated water usage.
Ecology (Flora & Fauna)	Gradual decline in green cover due to urban sprawl; no additional compensatory efforts.	Tree cutting unavoidable at station locations; compensated through replanting and biodiversity conservation measures under ESMP.
Traffic Congestion	Traffic volumes expected to rise further, leading to increased travel time, fuel use, and commuter stress.	Short-term construction-related congestion. Long-term reduction in road congestion due to high-capacity metro service reducing dependence on private vehicles.
Land Acquisition & Livelihoods	No new land disturbance. However, unregulated growth may lead to informal occupation and urban sprawl.	Limited land acquisition with minimal displacement. Compensation, resettlement (if any), and livelihood restoration are planned as per national and EIB standards.
Occupational Health & Safety	Not applicable, as no new infrastructure activity occurs.	Construction phase entails risks like dust exposure, accidents, noise—mitigated through PPE, training, and safety audits as part of the OHS plan.
Community Impact	Inadequate public transport continues to inconvenience residents, especially low-income groups.	Temporary disruptions (access, noise, dust) during construction. Long-term benefit through reliable, safe, and inclusive metro access.
Climate Change Impact	Unabated GHG emissions from growing vehicle population. No net positive impact on sustainability.	Significant reduction in carbon footprint through modal shift and energy-efficient systems (e.g., regenerative braking, electrified rail).
Social Inclusion & Equity	Limited, inequitable access to mobility; women, children, elderly, and persons with disabilities continue to face mobility barriers.	Universal access design, affordable fares, improved connectivity—promoting inclusive urban mobility and supporting social equity goals.

Chapter 7: PUBLIC CONSULTATIONS AND INFORMATION DISCLOSURE

A. CONSULTATIONS

570. EIB require projects to carry out meaningful public consultation on an ongoing basis. Public consultation for the PCMC to Nigdi (Phase-1 Extension) will: (i) begin early and carry on throughout the project cycle; (ii) provide timely disclosure of relevant information, understandable and accessible to people; (iii) ensure a free and un-intimidated atmosphere without coercion; (iv) ensure gender inclusiveness tailored to the needs of disadvantaged and vulnerable groups; and (v) enable the incorporation of all relevant views of affected people, and stakeholders into project decision making, mitigation measures, the sharing of development benefits and opportunities, and implementation issues.

571. Public consultation and participation are a continuous two-way process which involves promoting public understanding of the processes and mechanisms through which developmental problems and needs are investigated and solved. The public consultation, as an integral part of environmental and social assessment process throughout the project preparation stage, not only minimizes the risks and manages the expectation of the project but also abridges the gap between the community and the project formulators, which leads to timely completion of the project and making the project people friendly.

572. Public consultation/information is an integral part of PCMC to Nigdi (Phase-1 Extension) project cycle. Public consultations with the people of different sections of the society along the project alignments, shopkeepers, and influential persons of the area were made. Potential vulnerable people like, squatters, encroachers, schedule caste, and other backward section of society have been consulted as a part of SIA study to make them aware and identify adverse impacts of the project.

573. Considering the importance of people's participation in the project planning, public consultation and FGDs were also carried out both at community and government level. The objectives of the consultation were to disseminate information about the project to the potentially affected population in order to incorporate their views and suggestion for preparing the SIMP and the design and to assess the economic situation of the settlement. The consultation focuses on identification of issues raised by the PAHs and its integration in the Social Impact Management Plan.

574. As per EIB Environmental & Social Standards (ESS) 2022,

"In order to ensure the effective participation of the identified stakeholders, the promoter shall make available to the public the following information in the most accessible way and as soon as it can reasonably be provided:

a. *The purpose, nature and scale of the project, including the duration of proposed project activities;*
b. *The description of the likely project impacts and risks for local communities, as well as the proposed mitigation and/or compensatory/remedial measures as defined in Standard 1;*
c. *As and where applicable, the description of potential impacts and risks that might disproportionately affect vulnerable, marginalised, and/or discriminated-against groups and an overview of the different measures proposed to avoid and minimise these;*
d. *The proposed stakeholder engagement process and opportunities for public participation, including locations and dates of any envisaged public consultation meetings, and the process by which meetings are notified and reported, as described in the SEP and its revisions/updates where applicable;*
e. *The available project-level grievance or feedback mechanism, the EIB Group's Complaints Mechanism20 and how stakeholders can access them; and*
f. *Any opportunities for benefit-sharing and added value for affected communities, where applicable."*

575. Accordingly, Maha-Metro (PMRP) with the help of MITCON (the environmental consultant engaged for preparation of the ESIA) organised Public Consultations two locations along the PMRP North extension (PCMC to Nigdi) alignment. Notice for the same was given in the identified areas one week in advance (i.e. on 1st April, 2025) in the form of posters put up at bus stations and other locations along the alignment, frequented by general public. Total of 40 persons attended the Public Consultations and were informed about all relevant details of the project. Details of the Public consultation along with attendance sheets, and other relevant details is attached as **Annexure-13**.

B. IDENTIFICATION OF STAKEHOLDERS

576. Consultations with various stakeholders have been carried out during preliminary survey and during SIA study of the project. The primary stakeholders of the Project are:

(i) Project Affected Persons (PAPs),
(ii) Project beneficiaries, and
(iii) Implementing agency.

577. Following key stakeholders at Central, State, District and local levels will be consulted as part of the consultation process.

(i) Ministry of Environment, Forests and Climate Change (MoEF&CC),
(ii) Central Pollution Control Board (CPCB),
(iii) Maharashtra Pollution Control Board (MPCB),
(iv) State Environmental Impact Assessment Authority (SEIAA)
(v) State Traffic Police Department
(vi) Pune Municipal Corporation (PMC)
(vii) State Archaeology Department
(viii) Central Ground Water Authority (CGWA)
(ix) Maharashtra Forest Department (MFD)
(x) Indian Meteorological Department (IMD)
(xi) Various Non-Government Organizations (NGOs)
(xii) Women groups / Self Help Groups (SHGs)
(xiii) Shopkeepers associations
(xiv) Auto-rickshaw Associations

C. SCOPE OF WORK

578. All the baseline surveys and consultation meetings were organized by giving prior intimation to the displaced persons and participants. During the consultation process, efforts were made by the survey team to:

(i) Ascertain the views of the DPs/PAPs with reference to Pune Metro Rail Project PCMC to Nigdi (Phase-1 Extension)–alignments and minimization of impacts.
(ii) Understand the views of the community on land acquisition & compensation,
(iii) Identify the major socio-economic characteristics of the TH and NTH (Kiosk) to enable effective solution on loss of economic activity, if any during planning and implementation.
(iv) Obtain option from the discussion on issue related to impacts on community property resources.
(v) Examine DPs/PAPs opinion on problems and prospects of transport safety related issues.
(vi) Identify people's expectations from project.
(vii) Establish an understanding for identification of overall Phase I metro transport goals and benefits of the project.

D. METHODOLOGY

Public consultations and discussions with the displaced persons (DPs/PAPs) like Title Holders (TH), Non-title Holders (NTH), and wider communities like commuters, public

transporters, local leaders, and other stakeholders have been carried out as part of the Social Impact Assessment (SIA) studies carried out for the project. Methodology used for the consultations, is given in **Table 7-1**.

Table 7-1: Methodology for Public Consultations

Stakeholders	Method of PC
Displaced Person (DP) / Project Affected Person (PAP)	Baseline census survey involving head of the household as respondents.
Local community	Through Focus Group Discussion (FGD) at affected station locations.
Public Transporters	Through Focus Group Discussion (FGD) at affected station locations.
Implementing Agency	Individual interview, discussion, joint visits
Line Department Agencies	Individual meetings and discussions.

579. Consultations and discussions were held along the project corridor with the affected families and other stakeholders (details given in **Table 7-2**). All affected Families were consulted while interacting with them during the project census survey. Consultation meetings were organized to get wider public input from both the primary and secondary stakeholders. In addition to the individual consultation with all affected Families during census survey, a total of 66 including 28 males and 38 females were consulted in 5 consultation meetings/focused group discussions. Some of the major issues that were discussed and feedback received from the project affected persons during the course of the consultations are summarised in **Annexure-13** of this ESIA report. The project has received acceptability among the local people as it is expected to provide smooth flow of traffic and reduce travel time, reduce fuel consumption and subsequently reduce air emissions. The project would bring positive socio-economic changes in the area.

580. Public consultation as part of the ESIA studies were undertaken along the PCMC to Nigdi alignment. The PAPs and other stakeholders identified (auto drivers, students, shop & kiosk owners/ leases, etc.) have shown their satisfaction with the existing Pune Metro Rail Project (PMRP) Phase 1. When they were informed about the proposed extension of the existing network, they have given a positive response. The PAPs and stakeholders said that it is necessary to extend the metro line further because there are many hurdles to travel from outskirts of the city into main Pune city centre solely by road transport. Sometimes they find it difficult to travel by road due to traffic congestion and hence they would welcome the metro rail system, so that they can safely reach their destination on time.

Table 7-2: Details of FGDs and Public Consultations

Date	Location	Participants
June 24, 2024	Nigdi	7 Male, 2 Females (Total: 9)
June 24, 2024	Bhakti Shakti	12 Male, 1 Female (Total: 13)
June 26, 2024	Nigdi Alignment	9 Male, 4 Female (Total: 13)
June 27, 2024	Akurdi	0 Male, 25 Female (Total: 25)
June 27, 2024	Nigdi Alignment	0 Male, 6 Female (Total: 6)

E. DISCUSSION WITH LOCAL PEOPLES

581. As part of the ESIA-ESMP study, in order to enhance public understanding about the project and address the prior concerns of the community pertaining to mitigation of adverse impacts due to the project, meetings with 9 people among the community were conducted on 5th and 6th September 2024 along the project corridor. Public consultations were conducted by meeting the PAPs & other stakeholders who shared their views and opinions about the project.

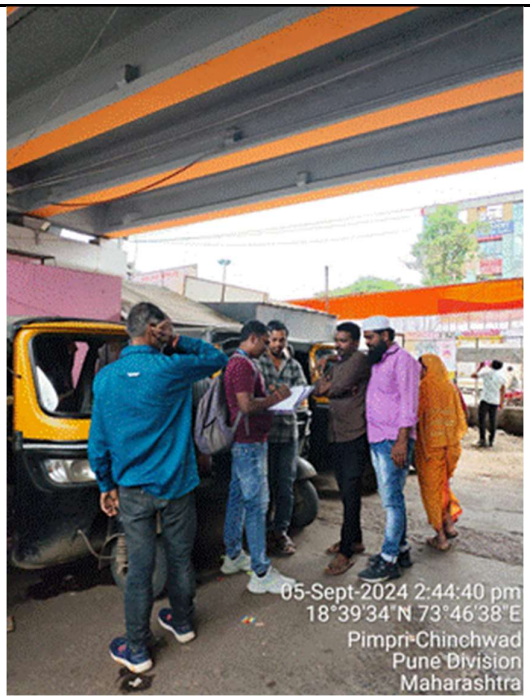
582. Summary, of the discussion held in public consultation that were part of ESIA study is

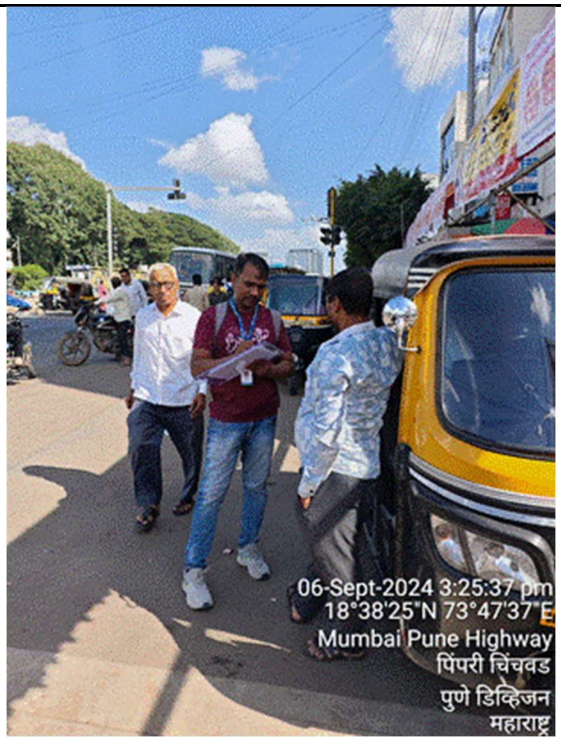
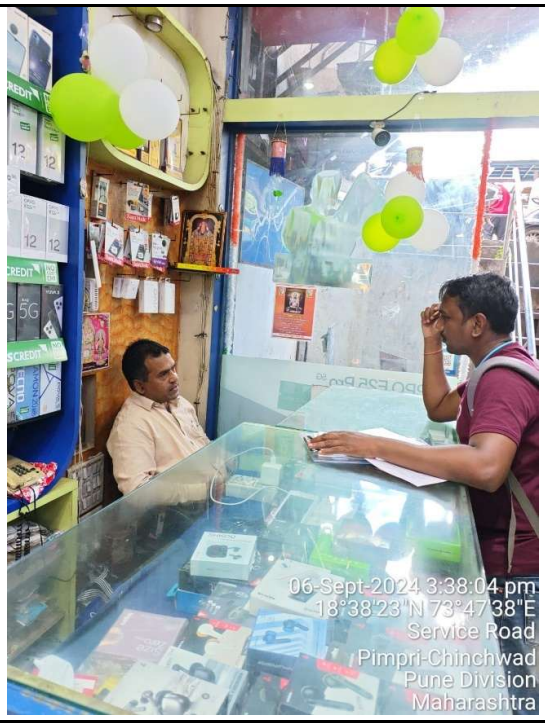
given below in **Table 7-3**.

Table 7-3: Summary & Findings of Public Consultations held as part of ESIA study

Sr. No.	Name of Person	Contact Details	Summary of Discussion	Reference Photograph
1	Mr. Ashok Bhagwat	PMPML Ticket Checker	Metro is good source for public transport. Traffic will increase during construction. Our Bust stop shed is removed for construction. Make arrangement for private Vehicle Parking at each station	
2	Mr. Vaibhav Balaji Kadam	College Student. Ramkrishna More College (Mob. No. 7569204580)	Metro is very good and rapid public transport for students. He is saying, it good for student for going to college within time frame. It will also save money.	

Sr. No.	Name of Person	Contact Details	Summary of Discussion	Reference Photograph
3	Mr. Balaji Mhetre	Loan Consultant (Mob No. 8766546422)	He said that Metro is good for transporation for public	
4	Mr. Mallappa Patil	Paper Stall Owner (Mob. No. 9890259803)	He Said that, Metro will not affect my Paper stall. Customer will be increased due to Metro hence my business will be increase. Metro is benefited to me and public too.	

Sr. No.	Name of Person	Contact Details	Summary of Discussion	Reference Photograph
5	Mr. Arif Shaikh	Auto Driver (Mob. No. 8857038177)	He said that, passenger has been increased due to Metro alignment. It is benefited to all Auto Rikshaw.	
6	Mr. Jagadale	Sugarcane Juice Centre Owner	He said that, provision Auto Rikshaw at each station to be provided as a feeder service	
7	Mr. Ajit Bhore	General Public (Mob. No. 9552549172)	Traffic conjunction may increase during construction phase. Proper signage and traffic instructor to be appointed at	No image

Sr. No.	Name of Person	Contact Details	Summary of Discussion	Reference Photograph
			designated places	
8	Mr. Santosh Pavar	Auto Driver (Mob. No. 9922322592)	He said that, passenger has been increased due to Metro alignment. It is benefited to all Auto Rickshaw	
9	Mr. Anil Madhavrav Nalabalwar	Mobile Shop Owner (Mob. No. 9823007821)	Transportation is easier than bus service. College student are getting benefited of the Metro. Income has been increased due to upcoming station opposite to his Shoppe.	

F. PLAN FOR FUTURE PUBLIC CONSULTATIONS

583. The effectiveness of the Public Consultation process is directly related to the degree of continuing involvement of those affected by the Project. Several additional rounds of consultations with DPs/PAPs will form part of further stages of project preparation and

implementation. The Implementing Agency – Maha Metro – will be entrusted with the task of conducting these consultations during implementation of the Resettlement Plan (RP), which will involve disclosure on compensation, assistance options, entitlement packages and restoration measures suggested for the project. The consultation will continue throughout the project implementation phase. The following set of activities are planned to be undertaken:

- In case of any change in engineering alignment planning, the DPs/PAPs and other stakeholders will be consulted in selection of alignment for minimization of resettlement impacts, development of mitigation measures, etc.
- Maha Metro will conduct information dissemination sessions (Metro Samvaad) in the project area and solicit the help of the local community / community leaders and encourage the participation of the DPs/PAPs in Plan implementation.
- During the implementation of RP, Maha Metro will organize public meetings (Metro Samvaad), and will appraise the communities about the progress in the implementation of project works, creating further awareness regarding proposed extension of project.
- Consultation and Focus Group Discussions (FGDs) will be conducted with the vulnerable groups, if any, like women-headed households, persons with disability and SC communities, to ensure that the vulnerable groups understand the process and their needs are specifically taken into consideration.
- To ensure facilities for women in the project construction & operation phases, they will be specifically involved in the consultation process.

G. INFORMATION DISCLOSURE

584. To keep more transparency in planning and for further active participation for DPs/PAPs and other stakeholders, in project extension, the project information will be disseminated through disclosure of all project related documents. Information disclosure will follow the procedure and requirements of EIB E&S policy for High Risk projects.

585. All environmental documents such as the final ESIA, any updated ESIA, corrective action plans prepared during project implementation and the environmental monitoring reports are subject to public disclosure, and therefore, will be made available to the public. The implementing agency, Maha Metro will translate the Executive Summary of the ESIA in Marathi and disclose it along with the Full ESIA report, on their website. The same will be disclosed on EIB website also. For DPs/PAPs who are illiterate, appropriate, and implementable methods will be followed to aware them. The Maha Metro will disclose the information through public consultations and other appropriate method and will pay specific attention to ensure those who are lacking for the information will receive information on a timely basis. The hard copies of ESIA will be made available at Maha Metro office as well as at other locations, easily accessible to all stakeholders. Maha Metro will also ensure that meaningful public consultations, particularly with Project Affected Persons (PAPs) are undertaken throughout the design, construction and operation.

Chapter 8: GRIEVANCE REDRESSAL MECHANISM

A. INTRODUCTION

586. The Grievance Redress Mechanism (GRM) is an integral and important arrangement for receiving, evaluating, and addressing/resolving the concern and grievances of the Displaced Persons' (DPs) / Project Affected Persons (PAPs) queries and complaints pertaining to social and environmental aspects of the project in a transparent and swift manner. The PMRP will formulate a project specific GRM intended to address the grievances related to the implementation of the project, particularly regarding the environmental management plan, rehabilitation and resettlement, compensation etc. will be acknowledged, evaluated, and responded to the complainant with corrective action proposed using understandable and transparent processes that are gender responsive, culturally appropriate, and readily accessible to all segments of the affected people. During the project preparation, the information regarding the availability of GRM will be disclosed to public through public consultation process. A Grievance Redress Committee (GRC) will be constituted by PMRP to address the grievances. Records of grievances received, during implementation of the project, corrective actions taken, and their outcomes will be properly maintained and form part of the periodic progress reports submitted to the funding agencies.

587. Many minor concerns of peoples are addressed during public consultation process initiated at the beginning of the project. However, the most common reason for delay in implementation of projects in urban areas is grievances of people losing their land and residential and commercial structures. Resolving such cases in the Court of Law will be a very time-consuming process. Considering this and based on past experiences of the Maha Metro Pune of dealing with DP/PAPs grievances in Phase I of the metro project, a common GRM has already been put in place in order to address social, environmental or any other grievances of Project Affected Persons (PAPs). Such a redress mechanism available at the project level itself will mean that the complainants do not necessarily have to directly approach a Court of Law, although availability of the GRC will not bar them from doing so.

B. CONSTITUTION OF GRIEVANCE REDRESS COMMITTEE (GRC)

588. A three tier GRM has been established with formation of Grievance Redress Committee (GRC) at three levels i.e. Junior Management Level, Senior Management Level and Higher Management Level.

589. Junior Management Level (Field Level) GRC Committee comprises of the:
- (i) Manager (Civil), Maha Metro (Chair Person)
- (ii) Asst. Manager/Manager (Social), Maha Metro
- (iii) Asst. Manager/Manager (Land), Maha Metro
- (iv) Asst. Manager/Manager (Environment), Maha Metro
- (v) Asst. Manager/Manager (Finance), Maha Metro
- (vi) Asst. Social/Environmental Expert of GC
- (vii) Asst. Manager/Manager (Legal), Maha Metro

590. The Senior Management Level GRC Committee comprises of the:
- (i) Director (Works), Maha Metro (Chair Person)
- (ii) Senior Deputy General Manager (Social & Land), Maha Metro
- (iii) Senior Deputy General Manager (Environment), Maha Metro
- (iv) Deputy General Manager (Finance), Maha Metro
- (v) Senior Environment/Social Expert of GC

591. The Higher Management Level GRC Committee comprises of the:
- (i) Managing Director (MD), Maha Metro (Chair Person)

(ii) Director (Works), Maha Metro
(iii) Director (Finance), Maha Metro

592. To receive and facilitate resolution of the DPs/PAPs concern & complaints in a transparent process. As per EIB's requirement, PMRP has already constituted Grievance Redress Committee (GRC) for PCMC to Nigdi project. The Grievance will be received by following ways,

(i) Letter to respective GRC or by email.
(ii) Telephonic grievance.
(iii) Grievance communicated to field staff or PMRP / GC / Contractor will have to be in writing and recorded by the field staff in a register which will be given to respective GRC.

593. The phone numbers and communication address shall be displayed at prominent locations near construction sites during Construction phase, and at all stations during Operation phase of the project.

594. Although the project has one common GRM, the composition of the GRC's for social and environmental issues differ to ensure dedicated and timely resolution of specific social or environmental grievances. Often the resettlement / social grievances will be resolved at a higher level GRC, whereas environment safeguard issues can be resolved at the working level GRC. Thus, GRC for the project will be at constituted at two levels – Site Level and Headquarters (HQ) level. The GRC working mechanism shall be as follows:

(i) Grievances of DPs/PAPs will be first brought to the attention at field level staff (Site Engineer).
(ii) Site Engineer will forward the received grievance to Deputy Chief Project Manager (Dy.CPM) and Chief Project Manager (CPM) for consideration and redressal. The CPM (Tier 1) to the extent possible will address the complaint.
(iii) For grievances addressed at site level (Tier 1), the copy of the compliance will be sent to the head office for record.
(iv) If the Grievance is not redressed at Tier-1, then the Grievance will forward to Tier-2 level i.e. at PMRP / Mah Metro head office.
(v) The Tier-2 GRC will include competent authority from land department of PMRP, designated officers from Revenue Department, Government of Maharashtra (GoM) along with representatives from NGOs / Community and a Social Expert.
(vi) The PMRP will maintain grievance registers both at site offices and at head office.
(vii) Both the GRCs at Tier-1 and Tier-2 will address only social and resettlement issues both for title holders and non-title holders. Grievances related to compensation and ownership rights will be dealt in court as per The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 only after the DPs dissatisfied with the verdict of GRM.
(viii) With a view to Affirmative Action to enhance women inclusivity, one-woman representative of local community from each 5 km section of the alignment will be members of the GRC and GRC-E. The representative(s) from the location(s) to which the grievance(s) pertain(s) will be invited to deliberations of the Committee.
(ix) When any grievance is brought to the Tier-1 GRC (Site level), it shall be resolved within 30 days from the date of complaint, whereas the time taken to redress the grievance at Tier-2 (HQ level) will be 2 weeks (14 days).
(x) PMRP will maintain a log of grievances documented at site and HQ levels respectively.

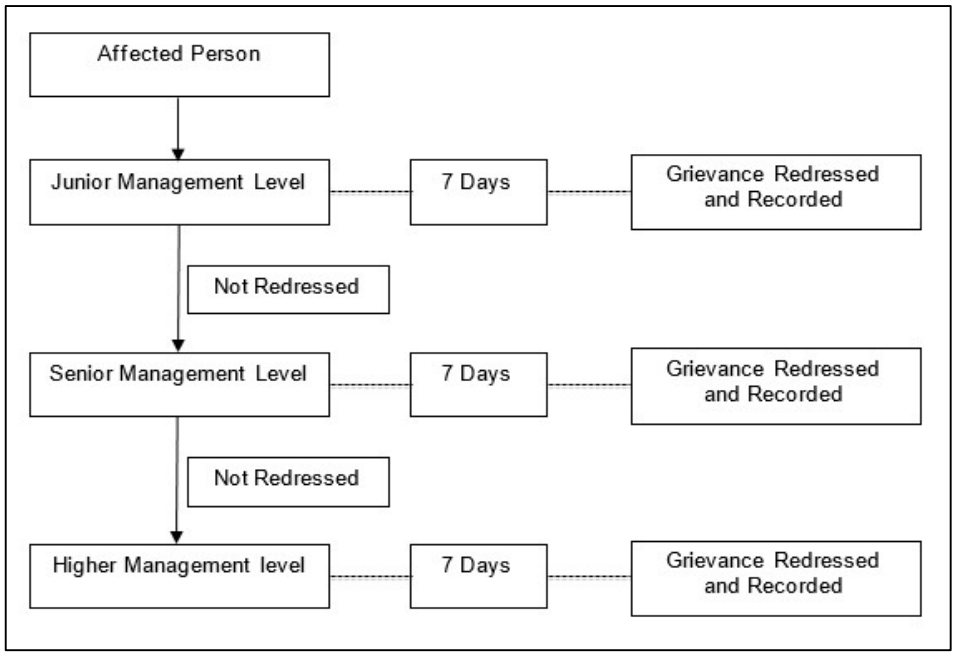
595. People who are, or may in the future be, adversely affected by the project may also submit complaint to EIB's Compliant Mechanism. The Complaints Mechanism provides an

independent forum and process whereby people adversely affected by EIB-assisted projects can voice, and seek a resolution of their problems, as well as report alleged violations of EIB's operational policies and procedures.

596. The decision of GRC will be documented and communicated to the concerned person in a transparent manner. However, the complainant is free to access the country's legal system at any time and stage. The GRC records will be made available to the external monitor for its review.

597. A flow chart of the Grievance Redressal Mechanism (GRM) in place for the PCMC to Nigdi project is indicated in **Figure 8-1**.

Figure 8-1: GRM for PMRP Phase 1 Extension (PCMC to Nigdi) Project



Chapter 9: ENVIRONMENTAL & SOCIAL MANAGEMENT PLAN (ESMP)

A. INTRODUCTION

598. The Environmental & Social Management Plan (ESMP) consists of a set of mitigation, monitoring and institutional measures to be taken for PCMC to Nigdi (Phase-1 Extension) project to avoid, minimize and mitigate adverse environmental and social impacts and enhance positive impacts. The plan also includes the actions needed for the implementation of these measures. The major components of the ESMP are:

(i) Mitigation of potentially adverse impacts;
(ii) Environmental monitoring;
(iii) Applicable Management Plans like stakeholder engagement, grievance management, worker GM, chance find procedure, waste management etc.
(iv) Emergency response procedures;
(v) Institutional arrangements and reporting mechanism;
(vi) Implementation Schedule;
(vii) Training and capacity building, and
(viii) Cost estimates.

599. The purpose of environmental and social monitoring is to ensure that the ESMP is fully and competently implemented across all phases of the project's development, and to provide a basis for appropriate and timely corrective action when it is found not to be. The environmental monitoring process should be understood not only as a means of supervision and enforcement, but also as a vehicle for organizational learning and progress towards mainstream international best practice in construction site and facility management. Effective monitoring can also be a vital tool in forestalling conflict with the communities most likely to suffer the consequences of negative environmental impacts, as problems can be identified and corrected in a timely manner, before they grow to nuisance or dangerous levels. Environmental monitoring must continue until issuance of a Project Completion Report (PCR).

B. OBJECTIVES OF ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

600. The main objectives of this ESMP are:

(i) To ensure compliance with MDBs' applicable policies, and regulatory requirements of GoM and GoI;
(ii) To formulate avoidance, mitigation measures for anticipated adverse environmental impacts during construction and operation, and ensure that socially acceptable, environmentally sound, sustainable and good practices are adopted; and
(iii) To stipulate monitoring and institutional requirements for ensuring safeguard compliance.

C. INSTITUTIONAL ARRANGEMENT

1. Executing Agency

601. Maharashtra Metro Rail Corporation Limited (Maha Metro) was incorporated by Government of India – Ministry of Corporate Affairs on 18th February 2015 as a Special Purpose Vehicle (SPV) for smooth implementation and operations of the Metro Rail Project. It has now been converted into a Joint Venture of Government of India (GoI) and Government of Maharashtra (GoM) with equal equity holding. The GoM and GoI will be the executing agency of the proposed four stations of metro project.

602. Maha Metro shall be responsible for implementation of the proposed four stations of metro rail project. The Managing Director (MD), Maha Metro will be the in charge of the overall project activities. Maha Metro shall be accountable to GoM (i.e. the executing agency).

603. Project Implementation Unit (PIU), Maha Metro headed by the Project Director (PD) is responsible for the overall execution of the project and implementation of the ESMP. The PIU will be assisted by General Consultant (GC). The safeguard role of GC is to assist Maha Metro in review of documentation and monitoring the implementation of ESMP and Environmental Monitoring Plan (EMoP) during construction and operation phases, by means of scheduled inspections, meetings and reports submitted to Maha Metro.

2. Implementation of ESMP

(a) Maha Metro:

604. ESMP will be committed by Maha Metro as part of its agreement with Multilateral Development Banks (MDBs). The responsibility to implement the ESMP including Grievance Redressal rests with Maha Metro. Environmental and other Clearances related to locations and design of the project will be secured before start of construction. Permissions / certifications required during operation of the project and Environment monitoring during operation, shall also be the responsibility of Maha Metro.

(b) Contractor:

605. Permits required during construction and those directly related to construction shall be the responsibility of the Contractor. The ESMP will be implemented by the Contractors of different packages based on the contract agreement. Contractor needs to prepare a Construction Environmental and Social Management Plan (CESMP) which needs to be approved by Maha Metro before the start of any construction activity on the site. The Contractor Social, Health and Environment SH&E team will be headed by a Senior Manager assisted by qualified and trained health and safety professionals and environment engineers along with onsite junior field personnel and community liaison personnel. This team will be assisted by:

(i) electrical and mechanical engineers qualified in safety evaluation;
(ii) environment engineer;
(iii) traffic engineer;
(iv) professionals in occupational health and labour welfare.
(v) Environment monitoring during construction
(vi) Regular monthly reports on implementation will be submitted by contractor to (GC).

606. The contractors' environmental team should include an environmental expert with proven experience in preparing Site-Specific CESMP for major construction contracts in line with internationally recognized standards. Such a role might be an itinerant short-term role separate from that of the full-time Environmental Officers and Health and Safety Officers. A bill of quantities (BoQ) item to be included in the bidding document will provide for the services of such an environmental expert to assist the contractor prepare the Site-Specific ESMP to meet international financing institutions' requirements. The Site-Specific ESMP will provide:

(i) Clear description of the project influence area especially broader affected areas subject to induced or secondary impacts
(ii) Clear identification of sensitive receptors along the alignment on a plan of appropriate scale
(iii) Risk assessment undertaken to determine how vulnerable the sensitive receptors are to project impacts (air, noise, vibration, water quality, erosion, sedimentation, traffic safety, etc.). This would include seasonal related impacts (heavy rain, flood, etc.).
(iv) Site-specific mitigation measures at specified locations based on the results of a risk assessment. This should include a narrative description of the site-specific mitigation methodology. The specific mitigation measures should be shown on site plans/designs showing what and where specific mitigation

measures/structures will be applied on the site.

(v) Environmental audit inspection procedures which describe how and when site audits are undertaken to check implementation and effectiveness of mitigation measures (including audit checklists based on Site-Specific ESMP, to be used for regular inspections) and how corrective action is initiated and resolved (internal communication mechanisms to ensure compliance with the Site-Specific ESMP). For example, inspection reports are discussed and provided to management, reported in progress meetings for action, etc.

607. The Employer Requirements for Health, Safety and Environment have been prepared for Project. They will be issued to the Contractors as part of the contract documentation for construction.

(c) Maha Metro and GC:

608. Supervision and review of implementation will be the responsibility of GC. With assistance from GC, Maha Metro will also be responsible for reviewing and approving any specific documents / plans that have to be provided by contractors (traffic management plan, site waste management plan, excavated soil and C&D waste / muck disposal plan, etc.). In view of the common principles of ESMP and common project implementation philosophy of MDB projects. Implementation of ESMP will be continuously monitored by the Safety, Health and Environment (SH&E) team of environment experts from GC and Maha Metro.

609. Maha metro's SH&E team will be headed by a Senior Manager assisted by qualified and trained mid-level safety professionals, environment engineers, traffic engineer, labour welfare officer. The Manager SH&E for the project in Maha Metro will report directly to Director (Works) and Managing Director, Maha Metro.

610. Terms of Reference for GC in implementation of the ESMP and EMoP is provided in **Annexure-9** of this ESIA-ESMP Report, which include following contribution:

(i) Specialists from fields of safety, environment, traffic engineering, occupational and community health, ecology, noise and vibration

(ii) Onsite junior field personnel.

(iii) The visits and review meetings will comprise:

  (a) Weekly site visits independently by Maha Metro and jointly with contractor;

  (b) Weekly review meetings by Maha Metro and contractor.

  (c) Periodic quarterly reports will be submitted on implementation of ESMP and its internal monitoring by Maha Metro to MDBs.

  (d) Orientation and training of Maha Metro team in implementation of ESMP and environmental monitoring will be undertaken at the beginning of the project.

(d) MDBs:

611. The monitoring of ESMP implementation will be conducted on a regular basis by the contractor and the GC, however, the monitoring reports will be disclosed semi-annually as per EIB's requirements once shared by Maha Metro. Implementation of the ESMP will be monitored half yearly by MDBs through their experts.

612. The General Consultant will document the project's compliance monitoring system in an environmental supervision procedures manual so that all parties have a clear understanding of their roles including regular monitoring tasks to be undertaken, checklists to be used and procedures to be followed. This will include roles and responsibilities of various parties, lines of communication, checklists to be used, and procedures to be followed including how and when noncompliance is communicated to the contractor and corrective actions initiated, tracked, and resolved. The manual will also describe regular recording and reporting requirements of these activities including information to be provided in contractor(s)' monthly

monitoring reports.

613. The General Consultant will have the right to suspend work or payments if the Contractor(s) are in violation of any of his obligations under the ESMP and Site-Specific ESMP.

(e) External Monitor:

614. An external agency will be engaged by Maha Metro, if required, in consultation with MDBs to evaluate the environmental performance of afore-mentioned parties. The agency will report to GC & Maha Metro who in turn will report it to the MDBs. Separate External Monitor will be engaged for entire Project. The terms of reference for engaging the External Monitoring Agencies are attached as **Annexure-5** and include:

(i) To conduct third party monitoring of environmental compliance under the project;
(ii) To ensure that the Project will be implemented in conformity with the policies of GoI, GoM, as well as the MDBs' policies;
(iii) To identify any safeguard related implementation issues and necessary corrective actions and reflect these in a time-bound corrective action plan for Maha Metro to implement;
(iv) Involving users and stakeholders in the monitoring process; and
(v) Strengthening the capacity of the Maha Metro to manage and replicate third-party monitoring with metro users and other stakeholders.

615. The reporting line of all relevant parties is: **Contractor → PIU → Maha Metro and GC → MDBs.** The environmental monitoring involves regular checking of the environmental management issues to ascertain the implementation of mitigation measures according to the progress of the project work. It provides the necessary feedback for the impact of the project on environment which ultimately leads to human health. The reporting procedure will be maintained as per prescribed below:

(i) The contractor will report to GC and GC will report to Maha Metro. Maha Metro may disseminate the information to all interested parties.
(ii) Non- compliance of the monitoring will be seen by the Maha Metro.
(iii) Photographic monitoring record will be maintained by the contractor. All material source points, disposal locations, plant locations, camp locations, etc. should be photographed.
(iv) A full record of construction activities will be kept as a part of normal contract monitoring system under the various stages of construction.

616. The external monitor will conduct independent monitoring and inspections to inform Maha Metro of any remediation actions to ensure the safeguard compliances. Monitoring and Reporting Frequency for implementation of the ESMP is shown in **Table 9-1**.

Table 9-1: Monitoring and Reporting for ESMP and EMoP

Particulars	Frequency of reporting	Reporting by / Reporting to	Review by / Monitoring by
Implementation of ESMP: • Start of the construction & during construction. (Monthly Environmental Monitoring Report)[54]	Monthly till completion of construction	Contractor to GC	Maha-Metro
Submission of ESMP & EMoP Progress report to MDBs	Half Yearly	GC to MDBs	Maha-Metro

[54] The monthly reports will include a summary of the status of environmental mitigation implementation including site inspection activities, issues identified, and associated corrective actions undertaken for resolution during the reporting month.

Submission of External E&S progress report by third party (If required)	• Semi-annually for the three years of construction phase • Yearly during first 2 years of Operation & Maintenance.	GC to MDBs	Maha-Metro

D. ESMP FOR PCMC TO NIGDI (PHASE 1 EXTENSION)

617. Environmental & Social Management Plan (ESMP) Matrix including mitigation measures proposed for PCMC to Nigdi (Phase-1 Extension) is presented in **Table 9-2**. The RAP is prepared to address the social issues in the project area or along the project corridor such as impact on private / common / business/ cultural properties and on the people residing or doing business/ work in the area. Project affected area includes the area in which property/assets would be affected or from where land would be acquired for the project. The RAP captures all social impacts resulted from the Project including involuntary resettlement impacts and the management plan will be prepared in the form of RAP. The ESMP and other safeguard requirements (including any conditions stipulated in the government clearances and permits) will be included in bidding documents and civil works contracts. The bidders will be required to submit, as part of their bids, the expected costs of implementing the ESMP to ensure that sufficient resources are allocated for ESMP implementation.

618. Following requirements of EIB E&S Standards (2022), Maha Metro Pune will apply pollution prevention and control technologies and practices consistent with international good practice as reflected in internationally recognized standards such as the World Bank Group's Environment, Health and Safety Guidelines. When Government regulations differ from these levels and measures, Maha Metro Pune will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, Maha Metro Pune will provide full and detailed justification for any proposed alternatives that are consistent with the requirements presented in EIB.

Table 9-2: Environmental and Social Management Plan (ESMP) Matrix

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
Planning and Design Phase							
1	Change in Land use	Land	Land use will be slightly changed	• PCMC developed the Comprehensive Mobility Plan (CMP) for PMRP in 2008 to identify the present and future mobility patterns of PCMC, • Proper clearances / permissions / consents will be sought from competent authorities before construction.	All clearances and approval copies	Maha Metro	Maha Metro (as SPA notified by GoM)
2	Contractor Management	EHS	• EHS accidents • Reputational Risk	• Integration of EHS contractor management into broader project management, procurement, human resources, legal, and financial management. • Prime contractor will be responsible for EHS practices of the subcontractor including HR policy which complies with applicable labour legislations, including decisions on material supplies and equipment given environmentally friendly priorities, and prepare subcontract agreements accordingly. • Contractor management incorporates “adaptive management” to monitor and adapt over time; integration with sustainable procurement approach or concepts. • Building culture and commitment by demonstrating the importance of EHS management to the president or director of project-implementing agency and president or director of subcontractor; including EHS aspects in routine senior management project contractor	EHS / Incident-Accident records	Contractor / GC	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				meetings and reports, reflecting both criticisms or suggestions and praise; designating responsibilities of EHS staff (for example, work stoppage); requiring strong and consistent training and participation of managers; acknowledging managers' participation in on-site supervision and resolution of issues; and providing awards, recognition, and incentives. • Training and Health & Safety plans • Contractor must prepare a CESMP that must be approved by the promoter before any construction starts.			
3	Contractor Preparatory Works (Upon issuance of Notice to Proceed)	EHS	Non-compliance with contract conditions and regulatory requirements.	• The Contractor shall complete the following activities no later than 30 days upon issuance of Notice to proceed, (a) appoint contractor's Safety, Health and Environmental Officer (SHEO); (b) SHEO will engage GC-Environment Specialist to discuss ESMP, seek clarification and recommend corresponding revisions if necessary; (c) SHEO will agree with GC the monthly monitoring template and deadlines for submission; (d) SHEO will submit for GC's approval all necessary sub-plans as listed in this ESIA. The plans will include a work plan to secure all permits and approvals needed to be secured during construction stage which will include but are not limited to: i) operation of crushers, ii) transport and storage of hazardous materials (e.g. fuel, lubricants, explosives), iii) waste disposal sites and disposal	EHS records and requisite permits and approvals	Contractor / GC	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				management plan, iv) temporary storage location, iv) water use, and v) emission compliance of all vehicles. Arrangements to link with government health programs on hygiene, sanitation, and prevention of communicable diseases including Covid-19 will also be included in the action plan; (e) SHEO will submit for GC's approval of the construction camp layout and management plan before its establishment;			
4	Labour Management	Labour	Labour rights	• Compliance with GoI's labour legislation, ratified with International Labour Organization (ILO) conventions • Prohibition of child labour, including prohibition of persons under 18 years old from working in hazardous conditions (which includes construction activities) and from working at medical examinations required to determine that persons above 18 years old are fit to work. • Elimination of discrimination with respect to employment and occupation, to be defined as any distinction, exclusion, or preference based on race, gender, religion, political opinion, trade union affiliation, national extraction, or social origin. • Human resource policy or plans that establish (a) the rights and responsibilities of project company employees and any contractor employee working in the project regarding remuneration, working conditions, benefits, disciplinary and	Labour records/Contractor Migratory labour records/contract agreements	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				termination procedures, occupational safety and health, promotion procedures, and training and (b) the rights, responsibilities, and requirements in contractor or subcontractor agreements related to worker rights. • Grievance Redress Mechanism (GRM) for workers should be established as early as possible to function no later than construction commencement. • There will be provision for group accidental and medical insurance for the workers. • Contractor will prepare a detailed Labour Management Plan including mitigation on labour camp management			
		Health and Safety	Accidents / illness	• Make mandatory the use of safety gears (helmets, safety belts, masks, gloves, Ear plugs/ muffs and boot) by workers depending on nature of work. • Necessary planning and safety approach will be made for rescue during emergency. • Use of dust controls (exhaust ventilation) for dust control • Workers will be provided with first aid and health facilities at the site. • There should have facility to deal with medical aspects of HIV/AIDS treatment with specialized services • Maha Metro Covid-19 protocols forming part of the SHE Requirements contained in the contract document shall be followed; labour shall be trained and informed of precautions such as social	EHS records and requisite permits and approvals	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				distancing, sanitizing, avoiding groups; arrangements for thermal scanners; provision of sanitisers, face masks, gloves etc.; site record of Covid-19 hospitals; daily disinfection of site, equipment and vehicles.			
5	Obtaining Clearance, Permission and Consents	Regulatory Compliance	Tree felling information, Consents to establish labour camps, pre-casting and material yards, depots, establish and operate hot mix plant, crushers, batching plant, DG sets, etc. C&D waste (muck) disposal	• Consultation and coordination with relevant authorities to prepare the documents to obtain clearance, permission and consents[55] ESIA for a list of required permissions and clearances). • Conditions set in permission and consents to be incorporated into the site-specific ESMPs, with dedicated officers to maintain the regulatory compliance tracker.	Government approvals and Tree felling records	Maha Metro / Contractor	Tree Authority (PCMC), Maharashtra Forest Dept. / MPCB
6	Site Clearance and Demolition	Tree felling	About 258 trees will be affected on viaduct and stations. Additionally, in some areas, pruning will be required. Other existing structures may need to be demolished	• Maha Metro and the Contractor need to conduct a final tree inventory survey (number, type, height) with the final designs of alignment and station. Trees with conservation value should be transplanted, if possible. Plan to avoid cutting trees, including adjustments in project design to minimize effect on such trees. • Revisit the works in public parks or green spaces and potential tree removal, especially involving patrimonial trees of special significance, so minimize the impacts as much as possible.	• Government approvals and Tree felling records • Government licenses and approvals • ACM handling and Management Plan • Stakeholder Analysis records of meetings • Waste Management Plan and Waste registers maintained at site	Maha Metro / Contractor	Tree Authority (PCMC), Maharashtra Forest Dept., GoM and PMRDA

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Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• If unavoidable, implementation of acceptable plans for transplanting (to the extent technically and economically viable) or replacing such trees and for their short-term maintenance and care. • Adequate coordination with applicable government regulatory authorities. As alignment passes through built-up land use, green belt development along elevated section is not feasible. Compensatory plantation of 10 saplings for every tree felled will be done in sites to be identified in consultation with PCMC and Maharashtra Forest Dept. Maha Metro to allocate sufficient tree replantation budget. • Prior to demolition of any building or structure contractor has to assess if Asbestos Containing Material (ACM) is potentially present in the building or structure to be demolished. The initial investigation on the potential presence of ACM has to be executed by a competent and duly qualified person. If the presence of ACM is likely or confirmed, contractor has to prepare an Asbestos Removal and Disposal Plan prior to the demolition works, to be approved by the PIU. • Stakeholder communication to avoid or minimize public concerns or protests. • Definition of adequate budget and contingencies as well as financial resources to cover all related costs. This will be finalized before work on relevant	• Worker training records		

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				section is commenced between Maha Metro and the Contractor. • Families impacted due to fully affected (displaced/demolished) structures and partially affected structures will be compensated in accordance with the approved Resettlement Plan. • To avoid negative impact on herbaceous vegetation, vehicle & Construction machinery movement should have restricted to designated roads. Similarly, it is suggested to avoid dumping of muck, excessive site clearance, levelling etc. in the river/nallah basin. • Proper management of waste material will be ensured. No excavated material should not be stored near river/nallah basin • Vegetation clearing by chemicals / herbicides will not be permitted • Workers should be briefed about do's and don'ts like "No hunting / poaching", "No burning of vegetation for firewood, or any other purpose", "No collection of eggs or any other forest resources", not causing any disturbances to any habitat, etc. • Sedimentation of storm water will be minimized by avoiding stockpiling of excavated material. Portable sanitation, treatment and disposal facility shall be provided at construction site.			

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
		Noise	Noise will be generated by the use of hand tools such as jackhammers, sledgehammers and picks etc.	• The procedure of demolition will be conducted as per the demolition plan prepared by the Contractor in consultation with Maha Metro. • The existing structures should be demolished one after another cautiously.	Noise Monitoring records	Contractor	GC / Maha Metro
		Physical Cultural Resources; sensitive buildings and structures	Historic and Cultural Value Loss	• Contractor to conduct pre-construction structural integrity inspections if there are known or a significant likelihood of archaeological and / or culturally valuable sites or finds in the project's direct area of influence. • Contractor will develop a photo-report that can be used as evidence for the condition of buildings inspected during this process. Any report should include photographs and consultation with those entrusted to protect the buildings' condition. • Prepare a monitoring scheme prior to construction based on the above inspections, with a focus on pre-identified receptors comprising educational, medical and physical cultural buildings located within recommended screening distance of 62m (for Category 2) on either side of alignment, or finds in the project's direct area of impact. • Compliance with applicable legislation (permits and procedures) and good international practice. • Adaptive management in site-specific ESMP during final design, including site	Site Inspection report by contractor	Contractor	GC / Maha Metro / PMRDA

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				locations (stations and construction staging areas). • Chance finds procedure to be prepared by Contractor and reviewed by GC/Maha Metro before submitting to all lenders.			
7	Severance of utilities	Social EHS	The proposed alignments will cross drains and utility services such as sewer, storm water drains, water and wastewater pipes, roadside lights, telephone cables, electricity power lines, electric poles, natural gas lines and traffic signals etc.	• Assets and utilities will be maintained without affecting and damages by shifting temporary/ permanently where it is necessary. • Based on utility maps and network information, Maha Metro and Contractor in collaboration with utility owners oversees an investigation of existing utility Maha Metro and Contractor to conduct on-site inspections and a topographic survey. Even when utilities are far enough below the surface, to avoid damage from construction, they may need to be diverted so that their maintenance will not affect the safe and efficient operations of the train system once construction is completed. Utility owners will be involved in providing any new utilities needed for the rail system and in designing the necessary diversions and protection measures to minimize the risk to existing utilities from ground movement and surface settlement. • For gas pipelines and HT electricity lines, Contractor will conduct the hazardous operation study to ensure the smooth and safe shifting. • Utility shifting plan will be developed by	• Daily site inspection reports/records • Hazard risk assessment study for utilities • Utility Shifting Plan	Maha Metro / Contractor	Maha Metro / PCMC MSEB, MNGL, Telecon companies, etc.

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				Maha Metro and Contractor in coordination with concerned authorities and shifting of utilities will be done as per agreed utility shifting plan prior to construction commenced. The plan will include required EHS management measures, supervision and monitoring of implementation, and final report and confirmation that construction works will be properly closed (for example, all waste will be removed or re-pavement will be completed as required). In case public utilities are required to be shifted to private land in exceptional circumstances, then adequate compensation shall be made by Maha Metro to the property owner on the same principles as temporary land acquisition as per the provisions of Resettlement Action Plan (RAP). Following completion of construction of metro, such utilities shall be rehabilitated on public land.			
8	Noise and Vibration Impacts Related Design	Environmental Nuisance and possible structural damages due to vibration.	Noise and vibration from construction and train operation	• The detailed noise and vibration analysis (mathematical modelling) at pre-identified receptors comprising educational, medical and physical cultural buildings and other fragile buildings located within recommended screening distance of 62m (RRT, Cat.2) for vibration and 100m (RRT, intervening buildings) for noise on either side of alignment based on final engineering designs should be carried out, based on which, a set of mitigations	Noise and Vibration Monitoring reports during the construction phase.	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				should be prepared and shared with all lenders for review, prior to commencement of construction. • Visual inspections of these buildings shall be done by the contractor so as to serve as baseline to monitor progression of building damage if any due to vibration. • Ballast less track structure is supported on two layers of rubber pads to reduce noise and vibrations, wherever required. In addition, baffle wall as parapets will be constructed up to the rail level so as reduce sound levels. Noise at source will be controlled or reduced by incorporating suitable feature in the design of structures and layout of machines and by use of resilient mounting and dampers etc. • Noise barriers made of suitable polycarbonate will be installed at identified sensitive receptor locations, where required.			
9	Coordinate with the Traffic Department on Traffic Management Plan	Land, Occupational safety, Community safety	Nuisance from traffic congestion	• The Contractor shall develop detailed and robust traffic management plans consistent with the Indian Guidelines on Traffic Management in work zones (IRC:SP:55-2014), prior to mobilization for respective sections with site- or station-specific plans and measures to minimize the overall impact on traffic throughout the construction and operation periods. • At congested sections, the temporary traffic coordinators will be engaged by	Traffic Management Plan Road Safety Awareness campaign records Incident/accident register at site	Contractor	GC / Maha Metro / Traffic Police Dept.

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				Maha Metro to facilitate the traffic management. • At the minimum, the traffic management plans will have the following components: construction traffic, ensuring access to properties, accommodating pedestrians, parking, access by construction vehicles, faulty traffic lights and problem interchanges, use of public roads, parking provision during construction, use of residential streets and traffic diversion due to temporary road closures, and construction and use of temporary access roads. • Strengthening impact and risk prevention measures, such as establishing construction site works to minimize the entrance and exit of vehicles at stations during peak traffic. • The logistics should be considered to manage transport materials from storage areas outside of the dense urban core to worksites and to return excavated soil and other materials to disposal locations. If needed, construction traffic may be confined to certain routes (based on infrastructure capacity) or restricted to certain off - peak hours (that is, to reduce noise pollution at night or to avoid commuting and school hours during the day). • Any diversions of traffic will cause considerable confusion for pedestrians and drivers as they rearrange their			

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				itineraries, hence, to minimize the effects of the diversion or reorganization, it is necessary to conduct communication campaigns and disseminate appropriate information to urban residents and taxi and bus drivers in advance of disruptions. Efforts will be given to divert traffic to roads wide enough to accommodate extra traffic. Compliance with scheduled deadlines for the detour is essential. If necessary, bus service and other public and private transport services in the area should be improved to meet residents' transportation needs. • Maha Metro and local authorities continue to play an oversight role in approving these plans during construction, evaluating their cumulative impact with other infrastructure projects in the region, and ensuring their dissemination to all relevant stakeholders.			
10	Construction method, construction material and sites selection	Environment	Pollution and nuisance	• Contractor is committed to use environmentally friendly construction methods and materials, including cement, asphalt, and other construction materials etc. • Construction material shall be sourced from legalized and approved quarries. • Energy saving technologies will be embedded into the Project design wherever possible. For instance, solar panels, rainwater harvesting, etc. • Update of plan based on final	Site inspection Site specific ESMP MPCB yearly compliance emonitoring reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				contractor-defined estimated volumes and timing for groundwater pumping with intension of minimizing the groundwater consumption. The primary objective shall be to avoid extraction of groundwater for construction. However, use of groundwater which has been generated by dewatering of excavations can be used in construction activities. In those instances, where extraction of groundwater becomes unavoidable, contractor shall, with consent of Maha Metro and the respective Water Authority, resort to such extraction. In such instances contractor-defined estimated volumes and timing for groundwater pumping with intention of minimizing the groundwater consumption. • Procedures for minimizing waste segregation, reuse, temporary storage, recycling, donation, and disposal. • Selection of waste disposal service providers (transport, recycling, and disposal) based on EHS criteria (including compliance with all regulatory requirements, no documented EHS issues related to materials at operation or site facilities, and agreement to provide access for site visits to discuss EHS management). • Final selection of disposal or reuse sites for extracted soils from construction and assessment and determination of truck routes from project sites to disposal or			

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				reuse site. • Focus will be placed on reuse of the extracted soil for enhancement of green space, waste recycle, and storm water runoff. • Construction yards with aggregate crushing and screening, pre-casting, material and fuel storage and ready-mix concrete plants will be located away from habituated or ecologically sensitive areas. Locations will be decided by Maha Metro and GC before construction commencement in consultation with PCMC. • Sites for disposal of excavated soil and C&D waste (muck) will be decided by Maha Metro before start of construction in consultation with MPCB, Pimpri Chinchwad Municipal Corporation to ensure a safe distance from residential areas, water bodies and ecologically sensitive locations as to avoid disrupting natural drainage. The muck shall be filled in the dumping site in layers and compacted mechanically. Suitable slopes will be maintained on the stockpile. Once the filling is complete, it will be protected by low walls, provided with a layer of good earth on the top and covered with vegetation. A muck disposal plan will be prepared by Contractor and approved by Maha Metro. Hazardous waste will be taken away by licensed vendors who will be responsible for due disposal at permitted			

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				sites.			
11	Climate Designs	Health and Safety	Natural disasters generated health and safety accidents Maintenance Cost	• Disaster management plan will pay special attention to road drainage during any natural disaster. • Other climate adaptation designs will be embedded in the final design, such as (a) Increase in capacity of storm water drainage will be made so as to deal with extreme flooding in addition to demand of future land use growth along this alignment. • Increased number of pits for RWH from elevated metro to cater to flood waters and heavy rains. • Climate change mitigation measures shall be implemented, such as solar panels on station buildings and roofs to reduce the extensive use of grid-generated electricity supplied to the station for operation and maintenance.	Disaster Management Plan Emergency Response and Communication Plan	Contractor	GC / Maha Metro
12	Documents Review and Information Disclosure	Environment	Unanticipated impacts management	• With the assistance of GC, Maha Metro will review the above said data collections, surveys and pre-construction plans prepared by Contractor. • Maha Metro will submit to all lenders to review the documents and disclose in a timely and meaningful manner prior to construction.	Site EHS register Physical inspection	Maha Metro	GoM
13	Establishment of Grievance Redress Mechanism	EHS	Complaints not resolved in time	• Separate Grievance Redress Mechanism for workers and project affected people should be established as early as possible to function no later	GRC committee formulation	Maha Metro	GoM

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				than ground work commencement. • The project affected GRM information and focal should be disseminated to public through the Maha Metro website or other media as approved by Maha Metro			
14	Community Liaison	Social	Complaints	• To ensure that the GRM functions effectively for affected people on construction nuisance at ground level with well documented grievance log. Contractor to develop a community communication plan as per the construction plan, including important measures to reduce community risk, such as fence and related protection around work sites (including strength and visual protection), education and awareness signs and information, and placement of safety risks (explosive and flammable materials, generators).	Community / External Communication Plan	Contractor	GC / Maha Metro
15	Land Acquisition and Resettlement	Social	Permanent Acquisition of 5579.13 Sqm. of land. Private land – 677.875 Government land-4848.343 Religious land-52.907 In addition to Permanent Land Acquisition – Temporary Land	• Land Acquisition is being carried out as per the provisions of GoM, GoI and EIB policies. The affected people will be compensated and assisted as per the provisions of Resettlement Action Plan (RAP). Land and structures to be acquired through Direct Purchase method by paying additional 25% of Market value as per Maharashtra State Govt. GR. In case of Direct Purchase Method fails, the land will be acquired under Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act (RFCTLARR), 2013. • The temporary land will be obtained	• Documents/ evidence of land sell deed and other records from the PAPs • Documents/ evidence of agreement other records from the PAPs	State Revenue Dept. Govt. of Maharashtra / Maha Metro	GoM

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			Acquisition- 493.73 (Private- 305.31 and Government- 188.42)	from private owners through administration of a lease agreement and appropriate compensation/rent will be paid on mutual agreement.			
16	Land Acquisition and Resettlement	Social	Physical displacement of residential structures (non-title holders)	• Compensation at replacement value with other relocation assistance • Option for alternate housing under EWS Scheme of PCMC. • Provision of all entitlements as per detailed entitlements in the RAP.	• Documents of • compensation received with supportive documents for alternative housing i.e. photographs and reports	Maha Metro	GoM
17	Land Acquisition and Resettlement	Social	Loss of Livelihood - Economic displacement and loss of economic structures and livelihoods	• Provision of all entitlements as per detailed entitlements in the RAP. Measures include the following as applicable for the different categories of PAPs (title holders / non-title holders; licensed / unlicensed): • Compensation for structure (valuation of structures without depreciation) • Relocation Assistance • Skill training for one of the members of the affected family • Support to access government income generating and development programs • Transportation Allowance • Subsistence Allowance • One-time allowance and assistance during shifting / relocation by Maha Metro.	• Verification of • structures, Report of the skill training and supportive documents i.e. photographs and reports for other compensation and assistance received • Supportive documents of completed transactions and assistance	Maha Metro	GoM
18		Social	Impact on vulnerable PAPs	• Assistance to all the vulnerable households	• Supportive documents of completed assistance	Maha Metro	GoM

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
19		Social	Displacement or loss of access to CPRs	• Reconstruction or relocation in consultation with the community • Civic infrastructure and community services with basic amenities would be provided in consultation with the affected community and the local administration • Compensation for structure if opted by the owner/ community	• Supportive documents of completed relocation of reconstructed structures	Maha Metro	GoM
20	Vulnerable sections especially Elderly and Persons with all kinds of Disability	Social	-Impacts on Vulnerable sections of society	• It shall be ensured that Train contains fully accessible carriages. • Stations for all levels should be fully accessible with wide entrances and shall be accessible by wheelchair • For persons with hearing impairments, an electronic sign board shall be displayed on each platform at noticeable locations for persons with visual impairments audio system announcing the station names and door location shall be available • The gap between the car doors and the platform shall be less than 12 mm Identification signage shall be provided on coach • Space for a wheel chair should be available at the side of the door. The space shall be indicated inside and outside the car by using the international symbol of access; Wheel stoppers and ring-strap or other appropriate safety grip shall be provided for wheelchair users • An appropriate number of designated seats for passengers with disabilities and elderly people shall be provided near the doors. • Approach route shall not have level differences. If the station is not on the same	•	Contractor	GC/ Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				level as the walkway or pathway, it shall have ramp. Walkway surfaces shall be non-slippery. • Approach walkway should have tactile pavements for persons with visual impairments. At least one of the counters shall have an induction loop unit to aid people with hearing impairments. • The counters shall have pictographic maps indicating all the services offered at the counter and at least one of the counter staff should be sign language literate. • There shall be at least one unisex accessible toilet • At least one of the ticket gates shall be for disable person (low level counter) to allow a wheelchair user through and have a continuous line of guiding paver for people with visual impairments • The Platforms shall have seating areas for people with ambulatory disabilities • All platforms shall inter- connect by means of an accessible routes or lifts and way finding references shall be available at decision points. • Colour shall be used to identify routes and aid in locating doors, walls and hazards. Structural elements such as columns shall be colour contrasted or brightly marked to assist visually impaired.			
Construction Phase							
21	Construction Monitoring	EHS	Breach of legislation, ESIA, ESMP, Contracts Accidents	• Contractor to collect and monitor the Ambient environmental data of air, water (surface and ground), noise& vibration, soil quality and submit monitoring reports to GC / Maha Metro on monthly	Environment Monitoring reports/records for all parameters	Contractor / GC	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				basis. • GC / Maha Metro to review the data compared to baseline data and urge Contractor to take immediate actions over any project generated pollution / contamination. • GC to submit monitoring reports on quarterly basis to Maha Metro. • If any unanticipated EHS impacts arise during construction, implementation or operation of the Project that were not considered in the ESIA / ESMP, Contractor and GC to promptly inform Maha Metro of the occurrence of such risks or impacts, with detailed description of the event and proposed corrective action plan. Maha Metro will report to all lenders accordingly. • Maha Metro to engage qualified and experienced third-party monitor, if required, to verify information produced through the Project monitoring process, and facilitate the carrying out of any verification activities by such third-party monitor. • Maha Metro to submit the semi-annual monitoring reports (GC's and third party's) using the agreed the template to all lenders. • Maha Metro to report all lenders any actual or potential breach of compliance with the measures and requirements set forth in the ESMP promptly after becoming aware of the breach.	MPCB compliance reports		

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
22	Community Liaison	Social	Complaints	• GRM for affected people should function effectively with well documented grievance log. • Contractor will provide a minimum of two (2) weeks notification to directly affected residents, businesses and other relevant groups of the intended construction commencement date. In providing a mechanism for communication between the contractor and the community and informing the public of construction details (timing, expected impacts), Maha Metro will undertake consultations. • Adaptive management that monitors, adjusts, or adds measures to reflect actual community risks. • Important measures to reduce community risk, such as fence and related protection around work sites (including strength and visual protection), education and awareness signs and information, and placement of safety risks (explosive and flammable materials, generators)	GRM records/Register Action Plans	Contractor	GC / Maha Metro
23	Construction Vehicle Management	Environment Social	Community disruption Accidents Reputational risk	• Contractor's transport vehicles and other equipment shall conform to emission standards. • Control, inspection, and documentation of trucks prior to leaving site, including removal of soil on tires. Contractor will provide a wash pit or a wheel washing and/or vehicle wheel facility at the exits from construction depots and batching plants. At such facility, high-pressure	Accident/Incident register Site EHS records Physical Verification Worker Training records	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				water jets will be directed at the wheels of vehicles to remove all spoil and dirt. Used water shall be collected and re-used after settling in a settling basin or tank. • Definition of allowable routes, speeds, and times (day or week). • Driver requirements and controls, including pre-work medical (and blood tests) and physical inspections, ongoing monitoring (of visual and alcohol or drug use), driver training, daily total allowable work time, and allowable deviations. • Driver contracts with clearly specified requirements and remedies for noncompliance. • Procedure for truck maintenance, including selection of service providers considering environmental aspects, application of low-Sulphur fuel, no idling of trucks, routine maintenance (including assurance of proper engine operations related to emissions and noise), and disposal of used oil and other fluids, batteries, and tires etc. • Equipment/vehicle repair/maintenance and re-fuelling areas will be confined to areas in construction sites designed to contain spilled lubricants and fuels. Such areas will be equipped with a concrete perimeter and drainage system leading to an oil/grease-water separator that will be regularly skimmed of oil to prevent spilled oil/grease being discharged to the ground surface			

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
24	Levelling of Site	Land	Surface levelling will alter the soil texture and compactness, which will affect the infiltration and soil ecology. Also, levelling will involve alteration of natural drainage	• Interim drainage system will be installed prior to construction. • Where feasible, infiltration losses will be countered by installing Rainwater Harvesting pits away from construction site	Field Verification/Site Inspection	Contractor	GC / Maha Metro
25	Auger piling	Noise	During piling operations, noise will be generated which may go up to 70-75 dB (A) at a distance of 5m	• At all piling locations, auger piling will be carried out in place of mechanical (by driven) piling which will generate less noise than mechanical piling (around 70-75 dB(A)). Also, 2m high barricade of GI sheet will be installed on all sides of piling operations. This could effectively cut down noise levels by 10-15 dB (A). Piling operations will be restricted during day time hours only. • Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. • Use of low-noise equipment and ensuring good maintenance, and trying to avoid using high-noise equipment simultaneously at the same section. • Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, safety measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan.	Noise Quality Monitoring reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities. • Monitoring required during construction, including field observations and measurements.			
		Vibration	Piling for viaduct piers and buildings may generate vibrations	• Cast-in-situ piling will be deployed at locations with sensitive receptors so as to reduce vibration. • At pre-identified receptors comprising educational, medical and physical cultural buildings and other fragile buildings located within recommended screening distance of 62m (for cat. 2) on either side of each alignment, the contractor shall implement the pre-construction structural integrity inspections, if required. • Contractor to ensure that vibration levels will not exceed 5.0 mm/s • Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. • Monitoring during construction including field observations and measurements.	Building condition Survey Vibration Monitoring reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
		Surface water	Degradation of water quality due to pier foundation construction in water courses	• It is prohibited to dispose excavated spoils and wastes into river/streams water; • All chemicals, fuel and oil shall be stored at least 500 m away from water and shall be stored at concreted platform with catchment pits for spills collection; • Contractor will make sure that spill kits are on site at any time in case of an accident or incident; • The contractor shall arrange awareness programme to all equipment operators, drivers, on immediate response for spill contamination and eventual clean-up. Further, emergency procedures and reports preferably written in easy-to-understand local dialects shall be distributed to the workers as well as local people; • If required, silt fencing and/or brush barrier shall be installed for collecting sediments before letting them into the water body. Silt/sediment shall be collected and stockpiled for possible reuse as surfacing of slopes for re-vegetation; • All wastes arising from the construction sites shall be collected and disposed in a designated location. The wastes shall be collected, stored and transported at approved disposal sites; • No vehicles or equipment shall be washed, parked or refuelled within 100 m distance to the nearest surface water, to avoid contamination of streams water	Spill control and prevention plan Surface water quality monitoring reports Water Quality management Plan	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				from fuel and lubricants; • Vehicle parking and maintenance areas will have waterproof floors from which drainage is collected and treated to legal standards; • No untreated sanitary wastewater from camps shall be discharged into the streams water; • Bridge and cross drainage work at river/streams will not be undertaken during the peak monsoon season. All supporting structures, construction materials, waste materials and debris will be removed from the riverbed prior to the peak monsoon season; • The contractor will take appropriate measures to avoid and contain any spillage and pollution of the water;		
		Physical Cultural Resources	Historic and Cultural Value Loss Conflicts with community	• On-site training shall be provided to site workers if any historical or cultural artefact is noticed during pilling. • The work shall be immediately stopped and information will be delivered to the higher authority. • All workers will undergo a briefing with the Archaeology Department to ensure safeguarding of heritage resource and / or cultural / religious practices. • A proof of compliance to this requirement to include the name of participants and date and location of briefing will form part of the monthly report to Maha Metro. • The project will implement, where required, chance finds procedure	Physical Verification EHS records	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				contained in ESS8 of WBG ESF. It includes requirement to notify relevant authorities; to fence-off the area of finds or sites to avoid further disturbance; to assess found objects or sites by cultural heritage experts; to identify and implement actions consistent with the requirements of this ESS and national law; and to train project personnel and project workers on chance find procedures.			
		Health & Safety	Noise and vibration generated during piling will affect the health and safety of the workers	• Auger piling methods will be used to reduce the impacts of noise. 2m tall screens of GI sheets will be installed between source (pile driver) and receptors (workers & nearby populations). • To reduce the harmful effects, personnel working at high noise levels would be provided with noise protective gears such as ear mufflers, sound barriers, job rotations per occupational exposure limits etc. • Procedure to receive, evaluate, and compensate (if applicable) damages due to construction and establishment of financial resources to cover this expense.	EHS records Noise Monitoring reports	Contractor	GC / Maha Metro
26	Excavation	Air	Excavation will result into fugitive dust generation	• Fugitive dust could be controlled using water sprinkling. Water sprinkling to be carried out by Contract at regular interval (to be mutually decided by the contractor and Maha Metro). Surface runoff, wastewater from construction sites, construction yards and treated	Air quality Monitoring reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				water will be used. • Imposition of speed controls for vehicles on unpaved site roads. 10-30 kmph is the recommended limit. • Every vehicle should be washed to remove any dusty materials from its body and wheels before leaving the construction sites. Used water shall be collected and re-used after settling in a settling basin or tank. Water for sprinkling and tire washing will be sourced from treated effluent from ETPs located nearby, seawater or surface runoff; use of municipal treated water shall be minimized. • Excavation machinery will be topped up by low-Sulphur fuel.			
		Noise and Vibration	Nuisance	• Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. • Use of low-noise equipment and ensuring good maintenance, and trying to avoid using high-noise equipment simultaneously at the same section. • Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. • Enclose especially noisy activities if	Noise and Vibration Monitoring reports Site inspection	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities. • Monitoring required during construction, including field observations and measurements. • Construction activities shall be scheduled such that demolition, earthmoving and ground-impacting operations do not occur in the same time period. At locations, where the alignment is close to sensitive structures, the contractor shall prepare a monitoring scheme prior to construction at such locations. In case of sensitive structures, vibration mitigation measures will be implemented. • Vibratory rollers near sensitive receptors shall be avoided. • The contractor should prepare a mitigation plan and implement the same during the final design and construction phase of the project. This scheme shall include: a. Monitoring requirements for vibrations at sensitive receptors during the construction period; Pre-construction structural integrity inspections of sensitive structures, if required. b. Information dissemination about the construction method, probable effects, quality control measures			

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				and precautions to be used. c. vibration monitoring plan during final design and the implementation of a compliance monitoring program during construction • Contractor to ensure that vibration levels at receptors comprising educational, medical and physical cultural buildings and other fragile buildings located within recommended screening distance of 62m (for cat. 2) on either side of each alignment will not exceed 5.0 mm/s.			
		Surface water	Dumping of construction waste like concrete, bricks, waste material etc. cause surface water pollution.	• Proper drainage systems using contour information will be constructed around active and & large construction sites. After settling, it shall be discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. • To avoid water pollution and soil erosion due to flooding, earthwork will be limited during monsoon season.	MPCB compliance monitoring and correspondences.	Contractor	GC / Maha Metro
		Groundwater	Dewatering (if done) will adversely affect the groundwater regime	• Proper drainage systems using contour information will be constructed around active and & large construction sites. After settling, it shall be discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. • To avoid water pollution and soil erosion due to flooding, earthwork will be limited	Ground water quality Monitoring reports Site inspection	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				during monsoon season.			
		Soil	Excavation will adversely affect the soil	• Soil erosion by runoff will be controlled by installing proper drainage systems using contour information It is suggested to avoid bringing soil from outside the project boundary and to use the excavated mounds for filling low lying area where it is necessary. • The topsoil should be preserved (by storing it at appropriate places) so that same can be restored after completion of work.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Physical Cultural Resources	Historic and cultural value loss Conflicts with community	• If any artefacts of archaeological importance are noticed, work should be stopped and information to be given to the higher authorities. • All workers will undergo a briefing with the Archaeology Department to ensure safeguarding of heritage resource and cultural/religious practices. • A proof of compliance to this requirement to include the name of participants and date and location of briefing will form part of the monthly report to Maha Metro. • The project will implement, where required, chance finds procedure contained in ESS8 of WBG ESF. It includes requirement to notify relevant authorities; to fence-off the area of finds or sites to avoid further disturbance; to assess found objects or sites by cultural heritage experts; to identify and implement actions consistent with the	Site inspection EHS audit reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				requirements of this ESS and national law; and to train project personnel and project workers on chance find procedures			
		Health and Safety	Accidents	• To specify the number and length of shifts for each worker. • Where a site boundary adjoins roads, streets or other areas accessible to the public, hoarding should be provided along the entire length except for a site entrance or exit. • If there is a reasonable likelihood of contamination, then a specific management plan that includes (a) monitoring during construction consisting of visual inspections, on-site and in-situ monitoring to detect and confirm levels of contamination (and supplemented as needed by laboratory analysis), (b) on-site temporary storage and treatment, (c) final disposal (both for water and soil), and (d) worker health and safety procedures.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Aesthetics	Temporary loss of aesthetics value due to excavation and related activities.	• The excavation sites will be barricaded on all sides using GI sheets. Hauling will be carried out in non-peak hours. • Aesthetic value of the site will be restored after completion of the works.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
27	Hauling of excavated material	Air	During transportation of excavated material, fugitive dust will be generated from two sources, (1) from re-suspension of dust	• The traffic management plan will be stringently implemented with regular monitoring and inspections. • Trucks / dumpers carrying the excavated material will be covered using tarpaulin/similar covering materials. • Sprinkling of water should be carried	Traffic Management Plan Site inspection EHS audit reports	Contractor	GC / Maha Metro / Traffic Police Dept.

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			from road surface, (2) from the movement of air, against the excavated material being hauled	out. • Truck tyres will be washed to excess remove soil clinging to it. Contractor will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. Used water shall be collected and re-used after settling in a settling basin or tank. • Water for sprinkling and tire washing will be sourced from treated effluent from ETPs located nearby, seawater or surface runoff; use of municipal treated water shall be minimized. Groundwater will not be used in construction or operation of the project. • Haul roads will be kept in good state of maintenance.			
		Noise	Dumper trucks carrying excavated material will result into high noise (typically in excess of 85 dB (A) at one m distance, or 57 dB (A) at 10 m distance). The adverse impacts of noise will be most intense in the residential / urban areas.	• The routing, timing and logistics of the haul truck movement should be planned to have minimal impacts on noise level. • The route selection will avoid any sensitive receptors. • Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. • Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control	Site inspection EHS audit reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. • Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities. • Monitoring required during construction, including field observations and measurements.			
		Social	Incessant movement of trucks could create social issues.	• The local community has to be taken into confidence before the construction commences. Their advice must be taken and incorporated in decision making. • GRM for affected people should function effectively with grievance log well documented.	GRM records	Contractor	GC / Maha Metro
		Health & Safety	The movement of trucks will increase the traffic risk of the commuters.	• The routing, timing and logistics of the haul truck movement should be planned to have minimal impact on occupational and community health and safety.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
28	Dumping of excavated materials	Air	The dumping operation of excavated material will generate fugitive dust in the nearby areas	• Site of dumping will be selected in consultation with authorities. • The disposal plan will be stringently implemented with site monitoring and inspections. • It will be located outside of urban habitation. • Sprinkling of water should be carried out. Water shall be sourced from surface runoff, wastewater from construction sites, and construction yards. Use of	Site inspection EHS audit reports	Contractor	Maha Metro / PMRDA /

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				municipal treated water shall be minimized.			
		Soil	Dumping may increase the height of the land and affect the natural drainage pattern of the area	• The dumping will be done in pre-designated low-lying areas identified by PCMC, MPCB, and Maha Metro for this specific purpose. • The disposal plan will be stringently implemented with regular monitoring and inspections. • Field inspections, monitoring, and documentation of dumping excavated materials.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
29	Traffic diversion	Air	The under-construction areas will be restricted for human and vehicular movements. This will result in detouring of vehicles and/or pedestrians, on the project line which passes through busy urban areas. This may also result into traffic congestion and air pollution from stagnated vehicles in urban areas. Primary pollutants will be NOx, CO, NMHC, and VOCs.	• Permission from PCMC Traffic Police will be sought before commencement of work. Detours will be properly planned and enacted during non-peak hours only, if possible. Traffic marshals will be posted near such detours. Proper signage has to be posted informing motorists about detours following IRC norms. • Adaptive management with field inspections and monitoring during plan implementation and adjustments, as needed, to reflect actual traffic congestion or related issues • The Contractor will discuss and coordinate the implementation of the traffic re-routing scheme particularly at station area when it starts the cut and cover activities and the hauling and disposal of excavated materials to the project sites.	Applicable permit/License copies Site inspection EHS audit reports	Contractor	GC / Maha Metro / Traffic Police Dept.

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
		Noise	Barricading & detouring may result into traffic congestion in the urban areas. This will result into (a) noise from vehicular movement and (b) honking noise due to congestion.	• Permission from PCMC Traffic police will be sought before commencement of work. Detours will be properly planned and enacted during non-peak hours only, if possible. Traffic marshals could be posted near busy intersections, to oversee the smooth flow of traffic. • Detour route selection to avoid sensitive receptors to noise. • Adaptive management with field inspections and monitoring during plan implementation and adjustments, as needed, to reflect actual traffic congestion or related issues.	Applicable permit/license copies Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Social	Traffic diversion (esp. for public transport) will create inconvenience	• Implement the traffic management plan consistent with the Indian Guidelines on Traffic Management in work zones (IRC: SP:55-2014). Plans will be made to spare traffic diversion during peak hours (morning and evening peaks). Also, separate arrangements for bus, auto and taxi parking bays will be made. Street furniture for pedestrians will be provided wherever possible. • Real-time communication to public prior to site-specific work (for example, via signs, radio, and newspaper) and during key periods of traffic interference or peak traffic. • Adaptive management with field inspections and monitoring during plan implementation and adjustments, as needed, to reflect actual traffic congestion or related issues.	Traffic Management Plan Applicable permit/license copies Site inspection EHS audit reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
		Resource consumption	Detouring will increase the road length to be travelled by a car, thus, increasing the overall fuel consumption.	• The detour will be planned to be optimum in terms of road length. The faster completion of works will also tend to reduce enhanced fuel consumption.		Contractor	GC / Maha Metro
30	Restricted pedestrian movement	Social	Restricted pedestrian movement will cause social uproar, esp. in people living near metro stations	• Safe passage for pedestrians with proper sunshade / fall protection and signage will be planned. Public consensus will be built. Representatives of non-governmental organisations and volunteers from local communities at respective sections of the project shall be invited to participate in meetings with Maha Metro, GC, and Traffic Police where joint decision on diversion measures will be arrived at. • GRM for affected people should function effectively with grievance log well documented.	Applicable permit/license copies Site inspection EHS audit reports GRm register	Contractor	GC / Maha Metro
		Health & Safety	Movement though constricted space may cause potential health & safety issues amongst pedestrians	• Movement through construction area shall be prohibited. • Safe passage for pedestrians with proper fall protection and signage will be planned. This applies to movement along existing roads on which elevated metro is constructed. It is clarified that their movement through construction areas shall be prohibited.		Contractor	GC / Maha Metro
31	C&D waste (muck) generation & disposal (incl. spent drill fluid and polymer	Surface water	Muck generated including spent polymer slurry from auger drilling operations will drain with surface runoff	• Muck disposal plan will be stringently implemented with regular monitoring and inspections. • The construction sites will be provided with garland drains with intercepting pits	Muck Disposal Plan Applicable permit/license copies Site inspection	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
	slurry)		and pollute nearby water bodies	to trap silt & muck. • Muck will be stored in lined tanks / ponds. Such tank/ ponds could be covered during monsoon to control runoff. • The temporary muck storage areas will be maintained by the Contractor at all times until the excavate is re-utilized for backfilling or disposed of as directed by Employer. Dust control activities will continue even during any work stoppage • Transportation of muck will be scheduled by time and route to minimize air pollution in habitat areas.	EHS audit reports		
		Groundwater	Muck, spent polymer slurry & drill fluids may settle down from pond / tanks and will affect groundwater	• The tanks / ponds holding muck will be lined to prevent infiltration into groundwater. It will be passed through settling chambers and discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. Upon discharge of general wastewater into municipal sewers by Maha Metro, the municipal agencies are required by law to treat it appropriately before disposal. Maha Metro shall duly consult with the agencies before start of construction. • Groundwater quality monitoring before, during and after the use of muck tanks/ponds.	Muck Disposal Plan Applicable permit/license copies Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Aesthetics	Muck generation will create an aesthetic issue	• The construction site will be covered from all sides to reduce visual impacts.	Muck Disposal Plan Applicable	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
					permit/license copies Site inspection EHS audit reports		
32	Steel structure preparation	Soil	Steel structure preparation will create steel scraps	• Steel scrap will be collected, sorted by diameter and sold to scrap dealers at regular intervals.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Health & safety	Bar bending & other activities (Inc. working at heights) might pose a H&S threat to workers	• Workers will be provided appropriate hand gloves and other personal protective equipment (PPE) such as fall protection when working at height. • Skilled workers working at height or doing hot work will be required to seek permission from site	Toolbox talk kit Worker Training records	Contractor	GC / Maha Metro
33	Stacking & warehousing of raw material	Surface water	Washed out raw material could pose serious threat to surface water bodies	• Small dykes and garlanding drains along the periphery of the yard and ploy boundary could be constructed. This will control runoff and washing out of finer material.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Soil	Spillage of materials / mix products on the ground could pollute soil	• Proper care will be taken. Such spills will be cleared by scraping and disposing the products as road sub-grade material.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Health & Safety	Fine products like cement/ silt/ sand could cause harm to respiratory system.	• Cement and sand will be stacked under tarpaulin and secured by GI sheet barricading (working & wind break). Shorter work shift and daily medical check-ups of workers will be implemented. • Dust filters atop cement silos, wet suppression for aggregate crushing and screening will be employed	Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Aesthetics	Stacking of raw material will cause	• The height of walls between the residential area and RM yard /	Site inspection	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			aesthetic issues for residential areas located nearby	construction area will be raised using GI sheets.	EHS audit reports		
34	RCC pouring (using concrete pump)	Noise	RCC pouring using concrete pump will generate low frequency rumbling noise. This will be more perceived and irritating in residential areas.	• Timing of using RCC pumps will be planned and specified by the Engineer. • RCC pumps will be covered from all sides. • Bends and excessive head will be avoided. •	Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Soil	Spillage from concrete pouring may contaminate soil	• The spoils from pouring concrete will be collected and reused as sub-grade material in road constriction.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Aesthetics	Spoils from concrete pouring will create unpleasant looking visuals	• After each pouring cycle, the spoils will be manually collected and reused as sub-grade material in road constriction.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
35	Setting of concrete (using needle vibrator)	Noise	Needle vibrators generate low frequency noise when dipped in concrete and high frequency noise when raised. Sound level varies between 82-93 dB (A).	• If the consistency of concrete could be altered, the need for use of vibrator (esp. in low temperature & low thickness casting) could be reduced. Damping could be used to reduce high frequency noise, and thereby reducing the noise levels. Workers should be provided with suitable PPEs. •	Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Soil	During setting, spillage from cast could take place.	• The spoils from pouring concrete will be collected and reused as sub-grade material in road construction.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
36	Curing of concrete (use of water)	Surface water	Curing water will drain to the low-lying areas and	• Garland drainage is proposed to be constructed around the construction yard. This will intercept the runoff	Site inspection EHS audit reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			pollute water courses	generated from site. • After settling it shall be discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. • Curing needs will be met from municipal supply, water resulting from dewatering during piling and surface runoff water. • Rainwater harvesting (as a compensatory measure) will be practiced.			
		Groundwater	Curing water will drain to the low-lying areas and pollute water courses	• Excess curing water shall be channelled properly in to the nearest public drain.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Aesthetics	Curing will create water impounding and may lead to vector propagation	• Garlanding drain will be constructed around the construction area. The curing water impounded will be reused for curing.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
37	Use of Crane & Launchers	Noise	Operation of launchers and crane will generate noise which in times may go up to 85-90 dB (A). Legris & Poulin has found that the average daily noise exposure was approx. 84 to 99 dB (A) for heavy equipment, and 74 to 97 dB (A) for the	• The sensitive receptors (workers & external parties, if applicable) have to be isolated from heavy construction noise generated. This is possible by erecting reinforced 2 m tall GI sheet barrier around the area where heavy construction works is undertaken. • Workers working inside or near construction equipment should be provided with proper PPEs like ear plugs / muffs complying with IS 4869. • Information dissemination to local residents and shop owners about the	Applicable permit/License copies Site inspection EHS audit reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			crane operators.	nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. • Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities.			
		Health & Safety	Cranes and launchers are a major safety concern.	• As per Maha Metro's SHE Manual, operation of launchers and cranes should be only done under the strict supervision of a qualified engineer and a safety supervisor. Only qualified & trained crane/ launcher operators should be allowed. Proper examination of crane, launchers, labours & operators must take place before commencement of work.	On site SHE manual Applicable permit/license copies Site inspection EHS audit reports	Contractor	GC / Maha Metro
38	Construction of labour camp(s) and associated environmental issues	Surface water	Sewage from labour camps may be discharged into open slopes thus contaminating surface water	• Labour camps will be constructed in semi urban set-up or outskirts of the city. At the campsites wastewater treatment facilities will be constructed (e.g., septic tank and soak pit and site drainage) to avoid spillage of wastewater into surface water or groundwater. Alternatively, a connection to the public sewer system may be realised. Sewage discharged into public sewers will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule	Applicable permit/License copies Site inspection EHS audit reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				VI standards of discharge of general effluents into surface water. • Alternately, the contractor shall install small STP/Bio-digester for treatment of sewage from workers' camps. This treated water shall be used for gardening & sprinkling on roads.			
		Groundwater	Surface water on flat terrain could percolate and contaminate groundwater.	• Contractor to collect the groundwater baseline data prior to construction. • Disposal in compliance with applicable regulatory requirements. • Groundwater quality monitoring. • Water abstracted must be measured / recorded periodically. • After Construction, Contractor will conduct groundwater analysis and be obliged to reinstate the used sites no worse than the conditions of pre-construction.	Applicable permit/License copies Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Soil	Solid waste generated from the labour camps will cause soil pollution	• Contractor to collect the soil baseline data prior to construction. • Municipal solid waste will be collected and taken away and disposed by municipality. • Solid waste will have to be disposed in compliance with Municipal Solid Waste (Management & Handling) Rules, 2000, as amended to date. • After Construction, Contractor will conduct soil analysis and be obliged to reinstate the used sites no worse than the conditions of pre-construction.	Waste Management plan Applicable permit/license copies Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Social	Influx of non-local labours will create a social issue	• Mixing of skilled non-local labours with local unskilled people will reduce social frictions.	Applicable permit/License copies	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• To avoid labor influx risk, sensitizing of local community and the non-local workers separately as well as jointly will be done regularly.	Site inspection EHS audit reports		
		Health & safety	Living in congested condition, make-shift temporary arrangement; the labours are prone to diseases.	• Regular counselling, medical check-ups and treatment at separate clinics, coordination with local health authorities will be conducted. • As per the Building & Other Construction Workers (BOCW) (Regulation of Employment and Conditions of Service) Act, 1996 the employer (contractor) is liable to arrange for sanitation, health care facilities of labourers, free of charge. Labour camps will be in full compliance of BOCW Act. • Covid-19 protocols for construction forming part of the Environmental Social Health and Safety Requirements shall be fine-tuned to be adopted for labour camps; camp residents shall be trained and informed of precautions such as social distancing, sanitizing, avoiding groups; arrangements for thermal scanners; provision of sanitisers, face masks, gloves; record of Covid-19 hospitals; protected ambulances at camp; daily disinfection of site, equipment and camp.	Applicable permit/License copies Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Resources	Labours will consume resources like wood for cooking	• Liquid Petroleum Gas (LPG) cylinders will be made available free of cost to the labourers by the Contractor. • Labour camps are provided with canteen systems. They shall be provided with treated water suitable for	Applicable permit/license copies Site inspection EHS audit reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				drinking, bathing and other needs.			
39	Loading / unloading of construction material	Air	Loading & unloading of construction material will generate fugitive dust	• The traffic management plan will be stringently implemented with regular monitoring and inspections. • The trucks/dumpers carrying the material will be covered using tarpaulin/similar covering materials. • Fugitive dust could be controlled using water sprinkling. Contractors should carry out water sprinkling. • Truck tyres will be washed to excess remove soil clinging to it. Contractor will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. Used water shall be collected and re-used after settling in a settling basin or tank. • Water for sprinkling and tyre washing will be sourced from treated effluent from ETPs located nearby, or surface runoff.	Air Quality Monitoring reports Site inspection records EHS register	Contractor	GC / Maha Metro
		Noise	Loading & unloading of construction material will generate noise	• The RM storage yard will be separately built and enclosed from all sides. This will reduce noise generation at site. • Concrete preparation will only take place in casting yards (away from habitation). • Information dissemination to local residents and shop owners about the	Noise Monitoring reports Community Awareness campaign records	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. • Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities.			
		Health & safety	Fugitive dust and noise generation will have potential health & Safety implications.	• Cement and sand will be stacked under tarpaulin and secured by GI sheet barricading (working & wind break). Shorter work shifts and regular health check-ups will be implemented. The RM storage yard will be separately built and enclosed from all sides. The worker will be provided with suitable PPEs. Also, they will be trained and encouraged in using PPEs.	Air quality Monitoring reports	Contractor	GC / Maha Metro
40	Use of batching plant	Air	Loading & unloading of construction material into batching plant will generate fugitive dust	• High GI sheet screens and water sprinkling will be employed. • Batching plant / casting yard shall be barricaded and made as a compulsory PPE zone. This will effectively reduce the fugitive dust generation.	Air Quality monitoring reports	Contractor	GC / Maha Metro
		Noise	Operation of batching plant will generate noise	• GI sheet barricading around batching area and worker PPE like ear muffs will be used. • Batching plant / casting yard shall be barricaded and made as a compulsory	Noise Monitoring report Physical verification of Worker PPE	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				PPE zone. This will reduce the impacts of noise generation.			
		Soil and Groundwater	Runoff of waste can contaminate soil and groundwater	• Contractor to collect baseline soil and groundwater quality data prior to operate the plants. • Municipal water will be used. In view of fragile groundwater status, extraction will be avoided. • The construction sites will be provided with drains with intercepting pits in which the cement and sand will settle. After settling it shall be discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. • Soil and Groundwater quality monitoring. • After Construction, Contractor will conduct soil and groundwater analysis and be obliged to reinstate the used sites no worse than the conditions of pre-construction.	Ground Water quality Monitoring reports	Contractor	GC / Maha Metro
		Hazardous waste	Health impacts and soil and groundwater pollution from hazardous water at batching/casting yards	• The use and storage of hazardous materials at the casting yard and batching plant should adhere to SPCB requirements. • The transport, handling and storage of hazardous waste will be done in accordance with the provisions of Hazardous and Other Wastes (Management and Transboundary Movement) Amendment Rules 2019. Hazardous wastes from construction	License (Consent to Establish / Consent to Operate) from MPCB Hazardous Waste Management Plan Waste management register	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				activity and equipment are labelled, recorded, stored in impermeable containment and for periods not exceeding mandated periods and, in a manner, suitable for handling storage and transport. • The contractor shall maintain a record of sale, transfer, storage of hazardous waste and make these records available for inspection. • The contractor shall get Authorized Recyclers to transport and dispose Hazardous Waste. • Proper collection and storage facilities will be provided especially for hazardous waste.			
		Resources	If the batching plant will get its power from DG sets, substantial diesel will be consumed. (A 30 m^3/hr. batching plant will require approx. 60 KW/hr. (or, approx. 75 KVA, assuming PF = 0.8) energy. In most cases the Contractor has used DG sets (from 100 – 250 kVA) for batching plant & ancillary facilities. Thus, the diesel req. will range from 30 - 45L/hr, at 100%	• As a primary source, power from the grid shall be used with prior permission from power supply company obtained by the Contractor. • DG sets, if used, should: (a) conform to height of stack norms as per CPCB rules; (b) conform to emission norms as per E (P) Act, 1986; (c) noise level at 1 m distance from enclosure should not be >75 dB(A). • The required permissions from local Environmental Authorities/Pollution Control Board/ CEIG or any other relevant Authority shall be obtained by the Contractor for using DG sets for power supply. • Diesel storage if done beyond threshold limit (1000 L) permission should be obtained from Chief Controller of		Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			load)	Explosives. Diesel should be stored on pukka platforms and spillages should be avoided. • Refer to Activity 42 “Use of DG sets” and Activity 44 “Storage of Diesel” for further measures.			
41	Casting of segments and I-beams	Groundwater	Casting will require use of water	• Municipal water will be used. In view of fragile groundwater status, extraction will be avoided. The construction sites will be provided with drains with intercepting pits in which the cement and sand will settle. After settling it shall be discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. • Groundwater quality monitoring.	R-CGWA permits and ground water quality monitoring records	Contractor	GC / Maha Metro
		Resources	Casting (incl. operation of gantry and hydraulic pre-stressing units) will consume lot of energy	• Pre-stressing and casting are basic requirements. However, whenever possible of the power should be drawn from approved lines, not from DG sets.	Physical Verification	Contractor	GC / Maha Metro
42	Curing of segments & I-beams	Groundwater	Curing will require a significant amount of water	• Garland drainage is proposed to be constructed around the construction yard. This will intercept the runoff generated from site. Stagnation of water (and resultant vector propagation) should be avoided. • Groundwater quality monitoring. • After precipitation, it shall be discharged into public sewers; it will be treated by municipal agencies to EPR 1986	Site inspection Ground Water quality Monitoring reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				standards of discharge of general effluents into surface water. • Groundwater will not be used. Water will be sourced from municipal supply, surface runoff or water from dewatering.			
43	Hauling of segments to site	Air	During transportation of segments, fugitive dust will be generated from re-suspension of dust from road surface. Plus, there will be air emission from trucks	• The traffic management plan will be stringently implemented with regular monitoring and inspections. • Sprinkling of water should be carried out. • Truck tyres will be washed to excess remove soil clinging to it. Contractor will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. Used water shall be collected and re-used after settling in a settling basin or tank. • Water for sprinkling and tire washing will be sourced from treated effluent from ETPs located nearby, or surface runoff. • Haul roads will be kept in good state of maintenance. • Project affected community members will be consulted prior to hauling of segments to site' to ensure adequate awareness of any disruption of temporary noise and air disturbance is disseminated to those affected	Traffic Management Plan Water Sprinking records	Contractor	GC / Maha Metro
		Noise	Trucks carrying segments will result into high noise	• The routing, timing and logistics of the haul truck movement should be planned to have minimal impacts on noise level.	Noise monitoring reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			(typically in excess of 85 dB(A) at1 m distance, or 57 dB(A) at 10 m distance). The adverse impacts of noise will be most intense in the residential/urban areas	The route selection will avoid any sensitive receptors. • Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. • Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. • Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities. • Monitoring required during construction, including field observations and measurements.	Field Verification		
		Social	Incessant movement of trucks could create social issues	• The local community has to be taken into confidence before the construction commences. Their advice has to be taken and incorporated in decision making. • GRM for affected people should function effectively with well documented grievance log.	GRM register/records Community consultation records	Contractor	GC / Maha Metro
		Health & safety	The movement of trucks will increase the traffic risk of the	• The routing, timing and logistics of the haul truck movement will be planned to have minimal impacts on occupational	Community and Occupational health and safety Management	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			commuters	and community health and safety.	Plan		
		Aesthetics	Movement of trucks will create an aesthetic problem	• Proper housekeeping activities have to be undertaken near the casting yard and nearby areas.	Housekeeping reocrds	Contractor	GC / Maha Metro
44	Use of DG sets	Air	Emission of NOx, SOx, CO, PM10, PM2.5 from DG sets will create air pollution problems	• Primary power source will be power distribution company; DG sets will be used only for power back-ups for stations. • The required permissions from local Environmental Authorities / MPCB or any other relevant Authority shall be obtained by the Contractor if using DG sets for power supply. DG sets compliant with CPCB norms will be used. Specification no. GSR 520(E) dt. 1-7-2003 for DG sets rating < 800 KW, and GSR 489(E) dt. 09-07-2002 for DG sets > 800 KW under E (P) Rules, 1986. • Stack height of DG sets will be as per CPCB requirement [stack ht. = 0.2*(rating in kVA)0.5] • Stack monitoring of the criteria pollutants will be conducted monthly, if the DG set id operated regularly. • Compliance monitoring will be done to the regularly and check the monitoring instruments. • Fuels used for DG will be High Speed Diesel with low-sulphur content.	Ambient Air quality and DG set stack monitoring reports	Contractor	GC / Maha Metro
		Noise & Vibration	Noise & vibration will be generated from the use of DG sets	• DG sets compliant with CPCB norms will be used. • Monitoring required during construction, including field observations and	Noise and Vibration Monitoring reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				measurements. • DG sets will be enclosed type, with noise levels approx. 75 dB (A) at a distance of 1m in compliance with GSR 371(E) dt. 17-05-2002. • Noise will be controlled using acoustic enclosure. • The DG sets will be mounted on damping skids, which will reduce the vibration generated from DG sets.			
		Resources	DG sets will consume Diesel (and in effect reduce the levels of a non-renewable resource)	• DG sets will be used as a power back up, and not the primary sources of power. This should be made mandatory for all Contractors. • Refer to Activity 42 “Storage of Diesel” for further measures.	Site inspection and monthly- Diesel consumption records	Contractor	GC / Maha Metro
		Aesthetics	Operation of DG sets will cause an aesthetic issue	• Enclosures will be used to keep them off from public views. • PM content of DG sets smoke will be as pert the CPCB norms, thus the DG will emit dark smokes only during start-up & shut-down (b) Noise will be controlled using acoustic enclosure.	DG stack monitoring reports	Contractor	GC / Maha Metro
45	All Construction Activities	Environment	Construction and Demolition (C&D) waste results from land clearing, excavation, construction, demolition, remodelling and repair of structures, roads and utilities	• Records of movement and loading/unloading of C&D waste and records of waste loaded by vendors. • C&D waste will be reused/recycled as it has the potential to save natural resources (stone, river sand, soil etc.) and energy. C&D waste generated from metro construction has potential use after processing and grading. • The contractor will segregate and temporarily store the C&D waste till the vendor takes it away for recycling and	Waste management register Site inspection records	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				disposal at authorized facilities. • Contractor will adhere with the C&D Waste Management Rules. • Management and storage of fuel, waste oil, and hazardous substances will be planned in accordance with the World Bank Group's Environmental, Health and Safety General Guidelines on Hazardous Materials Management. This includes the use of appropriate secondary containment structures capable of containing the larger of 110 % of the largest tank or 25% of the combined tank volumes in areas with above-ground tanks with a total storage volume equal or greater than 1,000 litters. Fuel storage tanks need to be placed under roofs and on concrete slabs with berms or dikes to contain spills in a secured covered area. • Spill clean-up equipment (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances will be maintained on-site. Should any accidental spills occur, immediate clean-up will be undertaken, and all clean-up materials will be stored in a secure area for further disposal. Disposal of such will be undertaken by a waste management company contracted by the Contractors. The waste management company must have the required licenses to transport and dispose of any hazardous waste before any such waste is removed from			

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				the site. The Contractors will keep copies of the company's licenses and provide waste transfer manifests at their camp site for routine inspection by the engineer.			
		Occupational Health and Safety	Accidents All parties' reputation	• Worker safety is important on all construction projects. It is important to consider the effects of staffing on worker safety and to provide appropriate training in safety awareness for all labour. • Contractor shall report significant environmental incidents to Maha Metro Pune / GC within 8 hrs. of the event and shall take necessary measures to rectify it as soon as possible. • Contractor will provide regular training and 'tool box talks' to ensure workers safety. • The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reach 140 dB(C), or the average maximum sound level reaches 110dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85 dB(A) • Provision of PPE for workers especially working ay heights or near water bodies in accordance with GIP health and safety regulations and requirements. This will include the provision of (as needed): life jackets, safety boots, helmets, gloves, protective clothing, respirators, goggles, earplugs, harnesses etc.	EHS reports Accident/Incident records Worker safety training records Tool Box talk records Site Health and safety Plan Labour Audit records.	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• Training will be regularly provided to workers on Occupational Health and Safety and work hazards including extreme climatic conditions, drowning, physical injury etc. Regular meetings with workers will be held and recorded • Occupational health and safety matters will be given a high degree of publicity to all work personnel and posters will be displayed prominently at construction sites. • All workers will be given basic training in sanitation, general health and safety matters, and work hazards. An awareness program for HIV/AIDS and other communicable diseases will be implemented for workers and the local communities. • Provide personal protection equipment to workers as needed, e.g. safety boots, helmets, gloves, protective clothing, goggles, ear protection. • Core labour standards will be implemented. Civil works contracts will stipulate priorities to: (i) employ local people for works; (ii) ensure equal opportunities for women and men; (iii) pay equal wages for work of equal value and pay women's wages directly to them; and (iv) not employ child or forced labour. Specific targets for employment have been included in the project gender action plan			
46	Storage of Diesel	Groundwater Health & safety	Diesel spillage (from underground or above ground storage facility) will	• Before it percolates into the groundwater, contaminated runoff water can be run through adsorbents such as	Daily Site inspection reports with photos Spill prevention and	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			affect groundwater quality adversely	polymer slurry to remove the diesel. The diesel will be quickly collected into steel trays and disposed to authorized recyclers. • All bulk diesel tanks shall be properly supported in an elevated position to facilitate gravity discharge. • Spillage will be controlled using methods mentioned in the environmental contingency plan, to be included in the emergency response plan. • Groundwater quality monitoring before installation of the tanks and after demobilization.	control plan Ground Water quality Monitoring reports		
			Storage of Diesel will attract the provisions of Hazardous Chemicals (Management & Handling) Rules and Petroleum Rules; as amended to date. It could cause serious damage to health & safety of workers / property if ignited	• Proper onsite emergency plan will be prepared and will be approved through Maha Metro. • If the diesel storage crosses the threshold limits permissions, proper fire protection norms have to be undertaken as per National Building Code, 2005 (if building) / Oil Industry Safety Directorate Standard 117 (if installation). • A registry of all activities that involve the handling of potentially hazardous substances will be developed, including protocols for the storage, handling and spill response. • All chemicals, toxic, hazardous, and harmful materials will be transported in spill-proof tanks with filling hoses and nozzles in working order. • All chemicals, toxic, hazardous, and harmful materials will be stored in secure	Onsite Emergency Plan Hazardous/Non-hazardous Material register Hazard/non-hazardous material storage handling and amanagement plan. Dialy site inspection reports.	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				areas with impermeable surfaces and protective dikes such that spillage or leakage will be contained from affecting soil, surface water or groundwater systems. The area should be a 110% volume of storage capacity. Their usage will be strictly monitored and recorded. • Good housekeeping procedures will be established to avoid the risk of spills. • Spills will be dealt with immediately, and personnel will be trained and tasked with this responsibility. • Workers will be properly trained before handling hazardous wastes and have the required protective equipment.			
47	Clean-up Operations, Restoration and Rehabilitation	Environment	Aesthetics	• The clean-up and restoration operations are to be implemented by the Contractor prior to demobilization. All spaces excavated and not occupied by the foundation or other permanent works shall be refilled with earth up to surface of surrounding ground.	Site Inspection records	Contractor	GC / Maha Metro
48	Labour Camps providing safe habitation to workers	Social	Social	• Providing hygienic conditions in Labor camps and adequate housekeeping in Labor camps • Contractor shall make sufficient arrangements to provide safe habitation to workers • Secluded sanitary facilities shall be provided for female laborers working onsite		Contractor, Maha Metro	Maha Metro /GC
50	Sanitation, Sewerage and waste disposal	Social	Social	• Authorized agencies shall be deployed for disposal of sewage and other solid waste generated at worker camps and construction sites	Site Inspection records	Contractor, Maha Metro	Maha Metro /GC

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
51	Traffic management	Social	Social	• Avoid and minimize inconvenience to public due to congestion and traffic jams during construction		Contractor, Maha Metro	Maha Metro /GC
Operation Phase							
52	Operation of metro trains	Noise and Vibration	The most significant source of noise will be rolling noise from contact between wheel and rail including noise from contact between the brake pad and wheel, followed by engine noise and aerodynamic noise.	• To minimize operation stage impacts, measures such as Ballast less track structure is supported on two layers of rubber pads to reduce noise and vibrations, if required. In addition, baffle wall as parapets will be constructed up to the rail level so as reduce sound levels. Noise at source will be controlled or reduced by incorporating suitable feature in the design of structures and layout of machines and by use of resilient mounting and dampers etc. • Since the rakes will be air conditioned and enclosed from all side, the impacts of noise on the travellers will be nominal. • Noise barriers will be installed at sensitive receptor locations based on final design noise prediction analysis, if required. • Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. If baseline noise is below the CPCB and IFC-EHS standards, the operation noise has to meet these standards that is, operation noise level has to be less than level prescribed in these standards. • The mitigations suggested based on the detailed noise and vibration analysis carried out prior to commencement of construction, should be strictly followed.	Noise and Vibration moitoring report Building condition Survey reports	Maha-Metro through Third Party Agency for Noise & Vibration Monitoring	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• Detailed vibration modelling is needed if sensitive receptors are located within the reported distances from the track in order to determine if the negative impacts can be fully mitigated through the following mitigation measures: a. Ballasted tie-welded track with elastic steel fastenings and plastic or rubber absorbing pad will reduce noise and vibration levels. Surface irregularities on the wheel and rail will be minimized by good maintenance of wheel and rail condition. b. Elastic pad between seat of the rail and the track slab as well as between track slab and the superstructure beneath it will reduce vibration will be installed to reduce transmission of vibration from the track and superstructure. c. Using floating slab and high resilience fasteners to reduce the vibration at the point of emission. • Vibration monitoring and building condition surveys is required to determine if there are negative impacts and annoyance post mitigation implementation. •			
		Health and Safety	Accidents Reputational risks	• Detailed specification of equipment e.g. power cables, rectifiers, transformer, E&M equipment etc. shall be framed to reduce conducted or radiated emissions as per appropriate international	Site EHS register Incident/Accident records	O & M -Maha Metro	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				standards. • The Metro system as a complete vehicle (trains, signalling & telecommunication, traction power supply, E&M system etc.) shall comply with the Electromagnetic compatibility (EMC) requirements of international standards viz. EN50121-3-1, EN50123, IEC61000 series etc. EMC requirements of international standards for whole railway system to the outside world shall comply with EN50121-2. • Automatic Train Protection and Automatic Train Supervision sub-systems will be installed to provide a high level of safety. • CCTV system will be installed for local and centralized monitor of operation. • In view of the potential hazards from system failure resulting to accidents, both on- site and off-site emergency measures will be implemented. All trains will have public address systems to warn the passengers of any emergency. • Emergency team, ambulance, contact number and hospital should be available. Emergency response plan should be implemented during operation periods.	Site inspection/Physical Verification		
			Operating Personnel Health risks	• Operating staff such as drivers and Control Centre staff shall be administered regular medical check-ups for musculo-skeletal disorders, fatigue, eye strain. • Well-designed workstations, lighting in Control Centre.	Medical records at site	O & M -Maha Metro	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• Emotional resilience training, counselling for recovery and rehabilitation.			
		Health of metro staff and commuters	Severely contagious diseases such as Covid-19 can impact health of staff thereby affecting operations; can cause economic loss to the country and loss of reputation to the project.	• National Covid-19 SOP shall be implemented; staff shall be trained; staff and commuters shall be informed of precautions such as social distancing, sanitizing; arrangements for stationary and hand-held thermal scanners; provision of sanitizer pedestals, vending machines of face masks and gloves etc. shall be provided in stations; site record of Covid-19 hospitals; daily disinfection of operating rooms, circulation spaces, equipment and vehicles; protected ambulances at stations.	Covid-19 SOP	O & M -Maha Metro	Maha Metro
		Aesthetics	Metro rail will increase the aesthetics of CIty	• A proper housekeeping routine will be followed to enhance the aesthetics of metro rail station.		O & M -Maha Metro	Maha Metro
53	Track repair	Environment	Spill accidents	• Maha Metro to ensure no illegal disposal of solid waste or wastewater.	Site EHS records/inspection	O & M -Maha Metro	
54	Use of DG sets	Air	Emission from DG sets will create air pollution problems	• DG sets compliant with CPCB norms will be used. Monitoring of air quality shall be done as per CPCB norms. Compliance monitoring will be undertaken as specified in the EMoP. • Fuel used for DG sets will have a low-sulphur content	Dg stack monitoring eport	O & M -Maha Metro	Maha Metro
		Noise & Vibration	Noise & vibration will be generated from the use of DG sets	• DG sets compliant with CPCB norms will be used. • Noise enclosures will be used and will comply with GSR 371(E) dt. 17-05-2002. • Wherever baseline noise already	Noise and monitoring reports	O & M -Maha Metro	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				exceeds the standards, only 3dB of noise increase is allowed. If baseline noise is below the CPCB and IFC-EHS standards, the operation noise has to meet these standards that is, noise level has to be less than level prescribed in these standards. • The DG sets will be mounted on damping skids, which will reduce the vibration generated from the use of the DG sets			
		Groundwater	Diesel spillage (from underground or above ground storage facility) will affect groundwater quality adversely	• Storage of diesel shall be done in designated areas paved with concrete floors and with an arrangement of oil interceptors to prevent oil entering the groundwater. • Precautions shall be taken to avoid any spillage of diesel. • Oil that is mixed in water will be removed in the ETP operated by municipal authorities or by other approved methods to EPR 1986 standards before disposal into surface- or ground-water	Site inspection reports with photographs Hazardous material storage, handling and Management Plan	O & M -Maha Metro	Maha Metro
		Health & safety	Storage of Diesel will attract the provisions of Hazardous Chemicals (Management & Handling) Rules and Petroleum Rules; as amended to date. It could cause serious damage to health & safety of workers /	• Diesel should be stored in designated sites prior to final disposal. • If the diesel storage crosses the threshold limits permissions from Chief Controller of Explosives (CCoE), proper fire protection norms shall be undertaken as per National Building Code, 2005. • Proper onsite emergency plan will be prepared by GC and will be approved through Maha Metro.		O & M -Maha Metro	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			property if ignited				
		Resources	DG sets will consume Diesel (and in effect reduce the levels of a non-renewable resource)	• DG sets compliant with CPCB norms will be used only as backup.	DG set stack monitoring reports	O & M -Maha Metro	
		Aesthetics	Operation of DG sets will cause an aesthetic issue	• Enclosures for DG Sets will be used.	Site inspection records	O & M -Maha Metro	Maha Metro
55	Development of feeder routes	Social	Along with Metro routes, metro feeder routes will be developed. This will have a positive impact in terms of enhanced connectivity and inclusion in the social mainstream	• Maha Metro will work with bus operators to implement metro feeder routes along major arterial and sub-arterial routes to reduce travel time to the nearest station. Better quality coaches & comfortable rides should be planned to enhance acceptability.	Metro feeder operating records	O & M -Maha Metro	Maha Metro
		Health & safety	Better & frequent transport system will reduce risk of traffic accidents	• The new feeder routes should: a. follow proper timetable; b. should have frequent services during the morning & evening peak; c. should have a limited carrying capacity. • The feeder buses should arrive and depart from designated bus bays or similar structures. Proper arrangements for road crossing should be established. • The appointed personnel should assist passengers to reach their destinations. An easily accessible grievance	Site inspect records	O & M -Maha Metro	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				Redressal system should be established by Maha Metro			
		Aesthetics	Better designed coaches will enhance ride pleasure and aesthetics	• The buses should be properly maintained from time to time in order to enhance the aesthetic value.	Inspection records.	O & M -Maha Metro	Maha Metro
56	Generation of employment	Social	The proposed project will result into generation of employment	• The project will cause direct and indirect employment generation. Economic activity will be stimulated by easier movement of passengers thus leading to indirect employment generation.	Interview with workers under indirect employment. HR records for direct employment.	O & M -Maha Metro	Maha Metro
57	Ancillary development along metro routes	Land	Ancillary developments will take place along with metro Project	• Provision for increased density of development along project is available through existing byelaws as well as new TOD norms. Mixed land use of TOD tends to reduce non-work trip length and its higher density promotes increased use of metro for work trips on long distances. • Implementation of increased densities is decided by State Government and managed by PMRDA in accordance with demand.	TOD plan	O & M -Maha Metro	
		Social	Ancillary development along the metro alignment will have positive effect on the social environment	• There should be positive participation of the common people in the ancillary development process. An open, transparent & people-centric outlook has to be adopted	Any record of meetimgs/consultations.	O & M -Maha Metro	Maha Metro
58	Children & Women	Social		• Priority seating for pregnant women and elderly citizens will be provided in the coaches. • Emergency intercom and video surveillance shall be part of metro operating system		Maha Metro /GC	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• Separate toilets for men and women at stations shall be provided; • Patrolling of platforms after sunset hours by security personnel shall be ensured • Lady security personnel to be deployed for frisking women passengers; • Proactively encourage and promote women's employment in the metro services sector • Secluded sanitary facilities shall be provided for women workers working onsite			
59	Elderly and Persons with Disability	Social		• It will be ensured that station operations shall be easy to understand and operate for persons with learning disabilities, intellectual disabilities, and elderly persons • Braille buttons and audio announcement system shall be ensured for persons with vision impairments • Information or help desks shall be close to the station entrance, and highly visible upon entering the station • Staff managing the counters shall know sign language and lighting shall be positioned to illuminate the receptionist/person managing the counter		Maha Metro /GC	Maha Metro/PMRP

Note: *Refer Resettlement Action Plan for details of Compensation and entitlement*

E. ESMP BUDGET

619. Mitigation measures proposed in the ESMP will be implemented by the Contractor. The budgetary provisions for the implementation of the environmental management plan of Metro rail Project- PCMC to Nigdi (Phase-1 Extension) are presented in **Table 9-3**.

Table 9-3: Summary of ESMP Budget for PCMC – Nigdi

Sr, No.	Item	Estimated Total Cost (₹)
1.	Compensatory Plantation of 2580 trees in lieu of 258 affected trees (as per the PCMC Tree Authority guidelines in 1:10 ratio)	2,58,00,000
2.	Rainwater Harvesting (@ Rs. 2,00,000 /RWH structure for total of 20 structures)	40,00,000
3.	Environmental Monitoring	1,90,40,000
4.	Training and Capacity building	10,00,000
5.	R&R and RP	21,88,00,000
6.	Public Consultation	10,00,000
Total ESMP Cost for PCMC to Nigdi (Phase-1 Extension)		**2,69,640,000**

Thus, cost of ESMP for PCMC to Nigdi works out to be around **₹ 269.64 million**

F. DEVELOPMENT AND IMPLEMENTATION OF SUB-PLANS

620. As part of the Construction phase ESMP, the contractors need to develop various sub-plans as discussed in the ESMP (item 4 to 13 during pre-construction stage) and in the ESHS system requirements as described in Maha Metro's Health and Safety Manual (**Annexure-10)**. These plans are aimed at good environmental management practices and serve as guide documents. While the relevant impacts have been adequately assessed in this ESIA, further topic or location specific information from the contractor will be needed to complete these plans which is not available for inclusion in the main ESMP at the time of approval. These sub-plans will form part of Construction phase ESMP, and be consistent with the contractor's SHE Plan to be included in the bid documents. Some of the key plans to be developed by the contractor and the party responsible for its approval, is summarised in **Table 9-4**.

Table 9-4: Contractors' Sub-plans and Approval Requirements

Sr. No.	Plan	Description	Approvals / NoC		
			PIU	GC	EIB
1.	Work plan for securing all permits and approvals	The plan will list all necessary permits, approvals and/ or consent including the responsible authorities and the timeframe of obtaining them.	Yes	Yes	No
2.	Construction and Labour Camp Management Plan	The plan will provide a layout map of the construction sites and campsite and clearly show the access road, entry and exit and different facilities inside the camp. Facilities inside the camp may include contractor's office, residential quarters, toilets, health center, construction plants, storage areas etc. The plan will include information on waste management, supply of water for drinking and bathing, waste water and drainage management, traffic movement routes etc.	Yes	Yes	No
3.	Site and Labour Camp Restoration Plan	Describes the clean-up and restoration operations to be implemented by the Contractor prior to demobilization including clearance of all temporary structures, disposal of all garbage, night soils and petroleum, oil and lubricants wastes and filling and sealing of all disposal pits or trenches.	Yes	Yes	Yes
4.	Muck Disposal Plan	The plan shall describe sources of muck generation (piling work for viaducts etc.), type and quantity of muck	Yes	Yes	Yes

Sr. No.	Plan	Description	Approvals / NoC		
			PIU	GC	EIB
		generated from various sources, use of muck generated, method collection and transportation, transportation routes, disposal site location and design, approvals required for disposal sites, and treatment methods. Recommendations provided in the ESIA must be considered.			
5.	Waste Management Plan	The plan shall describe waste streams and amounts, describe recycling/reuse methods for each material, identify the waste destinations and transport modes, including what materials are being segregated on site for reuse or recycling, specify responsibilities for managing and disposal of waste. Describe special measures for material use and handling. Describe communication and training to support and encourage participation from everyone on site. Recommendations provided in the ESIA must be considered.	Yes	Yes	No
6.	Traffic Management Plan	The plan shall be designed to ensure that traffic congestion and traffic safety impacts due to construction activities and movement of construction vehicles, haulage trucks, and equipment is minimized. The plan shall be prepared in consultation with traffic officials. The plan shall identify traffic diversion and management issues, haul road network plan, traffic schedules, traffic arrangements showing all detours/lane diversions, modifications to signaling at intersections, necessary barricades, warning/advisory signs, road signs, lighting, and other provisions to ensure that adequate and safe access is provided to motorists and other road users in the affected areas. Pre-construction access road surveys will also form part of the TMP. The plan shall also include locations for pedestrian crossings and conditions for the management of these crossings, including the use of flagmen.	Yes	Yes	No
7.	Occupational and Community Health and Safety Plan	Consistent with international standards (e.g., World Bank Group Environmental, Health, and Safety Guidelines, 2007) and Labour Code of India. The Plan shall address health and safety hazards associated with construction activities (e.g., excavations, piling, etc.), use of heavy equipment, transport of materials and other hazards associated with various construction activities and shall provide links to existing government health programs. The plan will also include a Covid-19 response and management plan. The document to be read together with the Camp Management Plan. Recommendations provided in the ESIA must be considered.	Yes	Yes	Yes
8.	Labour and Working Conditions Management Plan (**Annexure-8**)	This will include: policy / legal framework information (including labour and OHS requirements of National legislation, ADB SPS 2009, EIB standards), workforce induction and information on rights, child and forced labor, equal opportunity, migrant workers, promotion of local employment opportunities, labor union, worker accommodation requirements, provision for retrenchment plans, workforce grievance mechanism, security personnel (Voluntary Principles on Security and Human Rights), etc. Contractor needs to ensure that the core labor requirements are cascaded down across the entire contracting chains, including sub-contractors and suppliers of core materials. The plan shall also comply with IFC Guidance Note “Workers’ accommodation:	Yes	Yes	Yes

Sr. No.	Plan	Description	Approvals / NoC		
			PIU	GC	EIB
		processes and standards".			
9.	Code of Conduct	The Contractor shall prepare a Code of Conduct that outlines camp rules articulating acceptable behaviors of the workforce with local communities. Associated induction training will be provided to ensure rules are well understood and enforced.	Yes	Yes	Yes
10.	Emergency Response Plan	This plan shall prescribe measures to prevent, mitigate, respond to and recover from emergency events that could occur due to project activities such as accidents, spills of hazardous substances, fire, extreme weather events, and others; measures to prevent, mitigate, respond to and recover from emergency events that could occur due to project activities such as accidents, release of toxic gas, spills of hazardous substances, fire, floods, earthquakes, etc.	Yes	Yes	No
11.	Construction Vibration & Noise Management Plan	Detailing the procedures for vibration surveys, monitoring and control. Such details shall include; procedures to complete condition surveys (for all sensitive receptors indicated in this ESIA), Measurement locations and methods; methodology statements for works likely to induce vibrations, including programs of trial construction sections to determine the likely magnitude of vibrations at defined distances from the vibration source, in sufficient detail for the contractor to develop a final method for constructing the works without excessive vibration; description of the instrumentation and equipment to be used; copies of the instruction manuals and the laboratory calibration and test equipment certification. The resumes of the vibration monitoring technical support personnel, sufficient to define details of relevant experience; procedures for data collection and analysis; frequency of measurements; means and methods of providing warnings when the specified construction vibration limits are reached; and Action Plans to be implemented in the event that the specified construction vibration limits are reached. The generalized plans of action shall comprise the positive measures by the Contractor to control vibrations using alternative construction methods. In parallel, noise monitoring and control procedures shall be rigorously implemented. These will include baseline ambient noise assessments and selection of monitoring locations near sensitive receptors such as hospitals, schools, and residential areas. Measurements will follow international standards using calibrated sound level meters and dosimeters, with relevant equipment specifications and certifications provided. Noise modeling has been conducted to predict potential exceedances from planned construction activities. Methodology statements for high-noise operations—such as piling, concrete breaking, and machinery use—will be prepared to guide controlled execution. Data collection protocols, analysis methods, and monitoring frequency will be defined, covering both daytime and nighttime periods. Thresholds will align with regulatory standards, and alert systems will be in place to detect and respond to exceedances. Noise Action Plans will include mitigation measures such as quieter machinery,	Yes	Yes	Yes

Sr. No.	Plan	Description	Approvals / NoC		
			PIU	GC	EIB
		acoustic barriers, and optimized scheduling to minimize impact. The goal is to ensure construction proceeds with minimal disruption to nearby communities through effective monitoring and timely intervention.			
12.	Construction Water Management Plan	Plan to describe the water sources, required permits and ways to minimize water wastage	Yes	Yes	No
13.	Utility shifting and restoration plan	Plan to describe temporary or permanent diversions of utility services in order to secure that utility services remain operational during the entire construction period and after completion of project.	Yes	Yes	No
14	Stakeholder Engagement Plan	The Plan will outline the framework for identifying, informing, and engaging with project-affected communities and relevant stakeholders throughout the project lifecycle. It will include consultation schedules, methods of engagement, documentation protocols, and feedback incorporation mechanisms. The plan shall also provide for continued stakeholder engagement during implementation and operation phases.	Yes	Yes	No
15	Grievance Redress Mechanism for Workers and project affected families	The project will establish two separate grievance redress mechanisms: (i) one for workers, as part of the Labour Management Plan, to confidentially raise and resolve workplace-related complaints; and (ii) another for stakeholders and project-affected communities, as part of the Stakeholder Engagement Plan, to address concerns related to construction, environmental and social impacts. Each mechanism will outline clear processes for submission, response, resolution, escalation, and documentation.	Yes	Yes	No
16	Resettlement Action Plan (RAP)	The RAP outlines the process for identifying project-affected persons (PAPs), assessing involuntary resettlement and livelihood impacts, and ensuring timely compensation and assistance in line with applicable national laws (such as the RFCTLARR Act, 2013), the Maharashtra Direct Purchase Policy, and EIB's environmental and social standards. It includes a socio-economic survey and census of affected households, detailed entitlements, relocation and income restoration strategies, a grievance redress mechanism, implementation responsibilities, timelines, budget, and monitoring framework. All compensation and assistance will be provided before any displacement occurs.	Yes	Yes	Yes

G. ENVIRONMENTAL MONITORING PLAN (EMOP)

621. Environmental Monitoring Plan (EMoP) is a companion document of the ESMP. The ESMP contains parameters, location, sampling and analysis methods, frequency, and compared to standards or agreed actions that will indicate non-compliances and trigger necessary corrective actions. More specifically, the objectives of the EMoP are:

(i) Ensure that impacts do not exceed the established legal and project specific standards
(ii) Check the implementation of mitigation measures in the manner described in the ESIA report
(iii) Monitor implementation of the ESMP
(iv) Provide an early warning of potential environmental damage
(v) Check whether the proposed mitigation measures have been achieved the

intended results, and or / other environmental impacts occurred

622. The monitoring plan will be used for performance monitoring of the project. A monitoring plan defining all parameters to be monitored, with tentative location, project stages for measurements, implementation and institutional responsibility for different environmental components is prepared for all stages of project and presented in **Table 9-5**. Kindly refer to the RAP for details on monitoring and reporting on land acquisition, resettlement, and livelihood restoration aspects.

Table 9-5: EMoP for PCMC to Nigdi (Phase-1 Extension) with budgetary allocation

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated Total Cost (₹)
Pre-Construction stage					
Air	Emission of dust and particulate matter as PM2.5 and PM10, NOx and SOx, CO	GoI and WHO / IFC (most stringent)	Once, 24 hours continuously	Each station, batching plant and casting yard, Muck disposal site.	2,80,000
Water (Surface and Ground)	DO, Turbidity, Conductivity, pH, Heavy metals, *E.Coli*, TSS, Oil and Grease, VOCs and Volatile Chlorinated Hydrocarbons (groundwater only) and TDS	GoI and WHO / IFC (most stringent)	Once, 1 sample each location	Groundwater at batching plant and casting yard, Muck disposal site, construction camps and 4 excavation sites Surface water at wherever waterbody located within 100m from sites	1,60,000
Soil	pH, Sulphate (SO_3), Chloride, ORP, water Soluble salts, Organic Matter (Mineral Oil (GC)), Heavy metals, Poly-Aromatic Hydrocarbons (PAH), Moisture Content	GoI and WHO / IFC (most stringent)	Once, 1 sample each location	At batching plant and casting yard, Muck disposal site, construction camps	40,000
a) Noise & vibration	Noise levels in dB(A) Vibration PPV mm/s Building condition survey	GoI and WHO/IFC most stringent / Federal Transit Administration (FTA) Guideline Standards or any other internally recognized standards	a) Once Hourly basis for 24 hours (noise & vibration) b) Building Condition Survey: height measurements, crack survey, detailed photographic records etc.	a) At key structure locations, b) At receptors comprising educational, medical and physical cultural buildings and other fragile buildings located within recommended screening distance of 62m (for cat. 2) on either side of	3,20,000

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated Total Cost (₹)
				alignment.	
Sub-Total (A)					**8,00,000**
Construction stage					
Air	Emission of dust and particulate matter as PM2.5 and PM10, NOx and SOx, CO	GoI and WHO / IFC (most stringent)	24 hours continuously every month Continuous visual monitoring for dust.	For each station until civil works completed batching plant and casting yard, Muck disposal site, throughout construction phase (at each work-front site)	1,00,80,000
Water (Surface and Ground)	DO, Turbidity, Conductivity, pH, Heavy metals, TN, TP, *E.coli*, TSS, Oil and Grease, VOCs (groundwater only) and TDS	GoI and WHO / IFC (most stringent)	Quarterly, 1 sample each location	Groundwater at batching plant and casting yard, Muck disposal site, construction camps throughout construction phase; Surface water at wherever waterbody located within 100m from sites	19,20,000
Soil	PH, Sulphate (SO3), Chloride, ORP, water Soluble salts environmental clearance, Organic Matter (Oil), Heavy metals, PAH, Moisture Content	GoI and WHO / IFC (most stringent)	Quarterly, 1 sample each location	At batching plant and casting yard, Muck disposal site, construction camps throughout construction phase	9,60,000
a) Noise, b) Vibration c	a) Noise levels in dB(A) b) Vibration PPV mm/s c	GoI and WHO / IFC (most stringent) / Federal Transit Administration (FTA) Guideline Standards or any other internally recognized standards	a) Monthly or when complaint is received Hourly basis for 24 hrs. (noise) b) Continuous monitoring during piling (vibration)	a) For each station (at work front site) until completion of civil works b) At sensitive receptor locations c)	9,60,000
Occupational and Community Health and	As specified in project ESHS plan prepared by Contractor Sub-section F of	IFC General and Sector EHS Guidelines or any other	Weekly	Project Site	20,00,000

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated Total Cost (₹)
Safety	Section VII and Part D of PCC	international recognized guidelines			
				Sub-Total (B)	**1,59,20,000**
Operation Stage					
Air	Emission from DG sets (SPM, NOx and SOx), Odor	GoI and WHO / IFC (most stringent)	At least 2 times in a year for the first year, annually for next 3 years	DG sets of all stations	11,20,000
Groundwater	DO, Turbidity, Conductivity, pH, Heavy metals, TP, TN, *E. Coli*, TSS, Oil and Grease, VOCs and TDS	GoI and WHO / IFC (most stringent)	At least 2 times in a year for the first year; once annually for next 3 years	Groundwater at / near construction sites and other construction plants / yards, etc.	1,40,000
Noise	Noise levels in dB(A)	GoI and WHO / IFC (most stringent)	At least 2 times in a year for the first year, annually for next 3 years	Alignment, Stations	2,80,000
Vibration	PPV mm/s	Federal Transit Administration (FTA) Guideline Standards or any other internally recognized standards	At least 2 times in a year for the first year, once annually for next 3 years	At receptors comprising educational, medical and physical cultural buildings (if any) and other fragile buildings located within recommended screening distance of 62m (for cat. 2) on either side of alignment	2,80,000
Health and Safety	As specified in project ESMP and Maha Metro's SHE Manual	IFC General and Sector EHS Guidelines or any other international recognized guidelines	Monthly for 4 years	Station locations	5,00,000
				Sub-Total (C)	**23,20,000**
				Grand Total (A + B + C)	**1,90,40,000**

Thus, the total EMoP Cost for PCMC-Nigdi alignment works out to be around **₹ 19.04 million.**

H. GENERAL CONDITIONS FOR E&S WELFARE

623. In addition to implementation of ESMP as outlined in **Table 9-2**, the Contractor is expected to comply with the general conditions outlined under various clauses of SHE Conditions (Volume 4). The general conditions and reference SHE clauses are listed here in **Table 9-6**.

Table 9-6: General Conditions for Environment and Social Welfare

Sr. No.	General Condition	Responsibility
1	The Contractor as per Rule 69 of the MBOCW shall formulate a Safety & Health policy and get it approved by Chief Inspector and display it at conspicuous places at work sites in Hindi and Marathi i.e. languages understood by the majority of construction workers.	Corporate SHE Head / Project Manager
2	Contractor shall set the goals for environmental performance for certain periods of project duration and shall develop the plans to improve the performance and monitor it	Corporate SHE Head / Project Manager / SHE Head
3	Contractor shall prepare the method statement for major activities which will be undertaken at sites. It should be ensured that environmental risk assessment should be done for every activity and suitable plan is developed to mitigate the impact.	Project Manager / SHE Head / Quality Head
4	Contractor shall ensure that designer (appointed by the Contractor) shall include / prepare designs in a way that minimize the risk to health and safety of those who are going to construct, maintain, clean, repair, dismantle or demolish the structures as well as anyone else like adjoining road users / general public, who might be affected by the work.	Project Manager / Designer / SHE Head
5	The Contractor shall appoint the required SHE personnel as prescribed in General Instruction of Maha Metro Pune based upon the statutory requirement and establish the safety organization based upon the Contract value. The minimum educational qualification and the work experience are given in General Instruction of Maha Metro Pune	Corporate SHE Head / Project Manager / SHE Head
6	The Contractor shall ensure the formation, and monitor the functioning, of Contractor SHE committees. All employees should be able to participate in the making and monitoring of arrangements for safety, industrial health and environment at their place of work.	Corporate SHE Head / Project Manager / SHE Head
7	The Contractor shall ensure that all personnel working at the site receive an induction SHE training explaining the nature of the work, the hazards that may be encountered during the site work and the particular hazards attached to their own function within the operation. The training shall cover the contents as given in the General Instruction of Maha Metro Pune.	Corporate SHE Head/Project Manager/SHE Head
8	The Contractor shall organize SHE training to engage managers, supervisors and other personnel in behavioural change and improve safety performance. The environmental training module shall be approved by Maha Metro Pune / GC.	Corporate SHE Head / Project Manager / SHE Head

Sr. No.	General Condition	Responsibility
9	The Contractor shall evolve and administer a system of conducting environmental inspections twice in a month. Contractor key personnel including the project manager shall attend the site environmental inspections and necessary compliance shall be arranged for GC/Maha Metro Pune observations	Project Manager / SHE Head
10	Monthly environmental report shall be submitted by the contractor to GC / Maha Metro Pune on or before 10th of day of every month. The report shall track the progress in brief, compliance status of observations given by GC / Maha Metro Pune during site visits, general compliance with ESMP / EMP, monitoring records and other notable environmental issues related to site. The report shall include the demonstrative site photographs to highlight the issue.	Project Manager / SHE Head
11	Contractor shall develop the work permit system such that it considers the environmental aspects of major activities carried on site.	Project Manager / SHE Head
12	The Contractor shall take every effort to communicate the Environment management measures through posters campaigns / billboards / banners / glow signs being displayed around the work site as part of the effort to raise environmental/social awareness amongst the work force. Posters should be in Hindi, English, and other suitable language as deemed appropriate. Posters / billboards / banners/ glow signs should be changed at least once in a month to maintain the impact. The Contractor shall also observe important days as listed in General Instruction Maha Metro Pune	Project Manager / SHE Head
13	Contractor shall report significant environmental incidents to Maha Metro Pune / GC within 8 hrs. of the event and shall take necessary measures to rectify it as soon as possible. The environmental incident shall include but not be limited to excessive road soiling, excessive oil spills, excessive dust generation etc.	ProjectManager / SHE Head

I. TRAINING AND CAPACITY BUILDING PROGRAMS

624. While Maha Metro has sufficient capacity to manage and monitor environmental aspects of metro projects, it is proposed to organize targeted training programs for officials from Maha Metro, the General Consultant (GC), and contractors' environment, health, and safety (EHS) teams. These sessions will focus on meeting the monitoring and reporting requirements of EIB. If an external monitor is appointed, they will also contribute to capacity-building efforts. The training content will be finalized in consultation with Maha Metro and EIB, and funds for these activities have been allocated in the Environmental and Social Management Plan (ESMP).

625. To strengthen environmental oversight, an Environmental Safeguards Specialist has been added to the Project Implementation Unit (PIU) to oversee compliance across all EIB-funded corridors. Maha Metro’s core Environment Safeguards team will take overall responsibility for environmental management across corridors, supported during construction by dedicated environmental engineers assigned to each corridor. These engineers will work closely with safety, environmental, traffic, and labour welfare professionals from the General Consultant (GC). During the operational phase, the core team will continue monitoring the

implementation of the ESMP through metro operations contractors. External environmental monitoring agencies will be engaged to ensure compliance with the Environmental Monitoring Plan (EMoP) during operations.

626. Comprehensive training and capacity-building programs will be implemented for all site workers to ensure high standards of safety, efficiency, and technical competency. These initiatives will focus on a range of key areas, including occupational health and safety, proper handling of construction equipment, environmental awareness, emergency response preparedness, and adherence to standard operating procedures. Special emphasis will be placed on familiarizing workers with the specific challenges of working in urban, high-density environments, where coordination and precision are critical. The training sessions will be conducted regularly and tailored to different worker roles, ensuring that both skilled and unskilled labourers receive the knowledge necessary to perform their tasks effectively. By investing in continuous learning and skill enhancement, the project aims to minimize accidents, maintain worksite discipline, and uphold the quality and timelines of metro construction activities.

627. The tentative schedule of the training programs for Environmental Engineers is as **Table 9-7**:

Table 9-7: Schedule of the Training Programs for Environmental Engineers

Sr. No.	Particulars	Frequency	Agency
1	Awareness about principles, guidelines & compliance requirements of funding institutions	Quarterly	Third Party / GC
2	Monitoring & reporting of Environmental compliances during Construction and Operation Phases	Quarterly	Third Party through Contractor / GC
3	Safety, Health & Environment	As per the SHE Manual of Maha Metro	Contractor / GC

Chapter 10: CONCLUSION AND RECOMMENDATIONS

628. The alignment of the proposed Pune Metro Rail Project – Phase I, (PCMC - Nigdi) is not located in any protected area or near a site of historical / cultural significance. Some impact is anticipated due to cutting of about 258 public trees along existing roads.

629. Significant adverse impacts of `medium to high` risk and `likely to definite` likelihood are:
(i) social impacts due to involuntary resettlement,
(ii) loss of trees,
(iii) utility diversion,
(iv) air, noise, vibration, C&D waste (muck) disposal, labour safety, water demand,
(v) likely climate vulnerability.

630. Measures to mitigate adverse impacts have been recommended.

631. After mitigation some residual impacts are expected, predominantly due to noise, vibration, visual intrusion and health and safety risks.

632. Benefits include reduced air pollution and road accidents, increased benefits to economy and commuters on metro and road. Major roads along the proposed alignments are forecast to function beyond respective design service volume in year 2035 in absence of the project alignments.

633. Public consultations highlighted opinions of participants on benefits of Metro in terms of easing connectivity, pollution, congestion, accidents and travel on roads. Public consultations during construction and operation will form part of periodic reports sent by PMRP to EIB. This consultation will focus on the efficacy of mitigation measures being implemented.

634. Existing Phase I Grievance Redress Mechanism (GRM) will help assist the citizens, users of the Metro and other stakeholders communicate their queries, complaints and suggestions in connection with implementation of EMP and EMoP. GRM for both workers and communities will be instituted during pre-construction phase to continue through different phases.

635. Institutional arrangement, EMP, reporting and record keeping, emergency response and environment monitoring plan have been developed. Budgetary cost estimate to implement the EMP and EMoP has been prepared.

636. Best available technology and best management practices are built-in to the project design. All project components will be implemented and monitored in line with the applicable policies and standards.

637. Environmental and social benefits of the project and long-term investment program objectives outweigh the temporary negative impacts.

638. Where unanticipated environmental impacts become apparent during project implementation, the borrower/client will update the environmental assessment and EMP or prepare a new environmental assessment and EMP to assess the potential impacts, evaluate the alternatives, and outline mitigation measures and resources to address those impacts.

ANNEXURES

List of Annexures

Annexure-1	NABET Certificate (Mitcon)
Annexure-2	Air & Noise Quality Analysis (Laboratory reports)
Annexure-3	Water Quality Analyses (Laboratory reports)
Annexure-4	Soil Quality Analyses (Laboratory reports)
Annexure-5	Terms of Reference (ToR) for External Monitoring Agency
Annexure-6	Air Quality Modelling/ Ground Level Concentrations (GLCs)
Annexure-7	List of Sensitive Receptors
Annexure-8	Guideline for Site Selection and Management
Annexure-9	Guidelines/Tasks for GC in implementation of ESMP and EMoP
Annexure-10	Bidding documents for the design and construction of PCMC to Nigdi project including Maha Metro's Safety, Health & Environment (SHE) Manual
Annexure-11	Vibration Modelling Report
Annexure-12	List of Trees likely to be Affected
Annexure-13	Public Consultation Report
Annexure-14	Noise Modelling Report

Annexure-1:

NABET Certificate - MITCON

भारतीय गुणवत्ता परिषद्
QUALITY COUNCIL® OF INDIA
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NABET

National Accreditation Board for Education and Training

Certificate of Accreditation

MITCON Consultancy and Engineering Services Ltd., Pune

Agriculture College Campus, Next to DIC Office, Shivajinagar, Pune – 411005

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

S. No	Sector Description	Sector (as per)		Cat.
		NABET	MoEFCC	
1.	River Valley projects	1 (c)	3	A
2.	Thermal power plants	1 (d)	4	A
3.	Metallurgical industries (ferrous & non-ferrous)	3 (a)	8	A
4.	Petro-chemical complexes	5 (c)	18	A
5.	Synthetic organic chemicals industry	5 (f)	21	A
6.	Distilleries	5 (g)	22	A
7.	Sugar Industry	5 (j)	25	B
8.	Industrial estates/ parks/ complexes/areas, export processing Zones (EPZs), Special Economic Zones (SEZs), Biotech Parks, Leather Complexes	7 (c)	31	A
9.	Ports, harbours, break waters and dredging	7 (e)	33	A
10.	Highways,	7 (f)	34	A
11.	Common Effluent Treatment Plants (CETPs)	7 (h)	36	B
12.	Common Municipal Solid Waste Management Facility (CMSWMF)	7 (i)	37	B
13.	Building and construction projects	8 (a)	38	B
14.	Townships and Area development projects	8 (b)	39	B

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RAAC minutes dated July 19, 2024 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no QCI/NABET/ENV/ACO/24/3330 dated Aug 09, 2024. The accreditation needs to be renewed before the expiry date by MITCON Consultancy and Engineering Services Ltd., Pune following due process of assessment.

Issue Date
August 09, 2024

Valid up to
Feb 05, 2027

Mr. Ajay Kumar Jha
(Sr. Director, NABET)

Certificate No.
NABET/EIA/24-27/RA 0343

Prof (Dr) Varinder S Kanwar
(CEO NABET)

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

Annexure-2:

Air & Noise Quality Analyses

(Laboratory Reports)

MITCON Consultancy & Engineering Services Ltd.
Environment Management and Engineering Division
(Environmental Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

Format No. EME/LAB/Format 7.8/TR

Test Report

Report Number: MITCON/2024-25/ August /7218 **Issue Date:** 12/08/2024

Client's Name & Address	**Reference No.**	**MITCON/2024-25/ August /7218/13**
M/s. Maharashtra Metro Rail Corporation Limited	**Date of Monitoring**	09/08/2024
	Date of Analysis	11/08/2024
Project Name – Extension of Phase-I from PCMC to Nigdi	**Product Group**	**Atmospheric Pollution**
	Product Name	**Ambient Air**
	Method of Sampling	**IS 5182 Part 1 : 2006**
	Test Location	Bhakti Shakti Metro Station
	Latitude/Longitude	18°39'56.20 " N 73°46'21.07" E
	Monitoring Done By	MITCON

RESULT

Parameter No.	Description	Unit	Results	NAAQ Standards	Standard method
01	Sulphur Dioxide (SO_2)	µg/M³	17.54	≤ 80	IS:5182(Part 2)-2001 (Reaffirmed 2017)
02	Oxides of Nitrogen (NO_2)	µg/M³	24.85	≤ 80	IS:5182(Part 6)-2006 (Reaffirmed 2017)
03	Particulate Matter $PM_{10\ micron}$	µg/M³	78.65	≤ 100	IS:5182(Part 23)-2006 (Reaffirmed 2017)
04	Particulate Matter $PM_{2.5\ micron}$	µg/M³	32.85	≤ 60	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)
05	Carbon Monoxide (CO)	mg/M³	0.74	≤ 04 (1Hr)	Instrumental Manual

REMARKS/OBSERVATIONS:
- All above results are within National Ambient Air Quality standards.
- BDL: - Below Detectable Limit.

For MITCON Consultancy & Engineering Services Ltd,

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
Quality Manager/HOD

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Format No. EME/LAB/Format 7.8/TR

Test Report

Report Number: MITCON/2024-25/ August /7218 **Issue Date:** 12/08/2024

Client's Name & Address	**Reference No.**	**MITCON/2024-25/ August /7218/14**
M/s. Maharashtra Metro Rail Corporation Limited	**Date of Monitoring**	09/08/2024
	Date of Analysis	12/08/2024
Project Name – Extension of Phase-I from PCMC to Nigdi	**Product Group**	**Atmospheric Pollution**
	Product Name	**Ambient Air**
	Method of Sampling	**IS 5182 Part 1 : 2006**
	Test Location	Vidyaniketan Bhavan High School
	Latitude/Longitude	18°39'40.79 " N 73°46'30.10" E
	Monitoring Done By	MITCON

RESULT

Parameter No.	Description	Unit	Results	NAAQ Standards	Standard method
01	Sulphur Dioxide (SO_2)	µg/M³	≤ 10	≤ 80	IS:5182(Part 2)-2001 (Reaffirmed 2017)
02	Oxides of Nitrogen (NO_2)	µg/M³	16.47	≤ 80	IS:5182(Part 6)-2006 (Reaffirmed 2017)
03	Particulate Matter $PM_{10\ micron}$	µg/M³	42.14	≤ 100	IS:5182(Part 23)-2006 (Reaffirmed 2017)
04	Particulate Matter $PM_{2.5\ micron}$	µg/M³	10.54	≤ 60	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)
05	Carbon Monoxide (CO)	mg/M³	0.02	≤ 04 (1Hr)	Instrumental Manual

REMARKS/OBSERVATIONS:
- All above results are within National Ambient Air Quality standards.
- BDL: - Below Detectable Limit.

For MITCON Consultancy & Engineering Services Ltd,

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
Quality Manager/HOD

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Format No. EME/LAB/Format 7.8/TR

Test Report

Report Number: MITCON/2024-25/ August /7218 **Issue Date:** 12/08/2024

Client's Name & Address	**Reference No.**	**MITCON/2024-25/ August /7218/15**
M/s. Maharashtra Metro Rail Corporation Limited	**Date of Monitoring**	09/08/2024
	Date of Analysis	12/08/2024
Project Name – Extension of Phase-I from PCMC to Nigdi	**Product Group**	**Atmospheric Pollution**
	Product Name	**Ambient Air**
	Method of Sampling	**IS 5182 Part 1 : 2006**
	Test Location	Nigdi Metro Station
	Latitude/Longitude	18°39'29.32" N 73°46'41.02" E
	Monitoring Done By	MITCON

RESULT

Parameter No.	Description	Unit	Results	NAAQ Standards	Standard method
01	Sulphur Dioxide (SO_2)	µg/M³	15.46	≤ 80	IS:5182(Part 2)-2001 (Reaffirmed 2017)
02	Oxides of Nitrogen (NO_2)	µg/M³	21.33	≤ 80	IS:5182(Part 6)-2006 (Reaffirmed 2017)
03	Particulate Matter $PM_{10\ micron}$	µg/M³	64.87	≤ 100	IS:5182(Part 23)-2006 (Reaffirmed 2017)
04	Particulate Matter $PM_{2.5\ micron}$	µg/M³	22.50	≤ 60	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)
05	Carbon Monoxide (CO)	mg/M³	0.86	≤ 04 (1Hr)	Instrumental Manual

REMARKS/OBSERVATIONS:
- All above results are within National Ambient Air Quality standards.
- BDL: - Below Detectable Limit.

For MITCON Consultancy & Engineering Services Ltd,

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
Quality Manager/HOD

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Test Report

Report Number: MITCON/2024-25/ August /7218 **Issue Date:** 12/08/2024

Client's Name & Address	**Reference No.**	**MITCON/2024-25/ August /7218/16**
M/s. Maharashtra Metro Rail Corporation Limited	**Date of Monitoring**	09/08/2024
	Date of Analysis	12/08/2024
Project Name – Extension of Phase-I from PCMC to Nigdi	**Product Group**	**Atmospheric Pollution**
	Product Name	**Ambient Air**
	Method of Sampling	**IS 5182 Part 1 : 2006**
	Test Location	Akurdi Metro Station
	Latitude/Longitude	18°39'03.78" N 73°47'06.15" E
	Monitoring Done By	MITCON

RESULT

Parameter No.	Description	Unit	Results	NAAQ Standards	Standard method
01	Sulphur Dioxide (SO_2)	µg/M³	18.84	≤ 80	IS:5182(Part 2)-2001 (Reaffirmed 2017)
02	Oxides of Nitrogen (NO_2)	µg/M³	24.76	≤ 80	IS:5182(Part 6)-2006 (Reaffirmed 2017)
03	Particulate Matter $PM_{10\ micron}$	µg/M³	73.84	≤ 100	IS:5182(Part 23)-2006 (Reaffirmed 2017)
04	Particulate Matter $PM_{2.5\ micron}$	µg/M³	28.46	≤ 60	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)
05	Carbon Monoxide (CO)	mg/M³	1.17	≤ 04 (1Hr)	Instrumental Manual

REMARKS/OBSERVATIONS:
- All above results are within National Ambient Air Quality standards.
- BDL: - Below Detectable Limit.

For MITCON Consultancy & Engineering Services Ltd,

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
Quality Manager/HOD

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Test Report

Report Number: MITCON/2024-25/ August /7218 **Issue Date:** 12/08/2024

Client's Name & Address		
M/s. Maharashtra Metro Rail Corporation Limited **Project Name** – Extension of Phase-I from PCMC to Nigdi	**Reference No.**	**MITCON/2024-25/ August /7218/17**
	Date of Monitoring	**09/08/2024**
	Date of Analysis	**12/08/2024**
	Product Group	**Atmospheric Pollution**
	Product Name	**Ambient Air**
	Method of Sampling	**IS 5182 Part 1 : 2006**
	Test Location	Chinchwad Metro Station
	Latitude/Longitude	18°38'24.82" N 73°47'39.15" E
	Monitoring Done By	MITCON

RESULT

Parameter No.	Description	Unit	Results	NAAQ Standards	Standard method
01	Sulphur Dioxide (SO_2)	µg/M³	21.87	≤ 80	IS:5182(Part 2)-2001 (Reaffirmed 2017)
02	Oxides of Nitrogen (NO_2)	µg/M³	27.45	≤ 80	IS:5182(Part 6)-2006 (Reaffirmed 2017)
03	Particulate Matter $PM_{10\ micron}$	µg/M³	77.42	≤ 100	IS:5182(Part 23)-2006 (Reaffirmed 2017)
04	Particulate Matter $PM_{2.5\ micron}$	µg/M³	32.85	≤ 60	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)
05	Carbon Monoxide (CO)	mg/M³	1.54	≤ 04 (1Hr)	Instrumental Manual

REMARKS/OBSERVATIONS:
- All above results are within National Ambient Air Quality standards.
- BDL: - Below Detectable Limit.

For MITCON Consultancy & Engineering Services Ltd,

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
Quality Manager/HOD

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Test Report

Report Number: MITCON/2024-25/ August /7218 **Issue Date:** 12/08/2024

Client's Name & Address	**Reference No.**	**MITCON/2024-25/ August /7218/18**
M/s. Maharashtra Metro Rail Corporation Limited	**Date of Monitoring**	09/08/2024
	Date of Analysis	12/08/2024
Project Name –Extension of Phase-I from PCMC to Nigdi	**Product Group**	**Atmospheric Pollution**
	Product Name	**Ambient Air**
	Method of Sampling	**IS 5182 Part 1 : 2006**
	Test Location	Chinchwad (End of the Alignment)
	Latitude/Longitude	18°38'04.61" N 73°47'56.11" E
	Monitoring Done By	MITCON

RESULT

Parameter No.	Description	Unit	Results	NAAQ Standards	Standard method
01	Sulphur Dioxide (SO_2)	µg/M³	13.74	≤ 80	IS:5182(Part 2)-2001 (Reaffirmed 2017)
02	Oxides of Nitrogen (NO_2)	µg/M³	20.65	≤ 80	IS:5182(Part 6)-2006 (Reaffirmed 2017)
03	Particulate Matter $PM_{10\ micron}$	µg/M³	55.84	≤ 100	IS:5182(Part 23)-2006 (Reaffirmed 2017)
04	Particulate Matter $PM_{2.5\ micron}$	µg/M³	20.13	≤ 60	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)
05	Carbon Monoxide (CO)	mg/M³	05.4	≤ 04 (1Hr)	Instrumental Manual

REMARKS/OBSERVATIONS:

- All above results are within National Ambient Air Quality standards.
- BDL: - Below Detectable Limit.

For MITCON Consultancy & Engineering Services Ltd,

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
Quality Manager/HOD

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Test Report

Report Number: MITCON/2024-25/ August /7218 **Issue Date:** 09/08/2024

Client's Name & Address	**Reference No.**	**MITCON/2024-25/ August /7218/19**
M/s. Maharashtra Metro Rail Corporation Limited	**Date of Monitoring**	09/08/2024
	Product Group	**Atmospheric Pollution**
Project Name – Extension of Phase-I from PCMC to Nigdi	**Product Name**	**Ambient noise**
	Method of Sampling	IS 9989:1981 (RA 2008)
	Monitoring Done By	MITCON

READINGS

Sr. No.	Test Location	Latitude/ Longitude	Unit	Readings	
				11:00 Hrs. (Day Time)	23:50 (Night Time)
01	Bhakti Shakti Metro Station	18°39'56.20" N 73°46'21.07" E	dB(A)	64.7	46.7
02	Vidyanand Bhawan High School (Near)	18°39'41.66" N 73°46'31.81" E	dB(A)	41.5	38.5
03	Nigdi Metro Station	18°39'29.31" N 73°46'41.38" E	dB(A)	63.8	53.4
04	Khandoba Chowk	18°39'01.73" N 73°47'07.72" E	dB(A)	62.7	43.5
05	Chinchwad Metro Station	18°38'22.95" N 73°47'40.19" E	dB(A)	64.4	52.8
06	Chinchwad (End of Alignment)	18°38'04.61" N 73°47'56.11" E	dB(A)	63.4	53.7

REMARKS / OBSERVATIONS:

- All above results are within MPCB Limits.
- **Limits:** Maharashtra Pollution Control Board has prescribed 65 dB (A) as an upper limit of Noise Level during daytime & 55 dB (A) as an upper limit during night time in commercial area.
- **Note : 1 Day time shall mean from 6:00 a.m. and 10:00 p.m.**
- **Note : 2 Night time shall mean from 10:00 p.m. and 6:00 a.m.**

For MITCON Consultancy & Engineering Services Ltd,

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
Quality Manager/HOD

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Annexure-3:

Water Quality Analysis

(Laboratory Reports)

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Test Report

Report Number : MITCON/2024-25/ August /7218 **Issue Date: 16/08/2024**

Client's Name & Address	Sample Details	
M/s. Maharashtra Metro Rail Corporation Limited **Project Name** – Extension of Phase-I from PCMC to Nigdi	**Sample Code**	**MITCON/2024-25/ August /7218/1**
	Name of Sample	Surface water (SW1)
	Sample Details	Lake at LIG Colony,Nigdi
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	8/8/2024
	Date of Sample Receipt	8/8/2024
	Analysis Start Date	9/8/2024
	End Date of Analysis	16/8/2024

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	Test Methods
1	pH at 25 °C	7.27	-	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	25.6	°C	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	248.46	µS/cm	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	1.1	NTU	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	143.0	mg/l	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	149.0	mg/l	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Acidity as $CaCO_3$	<5	mg/l	IS 3025 (part 22),1986,(Rev 1R.A.2014)
8	Total Alkalinity as $CaCO_3$	48.16	mg/l	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	71.14	mg/l	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	15.16	mg/l	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	7.83	mg/l	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl^-	10.15	mg/l	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	11.25	mg/l	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	1.43	mg/l	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	Ammonical Nitrogen as NH_4-N	<0.1	mg/l	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
16	Total Kjeldahl Nitrogen as NH3-N	<1	mg/l	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.0183	ppt	By Calculation
18	Fluoride as F	<0.1	mg/l	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
19	Total Phosphorous	1.89	mg/l	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_3	<0.5	mg/l	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	1.19	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	<1	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	APHA 3500 Cr-B 3-71 23rd Ed.2017.
24	Iron (as Fe)	<0.05	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)

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Test Report

Report Number : MITCON/2024-25/ August /7218 **Issue Date: 16/08/2024**

25	Copper (as Cu)	<0.04	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
26	Nickel	<0.01	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
27	Zinc as Zn	<0.05	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
28	Manganese	<0.1	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
29	Chromium	<0.03	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
30	Lead	<0.01	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
31	cadmium	<0.003	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
32	Phenol	<0.001	mg/l	IS 3025 (Part 43)(Rev 1:R.A: 2014
33	Biochemical Oxygen Demand	07	mg/l	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	13	mg/l	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	4.5	mg/l	IS: 3025 (Part-38)-1989
36	Boron	<0.04	mg/l	APHA 4500 B-c 4-27 23rd Ed 2017
01	Total Coliforms	Present	Per100 ml	IS: 1622 (R.A 1 2014)
02	E-coli	Absent	Per100 ml	IS: 1622 (R.A 1 2014)

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2024-25/ August /7218 **Issue Date: 16/08/2024**

Client's Name & Address	Sample Details	
M/s. Maharashtra Metro Rail Corporation Limited **Project Name** – Extension of Phase-I from PCMC to Nigdi	**Sample Code**	**MITCON/2024-25/ August /7218/2**
	Name of Sample	Surface water (SW2)
	Sample Details	Bird Valley Lake(south)
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	8/8/2024
	Date of Sample Receipt	8/8/2024
	Analysis Start Date	9/8/2024
	End Date of Analysis	16/8/2024

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	Test Methods
1	pH at 25 °C	7.18	-	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	24.7	°C	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	414.2	µS/cm	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	1.4	NTU	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	289.0	mg/l	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	301.0	mg/l	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Acidity as $CaCO_3$	<5	mg/l	IS 3025 (part 22),1986,(Rev 1R.A.2014)
8	Total Alkalinity as $CaCO_3$	89.54	mg/l	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	137.89	mg/l	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	35.14	mg/l	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	13.34	mg/l	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl^-	12.68	mg/l	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	25.55	mg/l	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	3.02	mg/l	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	Ammonical Nitrogen as NH_4-N	<0.1	mg/l	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
16	Total Kjeldahl Nitrogen as NH3-N	<1	mg/l	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.023	ppt	By Calculation
18	Fluoride as F	<0.1	mg/l	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
19	Total Phosphorous	<1	mg/l	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_3	<0.5	mg/l	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	3.25	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	<1	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	APHA 3500 Cr-B 3-71 23rd Ed.2017.
24	Iron (as Fe)	<0.05	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)

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25	Copper (as Cu)	<0.04	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
26	Nickel	<0.01	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
27	Zinc as Zn	<0.05	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
28	Manganese	<0.1	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
29	Chromium	<0.03	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
30	Lead	<0.01	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
31	cadmium	<0.003	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
32	Phenol	<0.001	mg/l	IS 3025 (Part 43)(Rev 1:R.A: 2014
33	Biochemical Oxygen Demand	10	mg/l	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	32	mg/l	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	4.0	mg/l	IS: 3025 (Part-38)-1989
36	Boron	<0.04	mg/l	APHA 4500 B-c 4-27 23rd Ed 2017
01	Total Coliforms	Present	Per100 ml	IS: 1622 (R.A 1 2014)
02	E-coli	Present	Per100 ml	IS: 1622 (R.A 1 2014)

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Client's Name & Address	Sample Details	
M/s. Maharashtra Metro Rail Corporation Limited **Project Name** – Extension of Phase-I from PCMC to Nigdi	**Sample Code**	**MITCON/2024-25/ August /7218/3**
	Name of Sample	Surface water (SW3)
	Sample Details	Pavana River(D/S)
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	8/8/2024
	Date of Sample Receipt	8/8/2024
	Analysis Start Date	9/8/2024
	End Date of Analysis	16/8/2024

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	Test Methods
1	pH at 25 °C	7.18	-	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	24.2	°C	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	341.5	µS/cm	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	1.2	NTU	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	185.0	mg/l	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	193.0	mg/l	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Acidity as $CaCO_3$	<5	mg/l	IS 3025 (part 22),1986,(Rev 1R.A.2014)
8	Total Alkalinity as $CaCO_3$	74.12	mg/l	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	95.78	mg/l	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	38.17	mg/l	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	14.10	mg/l	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl^-	14.56	mg/l	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	26.12	mg/l	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	2.02	mg/l	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	Ammonical Nitrogen as NH_4-N	<0.1	mg/l	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
16	Total Kjeldahl Nitrogen as NH3-N	<1	mg/l	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.026	ppt	By Calculation
18	Fluoride as F	<0.1	mg/l	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
19	Total Phosphorous	<1	mg/l	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_3	<0.5	mg/l	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	4.01	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	<1	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	APHA 3500 Cr-B 3-71 23rd Ed.2017.
24	Iron (as Fe)	<0.05	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)

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25	Copper (as Cu)	<0.04	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
26	Nickel	<0.01	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
27	Zinc as Zn	<0.05	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
28	Manganese	<0.1	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
29	Chromium	<0.03	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
30	Lead	<0.01	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
31	cadmium	<0.003	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
32	Phenol	<0.001	mg/l	IS 3025 (Part 43)(Rev 1:R.A: 2014
33	Biochemical Oxygen Demand	09	mg/l	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	27	mg/l	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	4.3	mg/l	IS: 3025 (Part-38)-1989
36	Boron	<0.04	mg/l	APHA 4500 B-c 4-27 23rd Ed 2017
01	Total Coliforms	Present	Per100 ml	IS: 1622 (R.A 1 2014)
02	E-coli	Present	Per100 ml	IS: 1622 (R.A 1 2014)

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Client's Name & Address	Sample Details	
M/s. Maharashtra Metro Rail Corporation Limited **Project Name** – Extension of Phase-I from PCMC to Nigdi	**Sample Code**	**MITCON/2024-25/ August /7218/4**
	Name of Sample	GW 1
	Sample Details	Bhakti Shakti metro station
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	8/8/2024
	Date of Sample Receipt	8/8/2024
	Analysis Start Date	9/8/2024
	End Date of Analysis	16/8/2024

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.45	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	24.4	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	505.42	µS/cm	N.S.	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	<1	NTU	≤ 1	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	373.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	376.0	mg/l	N.S.	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Total suspended Solids	<5	mg/l	N.S	APHA 2540 D ,2-70 to 2-71 23rd Ed 2017
8	Acidity as $CaCO_3$	<5	mg/l	N.S.	IS 3025 (part 22),1986,(Rev 1R.A.2014)
9	Total Alkalinity as $CaCO_3$	110.25	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	165.14	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	31.16	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	28.45	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	21.57	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	15.65	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	<1.0	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
16	Ammonical Nitrogen as NH_4-N	<0.1	mg/l	N.S.	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
17	Total Kjeldahl Nitrogen as NH3-N	<1	mg/l	N.S.	APHA 4500 N org B and 4500 N-NH_3 C
18	salinity	0.039	ppt	N.S.	By Calculation
19	Fluoride as F	<0.1	mg/l	≤ 1.0	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
20	Total Phosphorous	<1	mg/l	N.S.	APHA 4500 P-C4-162, 23rd Ed.2017.

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21	Silica as SiO_3	1.52	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	7.10	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	<1	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 ,23rd Ed.2017. (AAS)
24	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	N.S.	APHA 3500 Cr-B 3-71 23rd Ed.2017.
25	Iron (as Fe)	<0.05	mg/l	≤ 0.3	APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017.
26	Copper (as Cu)	<0.04	mg/l	≤ 0.05	APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017. (AAS)
27	Nickel	<0.01	mg/l	≤ 0.01	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
28	Zinc as Zn	<0.05	mg/l	≤ 5	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
29	Manganese	<0.1	mg/l	≤ 0.1	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
30	Chromium	<0.03	mg/l	≤ 0.05	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
31	Lead	<0.01	mg/l	≤ 0.01	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
32	cadmium	<0.003	mg/l	≤ 0.003	APHA 3111 B, 3-18 TO 3-2123rd Ed.2017.(AAS)
33	Phenol	<0.001	mg/l	≤ 0.001	IS 3025 (Part 43)(Rev 1:R.A: 2014
BACTERIOLOGICAL POTABILITY					
01	Total Coliforms	Absent	Per100 ml	Absent	IS: 1622 (R.A 1 2014)
02	E-coli	Absent	Per100 ml	Absent	IS: 1622 (R.A 1 2014)

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Client's Name & Address	Sample Details	
M/s. Maharashtra Metro Rail Corporation Limited **Project Name** – Extension of Phase-I from PCMC to Nigdi	**Sample Code**	**MITCON/2024-25/ August /7218/5**
	Name of Sample	GW 2
	Sample Details	Nigdi Metro station
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	8/8/2024
	Date of Sample Receipt	8/8/2024
	Analysis Start Date	9/8/2024
	End Date of Analysis	16/8/2024

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.32	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	24.4	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	643.2	µS/cm	N.S.	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	<1	NTU	≤ 1	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	383.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	386.0	mg/l	N.S.	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Total suspended Solids	<5	mg/l	N.S	APHA 2540 D ,2-70 to 2-71 23rd Ed 2017
8	Acidity as $CaCO_3$	<5	mg/l	N.S.	IS 3025 (part 22),1986,(Rev 1R.A.2014)
9	Total Alkalinity as $CaCO_3$	141.25	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	174.52	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	54.13	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	32.73	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	42.16	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	20.02	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	<1.0	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
16	Ammonical Nitrogen as NH_4-N	<0.1	mg/l	N.S.	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
17	Total Kjeldahl Nitrogen as NH3-N	<1	mg/l	N.S.	APHA 4500 N org B and 4500 N-NH_3 C
18	salinity	0.076	ppt	N.S.	By Calculation
19	Fluoride as F	<0.1	mg/l	≤ 1.0	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
20	Total Phosphorous	<1	mg/l	N.S.	APHA 4500 P-C4-162, 23rd Ed.2017.

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21	Silica as SiO_3	4.52	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	9.15	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	<1	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 ,23rd Ed.2017. (AAS)
24	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	N.S.	APHA 3500 Cr-B 3-71 23rd Ed.2017.
25	Iron (as Fe)	<0.05	mg/l	≤ 0.3	APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017.
26	Copper (as Cu)	<0.04	mg/l	≤ 0.05	APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017. (AAS)
27	Nickel	<0.01	mg/l	≤ 0.01	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
28	Zinc as Zn	<0.05	mg/l	≤ 5	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
29	Manganese	<0.1	mg/l	≤ 0.1	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
30	Chromium	<0.03	mg/l	≤ 0.05	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
31	Lead	<0.01	mg/l	≤ 0.01	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
32	cadmium	<0.003	mg/l	≤ 0.003	APHA 3111 B, 3-18 TO 3-2123rd Ed.2017.(AAS)
33	Phenol	<0.001	mg/l	≤ 0.001	IS 3025 (Part 43)(Rev 1:R.A: 2014
BACTERIOLOGICAL POTABILITY					
01	Total Coliforms	Absent	Per100 ml	Absent	IS: 1622 (R.A 1 2014)
02	E-coli	Absent	Per100 ml	Absent	IS: 1622 (R.A 1 2014)

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
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(Senior Vice President)

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Report Number : MITCON/2024-25/ August /7218 **Issue Date: 16/08/2024**

Client's Name & Address	Sample Details	
M/s. Maharashtra Metro Rail Corporation Limited **Project Name** – Extension of Phase-I from PCMC to Nigdi	**Sample Code**	**MITCON/2024-25/ August /7218/6**
	Name of Sample	GW 3
	Sample Details	AKurdi Metro station
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	8/8/2024
	Date of Sample Receipt	8/8/2024
	Analysis Start Date	9/8/2024
	End Date of Analysis	16/8/2024

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.34	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	24.3	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	583.9	µS/cm	N.S.	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	<1	NTU	≤ 1	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	391.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	393.0	mg/l	N.S.	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Total suspended Solids	<5	mg/l	N.S	APHA 2540 D ,2-70 to 2-71 23rd Ed 2017
8	Acidity as $CaCO_3$	<5	mg/l	N.S.	IS 3025 (part 22),1986,(Rev 1R.A.2014)
9	Total Alkalinity as $CaCO_3$	155.23	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	189.25	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	56.16	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	34.14	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	48.25	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	22.48	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	<1.0	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
16	Ammonical Nitrogen as NH_4-N	<0.1	mg/l	N.S.	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
17	Total Kjeldahl Nitrogen as NH3-N	<1	mg/l	N.S.	APHA 4500 N org B and 4500 N-NH_3 C
18	salinity	0.087	ppt	N.S.	By Calculation
19	Fluoride as F	<00.1	mg/l	≤ 1.0	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
20	Total Phosphorous	<1	mg/l	N.S.	APHA 4500 P-C4-162, 23rd Ed.2017.

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21	Silica as SiO_3	6.23	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	5.88	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	<1	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 ,23rd Ed.2017. (AAS)
24	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	N.S.	APHA 3500 Cr-B 3-71 23rd Ed.2017.
25	Iron (as Fe)	<0.05	mg/l	≤ 0.3	APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017.
26	Copper (as Cu)	<0.04	mg/l	≤ 0.05	APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017. (AAS)
27	Nickel	<0.01	mg/l	≤ 0.01	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
28	Zinc as Zn	<0.05	mg/l	≤ 5	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
29	Manganese	<0.1	mg/l	≤ 0.1	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
30	Chromium	<0.03	mg/l	≤ 0.05	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
31	Lead	<0.01	mg/l	≤ 0.01	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
32	cadmium	<0.003	mg/l	≤ 0.003	APHA 3111 B, 3-18 TO 3-2123rd Ed.2017.(AAS)
33	Phenol	<0.001	mg/l	≤ 0.001	IS 3025 (Part 43)(Rev 1:R.A: 2014
BACTERIOLOGICAL POTABILITY					
01	Total Coliforms	Absent	Per100 ml	Absent	IS: 1622 (R.A 1 2014)
02	E-coli	Absent	Per100 ml	Absent	IS: 1622 (R.A 1 2014)

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Client's Name & Address	Sample Details	
M/s. Maharashtra Metro Rail Corporation Limited **Project Name** – Extension of Phase-I from PCMC to Nigdi	**Sample Code**	**MITCON/2024-25/ August /7218/7**
	Name of Sample	GW 4
	Sample Details	Chinchwad metro station
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	8/8/2024
	Date of Sample Receipt	8/8/2024
	Analysis Start Date	9/8/2024
	End Date of Analysis	16/8/2024

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.39	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	24.3	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	396.8	µS/cm	N.S.	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	<1	NTU	≤ 1	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	195.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	197.0	mg/l	N.S.	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Total suspended Solids	<5	mg/l	N.S	APHA 2540 D ,2-70 to 2-71 23rd Ed 2017
8	Acidity as $CaCO_3$	<5	mg/l	N.S.	IS 3025 (part 22),1986,(Rev 1R.A.2014)
9	Total Alkalinity as $CaCO_3$	90.45	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	98.13	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	44.23	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	25.14	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	22.42	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	19.85	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	<1.0	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
16	Ammonical Nitrogen as NH_4-N	<0.1	mg/l	N.S.	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
17	Total Kjeldahl Nitrogen as NH3-N	<1	mg/l	N.S.	APHA 4500 N org B and 4500 N-NH_3 C
18	salinity	0.040	ppt	N.S.	By Calculation
19	Fluoride as F	<0.1	mg/l	≤ 1.0	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
20	Total Phosphorous	<1	mg/l	N.S.	APHA 4500 P-C4-162, 23rd Ed.2017.

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21	Silica as SiO_3	4.73	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	2.12	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	<1	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 ,23rd Ed.2017. (AAS)
24	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	N.S.	APHA 3500 Cr-B 3-71 23rd Ed.2017.
25	Iron (as Fe)	<0.05	mg/l	≤ 0.3	APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017.
26	Copper (as Cu)	<0.04	mg/l	≤ 0.05	APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017. (AAS)
27	Nickel	<0.01	mg/l	≤ 0.01	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
28	Zinc as Zn	<0.05	mg/l	≤ 5	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
29	Manganese	<0.1	mg/l	≤ 0.1	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
30	Chromium	<0.03	mg/l	≤ 0.05	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
31	Lead	<0.01	mg/l	≤ 0.01	APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS)
32	cadmium	<0.003	mg/l	≤ 0.003	APHA 3111 B, 3-18 TO 3-2123rd Ed.2017.(AAS)
33	Phenol	<0.001	mg/l	≤ 0.001	IS 3025 (Part 43)(Rev 1:R.A: 2014
BACTERIOLOGICAL POTABILITY					
01	Total Coliforms	Absent	Per100 ml	Absent	IS: 1622 (R.A 1 2014)
02	E-coli	Absent	Per100 ml	Absent	IS: 1622 (R.A 1 2014)

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President

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Annexure-4:

Soil Quality Analysis

(Laboratory Reports)

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Client's Name & Address	Sample Details	
M/s. Maharashtra Metro Rail Corporation Limited **Project Name** – Extension of Phase-I from PCMC to Nigdi	**Sample Code**	**MITCON/2024-25/ August /7218/8**
	Name of Sample	Soil
	Sample Details	Bhakti Shakti metro station
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	8/8/2024
	Date of Sample Receipt	8/8/2024
	Analysis Start Date	9/8/2024
	End Date of Analysis	16/8/2024

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	clay	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	18.0 25.0 57.0	% % %	IS 2720 (Part 4)
03	Soil Moisture	15.54	%	IS 2720 Part II1973
04	Bulk Density	1.14	gm/cm^2	IS 2720 (part XXIX)
05	Water Holding Capacity	45.4	%	IS 14767:2000
06	pH	8.02	--	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	565.25	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.18	%	IS 2720 (Part 22)
09	Calcium (as Ca)	80.2	mg/kg	P.K Behra soil analysis manual
10	Magnesium (as Mg)	45.44	mg/kg	P.K Behra soil analysis manual
11	Available Nitrogen	91.52	kg/ha	IS 14684
12	Phosphorous (as P)	13.24	kg/ha	IS 10158
13	Potassium (as K)	101.52	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.11	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.20	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.51	mg/kg	USEPA 3050 B
17	Sodium	29.4	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.19	mg/kg	USEPA 3050 B
19	Total Chromium (as Cr)	<0.05	mg/kg	USEPA 3050 B
20	Nickel (as Ni)	<0.02	mg/kg	USEPA 3050 B
21	Cadmium (as Cd)	<0.05	mg/kg	USEPA 3050 B
22	Lead (as Pb)	<0.1	mg/kg	USEPA 3050 B
23	Sodium Absorption Ratio	1.35	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Client's Name & Address	Sample Details	
M/s. Maharashtra Metro Rail Corporation Limited **Project Name** – Extension of Phase-I from PCMC to Nigdi	**Sample Code**	**MITCON/2024-25/ August /7218/9**
	Name of Sample	Soil
	Sample Details	Nigdi Metro station (formica ltd premises)
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	8/8/2024
	Date of Sample Receipt	8/8/2024
	Analysis Start Date	9/8/2024
	End Date of Analysis	16/8/2024

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	Sandy loam	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	30.0 20.0 50.0	% % %	IS 2720 (Part 4)
03	Soil Moisture	24.02	%	IS 2720 Part II1973
04	Bulk Density	1.19	gm/cm^2	IS 2720 (part XXIX)
05	Water Holding Capacity	41.6	%	IS 14767:2000
06	pH	7.98	--	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	612.25	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.14	%	IS 2720 (Part 22)
09	Calcium (as Ca)	65.12	mg/kg	P.K Behra soil analysis manual
10	Magnesium (as Mg)	50.27	mg/kg	P.K Behra soil analysis manual
11	Available Nitrogen	110.28	kg/ha	IS 14684
12	Phosphorous (as P)	15.24	kg/ha	IS 10158
13	Potassium (as K)	106.28	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.10	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.13	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.42	mg/kg	USEPA 3050 B
17	Sodium	31.7	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.12	mg/kg	USEPA 3050 B
19	Total Chromium (as Cr)	<0.05	mg/kg	USEPA 3050 B
20	Nickel (as Ni)	<0.02	mg/kg	USEPA 3050 B
21	Cadmium (as Cd)	<0.05	mg/kg	USEPA 3050 B
22	Lead (as Pb)	<0.1	mg/kg	USEPA 3050 B
23	Sodium Absorption Ratio	1.49	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Client's Name & Address	Sample Details	
M/s. Maharashtra Metro Rail Corporation Limited **Project Name** – Extension of Phase-I from PCMC to Nigdi	**Sample Code**	**MITCON/2024-25/ August /7218/10**
	Name of Sample	Soil
	Sample Details	Khandoba chowk (Near akurdi metro station)
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	8/8/2024
	Date of Sample Receipt	8/8/2024
	Analysis Start Date	9/8/2024
	End Date of Analysis	16/8/2024

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	clay	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	24.0 25.0 41.0	% % %	IS 2720 (Part 4)
03	Soil Moisture	18.42	%	IS 2720 Part II1973
04	Bulk Density	1.18	gm/cm^2	IS 2720 (part XXIX)
05	Water Holding Capacity	55.16	%	IS 14767:2000
06	pH	8.01	--	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	745.8	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.16	%	IS 2720 (Part 22)
09	Calcium (as Ca)	89.18	mg/kg	P.K Behra soil analysis manual
10	Magnesium (as Mg)	41.16	mg/kg	P.K Behra soil analysis manual
11	Available Nitrogen	87.28	kg/ha	IS 14684
12	Phosphorous (as P)	10.15	kg/ha	IS 10158
13	Potassium (as K)	120.44	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.18	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.36	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.39	mg/kg	USEPA 3050 B
17	Sodium	34.2	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.10	mg/kg	USEPA 3050 B
19	Total Chromium (as Cr)	<0.05	mg/kg	USEPA 3050 B
20	Nickel (as Ni)	<0.02	mg/kg	USEPA 3050 B
21	Cadmium (as Cd)	<0.05	mg/kg	USEPA 3050 B
22	Lead (as Pb)	<0.1	mg/kg	USEPA 3050 B
23	Sodium Absorption Ratio	1.57	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Client's Name & Address	Sample Details	
M/s. Maharashtra Metro Rail Corporation Limited **Project Name** – Extension of Phase-I from PCMC to Nigdi	**Sample Code**	**MITCON/2024-25/ August /7218/11**
	Name of Sample	Soil
	Sample Details	Chinchwad (near st francis Xavier church)
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	8/8/2024
	Date of Sample Receipt	8/8/2024
	Analysis Start Date	9/8/2024
	End Date of Analysis	16/8/2024

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	Loam	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	22.0 30.0 48.0	% % %	IS 2720 (Part 4)
03	Soil Moisture	19.16	%	IS 2720 Part II1973
04	Bulk Density	1.15	gm/cm^2	IS 2720 (part XXIX)
05	Water Holding Capacity	51.16	%	IS 14767:2000
06	pH	8.07	--	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	789.6	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.24	%	IS 2720 (Part 22)
09	Calcium (as Ca)	91.52	mg/kg	P.K Behra soil analysis manual
10	Magnesium (as Mg)	39.83	mg/kg	P.K Behra soil analysis manual
11	Available Nitrogen	92.58	kg/ha	IS 14684
12	Phosphorous (as P)	8.52	kg/ha	IS 10158
13	Potassium (as K)	115.16	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.34	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.52	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.25	mg/kg	USEPA 3050 B
17	Sodium	31.7	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.24	mg/kg	USEPA 3050 B
19	Total Chromium (as Cr)	<0.05	mg/kg	USEPA 3050 B
20	Nickel (as Ni)	<0.02	mg/kg	USEPA 3050 B
21	Cadmium (as Cd)	<0.05	mg/kg	USEPA 3050 B
22	Lead (as Pb)	<0.1	mg/kg	USEPA 3050 B
23	Sodium Absorption Ratio	1.45	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2024-25/ August /7218 **Issue Date: 16/08/2024**

Client's Name & Address	Sample Details	
M/s. Maharashtra Metro Rail Corporation Limited **Project Name** – Extension of Phase-I from PCMC to Nigdi	**Sample Code**	**MITCON/2024-25/ August /7218/12**
	Name of Sample	Soil
	Sample Details	Chinchwad (near D mart)
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	8/8/2024
	Date of Sample Receipt	8/8/2024
	Analysis Start Date	9/8/2024
	End Date of Analysis	16/8/2024

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	sandy	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	30.0 25.0 45.0	% % %	IS 2720 (Part 4)
03	Soil Moisture	12.42	%	IS 2720 Part II1973
04	Bulk Density	1.18	gm/cm^2	IS 2720 (part XXIX)
05	Water Holding Capacity	58.40	%	IS 14767:2000
06	pH	8.08	--	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	800.83	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.32	%	IS 2720 (Part 22)
09	Calcium (as Ca)	83.24	mg/kg	P.K Behra soil analysis manual
10	Magnesium (as Mg)	42.14	mg/kg	P.K Behra soil analysis manual
11	Available Nitrogen	90.25	kg/ha	IS 14684
12	Phosphorous (as P)	5.25	kg/ha	IS 10158
13	Potassium (as K)	91.25	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.16	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.49	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.22	mg/kg	USEPA 3050 B
17	Sodium	29.6	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.18	mg/kg	USEPA 3050 B
19	Total Chromium (as Cr)	<0.05	mg/kg	USEPA 3050 B
20	Nickel (as Ni)	<0.02	mg/kg	USEPA 3050 B
21	Cadmium (as Cd)	<0.05	mg/kg	USEPA 3050 B
22	Lead (as Pb)	<0.1	mg/kg	USEPA 3050 B
23	Sodium Absorption Ratio	1.37	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Annexure-5:

Terms of Reference (ToR) for External Monitoring Agency

Annexure 5 - Terms of Reference for Engaging External Monitoring Agency / Expert

A. Background

Project Description: The proposed Project consists of extension of the PMRP Phase-I (PCMC to Nigdi) with total length of around 4.413 km, all elevated corridors, with total of 4 stations.
Project Category: The Project is assigned as category A for Environment and Involuntary Resettlement as the project is likely to have significant adverse environmental and social (E&S) impacts. Maha Metro will retain external monitor, if required, to conduct the third party monitoring and verify the monitoring information submitted by General Consultant (GC).

B. Objective(s) of the Assignment

1. To conduct third-party monitoring of the implementation of the Environmental, Social, and Health & Safety (ESHS) requirements under the project.
2. To ensure that the Project will be implemented in conformity with the policies of Government of India (GoI), Government of Maharashtra (GoM), as well as the lenders' E&S policies;
3. To identify any environment and social related implementation issues and necessary corrective actions and reflect these in a time-bound corrective action plan for Maha Metro to implement;
4. Capturing social, environmental and economic benefits and particular potential benefits to the poor and vulnerable groups in the corridor;
5. Involving users and stakeholders in the monitoring process; and
6. Strengthening the capacity of the Maha Metro to manage and replicate third-party monitoring with rail users and stakeholders.

C. Scope of Services, Tasks and Expected Deliverables:

Scope of Services: Monitor the implementation of the Environmental Management Plan (EMP), Resettlement Plan (RP), Gender Action Plan (GAP), Vulnerable Communities Plan (VCP) / Indigenous Peoples Development Plan (IPDP), and Health & Safety provisions, as applicable, and monitoring activities by the respective contractors and supervision consultants. Provide technical guidance and feedback to the respective contractors and supervision consultants. Monitor operational stage and residual impacts during project implementation.
The Tasks include, but are not limited to, the following:

i. Review the Social Impact Assessment with a focus on (RAP), and the Environmental Impact Assessment (EIA) with a focus on EMP;
ii. Review the Environmental, Health and Safety clauses included in the civil works contract agreement;
iii. Review the Health and Safety management framework, including worker and community safety protocols, emergency preparedness, and incident reporting mechanisms.
iv. Review the internal E&S monitoring reports;
v. Undertake independent field inspections to verify the implementation of RP / GAP, VCP / IPDP and consult community and affected people;
vi. Review the Grievances register logs at project sites;
vii. Visit the project sites, oversee quantitative environmental monitoring activities of Maha Metro to confirm appropriate methodologies being used and results correctly interpreted, and consult potentially affected people about the environmental nuisances;
viii. Randomly interview the labours and staff regarding compliance with occupational health and safety standards, use of protective equipment, and safety training received;
ix. Assess EMP implementation performance, qualitatively or by conducting additional quantitative environmental monitoring as required;
x. Discuss findings of assessment with Maha Metro and provide recommendations to resolve any issues or problems on implementing EMP / RP / GAP and VCP / IPDP;

xi. Prepare the external E&S monitoring reports, which should confirm the project's compliance with the EMP, RP, GAP, VCP / IPDP, and reflect in the time-bound corrective action plan for any non-compliances;

xii. Confirm project compliance with Health & Safety management systems and identify any gaps or corrective actions required.

D. Deliverables:

The following are the key outputs expected from the consultants:

a. External SMP monitoring reports: a. Once upon payment of compensation and entitlements
b. Implementation of livelihood restoration and its efficacy: semi-annually during construction stage
c. Implementation of GAP and its efficacy: annually during first 2 years of operation and maintenance
d. External EMP monitoring reports:
    i. Implementation of EMP, EMoP, Grievance Redressal and their efficacy: semi-annual during construction stage
    ii. Implementation of EMP, EMoP, Grievance Redressal and their efficacy: annually during operation & maintenance during first 2 years of operation and maintenance.
e. External Health and Safety (H&S) monitoring reports: semi-annually during construction and annually during the first 2 years of operation and maintenance.

E. Team Composition & Qualification Requirements:

One environmental expert and one social expert would be required with E&S related disciplines and with at least 10 years of work experience in E&S management of linear projects, preferably in transport sector.

- Total estimated man-days for both experts during construction stage: (25 person × day / report) × (2 reports / year) × 4 years = 200 person × day.
- Total estimated man-days during O&M stage: (20 person × day / report) × (1 report / year) × 2 years = 40 person × day.

Annexure-6:

Air Quality Modelling / Ground Level Concentration (GLC)

Annexure 6 – Air modelling Report

Project Description

Maha Metro is a Special Purpose Vehicle (SPV) created for the smooth implementation and operations of the Pune Metro Rail Project and is an equal equity joint venture of Government of India (GoI) & Government of Maharashtra (GoM). PMRP shall be solely responsible for the successful and timely completion of the project & its operations subsequently.

Systra has carried out the investigation and studies for Pune Metro Rail Project (PCMC TO NIGDI & Swargate to Katraj) and prepared a Detailed Project Report (DPR) in August 2021 & December 2021 respectively based on which the project is proposed to be implemented

A. DESCRIPTION OF PMRP PCMC TO NIGDI (PHASE-1 EXTENSION)

Proposed Project comprise of 16 elevated and 3 Underground stations in three lines in this Pune MRTS projects are

Table 1: Stations information

Description	Route (km)	Stations
PCMC to Nigdi (Phase-1 Extension)	4.413	4

Route Allignment – (PCMC to Nigdi)

- Proposed alignment of Phase-1 Extension starts from PCMC and goes up to Nigdi near Bhakti shakti Udyan. Total length of the corridor is 4.413 km which is completely elevated.
- This corridor is an extension of existing corridor 1 under Phase 1 i.e. PCMC to Swargate.
- 4 Stations have been proposed in Phase 1, all of which are elevated stations. Summary of the section is given below:

The proposed alignment of Project is an extension of Pune Metro Phase 1

Total 2: Stations (Elevated) are proposed

Name of Stations	Type
Station 1 (Chnichwad)	Elevated
Station 2 (Akurdi)	Elevated
Station 3 (Nigdi)	Elevated
Station 4 (Bhakti Shakti)	Elevated

Figure 1: Alignment Map of Project showing station locations

Total length of Project is 4.413 km, which is fully elevated. Length of viaduct beyond the end point of terminal station (Nigdi) is ~30 m.

Baseline Monitoring with respect to Air Environment

1. Ambient Air Environment

Air quality is an important parameter of the baseline environment and its study is an indispensable tool for planning further development in the adjoining areas of the project. The extant air quality was studied to assess the current status of the same and to check the air quality status of the region vis-à-vis the air quality standards prescribed by the Central Pollution Control Board.

(a) Methodology (Criteria for choice of Parameters for Air monitoring)

The Air Quality Index monitored in India comprises Particulate matter, carbon monoxide, sulphur dioxide, nitrogen dioxide, ammonia, lead and ozone. The US EPA list of criteria pollutants comprises all of the above except ammonia. As per WHO, concentrations of nitrogen dioxide are often strongly correlated with those of other toxic pollutants, and because it is easier to measure, it is often used as a surrogate for the pollutant mixture as a whole. Wide adverse effects of particulate matter (PM) are observed in both short-term and long-term exposures. It is possible to derive a quantitative relationship between the

concentration of the pollutant as monitored in ambient air and specific health outcomes (usually mortality).

The biggest source of lead in air is petrol and mining: neither of them are present in Pune and so lead was not measured. Ammonia was not measured because it is highly reactive making it difficult for monitoring instruments to capture it; uncertainty surrounding sources; the gas can have a very short life span. Ozone is a secondary pollutant resulting from action of nitrogen oxides and VOCs; nitrogen oxides are measured as dioxide and therefore ozone was not measured.

The sampling and analysis of ambient air quality parameters was carried out as per the procedures detailed in relevant Parts of IS-5182 (Indian Standards for Ambient Air Quality Parameters).

The following air pollution parameters were monitored and measured by sampling:

(i) Particulate Matter less than 10µm (PM_{10})
(ii) Particulate Matter less than 2.5µm (PM2.5)
(iii) Sulphur dioxide (SO_2)
(iv) Oxides of nitrogen (NO_X)
(v) Carbon monoxide (CO)

(b) Sampling Period, Frequency and Parameters

Ambient air quality monitoring was conducted at a total of 6 locations in the project study area. Location maps showing Air sampling locations for the project, is presented as Error! Reference source not found.**.** The monitoring locations have been selected primarily based on the predominant wind direction. The other factors considered while selection of the monitoring stations include accessibility, location of receptors and availability of power. Justification for selection of the locations for ambient Air quality monitoring in the Project Study area is summarised in **Error! Reference source not found.**, while details of the same are given in Error! Reference source not found.

Table 3: AAQ locations for Phase-1

Corridor	AAQ locations	AAQ locations at Sensitive Receptors	Crosswind Locations	Downwind Locations	Upwind Locations
1A	6	1	3	3	0

Table 4: Ambient Air Quality Stations monitored in Project Study Area

Sampling Code	Sampling Location	Latitude	Longitude	Wind type#
AAQ.1	Bhakti Shakti Metro Station	18°39'56.20"N	73°46'21.07"E	CW
AAQ.2	Vidyanand Bhavan	18°39'40.79"N	73°46'30.10"E	CW

Sampling Code	Sampling Location	Latitude	Longitude	Wind type[#]
	High School			
AAQ.3	Nigdi Metro Station	18°39'29.32"N	73°46'41.02"E	DW
AAQ.4	Akurdi Metro Station	18°39'3.78"N	73°47'6.15"E	DW
AAQ.5	Chinchwad Metro Station	18°38'24.82"N	73°.15"E	DW
AAQ 6	Chinchwad (End of the Alignment)	18˚38’04.61’’ N	73˚47’56.11’’ E	CW

[#] *DW – Down-wind; CW – Cross-wind; UW – Up-wind.*

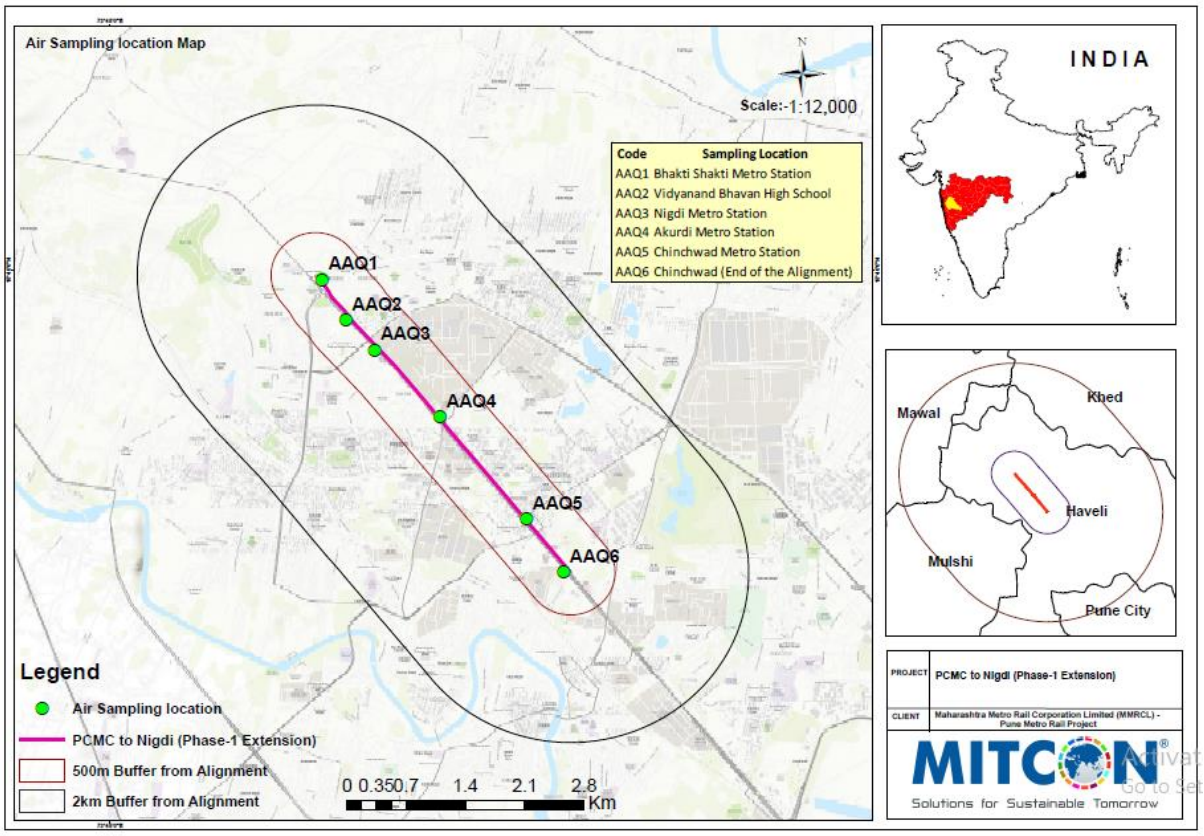

Figure 1: Air Monitoring Locations for PMRP-Phase I Project

(c) Ambient Air Quality Results

1. The air pollutants emitted by point and non-point sources are transported, dispersed or concentrated by meteorological and topographical conditions. **Table** shows a summary of the analytical results of Air Quality monitoring samples gathered in the Project Study Area.

Table 5: Summary of Results of Ambient Air Quality monitoring

Sampling	$PM_{2.5}$	PM_{10}	SO_2	NO_X	CO

Location	(60 µg/m³)	(100 µg/m³)	(80 µg/m³)	(80 µg/m³)	(2 mg/m³)
AAQ1	32.85	78.65	17.54	24.85	0.74
AAQ2	10.54	42.14	≤ 10	16.47	0.02
AAQ3	22.5	64.87	15.46	21.33	0.86
AAQ4	28.46	73.84	18.84	24.76	1.17
AAQ5	32.85	77.42	21.87	27.45	1.54
AAQ6	20.13	55.84	13.74	20.65	0.54

24-hour air quality monitoring results indicates that all parameters were within the permissible level of National Ambient Air Quality Standards (NAAQS). However, both PM10 and PM2.5 as well as NOx exceed the WHO guidelines and the WBG-EHS guidelines and SO2 exceed the WBG-EHS guidelines. The measured parameters were compared with the NAAQS laid down by CPCB, the WHO guidelines (2021 AQGs) as well as the WBG-EHS limits for ambient air quality (2007)

Anticipated Impacts during Operation Phase

During Operation Phase, the significant impact on air pollution will be due to operation of D.G. Set. However, D.G. Sets will be operated only in case of emergency power failure. Each station will be provided with 1 no. of D.G. Set of capacity 250 kVA as an emergency power back up.

Air modelling

It is to provide a means of calculating ambient ground-level concentrations of an emitted substance given information about the emissions and the nature of the atmosphere. The amount released can be determined from knowledge of the process or actual measurements. It is a steady-state plume model. In the stable boundary layer (SBL), it assumes the concentration distribution to be Gaussian in both the vertical and horizontal. In the convective boundary layer (CBL), the horizontal distribution is also assumed to be Gaussian, but the vertical distribution is described with a bi-Gaussian probability density function.

AERMOD constructs vertical profiles of required meteorological variables based on measurements and extrapolations of those measurements using similarity (scaling) relationships. Vertical profiles of wind speed, wind direction, turbulence, temperature, and temperature gradient is estimated using all available meteorological observations. AERMOD requires only a single surface measurement of wind speed, wind direction and ambient temperature. Like ISC3, AERMOD also needs observed cloud cover.

Input to the Model

Table 6: The input parameters required for carrying out Air Modelling are presented below table

Sr. No.	Particulates	DG Set 250 kVA
1.	Fuel Firing rate (lit/hr)	56.9
2.	Fuel Type	HSD
3.	Temperature (^{O}C)	550

4.	Volumetric Flow rate (Nm3/hr)	226.65
5.	Height (m)	20
6.	Stack dia.(m)	0.18
7.	Exit velocity (m/s)	12
8.	Emission Rate of PM10 (g/s) carried for impact Assessment	0.02
9.	Emission Rate of SO2 (g/s) carried for impact Assessment	0.07
10.	Emission Rate of NOx (g/s) carried for impact Assessment	0.44
11.	Fuel Used	Low sulphur fuel

* **Note –** The operation of all the DG sets has been considered simultaneously for 24 hours as worst-case scenario. Since Ash Content in HSD is 0.01%, PM2.5 is not emitted hence not considered for modelling.

Study Area

10 km radius study area has been considered from the centre of each alignment and the contours are plotted accordingly.

Meteorological Data

Meteorology data from IMD for Pune Station (nearest IMD Station) for the period of July and august, for wind speed, wind direction and temperature has been used for computations. Hourly atmospheric stability has been calculated. As the site-specific mixing heights are not available, the mixing height data as published by CPCB document PROBES/88/2002-2003 is followed for project area has been considered for modelling. A baseline monitoring of 24 hours was conducted in July and August during non-rainy days to determine the present conditions of the site. The same results have been used a background concentration.

Results & Discussion

The short-term ground level concentrations predicted for SPM within study area is presented Below

The isopleths of incremental concentration for PM_{10}, SO_2 & NO_X have been shown in below **Figure 1**. Cumulative concentration at the receptors due to operation of DG sets for PM10, SO2 & NOX have been shown in **Table 1** to **Table 3** below –

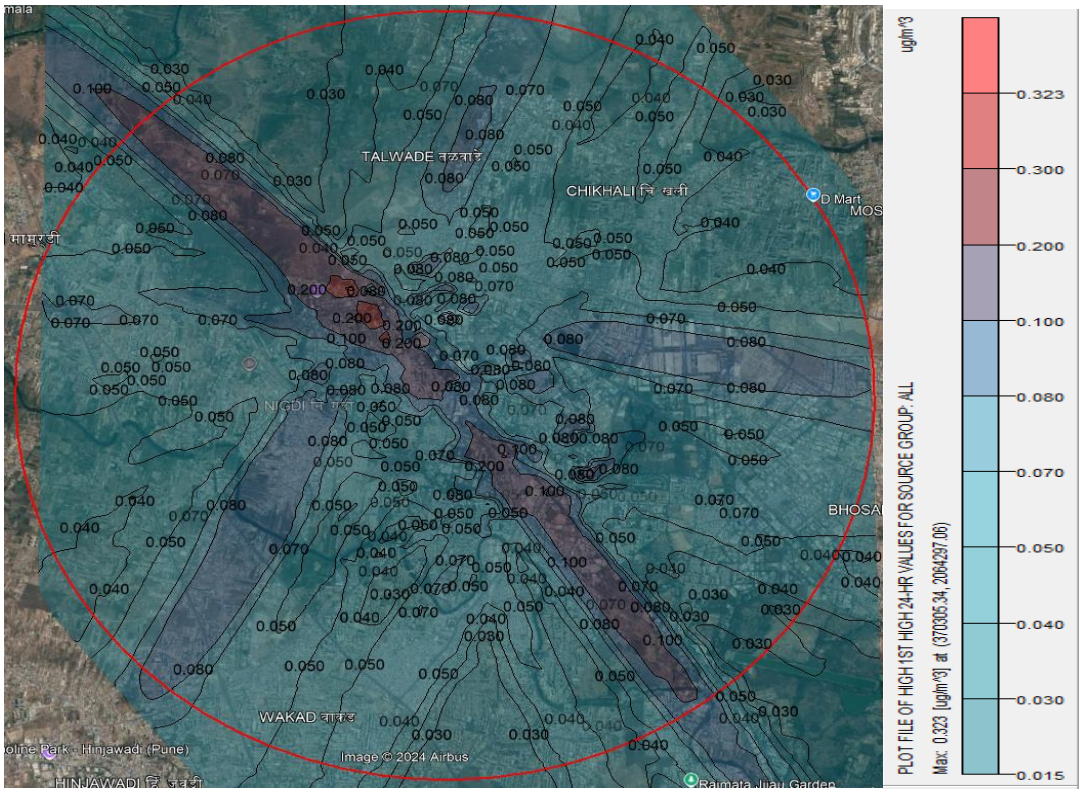

Figure 2: Isopleth of Incremental concentration of PM10

Table 7: Cumulative concentration of PM10

Sampling Location	Sampling Location	PM_{10} (100 µg/m³)	Incremental Concentration (µg/m3)	Total Concentration (µg/m3)
AAQ1	Bhakti Shakti Metro Station	78.65	0.323	78.97
AAQ2	Vidyanand Bhavan High School	42.14	0.2	42.34
AAQ3	Nigdi Metro Station	64.87	0.1	64.97
AAQ4	Akurdi Metro Station	73.84	0.2	74.04
AAQ5	Chinchwad Metro Station	77.42	0.3	77.72
AAQ6	Chinchwad (End of the Alignment)	55.84	0.1	55.94

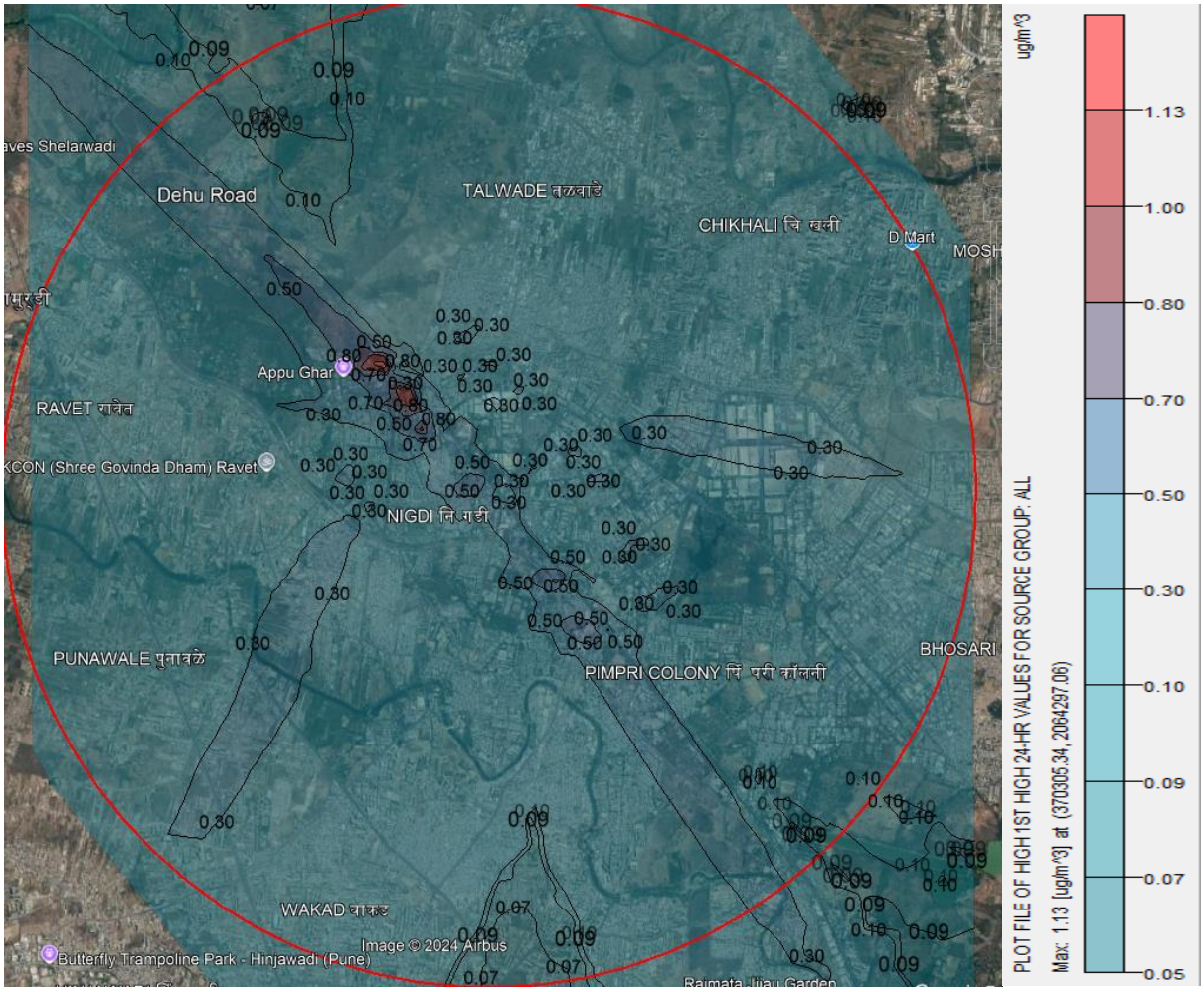

Figure 3: Isopleth of Incremental concentration of SO2

Table 8: Cumulative concentration of SO2

Sampling Location	Sampling Location	Baseline Concentration (µg/m3)	Incremental Concentration (µg/m3)	Total Concentration (µg/m3)
AAQ1	Vidyanand Bhavan High School	17.54	1.13	18.67
AAQ2	Nigdi Metro Station	<10	1.13	11.13
AAQ3	Akurdi Metro Station	15.46	1.0	16.46
AAQ4	Chinchwad Metro Station	18.84	0.8	19.64
AAQ5	Chinchwad (End of the Alignment)	21.87	0.7	22.57
AAQ6	Chinchwad (End of the Alignment)	13.74	0.7	14.44

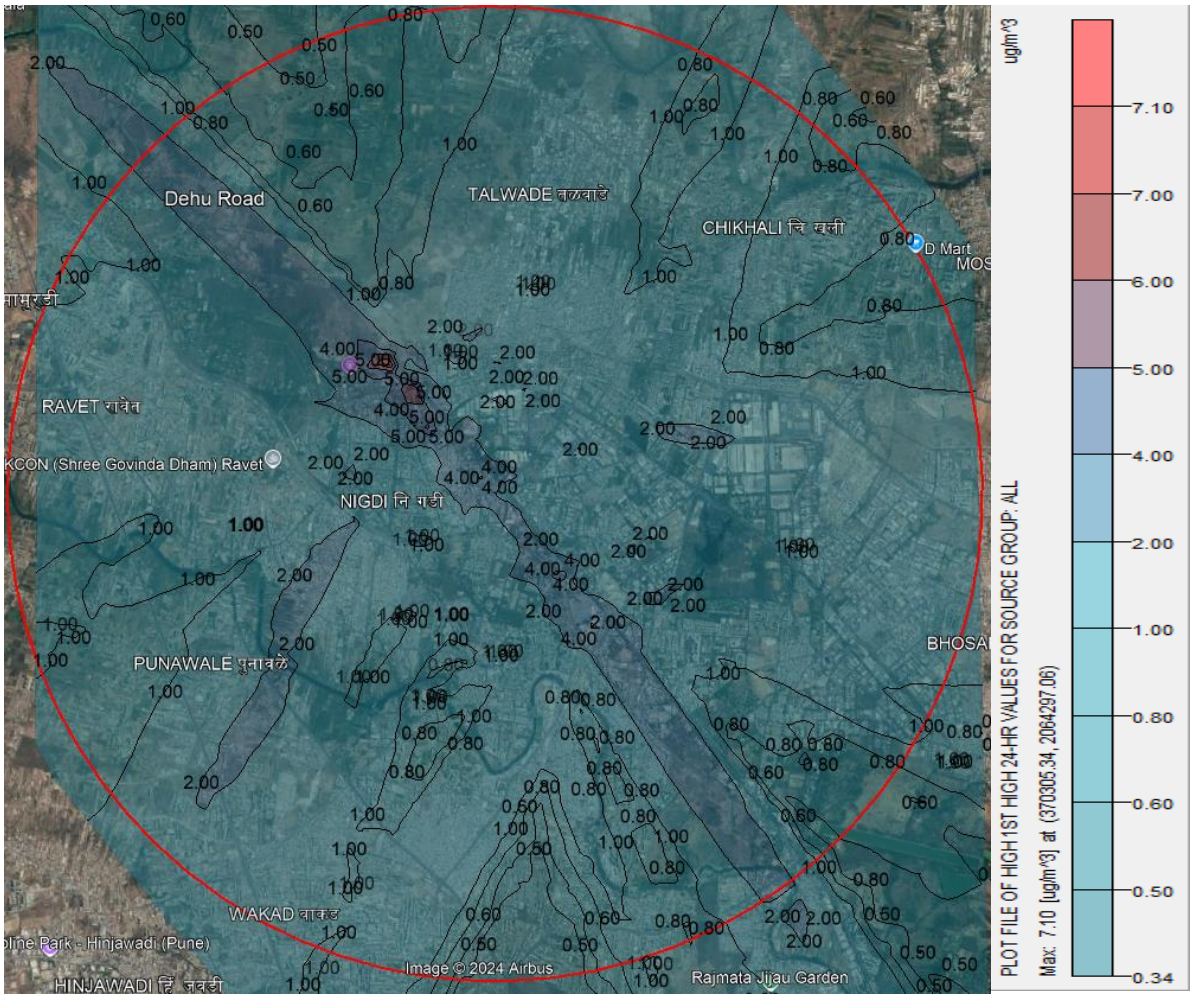

Figure 4: Isopleth of Incremental concentration of NOx

Table 9: Cumulative concentration of NOx

Sampling Location	Sampling Location	Baseline Concentration (µg/m3)	Incremental Concentration (µg/m3)	Total Concentration (µg/m3)
AAQ1	Vidyanand Bhavan High School	24.85	7.1	31.95
AAQ2	Nigdi Metro Station	16.47	5.0	21.47
AAQ3	Akurdi Metro Station	21.33	4.0	25.33
AAQ4	Chinchwad Metro Station	24.76	2.0	26.76
AAQ5	Chinchwad (End of the Alignment)	27.45	4.0	31.45
AAQ6	Chinchwad (End of the Alignment)	20.65	4.0	24.65

Conclusions:

The air quality modelling results provide an estimate of the short-term incremental ground-level concentrations of pollutants—namely PM_{10}, SO_2, and NO_x—arising from the operation of DG sets during the project's implementation. These incremental concentrations have been superimposed on the existing baseline levels to assess the total cumulative concentrations at various sensitive receptor locations. For PM_{10}, the highest incremental concentration observed was 0.323 µg/m³ at Bhakti Shakti Metro Station, leading to a total concentration of 78.97 µg/m³, which remains below the National Ambient Air Quality Standards (NAAQS) limit of 100 µg/m³ for PM_{10}. Similarly, for SO_2, the maximum incremental rise was 1.13 µg/m³, resulting in a total concentration of 18.67 µg/m³ at Vidyanand Bhavan High School, far below the NAAQS limit of 80 µg/m³. In the case of NO_x, the highest total concentration was recorded at Vidyanand Bhavan High School with a cumulative value of 31.95 µg/m³, also well within the NAAQS limit of 80 µg/m³. These results indicate that the predicted incremental impacts from project-related emissions are marginal in comparison to ambient standards, suggesting that the project's operation will not pose significant additional environmental or public health risks due to air quality deterioration at the assessed locations.

Recommendations:

- **Maintain Compliance with Standards**: Continue to monitor pollutant levels to ensure they remain within National Ambient Air Quality Standards (NAAQS), as current modelling shows only marginal increases.
- **Routine Maintenance of DG Sets**: Conduct regular servicing of diesel generator sets to reduce emissions and improve operational efficiency.
- **Use Cleaner Fuels**: Wherever feasible, replace conventional diesel with cleaner alternatives such as natural gas.
- **Install Green Buffers**: Develop vegetative barriers (trees or shrubs) around sensitive receptors such as schools and residential areas to help absorb airborne pollutants.
- **Implement Continuous Air Quality Monitoring**: Set up real-time air quality monitoring systems at key locations to track changes during construction and operation phases.
- **Enforce Occupational Health & Safety Measures**: Provide personal protective equipment (PPE) and safety training for workers exposed to air emissions.
- **Incorporate Emission Reduction Strategies in Project Planning**: Integrate environmental mitigation measures into the project execution plan, including scheduling high-emission activities during low-traffic periods.

Annexure- 7:

List of Sensitive Receptors

List of Sensitive Receptors

(List of community resources of Religious and cultural nature, and Sensitive Receptors within 150m from project Alignment)

Sr.	Description	Type	Distance from Nearest Proposed Metro Station	Direction	Latitude	Longitude
Physical Cultural Resources (PCR)						
1	Crystal Deck Roof Top	Banquet Hall	40m	E	18°38'53.49"N	73°47'15.49"E
2	Seasons Banquets Akurdi	Banquet Hall	40m	E	18°38'52.97"N	73°47'15.81"E
3	Amardham smashan bhumi nigdi	Cemetery	430m	E	18°40'3.63"N	73°46'28.76"E
4	Muslim Kabrastan	Cemetery	480m	E	18°40'5.31"N	73°46'30.91"E
5	Shankar Shetty Park	Garden	125m	E	18°38'39.14"N	73°47'32.55"E
6	Bhakti-Shakti Garden	Garden	40m	W	18°39'51.78"N	73°46'17.45"E
7	Maharana Pratap Garden	Garden	35m	E	18°39'34.73"N	73°46'39.29"E
8	Dmart Chinchwad	Shopping mall	34 m	E	18°38'13.39"N	73°47'50.39"E
9	Premier Plaza Mall	Shopping mall	37m	E	18°38'11.46"N	73°47'47.07"E
10	Gems Crystal Mall	Shopping mall	39m	W	18°38'52.92"N	73°47'15.46"E
11	Aishwaryam One	Shopping mall	32m	E	18°38'48.25"N	73°47'19.46"E
12	Vasant Center	Shopping mall	70m	W	18°38'17.03"N	73°47'41.04"E
13	Carnival Cinemas Chinchwad	Theater	95m	E	18°38'9.22"N	73°47'46.18"E
Sensitive Receptors						
14	Pratibha International School	Educational	607m	E	18°38'41.79"N	73°47'28.87"E
15	Urdu High School	Educational	92m	W	18°39'1.84"N	73°47'3.18"E
16	MANAPA School Akurdi	Educational	118m	W	18°39'1.87"N	73°47'1.66"E
17	Fakirbhai Urdu Primary School	Educational	81m	W	18°39'3.56"N	73°47'1.83"E
18	Vidyanand Bhavan High School Secondary section High school	Educational	75m	E	18°39'39.86"N	73°46'29.44"E
19	Novel's NIBR College of Hotel Management	Educational	145m	W	18°39'27.73"N	73°46'37.44"E
20	Pratibha Junior College	Educational	115m	E	18°38'41.87"N	73°47'27.33"E
21	Aegis Multispeciality Hospital	Health / Hospital	55m	W	18°38'57.27"N	73°47'12.19"E
22	Star Hospital Akurdi Pune	Health / Hospital	85m	W	18°39'6.23"N	73°47'0.47"E
23	Tongaonkar Hospital	Health / Hospital	150m	W	18°39'10.85"N	73°46'52.07"E
24	Diwan Hospital Pune	Health / Hospital	108m Nigdi station	W	18°39'35.91"N	73°46'39.27"E
25	Niranjan Nursing Home	Health / Hospital	90m	W	18°39'42.32"N	73°46'26.05"E
26	Hanuman & Shani Mandir,Chinchwad	Religious places	40m	E	18°38'5.63"N	73°47'56.00"E
27	Dakshin-Mukhi Ubha Maruti Temple, Akurdi	Religious places	45m	W	18°38'50.25"N	73°47'18.25"E
28	Khandoba Mandir, Akurdi	Religious places	50m	E	18°39'2.65"N	73°47'7.57"E
29	Tulja Bhavani Temple, Akurdi	Religious places	45 m	E	18°39'8.10"N	73°46'58.84"E
30	Shree Krishna Mandir, Nigdi	Religious places	85m	W	18°39'49.76"N	73°46'26.92"E
31	Riddhi Siddhi Ganesh Mandir,Akurdi	Religious places	38m	E	18°39'0.38"N	73°47'8.98"E

32	New Life Fellowship church, Chinchwad	Religious places	64m	E	18°38'12.65"N	73°47'51.54"E
33	St. Francis Xavier's Church Chinchwad	Religious places	29 m	E	18°38'37.08"N	73°47'29.33"E
34	Shri Mahalaxmi Aai Mandir.	Religious places	15m chinchwad station	E	18°38'20.83"N	73°47'42.47"E
Schools						
49	Urdu High School		85m	W	18°39'1.06"N	73°47'3.18"E
51	Fakirbhai Urdu Primary School		70m	w	18°39'3.56"N	73°47'1.83"E
54	Vidyanand Bhavan High School Secondary section High school		75m	E	18°39'39.86"N	73°46'29.44"E
Hospital						
61	Aegis Multispeciality Hospital		55m	W	18°38'57.27"N	73°47'12.19"E
64	Star Hospital Akurdi Pune		50m	W	18°39'6.23"N	73°47'0.47"E
66	Diwan Hospital Pune		70m	W	18°39'35.91"N	73°46'39.27"E
67	Niranjan Nursing Home		90m	W	18°39'42.32"N	73°46'26.05"E
Temple						
70	Hanuman & Shani Mandir		40m	E	18°38'5.63"N	73°47'56.00"E
72	Dakshin-Mukhi Ubha Maruti Temple		45m	E	18°38'50.25"N	73°47'18.25"E
73	Khandoba Mandir		50m	E	18°39'2.65"N	73°47'7.57"E
74	Tulja Bhavani Temple		45 m	W	18°39'8.10"N	73°46'58.84"E
75	Shree Krishna Mandir		85m	E	18°39'49.76"N	73°46'26.92"E
77	Riddhi Siddhi Ganesh Mandir		38m	E	18°39'0.38"N	73°47'8.98"E
78	Shri Mahalaxmi Aai Mandir.		25m	E	18°38'20.73"N	73°47'42.44"E
Garden						
81	Bhakti-Shakti Garden		40m	W	18°39'51.94"N	73°46'17.55"E
82	Maharana Pratap Garden		35m	E	18°39'34.64"N	73°46'39.32"E
84	shridhar nagar garden		1 km	W	18°37'55.42"N	73°47'16.25"E
Shopping centre / Mall						
87	Dmart Chinchwad		34 m	E	18°38'13.61"N	73°47'49.72"E
88	Premier Plaza Mall		37m	W	18°38'11.38"N	73°47'47.19"E
89	Gems Crystal Mall		39m	E	18°38'53.00"N	73°47'15.47"E
90	Aishwaryam One		32m	E	18°38'48.58"N	73°47'19.58"E
91	City One Mall		27m	E	18°37'58.19"N	73°48'2.09"E
92	Vasant Center		70m	W	18°38'17.30"N	73°47'41.70"E
Theatre						
94	Carnival Cinemas Chinchwad		95m	E	18°38'9.29"N	73°47'46.50"E
Banquet Hall						
95	Crystal Deck Roof Top Banquet Hall		40m	E	18°38'53.48"N	73°47'15.50"E
96	Seasons Banquets Akurdi		40m	E	18°38'53.01"N	73°47'15.82"E
Post Office						
98	Post Office Akurdi Pune		53m	W	18°39'14.39"N	73°46'53.29"Es

Annexure- 8:

Guidelines for Site Selection and Management

Annexure 8A : Guidelines for Site Selection and Management (Labour Camps & Construction Yards)

1. Purpose

Labour camps and construction plants represent the potentially most polluting locations during implementation of an infrastructure project. Air pollution may be caused by emissions from Crushers, Hot-Mix plants, Concrete Batching Plants and Casting Yards. Water pollution may be caused by discharge of sediment, oil & grease, and organics laden run-off from these plants and their ancillary facilities as well as workshops and residential quarters for the labour. Land may be polluted due to indiscriminate disposal of domestic waste or (accidental) release of hazardous liquids or solids from storage areas.

While the installation and operation of construction plants, in general, is regulated by the respective State Pollution Control Boards, detailed guidance on the environmental management aspects of the Contractor's campsites is often lacking. This guideline for site selection and management is designed to fill this gap.

2. Site Selection for Labour Camp and Construction Plant

The following guidelines are recommended to avoid any environmental issues while siting construction camps. Further specific guidance maybe taken from the relevant national / state regulations or conditions issued with the Consent to Establish:

- Labour camps, plant sites and debris disposal site are not located close to habitations, schools, hospitals, religious places and other community places. A minimum distance of 500 m must be maintained for setting up such facilities.
- Maintain a distance of about 1 km (or as per clearance conditions from forest department) from boundaries of designated Reserved Forests, Sanctuary or National Park area for locating any temporary or permanent camps.
- Maintain a distance of 1 km from any archaeological site.
- Maintain 500 m distance from river, stream, lake and ponds
- Maintain 200 m distance from the boundary of state and national highways.
- Locate facilities in areas not affected by flooding and clear of any natural or storm water courses.
- Locate facilities in the (most prevalent) downwind direction of nearest village(s). The boundary of the facilities should be at a suitable distance from the nearest habitation and in compliance with relevant national or state regulations such as the state pollution control board requirements so that the incoming labour does not stress the existing local civic facilities.
- The ground should have gentle slope to allow free drainage of the site.
- Recorded consultations should be held with residents of the nearest settlement and/or their representatives to understand and incorporate where possible, what they would like to see within their locality.
- While complying with the above, labour- and construction camps and muck and waste disposal sites must be located as close to the construction site as reasonably possible in order to minimize travelling distances.

3. Facilities at camps

During the construction stage of the project, the contractor will construct and maintain necessary (temporary) living accommodation, rest area and ancillary facilities for working staff & labour. Facilities required are listed and elaborated below.

- Site barricading
- Clean Water Facility
- Clean kitchen areas with provision of clean fuels like LPG, etc.
- Sanitation Facilities
- Waste Management Facilities

- Rest area for workers at construction site
- Adequate Illumination & ventilation
- Safe access road is required at camps
- Health Care Facilities
- Fire-fighting Facility
- Emergency Response Area

Site barricading: Site should be completely barricaded from all the sides to prevent entry of outsiders and animals into the site. Entry gate should be provided at each site, which should be guarded by security guard. All workers should be issued ID cards and entry of outsiders shall be maintained in the register at the gate. Board should be displayed at the site and the labour camp, the name of project, capacity of project, authority carrying out the project, restriction of entry without authorization, and no smoking zone and associated risks.

Clean water facility: Potable water shall be provided for working staff & construction labour for drinking & cooking purpose. Clean water shall be provided for bathing, cleaning and washing purpose. Water quality testing for water shall be carried out on quarterly basis.

Clean kitchen area: Provision of clean kitchen area for cooking and storage of eatables shall be provided. Clean fuels like LPG shall be provided for cooking purpose. Burning of firewood, garbage, paper and any other material for cooking or any other purpose shall strictly be prohibited at the site.

Sanitation facilities: Construction camps shall be provided with sanitary latrines and urinals. Toilets provided should have running water availability all the time. Bathing, washing & cleaning areas shall be provided at the site for construction labour. Washing and bathing places shall be kept in clean and drained condition. Workers shall be hired especially for cleaning of the toilets and bathing area. Septic tanks and soak pits shall be provided at site for disposal of the sewage generated.

Waste management facilities: Waste generated should be segregated at the site by providing the different colour bins for recyclable and non-recyclable waste. Recyclable waste shall be sold to authorized vendors and non-recyclable shall be handed over to authority responsible in area for waste management. Waste management for construction site shall be as per waste management plan proposed in EMP.

Rest area: A rest area / shelter shall be provided at the site for construction workers where they can rest after lunch time and shall not lay down at site anywhere. The height of shelter shall not be less than 3m from floor level to lowest part of the roof. Sheds shall be kept clean and the space provided shall be on the basis of at least 6×6 sq. feet per head.

Illumination and ventilation: Construction worker camps shall be electrified and adequately illuminated. Illumination level shall be maintained after 5.30 PM at the site to minimum 200 Lux. Labour camps shall be adequately ventilated. Fans shall be provided for ventilation purpose.

Access road: Temporary paved surface shall be constructed to approach the labour camp from the site. Movement shall not be hampered during monsoon season due to water logging and muddiness.

Health care facilities: First aid box, first aid room and personnel trained in first aid shall be available at labour camp and site all the time (24X7). A resident doctor shall be available at camp. Equipment in first-aid box shall be maintained as per State Factory's Law. Ambulance/ 4 wheeler motorized vehicle shall be available at the site for carrying injured to the nearby hospital. Tie-ups should be made with nearby hospital to handle emergency, if any. Nos. of ambulance, doctors and nearby hospital shall be displayed in first-aid room, site office & labour camps. Workers shall be made aware about the causes, symptoms and prevention from communicable diseases such as Covid-19 and HIV/AIDS through posters and awareness programs.

Firefighting: Fire-fighting facility such as sand filled buckets and potable fire-extinguishers shall be provided at labour camps and at site. Fire-extinguishers shall be provided as per NBC norms.

Emergency response area: Area shall be demarcated as emergency collection area near the gate where all the workers shall be guided to collect in case of any emergency like fire, flood and earthquake.

4. Activities prohibited at site

Activities which should be strictly prohibited at site shall include

- Open burning of wood, garbage and any other material at sit for cooking or any other purpose
- Disturbance to the local community.
- Operation of the plant and machinery between 10 pm to 6 am unless approved by team leader
- No animal (wild or domestic or bird) shall be harmed by any construction worker in any condition at site and nearby areas
- Cutting of tree without permission of team leader/authorized person
- No indigenous population shall be hurt or teased

5. Guidelines for night time working at the site.

No activity generating noise shall be carried out at the site after 10:00 PM. Night working protocol should be followed (if required) as per guidelines prepared by contractor and approved by the General Consultant (GC). Site should be well illuminated to maintain minimum illumination level of 200 Lux. Personnel working shall obtain permit to work from the team leader prior carrying out any work in night time and the record of such working shall be maintained in register. Any accidents, if occurs at site during night time working shall be immediately reported and recorded. Penalty shall be imposed on the contractor for the accident. Analysis shall be carried out to find the reason for such accidents for future learning.

6. Record keeping & Maintenance

Record of entry/exit of the people in the construction site and labour camp area shall be maintained in register at gate. Record of material coming in and going out from site also shall be maintained.

7. Auditing & Inspection

Conditions of labour camp and site shall be inspected and audit report shall be submitted to GC on monthly basis.

8. Establishment, Operation, and Closure of Camps and Plants

- The facilities within the camp and plant sites should be laid out so that the separation distances suggested in other guidelines are maintained.
- Topsoil from the area of the plant shall be stored separately for the duration of the operation of the camp and protected from being washed away, unless agreed otherwise in writing with the owner. If stored, it will be returned on to its original location at the time of closure of the site.
- The Contractor shall prepare, make widely available (especially to staff responsible for water and material management), and implement a Storm Water Management Plan (SWMP) for (all) the site(s) following approval of the same by the Engineer.
- The Contractor shall prepare an Emergency and Spill Response Plan to cover the spillage of fuel, oil, grease bitumen and/or chemicals like retarders, curing compounds, etc.
- The Contractor shall prepare a Waste Management Plan describing the types and quantities that are likely to be generated from within the camp site, with the period and duration during the construction schedule; methods to be adopted to minimize these; methods of removal, treatment and (on-site or off-site) disposal for each type; as well as location of final disposal site, if any.

- The Contractor shall provide safe ingress and egress for vehicles from the site and public roads and shall not impact existing through traffic.
- Water tankers with sprayers must be available at the camp site at all times to prevent dust generation.
- In case of stockpiles of stored material rising higher than wind-breaking perimeter fencing provided, sprinklers shall be available on site to prevent dusting from the piles during windy days.
- On completion of works, the Contractor shall restore the site to the condition it was in before the establishment of the campsite, unless agreed otherwise in writing with the owner(s) of the site(s). If such a written agreement has been made, the Contractor shall hand over the site to the owner(s) in accordance with such an agreement. Following measures are required to be taken during closure:
    - Septic tanks/soak pits should be dismantled
    - Any temporary/permanent structure constructed shall be dismantled
    - Construction/demolition waste, hazardous waste and municipal waste at site and labour camp site shall be disposed of as per waste management plan in EMP
    - The site shall be cleaned properly
    - Tree plantation to be carried out, if any required for stabilizing the area
    - Any pit excavated shall be filled back
    - Closure of the site and labour camp shall be approved by authorized person.
- Construction waste disposal should be disposed only at landfill facilities which are selected, designed, constructed and operated to ensure environmentally safe disposal, and these facilities have to be approved by the regulators.

9. Workshop and Maintenance areas

- These areas must have impervious flooring to prevent seepage of any leaked oil & grease into the ground. The area should be covered with a roof to prevent the entry of rainwater.
- The flooring shall be sloped towards from both directions to one corner where an oil-and-grease trap with sufficient capacity should be installed. All discharges from the workshop area must pass through the trap to remove the floating oil and grease before entering the drainage system of the site. The trap should be designed to provide a hydraulic residence time of about 20 minutes for the peak hourly discharge anticipated from the area (as per following figure).
- Alternatively, degreasing can also be carried out using mechanical spray type degreaser, with complete recycle using an enclosure with nozzles and two sieves, coarse above and fine below, may be used as shown in the adjacent photograph. This arrangement will require some initial investment and running cost for the pump, but the payback period, in terms of the use of diesel, under Indian conditions, has been reported to be less than 1 year.
- All the waste oil collected, from skimming of the oil trap as well as from the drip pans, or the mechanical degreaser shall be stored in accordance with the Environment Protection (Storage and Disposal of Hazardous Wastes) Rules, 1989. For this purpose, metallic drums should be used. These should be stored separately in sheds, preferably bunded. The advantage of this arrangement is that it allows for accurate accounting in case the waste material is sold to oil waste recyclers or other users like brick-kiln owners who can burn such inferior fuel.
- A separate vehicle washing ramp shall be constructed adjacent to the workshop for washing vehicles, including truck mounted concrete mixers, if any, after each day's construction is over, or as required. This ramp should have an impervious bottom and it should be sloped so that it drains into a separate chamber to remove the sediment from the wash water before discharge. The chamber should allow for a hydraulic residence time of about 10 minutes for discharge associated with the washing of each truck.

Annexure 8B : Guidelines for Muck Disposal

Muck generated from tunnelling and excavation of any project component is required to be disposed in a planned manner so that it takes a least possible space and is not hazardous to the environment. An account of the same has been given in the following paragraphs.

1. Criteria for selection of Muck Disposal Sites:

Based on the geological nature of the rocks and engineering properties of the soil, a part of the muck can be used as construction material. The remaining muck is to be disposed of at muck disposal sites. The identification of muck disposal areas is done in line with the topographic and site specific conditions.

The following points will be considered and followed as guidelines for finalization of the areas to be used as muck disposal sites:

- The dumping sites have been selected as close as possible to the project area to avoid long distance transport of muck.
- The dumping sites are located in already modified habitat.
- The sites are free from possibility of toe erosion and slope instability.
- The dumping sites are either at higher level than the flood level or are away from the river course so that the possibility of muck falling into the river is avoided at all times.
- There is no active channel or stream flowing through the dumping sites.
- The sites are far away from human settlement areas.

The muck that needs disposal is expected to be comprised of fragmented rock mixed with soil and would be piled at an angle of repose less than 30° at the proposed dumping sites. For this, the slopes would be broken up by creating benches across the slope. This will be done to provide stability to the slopes and also to provide ample space for planting trees, which would further help in holding and consolidating the material stacked at different sites. The description regarding the stabilization of the stacked material along the proposed roads has been discussed in the following paragraphs.

The options like dumping muck in stages and allowing it to consolidate/settle through the monsoon, compacting the dumped muck with Dozer movement, zoning the dump judiciously to ensure the stability of 30° slope under all superimposed conditions will be utilised.

2. Methodology of Dumping

The main objectives of process of muck dumping and restoration of these muck disposal sites are:

- to protect and control soil erosion;
- to create greenery in the muck disposal areas;
- to improve and develop the sites into recreational sites;
- to ensure maximum utilization of muck for the construction purpose;
- to develop the muck disposal sites/ dumping yards to blend with the surrounding landscape; and,
- to minimise damages due to the spoilage of muck in the project area.

The generated muck will be carried in dumper trucks covered with heavy duty tarpaulin properly tied to the vehicle in tune with international practice. All precautionary measures will be followed during the dumping of muck. All dumpers will be well maintained to avoid any chances of loose soil from being falling during the transportation. All routes will be periodically wetted with the help of tanker prior to the movement of dump trucks. Dumping would be avoided during the high speed wind, so that suspended particulate matters (SPM) level could be maintained. Further, transportation will be avoided during heavy traffic. After the dumping the surface of dumps will be sprayed with water and then compacted.

A retaining wall shall be constructed prior to dumping of muck. Loose muck would be compacted layer-wise. The muck brought by dumpers will be spread in layers behind the wire crate walls and then compacted by rollers till the top level is achieved. The retaining wall shall be laid with proper berm and the muck dumped behind it in layers and compacted by rollers. The process shall be repeated up to 50 cm level below the desired height which shall be laid with good soil for providing grass cover. At a regular vertical interval of 1.5 m and 3.0 m c/c masonry drains (catch water drains) shall be provided to drain off the rain water. Proper fencing of the entire area will be done. The muck disposal area will ultimately be covered with fertile soil and suitable plants will be planted adopting suitable bio-technological measures. The project authorities would ensure that the dumping yards blend with the natural landscape by developing the site with gentle slope, patches of greenery in and around them. These sites can also be developed later as recreational parks and tourist spots with sufficient greenery by planting trees.

All measures would be adopted to ensure that the dumping of muck does not cause injury or inconvenience to the people or the property around the area. The spillage of muck into water bodies must be prevented at any site, if necessary by making concrete retaining walls to retain the muck pile. It shall be ensured that dumping is carried out at a minimum distance of 50 m away from any water body. The top surface would be levelled and graded after the capacity of any dumping site is exhausted. The top surface will be covered with soil and grass seeding will be ensured to promote vegetation cover.

Annexure 8C : Guidelines for Construction Waste Disposal

1. Purpose:

Solid waste will be generated from the construction site and labour camps during the construction phase. To maximize re-use of material generated during construction and to avoid environmental hazards due to improper disposal of construction waste material the following procedures should be followed for upkeep of storage and disposal sites.

2. Procedure:

- • Municipal waste will be generated from labour camp. Dustbins for recyclable and non-recyclable waste shall be provided in labour camp area. Recyclable waste shall be sold to authorized vendors on a regular basis and non-recyclable shall be disposed off through authorized agency in area responsible for waste collection and management;
- • Construction waste should be segregated into recyclable and non-recyclable waste. Recyclable waste shall be stored in the covered area and shall be sold to authorized vendors on a regular basis. Non-recyclable waste shall be disposed off at approved sites, transported in covered vehicles;
- • Disposal sites shall not contaminate ground water or any surface water sources, therefore the site should be located away from water body and disposal site should be lined properly to prevent infiltration of water;
- • Contractor shall maintain register for keeping records on kilometer-wise quantities of material generated during demolition, excavation and any other activity that generates debris;
- • Contractor shall re-use construction material to the extent possible based on engineering properties. Possible re-use areas are fill sections, embankment slope, approach roads etc. Debris without bitumen could be used for backfilling of quarry / borrow areas as recommended by the GC. At locations identified for dumping of residual bituminous wastes, the dumping shall be carried out over a 60mm thick layer of rammed clay so as to eliminate the possibility of the leaching of the wastes into the ground water. The contractor shall ensure that the filled area is covered with a layer of preserved topsoil.
- • Contractor shall prepare a plan including detailed lay out and cross-section for disposal of debris and bitumen waste and get approval of the same by the GC;
- • Bentonite slurry or similar debris generated from pile driving or other construction activities shall be disposed such that it does not flow into the surface water bodies or form mud puddles in the area;
- • Contractor and GC shall ensure that disposal areas are properly treated as per agreed plan;
- • Contractor and GC's representatives shall undertake joint weekly inspection to ensure compliance of various environmental requirements.
- • GC's representatives shall issue non-compliance if disposal site is not managed as per agreed plan;
- • All arrangement for transportation during construction including provision, maintenance, dismantling and clearing debris, where necessary will be considered incidental to the work and should be planned and implemented by the contractor as approved and directed by the GC.
- • Construction waste disposal should be disposed only at landfill facilities which are selected, designed, constructed and operated to ensure environmentally safe disposal, and these facilities have to be approved by the regulators. Contractor shall dispose of
- waste strictly at fully legally compliant and approved site/s only. Record of all such sites should be maintained along with the area of disposal site, type & quantity of material disposed of daily and capacity of disposal site.

Annexure-9:

Guidelines/Tasks for GC in implementation of ESMP and EMoP

Annexure 9 - Terms of Reference of General Consultant in Implementation of EMP and EMoP

1. Review and update EIA including EMP and EMoP as appropriate; incorporate necessary technical specifications following design and contract documentation;
2. Assist MahaMetro in preparation of documents and taking necessary procedures in accordance with in the EIA Report for the Project, if any;
3. Assist MahaMetro in dissemination and explanation of additionally confirmed and identified environmental issues to public including holding public consultations;
4. Assist MahaMetro in obtaining necessary permits from relevant authorities and/or departments in accordance with the planned implementation schedule stated in the EIA Report;
5. During the preparation of bidding documents, clearly include environmental responsibilities as explained in the EIA Report and EMP as "Environmental Contract Specifications (ECS)";
6. Ensure that designs and construction methods provide for, as per the EMP, environment-friendly building materials, reuse, resource saving and climate adaptation elements like natural ventilation, solar power installations and rain water harvesting; piling methods and track design which minimize noise and vibration;
7. Ensure the primary baseline data of environmental elements are in place prior to mobilization;
8. Assist MahaMetro in reviewing the Contractor's Environmental Program (CEP) to be prepared by the contractor in accordance with EIA, EMP, ECC (Environmental Compliance Certificate) and ECS, relevant plans, conditions set out in relevant permits and clearances and Funding Agencies' Environmental Policy and to make recommendations to MahaMetro regarding any necessary amendments for its approval;
9. Assist MahaMetro to implement the measures identified in the EMP;
10. Monitor the effectiveness of EMP and negative impacts on environment caused by the construction works and provide technical advice, including a feasible solution, so that MahaMetro can carry out improvement when necessary;
11. Monitor compliance with the requirements under EMP and Funding Agencies' Environmental Policy. Submit the Environmental Monitoring Report to MahaMetro at every month after the commencement of the services until the completion of the Project. After the completion of the Project, the Report will be submitted **semi-annually for two (2) years**. The Environmental Monitoring as per Funding Agencies E&S templates will be filled and attached to the Report;
12. After verifying the Environmental Monitoring Report by MahaMetro, assist submitting the report to Funding Agencies as part of the Progress Status Report at every **three months** after the commencement of the services until the completion of the Project and **semi-annually for two (2) years** after the completion of the Project;
13. Assist MahaMetro in preparation of the answer to the request from Funding Agencies for environmental considerations if necessary;
14. Assist MahaMetro in facilitating stakeholder's participation (including focus group discussions for vulnerable PAPs) and providing feedbacks on their comments regarding EMP and EMoP;
15. Supervise Contractor's activities to check compliance with CEP and prepare periodic monitoring reports;
16. Assist MahaMetro to establish a multi-layer Grievance Redress Mechanism (GRM) including Grievance Redress Committee (GRC) to resolve the Grievances of environment, health and safety matters in a timely manner;
17. Assist MahaMetro in the capacity building of MahaMetro staff on environmental management through on-the-job training on environmental assessment techniques, mitigation measure planning and implementation, supervision and monitoring, and reporting;
18. At the completion of project, (a) undertake final environmental monitoring and evaluation against the set indicators, (b) evaluate sustainability of environmental benefits associated with the project, taking into account both positive and negative impacts associated with the project, and (c) prepare an evaluation report for the project002E

Annexure-10:

Bidding documents for the design and construction of PCMC to Nigdi project including Maha Metro's Safety, Health & Environment (SHE) Manual

MAHARASHTRA METRO RAIL CORPORATION LIMITED

(PUNE METRO RAIL PROJECT, PHASE-1 Extension)

BID DOCUMENTS

FOR

Name of work:

Design and Construction of Elevated Viaduct of Length 4.519 Kms from CH: (-)1079.899m to CH: (-)5599.298m between PCMC and NIGDI on the North-South Corridor of Pune Metro Rail Project- Reach1- Extension.

Tender No. P1A-C-01/2023

PART 3:
CONDITIONS OF CONTRACT AND CONTRACT FORMS
Section XI: SHE Manual

Maharashtra Metro Rail Corporation Limited

Civil Court Metro Station, Nyayamurti Ranade Path, Pune-411005, Maharashtra, INDIA

E-mail: tenders.pmrp@mahametro.org
Website: www.punemetrorail.org

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PART I: SHE MANAGEMNT

1.0 GENERAL

1.1 Scope

1.1.1 This document defines the principal requirements of the Employer on Safety, Health, and Environment (SHE) associated with the Contractor / sub-contractor and any other agency to be practiced at construction worksites at all time.

1.2 Definition / languages

1.2.1 The Environmental Quality Management Manual (EQM) forms an essential part of the overall Environmental Protection System employed by Maha-Metro for the construction of Pune Metro Rail Project.

1.2.2 Definition & Abbreviations

a) **"Environment"** means the total surroundings of an organism including water, air and land and other living creatures.

b) **"Environmental Pollutant"** means any solid, liquid or gaseous substance present in such concentration as may be or tend to be injurious to environment.

c) **"Environmental Pollution"** means the presence in the environment of any environmental pollutant.

d) **"Nuisance"** is annoyance, which results from any construction activity that affects the material comfort and quality of life of the inhabitants of the area surrounding the construction site.

e) **"Monitoring"** is the use of direct or indirect reading field instrumentation to provide information regarding the levels of pollutants released during construction.

f) **"Construction Site"** is the contract limits for construction. It shall be all the area within the limits of the work as shown on the Plans. Construction Site shall also include staging, and debris disposal areas and transportation routes to and from these areas.

g) **"Noise"** is any unwanted sound disturbance of the environment around the area of construction operations.

h) **"Decibel"** is a measure on a logarithmic scale of the magnitude of a particular quantity (such as sound pressure, sound power) with respect to a standardized reference quantity.

i) **"A - weighted Noise levels"** in Decibels (referenced to 20 micro-Pascal) as measured with A-weighting network of standard sound level meter, abbreviated dB (A).

j) **"Energy Equivalent Level (L_{eq})"** is the level of a steady noise which has the same energy as the fluctuating noise level integrated over the period of measurement. **L_{max}** is the maximum Noise Level during the period of measurement. **L_{10}** and **L_{90}**are the percentile exceeding levels of sound which is exceeded 10% and 90% of the time of measurement.

k) **"Waste"** is unwanted surplus substance arising from the application of all construction operations and any substance or article, which is required to be disposed.

l) **"Suspended Particulate Matter"** is abbreviated as SPM and measured in $\mu g/m^3$.

m) **"Environmental Quality Management Manual"** is abbreviated as **EQM**.

n) **"Air Monitoring and Control Plan"** is abbreviated as **AMCP**.

o) **"Noise Monitoring and Control Plan"** is abbreviated as **NMCP**.

p) **"Ministry of Environment and Forests, Government of India"** is abbreviated as **MOEF**.

q) **"Central Pollution Control Board"** is abbreviated as **CPCB**.

r) Notwithstanding the definition of "Site" of Clause 1.1.6.7 of the GCC and in the context of the present specification the ESHS specifications, the word "Worksite(s)" means: The land where work will be carried out, or

i. the land necessary for the implantation of Worksite facilities (work camp, workshops, offices, storage areas, concrete production plants) and including special access roads, or

ii. quarries for aggregates, rock material and riprap, or

iii. borrow areas for sand and other selected material, or

iv. stockpiling areas for backfill material or other demolition rubble, or

v. any other location, specifically designated in the Contract as a Worksite

The term « Worksite(s) » encompasses any individual Worksite or all Worksites.

1.2.3 In this document:

i. The use of **"shall'** indicates a mandatory requirement.

ii. The use of **"should"** indicates a guideline that is strongly recommended.

iii. The use of **"may"** indicates a guideline that is to be considered.

iv. **"SHE"** means Safety, Health, and Environment.

v. **"Employer"** means Maharashtra Metro Rail Corporation Limited or Maha-Metro

vi. **"Chief Safety Officer"** means an officer nominated by Maha-Metro who is overall responsible for monitoring all SHE functions prescribed in this document.

vii. **"BOCWA"** means Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996

viii. **"BOCWR"** means Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Central Rules, 1998

ix. **"DG"** means Director General of Ministry of Labour, Govt. of India.

x. **"BOCWWCA"** means Building and Other Construction Workers' Welfare Cess Act, 1996

xi. **"BOCWWCR"** means Building and Other Construction Workers Welfare Cess Rules 1998

xii. "MBOCWR" means Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2003

xiii. **"Notifications"** (Central and state) – collection of cesses.

xiv. "**CIIBC**" means Chief Inspector of Inspection of Building and Other Constructions of Government of Maharashtra

xv. "HIRA" means Hazard Identification and Risk Assessment

1.3 Application of this document

1.3.1 This document applies to all aspects of the Contractor's scope of work, including allaspects conducted by sub-contractors and all other agencies. There shall be no activity associated to the Contract, which is exempted from the purview of this document.

Pursuant to Clause 4.4 of the GCC, the Contractor is fully liable for all actions, non-compliance and negligence by subcontractors, their representatives, employees, and workers, to the same degree as it would be held liable for its own actions, non-compliance or negligence or that of its own representatives, employees or workers.

1.3.2 The present SHS specifications apply to the Contractor and unless explicitly agreed with the engineer, all subcontractors used for the execution of the works. Pursuant to Clause 4.4 of the GCC, the Contractor is fully liable for all actions, non-compliance and negligence by subcontractors, their representatives, employees and workers, to the same degree as it would be held liable for its own actions, non-compliance or negligence or that of its own representatives, employees or workers.

1.3.3 "The SHE specifications refer to:

a) Protection of the natural environment (water, air, soil, vegetation, biological diversity) in areas adjacent to the Worksite, access roads, quarries, borrow areas, stockpiling of backfill material, labour camps or storage areas,

b) Health and safety conditions to be maintained for the Contractor's personnel and any other person present on the Worksites, or along access routes,

c) Working practices and the protection of people and populations living near the Worksite, but exposed to the general disturbance caused by works

1.4 Purpose of this document

1.4.1 The objective of these guidelines is to ensure that adequate precautions are taken to avoid accidents, occupational illness, and harmful effects on the environment during construction.

1.4.2 This document:

i. Describes the SHE interfaces between Employer and the Contractor

ii. Details the processes by which the Contractor shall manage SHE issues while carrying out the work under the Contract.

iii. Describes by reference, the practices and procedures as given in the Maha-Metro Project Safety, Health & Environment Manual for best SHE performance.

1.4.3 These requirements shall be read together with **Maha-Metro's Project SHE Manual** as amended/revised time to time and all ammendments/revisions during the execution of the work shall also be applicable, **ISO 45001-2018** Occupational Health and Safety Management System and **ISO 14001: 2015** Environmental Management Systems. Definition of key terms used in these requirements related to **ISO 45001-2018** and **ISO 14001:2015** standards are found in Maha-Metro's Project SHE Manual.

2.0 'SHE' TARGETS AND GOALS

2.1 The SHE targets, goals and aim for the Works are to achieve:

(i) Zero total recordable injuries.

(ii) Zero reportable environmental incidents

(iii) All personnel inducted in accordance with the approved contractor's SHE plan.

(iv) Total compliance of conducting inspections and audits as per approved SHE plan

(v) 100% incident recording and reporting

(vi) 100% adherence of usage of appropriate PPEs at work

(vii) Executing construction work with least disturbance to the environment, adjoining road users and traffic.

3.0 COMPLIANCE

3.1 Memorandum of Understanding (MOU)

3.1.1 A Memorandum of Understanding placed at Appendix No. 1 shall be executed before the award of Contract by the Contractor with regard to various provisions on Safety, Health, and Environment to be practiced during the construction work.

3.2 Maha-Metro's SHE Policy and Management Systems

3.2.1 The construction works shall be undertaken in accordance with Maha-Metro's SHE Policy and Management Systems as amended from time to time provided in Project, SHE Manual.

3.3 Indian statutory requirements

3.3.1 Primary statutory regulations

3.3.1.1 Contractor shall develop thorough understanding about Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996, Central Rules 1998, The Building & Other Construction Workers Welfare Cess Act 1996 and Central Welfare Rules 1998, Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2003, Building and Other Construction Workers Welfare Cess act 1996 and Central Rules 1998, Notification [Central & State] – Collection of Cess, not only to satisfy the Inspectors' perspective but the use of legislation as the strong tool for effective SHE management at construction worksites. Contractor is strongly advised to practice the principle of voluntary compliance.

3.3.1.2 In order to facilitate the Contractor for better understanding on the various provisions of the above Act and Rules, a tabulated information highlighting the Sections/Rules referring to the corresponding registration of Contractors, maintenance of registers and records, hours of work and wages, cess & welfare, medical facilities, and safety requirements are given in Appendix No. 2. It is an indicative one and not a limiting list.

3.3.2 In addition, the construction works shall be undertaken in accordance with all applicable legislation and Indian statutory requirements listed below but not limiting to:

(i)	Indian Electricity Act 2003 and Rules 1956 and its amendments
(ii)	National Building Code, 2005 and its amendments
(iii)	Factories Act, 1948, Maharashtra Government Factories Rules, 1963 and its amendments
(iv)	Motor Vehicles Act as amended in 1994 and The Central Motor Vehicles Rules, 1989
(v)	The Motor Transport Workers Act 1961 &Maharashtra Rules 1965 and its amendments
(vi)	Indian Road Congress Code IRC: SP: 55-2001 'Guidelines on Safety in Road Construction Zones'
(vii)	The Petroleum Act, 1934 and Rules 1976 and its amendments
(viii)	Gas Cylinder Rules, 2003 and its amendments
(ix)	Indian Explosives Act, 1884, along with the Explosives Substance Act 1908 and the Explosives Rules 1983
(x)	The (Indian) Boilers Act, 1923 and its amendments
(xi)	The Public Liability Insurance Act 1991 and Rules 1991 and its amendments
(xii)	Minimum Wages Act, 1948 and The Minimum Wages (Maharashtra Rules) 1961 and its amendments
(xiii)	The Contract Labour (Regulation & Abolition) Act 1970 & The Contract Labour (P&R) (Maharashtra) Rules, 1972 and its amendments
(xiv)	The Child Labour (Prohibition & regulation) Act 1986 and Maharashtra Rules 1994 and its amendments
(xv)	Environment Protection Act, 1986 and Rules 1986 and its amendments
(xvi)	Air (Prevention and control of Pollution) Act, 1981 and its amendments

(xvii) Water (Prevention and Control of Pollution) Act, 1974 and its amendments

(xviii) The Noise Pollution (Regulation & Control) Rules, 2000 and its amendments

(xix) The Maharashtra (Urban Areas) Preservation of Trees Act, 1975 and its amendments

(xx) Notification on Control of Noise from Diesel Generator (DG) sets, 2002 and its amendments

(xxi) Recycled Plastic Usage Rules, 1998 and its amendments

(xxii) Notification, Central Ground Water Board, Act January 1997 and its amendments

(xxiii) The Manufacturing, Storage, and Import of Hazardous Chemical Rules, 1989 and its amendments

(xxiv) Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996 and its amendments

(xxv) The Hazardous Waste (Management, Handling& Trans-boundary Movement) Rules, 2007 and its amendments

(xxvi) Relevant Rules / Guidelines regarding Preservation of Trees

(xxvii) Batteries (Management and Handling) Rules and its amendments

(xxviii) Fly ash utilization notification, Sept 1999 as amended in August 2003 and its amendments

(xxix) Guidelines of Pune Urban Development Authority

(xxx) Guidelines of Maharashtra Pollution Control Board

Further, Contractor shall apply and take various clearances from the concerned agencies as presented in Table below: These clearances are indicative and contractor is required to take any other clearance as required for its construction activities.

Table: Key Clearance Required

Permission/ Clearance/Permit	Relevant Acts/Rules	Concerned Agency
Consent to Establish and Consent to Operate batching plants,casting yards, grouting plant, Hot Mix plant, if any	• The Water (Prevention and Control of Pollution) Act, 1974, amended 1988 and • The Air (Prevention and Control of Pollution) Act 1981, amended 1987	Maharashtra Pollution Control Board (MPCB)
Authorization for generation, handling, storage and transportation hazardous waste	Hazardous and other Wastes (Management & Transboundary Movement) Rules, 2016 and its amendments	Maharashtra Pollution Control Board (MPCB)
Permission for extraction of ground water	Environment (Protection) Act, 1986/Central Ground Water Authority guidelines	Central Ground Water Authority
Pollution Under Control Certificate	Central Motor and Vehicle Act 1988 Vehicular Exhaust Norms, CPCB 2007	Department of Transport, Maharashtra
C&D Waste Management Plan	Construction & Demolition Waste Management Rules, 2016	Local Authority (Municipal Corporation)

3.3.3 Workman Compensation Act, 1923 along with allied Rules

The Contractor shall ensure that all his employees / workmen are covered under 'Workmen Compensation Act' and shall pay compensation to his workmen as and when the eventuality for the same arises.

3.3.4 Notwithstanding the above Act/Rules, there is nothing in those to exempt the Contractor from the purview of any other Act or Rule in Republic of India for the safety of men and materials.

3.3.5 If the requirements stated in this document are less stringent than or in conflict with the country's applicable legislation, the latter shall apply.

3.4 International Standards, Guidelines & ISO Certifications

3.4.1 The Contractor complies with norms, standards and discharge limit values recommended by the specialised international organisations affiliated to the United Nations, as described in relevant clause below.

3.4.2 The specialised international organisations affiliated to the United Nations referred in relevant clause include:

- World Bank, including the IFC and its Environmental, Health and Safety guidelines available from http://www.ifc.org/ehsguidelines

For matters not addressed in the IFC above document, the norms, standards, and discharge limit values of the following institutions shall apply:

- World HealthOrganization (WHO)
- Internaitonal Labour Organization (ILO) (in particular in pursuance to Clauses 6.20, 6.21, 6.23 and 6.24 of the GCC)
- International Maritime Organization (IMO)

3.4.3 The works should be undertaken in accordance with the applicable international guidelines, standards and specifications on SHE and every contract shall aim to achieve ISO certifications listed below during the currency of the contract:

ISO 45001-2018 : Occupational Health and Safety Management System.
ISO 14001-2015 : Environmental Management Systems.

3.4.4 The process of certification shall start immediately after the award of the work and to be completed within 4 months' timeline. Towards this, the Contractor shall undertake the required steps including appointment of ISO consultant for obtaining the certification on Occupational Health and Safety Management System and Environment Management System. The certification shall be maintained throughout the currency of the contract.

3.1 In case of failure on the part of the Contractor, the Employer at the cost of the Contractor shall do the same.

3.5 Method Statement and Risk Assessment

3.5.1 Method Statement should be submitted by the Contractor. The Method Statement should include activity list, job step, equipment list, HIRA (Hazard Identification and Risk Assessment) etc.

3.5.2 Method statements shall be submitted to the Engineer **Twenty-One (21)** days prior to commencement of task.

3.5.3 Method statements shall incorporate control measures within the process methodology as identified within the risk assessment.

3.5.4 Risk Assessment should be work-site and Situation specific; a Generic format shall not be acceptable.

3.5.5 Risk Register & Hazard Log

(i) A proper record of monitoring and control of Risk Assessment and appropriate control measures shall be maintained at site, which shall be produced when asked for.

(ii) All applicable Method Statement and Standard Operating Procedure confirming to the work and site requirement is an essential control measure. The contractor shall ensure submission of Method Statement along with applicable requisite procedures as part of SHE Plan well in advance as mentioned herein before commencement of work. The Hazard Log with Risk Assessment shall identify future method statement and operational procedures pertaining to specific equipment, operations, and local environmental constraints. OHS&E Plans for execution of work, shall not be accepted without the completed Hazard Log and Risk Register.

4.0 CONTRACTOR ENVIRONMENT HEALTH AND SAFETY POLICY AND PLAN

4.1 The contractor as per rule 39 of the BOCW central rule shall formulate a Safety & Health policy in line with Maha-Metro's policies and display it at conspicuous places at work sites in Hindi and a local language understood by the majority of construction workers. The policy shall contain the following as minimum coverage:

i. The intention and commitments of the establishment regarding health, safety and environment protection of the workers
ii. Organisational arrangement made to carry out the policy specifying the responsibilities at different levels of hierarchy
iii. Responsibilities of the contractors, sub-contractor, transporter or other agencies involved in the construction work
iv. Techniques and methods for assessment of risk to safety and health and remedial measures
v. Arrangement for training of works, supervisors or other persons engaged in the construction work
vi. Other arrangement for making the policy more effective

4.2 Contractor shall revise the policy whenever any modification having implication on the safety and health of the workers is made or any new construction work, substances, or technique are introduced which have implication on health, safety of workers

4.3 Within Eight weeks from date of contract agreement, the Contractor shall submit a detailed and comprehensive Contract specific site Safety & Health Plan. The Safety & Health Plan shall include detailed policies, procedures and regulations which, when implemented, will ensure compliance of the contract provisions as well as statutory regulations. The Safety & Health Plan shall include the following but not be restricted to:

I. A statement of the Contractor's policy, organization and arrangements for Safety & Health

II. The name(s) and experience of person(s) within the Contractor's proposed management who shall be responsible for coordinating and monitoring the Contractor's Safety & Health performance;

III. The number of Safety & Health staff who shall be employed on the Works, their responsibilities, authority and line of communication with the proposed Contractor's agent;

IV. A statement of the Contractor's policy and procedures for identifying and estimating hazards, and the measures for addressing the same;

V. A list of Safety & Health hazards anticipated for this Contract and sufficient information to demonstrate the Contractor's proposals for achieving effective and efficient health and safety procedures;

VI. A description of the Safety & Health training courses and emergency drills which shall be provided by the Contractor, with an outline of the syllabus to be followed;

VII. Details of the safety equipment which shall be provided by the Contractor, including personal protective equipment;

VIII. A statement of the Contractor's policy and procedures for ensuring that Contractor's Equipment used on the Project Site are maintained in a safe condition and are operated in a safe manner;

IX. A statement of the Contractor's policy and procedures for ensuring that sub- contractors comply with the Contractor's safety plan;

X. A statement of the Contractor's disciplinary procedures with respect to Safety & Health related matters;

XI. A statement of the Contractor's procedure for reporting and investigating accidents, dangerous occurrences or occupational illnesses;

XII. Detailed Standard Operating Procedures (SOP)/Safe Work Procedures (SWP) for every activity likely to be undertaken as well as for use and maintenance of Plant, Machines & Equipment shall be made as part of Safety & Health Plan;

XIII. Contract shall formulate format like work permit etc. and made checklist for activity involving risk as well as for using plant & machines/equipment's.

4.4 The Contractor shall formulate an Environment Policy in line with Maha-Metro Environment and other policies and display it at conspicuous places at work sites in Hindi and a local language understood by the majority of construction workers.

4.5 Within Eight weeks of the notification of acceptance of the tender, contractor shall submit a detailed and comprehensive contract specific site Environmental Plan. The Environment Plan shall include detailed policies, procedures and regulations which, then implemented, will ensure compliance of the contract provisions.

4.6 The site Environment Plan shall include the following but not be restricted to:

(i) Within the period defined above, the contractor shall submit a draft contract specific Site Environment Plan for the approval of the Maha-Metro/Engineer and a final version prior to the commencement of the works.

(ii) The site Environment Plan shall provide details of the means (as elaborated in Point No. 3 below) by which the contractor (and all sub-contractors working for the contractor) will implement the recommended mitigation measures and achieve the environmental performance standards defined both in Indian environmental legislation and in this document.

(iii) The contract specific Site Environmental Plan will contain details of manpower required for environment related works, description of all procedures developed to meet the requirement defined in various sections of this document, to control environment pollution and organizational hierarchy for the effective implementation of the plan. Elements of the plan must address the management of pollution, the monitoring programme and the reporting requirements.

(iv) Outline of the Site Environmental Plan is given below:

S. No.	SITE ENVIRONMENTAL PLAN OUTLINE
1	**GENERAL**
(i)	The Environmental Policy of the Contractor is clearly defined in the Site Environmental Plan, which, inter-alia, commits the Contractor to follow national and state environmental legislation and regulations.
(ii)	The person responsible for day-to-day environmental matters is identified and vested with authority to execute the Site Environmental Plan. The Contractor has environmental lines of communication.
(iii)	Procedure is available for Contractor's system of enforcing good environmental practices of its Sub-contractor. By procedure it is implied that the Sub Contractor has been given clear written directions to comply with all requirements mentioned in this document and as applicable.
(iv)	The Site Environmental Plan contains procedures for screening material used in the contract, for their environmental friendliness. This implies that the procedure will comply with MC2 and MC 3 credits of IGBC Green Mass Rapid System (MRTS).
2	**ENVIRONMENT FRIENDLY CONSTRUCTION PRACTICES**
(i)	The Site Environmental Plan shall contain specific procedures for achieving environmental performance requirements as given in the Employer's requirements on Environment.
(ii)	Procedures for carrying out Aspect/Impact analysis of contractor's proposed works and their effect on environment. This will be cross reference with ISO 14001:2015 (EMS) procedures.
(iii)	Procedures for setting up Objectives and Targets commensurate with Employer's requirement on Environment and how these shall be met.

(iv)	Procedures for formulating Environmental Management Plans and Operational Control Procedures to meet contractual requirements.
(v)	Procedures for offering environmental training and methods for promoting environmental awareness amongst his employees.
(vi)	The Site Environmental Plan must contain details on Air Monitoring and Control Plan which details Mitigation measures / Corrective Action / Preventive Action and Monitoring Schedule.
(vii)	The Site Environmental Plan must contain details on Noise Monitoring and Control Plan which details Mitigation measures / Corrective Action / Preventive Action and Monitoring Schedule.
(viii)	The Site Environmental Plan must contain procedures on prevention and control of water pollution from sanitary surface runoff and process wastewater.
(ix)	The Site Environmental Plan must contain details on procedures for Storage, handling and disposal of waste including, Municipal, C&D, Plastic, Bio-Medical, Chemical and Hazardous wastes.
(x)	The Site Environmental Plan must contain procedures for reuse/recycle of waste, selling to authorized recyclers and records thereof.
(xi)	The Site Environmental Plan must contain procedures for preservation of landscape disturbed due to construction, housekeeping/Environmental Sanitation and traffic management as required under the contract.
(xii)	The Site Environmental Plan must contain procedures for dealing with unforeseen environmental situations under Environmental Emergency.
3	**MONITORING, AUDITS AND RECORDS**
(i)	The Site Environmental Plan shall contain the environmental monitoring requirements as per the contract requirements.
(ii)	The Contractor keeps records of environmental monitoring and the Site Environmental Plan must contain provision for reporting results of environmental monitoring in a manner as specified in this document.
(iii)	The Site Environmental Plan must contain procedures for carrying out inspections
(iv)	The Site Environmental Plan must contain provisions for submitting monthly Environmental Management reports.
(v)	The Site Environmental Plan must contain procedures for recording environmental complaints and response process.

4.7 The Contractor shall, from time to time and as necessary as required by the Employer to produce supplements to the Safety & Health and Environment Plans such that it is at all times a detailed, comprehensive and contemporaneous statement by the Contractor of his site safety industrial health, responsibilities, policies and procedures relating to work on Site. Any and all submissions of supplements to the Safety & Health and Environment Plans shall be made to the Employer in accordance with the agreed procedures.

4.8 If at any time the Safety & Health and Environment plans is, in the Employer's opinion, insufficient or requires revision or modification to ensure the security of the Works and the safety, health and welfare of all workmen upon and visitors to the Site, the Employer may instruct the Contractor to revise the Safety & Health and Environment plans and the Contractor shall within 7 days submit the revised plan to the Employer for review.

4.9 Any omissions, inconsistencies and errors in the Safety & Health and Environment Plans or the Employer's acceptance or rejection of the Safety & Health and Environment Plans and/or supplements thereto shall be without prejudice to the Contractor's obligations with respect to site safety, industrial health and environment and shall not excuse any failure by the contractor to adopt proper and recognized safety and environmental practices throughout the execution of the Work.

4.10 The Contractor shall adhere to the Safety & Health and Environment Plans and shall ensure, as far as practically possible, that all sub-contractors of all tiers require that contracting parties each have a copy of the Site Safety & Health and Environment Plans and comply with its provisions.

4.11 The details of contents to be covered in the site Health & Safety Plan are given in Appendix No. 3.

5.0 DESIGNER'S ROLE

5.1 Designer's role in Safety, Health, and Environment

Designer's primary role includes to minimise the risk to Environment, health and safety of those who are going to construct, maintain, clean, repair, dismantle or demolish the structures and anyone else like adjoining road users/general public, who might be affected by the work.

5.2 General Philosophy

When considering health and safety in designer's work, they shall be expected to do what is reasonable at the time the design is prepared. It may be possible for hazards, which cannot be addressed at the feasibility stage to be looked at during detailed design. In deciding what is reasonably practicable, the risk to health and safety produced by a feature of the design has to be weighed against the cost of excluding the feature. The overall design process does not need to be dominated by a concern to avoid all risks during the construction phase and maintenance. However, a judgement has to be made by weighing up one consideration against another so the cost is counted not just in financial terms, but also those of fitness for purpose, aesthetics, build ability or environmental impact. By applying these principles, it may be possible to make decisions at the design stage, which will avoid or reduce risks during construction work. In many cases, the large number of design considerations will allow a number of equally valid design solutions. What is important is the approach to the solutions of design problems. This should involve a proper exercise of judgement, which takes account of health and safety issues.

5.3 Hierarchy of Risk Control

5.1 Designers shall need, so far as reasonably practicable, to avoid or reduce risks by applying a series of steps known as the hierarchy of risk control or principles of prevention and protection. The steps to be adopted shall include the following:

(i) consider if the hazard can be prevented from arising so that the risk can be avoided (e.g., alter the design to avoid the risk);

(ii) if this cannot be achieved, the risk should be combated at source (e.g., ensure the design details of items to be lifted include attachment points for lifting);

(iii) failing this, priority should be given to measures to control the risk that will protect all people;

(iv) only as a last resort should measures to control risk by means of personal protection be assumed (e.g., use of safety harnesses).

5.4 Duty to provide health and safety risks in the drawing itself

5.1 In case of situations where the designers have carried out the design work and concluded that there are risks, which are not reasonably practicable to avoid, detailed information shall be given about the health and safety risks, which remain. This information needs to be included with the design to alert others to the risks, which they cannot reasonably be expected to know. This is essential for the parties who have to use the design information.

5.2 If the designers' basic design assumptions affect health or safety, or health and safety risks are not obvious from the standard design document, the designer shall provide additional information. The information shall include a broad indication of the assumptions about the precautions for dealing with the risks. The information will need to be conveyed in a clear manner; it shall be included on drawings, in written specifications or outline method statements. The level of detail to be recorded will be determined by the nature of the hazards involved and the associated level of risk.

5.5 Employer's approval

5.1 Every structure like scaffold, false work, launching girder, earth retaining structures etc. shall have its design calculations included in the method statements in addition to health and safety risks. Employers' designer or his approved proof check consultants as applicable as per the contract conditions shall approve all these designs.

5.6 Any non-standard structures like trestles made up of re-bars or structures which are very old, corroded, repaired for many times etc. for which no design calculations can be made accurately from any national standards, shall not be allowed to be used at sites even for short duration.

5.7 If any of the above-mentioned clauses are not adhered penalty shall be imposed depending upon the gravity of the unsafe act and or condition.

6.0 CONTRACTOR SHE ORGANISATION

6.1 Education and Experience

6.1.1 The Contractor shall appoint the required Environment, Health and Safety personnel as prescribed in General Instruction Maha-Metro/SHE/GI/001 (enclosed at the end) based upon the statutory requirement and establish the SHE organisation based upon the Contract value. The minimum educational qualification and the work experience are given in General Instruction Maha-Metro/SHE/GI/002.

6.1.2 The Contractor appoints a person responsible for relations with external stakeholders for the site: local communities, administrative authorities, and representatives of economic activities located within one-hour travel from the Worksite. This person will be based on the Worksite on a permanent basis. Administrations and local authorities will be informed of the existence of this person as of the start of works and will be provided with telephone contact details so as to be able to contact this person if a problem arises during the execution of works or concerning the behaviour of the Contractor's employees outside the Worksite.

6.1.3 In order to effectively interact on labour welfare matters with the Employer and the statutory authorities enforcing the labour welfare legislations every Contractor shall employ a duly qualified and experienced full time Labour Welfare Officer.

6.2 Conduct and competency

6.2.1 The conduct and functioning of the Contractor SHE personnel shall be monitored by the Employer. Any default or deficiency shall attract penalty as per details given under penalty Clause of this document.

6.2.2 The Contractor shall ensure that all personnel are competent to perform the job assigned to them. In the event that the Contractor is unable to demonstrate the competency of any person whose activities can directly impact on the Works' SHE performance, the Employer shall remove that person from the site without any procedural formalities.

6.2.3 Security Guards

Necessary security and checks as required shall be established by the contractor to prevent entry of any unauthorised and unprotected person to the construction site.

6.3 Approval from Employer

6.3.1 The name, address, educational qualification, work experience and health condition of each personnel deployed for SHE jobs shall be submitted to the Maha-Metro Environment, Health & Safety department in the format prescribed for the purpose for comments and approval well before the start of the work. Only on approval by the Employer these personnel are authorised to work. In case any of the SHE personnel leaves the Contractor the same shall be intimated to the Employer. The Contractor shall recruit new personnel and fill up the vacancy.

6.4 Responsibility of SHE personnel

6.4.1 For all works carried out by the Contractor and his sub-contractors, the responsibility of ensuring the required SHE manpower lies with the main Contractor only. The minimum required manpower indicated by the Employer includes the sub-contractors' work also. It shall be the responsibility of the main Contractor to provide required SHE manpower for all the works executed by all Contractors. Necessary conditions shall be included in all sub-contract documents executed by the main Contractor.

6.5 Employment status of SHE personnel

6.5.1 No Contractor shall engage SHE manpower from any outsourcing agencies in which case the effectiveness would be lost. All SHE manpower shall be on the payroll of the main Contractor only and not on the payroll of any subcontractor or outsourcing manpower agencies etc. This condition does not apply to positions like traffic marshals who are engaged almost on a daily requirement basis.

6.6 Reporting of SHE personnel

6.6.1 All SHE personnel are to report to the Chief SHE Manager who shall report directly to the Chief Project Manager. The Employer Environment, Health and Safety department shall monitor adherence to this procedure at all times. In case of non-adherence penalty shall be levied as indicated in the penalty clause.

6.7 Inadequate SHE personnel

6.7.1 Contractor shall appoint its Chief Safety Manager well before the start of activity for preparatory work like formulation, submission & approval of Safety, Health and Environment Plan, Method Statements, Environment, Health & Safety training facilities, identification & finalization of Agencies for External Safety & Health Audit, ISO certification, Safety & Health Training, Hospital Tie-up etc. The organisation shall grow as the work fronts are made available and adequate Safety & Health

manpower shall be ensured as per the contract agreement and site availability. No demobilization of Environment, safety & Health Manpower shall take place without the approval of Maha Metro concerned department and shall be remained filled till final handover of the project to Maha Metro.

6.7.2 In case if the Contractor fail to provide the minimum required manpower as illustrated in General Instruction Maha-Metro/SHE/GI/001 or fail to fill up vacancies created within 14 days, the same shall be provided by the Employer at Contractor's cost. Any administrative expenses involved, providing the same like paper advertisement or manpower consultant charges, etc shall also be at the cost of Contractor.

6.8 Prohibition of performance of other duties

6.8.1 As per Schedule VIII of BOCWR, no SHE personnel shall be required or permitted to do any work which is unconnected to, inconsistent with or detrimental to the performance of the SHE duties for respective category mentioned in General Information Maha-Metro/SHE/GI/001.

6.9 Facilities to be provided to SHE personnel

6.9.1 As per Schedule VIII of BOCWR, the Contractor shall provide all SHE personnel with such facilities, equipment and information that are necessary to enable him to dispatch his duties effectively.

6.9.2 The minimum Employer's requirements of such facilities / equipments to be provided for SHE personnel are given in the General Instruction Maha-Metro/SHE/GI/003.

7.0 CONTRACTOR SHE COMMITTEE

7.1 All employees should be able to participate in the making and monitoring of arrangements for safety, industrial health and environment at their place of work. The establishment of site SHE committees in which employees and Contractor and sub-contractor management are represented can increase the involvement and commitment of employees. The Contractor shall ensure the formation and monitor the functioning of Contractor SHE committees.

7.2 Guidelines onTerms of Reference, Agenda, MoM of SHE Committee

7.2.1 The Guidelines on Terms of Reference, Agenda, Minutes of Meeting of SHE Committee shall be as follows:

i. To establish company Safety & Health and Environment policies and practices
ii. To monitor the adequacy of the contractor's site Safety & Health and Environment plans and ensure its implementation
iii. To review compliance to Safety & Health and Environment legal requirements
iv. To review Safety & Health and Environment training
v. To review the contractor's monthly monitoring report consisting Air and Noise monitoring results
vi. To review the contractor's monthly waste management records
vii. Review the progress of ISO certification
viii. To review the contractor's monthly Safety & Health and Environment reports.
ix. To identify probable causes of accident and unsafe practices in building or other construction work and to suggest remedial measures.
x. To stimulate interest of Employer and building workers in safety by organizing safety week, safety competition, talks and film-shows on safety, preparing posters or taking similar other measures as and when required or as necessary.
xi. To go round the construction site with a view to check unsafe practices and detect unsafe conditions, condition of health and welfare amenities and to recommend remedial measures for their rectifications including medical first-aid, occupational health centers and welfare facilities like canteen, rest room, drinking water, toilet/urinals etc.

xii. Committee team members should perform a site inspection before every committee meetings and to monitor Safety & Health and Environment inspection reports.
xiii. To bring to the notice of the Employer the hazards associated with use, handling and maintenance of the equipment used during the course of building and other construction work
xiv. To suggest measures for improving welfare amenities in the construction site and other miscellaneous aspect of safety, health and welfare in building or other construction work.
xv. To look into the health hazards associated with handling different types of explosives, chemicals and other construction materials and to suggest remedial measures including personal protective equipment.
xvi. To review the last, SHE committee meeting minutes and to take action against persons/sub-contractors for non-compliance if any.

7.3 Within 14 days of award of Contract, the SHE Committee shall be constituted and notification regarding the same shall be communicated to the members and employees as per the format provided in Form No. SF 001.

7.4 Site SHE Committee meeting shall be conducted at least once in a month with the minimum members listed below:

Chairman	Project Manager
Secretary	Chief SHE Manager (In-charge)
Members	Labour Welfare Officer Sr. Environment Manager In charge of plant and machinery In charge of site electrics In charge of stores. Senior Managers/ Engineers heading different sub functions. Sub – contractor's representative Labour Contractor's representative Workers' representative Co-contractor representative. Other SHE staffs
Employer's Representatives	Maha-Metro Safety, Health and Environment in charge and other representatives

7.5 Construction SHE Committee meeting shall be conducted at least once in a week with the minimum members listed below:

Chairman	Project Manager
Secretary	Chief SHE Manager (In-charge)
Members	Sr. Environment Manager Labour Welfare Officer In charge of plant and machinery In-charge of site electricity Senior Managers / Engineers heading different sub functions Sub- Contractor's representative Labour contractor's representative Workers' representatives Other SHE Staffs

7.6 Co-contractors' participation

7.6.1 In case of depot, station and other contiguous areas where more than one main contractor are working together, the Employer shall instruct the other contractors to join for the monthly SHE committee meeting of the main civil contractor, so as to discuss and decide about the common provision of security, lighting, toilet, drinking water etc. and sharing the maintenance cost of the same etc.

7.6.2 The general principle for sharing the cost shall be either based on the Contract value of works executed at the contiguous area or the daily average number of workmen employed by each contractor in the contiguous area.

7.7 Minimum time between two monthly SHE Committee meetings

7.7.1 A minimum period of 21 days shall be maintained between any two SHE monthly committee meetings.

7.8 Agenda

7.8.1 The Secretary shall circulate the agenda of the meeting at least seven working days in advance of the scheduled date of the meeting to all members.

7.8.2 The agenda should broadly cover the following:

(i) Confirmation of minutes

(ii) Chairman's review/overview of site SHE performance / condition

(iii) Previous month SHE statistics

(iv) Incident and Accident Investigation / dangerous occurrence / near miss report

(v) Site SHE inspection

(vi) Sub-contractors' SHE issues

(vii) Safety presentation by Members

(viii) Report from Employer

(ix) Presentation on Environment aspects by Contractor's Environment representative which shall include the following:

(i) Legal compliance
(ii) Air and Noise monitoring results
(iii) Monthly waste management record
(iv) Progress of ISO certification
(v) Progress of Green Building Certification
(vi) Material consumption details (cement, aggregate, water, steel, sand etc)
(vii) Fly ash consumption details
(viii) Use of products made from recycled C&D waste products
(ix) Public Complaints on Environment especially related to Noise, dust and vibration
(x) Steps taken to improve Environment sanitation at site
(xi) Steps taken to address Employers instructions on Environment
(xii) Environmental issues related to site

7.9 Minutes of the meeting

7.9.1 The Minutes of the meeting shall be prepared as per the format provided at Form No. SF-002 and sent to all members within 2 working days preferably by mail followed by hardcopy. Safety Committee meeting minutes shall also be displayed in the notice board for wider publicity to all concerned.

7.10 Disciplinary Action

7.10.1 The chairman shall inform the members of any outstanding issues in the meeting and in case of repeated offence/ non-compliance by some members or other co/sub contractors and propose suitable disciplinary action including provisions of monitory penalty as per the relevant contract clauses, the Employer shall ensure that the same is implemented.

8.0 ID CARD AND FIRST DAY AT WORK, SHE ORIENTATION TRAINING

8.1 The Contractor shall ensure that all personnel working at the site receive an induction SHE training explaining the nature of the work, the hazards that may be encountered during the site work and the particular hazards attached to their own function within the operation. The training shall cover the contents as given in the General Instruction Maha-Metro/SHE/GI/004.

8.2 All personnel shall be issued a photo identity card of size 85mm x 55mm duly signed by the authorized representative of the Contractor before they are engaged for any work as per the format given in the General Instruction Maha-Metro/SHE/GI/005

8.2.1 Starting work sessions are organised for each employee and shall cover as a minimum:

a) Rules of precedure
b) Safety rules on Worksite
c) Protection of areas adjacent to Worksite
d) Risks relating to sexually transmitted diseases (Clause 6.7 of the GCC)
e) Basic health: combating malaria (if prevalent) and waterborne diseases, improving hygiene
f) Emergency response procedures or evacuation

8.2.2 Technical training:

a) Training in the skills needed for tasks requiring a work permit
b) Training in first aid and transporting the injured in order to achieve the targets defined in relevant clause on the number of first aid officers per shift.
c) Ability to drive on rough ground.

8.3 Contractor shall also issue personnel SHE handbook in a language known to the workers, which provides information on SHE and emergency procedures that all personnel working on contract are required to know and the need to follow. Contractor shall ensure that this is distributed, and its content introduced to all personnel working at the site.

8.4 All personnel shall be issued with a temporary ID Cards on completion of Contractor's' induction. The temporary ID shall be signed by the Human Resource Manager of contractor or their appointed representative, with the validity period of one week, and after expiry of which the temporary ID Card shall be replaced with a permanent ID Card with photograph.

8.5 No Individuals shall be permitted to enter work site without a valid ID Card.

8.6 The contractor shall ensure proper accounting and records of issued and cancelled ID Cards. These ID cards shall be maintained strictly for any checks and inspections. On the expiry of the validity, new ID Card shall be issued. The expired/cancelled ID Cards shall be properly destroyed, and records shall be maintained by the contractor.

9.0 SHE TRAININGS

9.1 The behaviour of people at all levels of the Contractor is critical for SHE performance. To achieve a more participative approach and sharing of Safety functions by site teams, the contractor shall ensure that all site staff engaged for project execution is Safety trained.

9.2 The Contractor shall organise quality SHE training to engage Managers, supervisors and other personnel in behavioural change and improve safety performance and effective compliance of labour welfare provisions. The attendance for the same shall be maintained and produced on demand of Maha Metro.

9.3 The Contractor shall analyse the training requirements for all the employees and initiate a training program to demonstrate that all persons employed, including subcontractors, are suitably qualified, competent and fit. This will include:

i. Detailed Job descriptions for all personnel, to include their specific Safety & Health and Environment responsibilities
i. Specification of qualifications, competency and training requirements for all personnel
ii. Assessment and recording of training needs for all personnel, including subcontractors' employees in the workforce, vendor representatives and site visitors
iii. A system for assessing new hirers e.g. previous training
iv. A means of confirming that the system is effective
v. A matrix and schedule of training requirements, covering general, task– specific and Safety & Health and Environment-related training, showing the training frequency and interval between refresher courses
vi. Timely, competent delivery of training courses

9.4 The Contractor shall arrange behavioural-based training programmes for all the executives to identify, recognise and eliminate unsafe act and unsafe conditions.

9.5 The minimum Employer's requirement of training needs for various categories of employees are given in General Instruction Maha-Metro/SHE/GI/006

9.6 The contents of SHE training to Managers/Supervisors as given in General Instruction Maha-Metro/SHE/GI/007 shall be conducted.

9.7 The refresher-training programme to all employees shall be conducted once in six months for a minimum duration of 24 (3X8 hrs) working hours.

9.8 Toolbox talk as given in the Employer's Project SHE Manual shall be conducted to all high-risk workmen every day.

9.9 On-the spot practical skill development training on height safety including scaffold safety, crane safety, welding safety, electrical safety, traffic safety for marshals shall also be conducted to all foremen/ workmen who were associated to the concerned jobs.

9.10 Every employee including workman shall take safety Oath daily without fail.

9.11 All vehicle drivers including heavy vehicle operators shall be trained on defensive driving at training institute recognized by MaharashtraState Road Transport Corporation / Government of Maharashtra, or any other driving institute registered under Motor Vehicles Act.

9.12 All the above listed training programmes except at Clause 9.11 shall be organised by the Contractor only after taking approval from the Maha Metro for the training faculty / organisation, content, and durations.

9.13 In case of failure on the part of the Contractor to provide all the above-mentioned training programs to all employees in time, the same shall be provided by the Employer through accredited agencies if required by formulating a common scheme to all contractors. Any administrative expenses and training fee towards the same shall be at the cost of the Contractor.

9.14 The Contractor detail in the training programme the actions and ESHS training for subcontractors and other members of the joint venture when applicable.

9.16 Records of all training conducted shall be maintained and made available for inspection and monitoring.

10.0 SHE INSPECTIONS

10.1 The Contractor shall evolve and administer a system of conducting SHE inspections and other risk management analysis on a periodical basis.

10.2 The purpose of SHE inspection is to identify any variation in construction activities and operations, machineries, plant and equipment and processes against the SHE Plan and its supplementary procedures and programs.

10.3 Following SHE inspections program shall be adopted:

i. Planned General Inspection
ii. Routine Inspection
iii. Specific Inspection
iv. Other Inspection

10.3.1 Planned General Inspection

10.3.1.1 Planned general inspection are performed at predetermined intervals and it usually involves the representation from both Contractor and the Employer.

10.3.1.2 Inspections that will be classified under this inspection program are:

i. Monthly contractor and sub-contractors site Safety, Haelth and Environment Committee Inspection.
ii. Weekly Safety, Haelth and Environment inspection by construction supervisors (Contractors and Sub-contractors)
iii. Daily safety inspection by contractor site Safety, Haelth and Environment team.

10.3.2 Routine Inspection

10.3.2.1 Routine inspections are often referring to the inspection of work site, equipment and temporary structures performed by site and equipment operators and temporary structure erectors.

Inspections that will be classified under this inspection program are:

i. Daily Inspection of plant and equipment by operator
ii. Weekly Inspection of scaffold by scaffolding supervisor
iii. Monthly Inspection of electrical hand tools by competent electrical supervisor
iv. Quarterly Inspection of temporary electrical systems by competent electrical supervisor
v. Wages, PF and ESI related records
vi. Half-yearly inspection of lifting machinery, lifting appliances, equipment and gears by Govt. approved competent person.

10.3.2.2 The list mentioned above is not exhaustive. Contractor may add additional categories. Contractors' Site SHE Manager will ensure that a system of routine inspections are carried out periodically to all plants, equipment, powered tools, and any other temporary structures that will pose a hazard to operators and workmen.

10.3.3 **Specific Inspection**

10.3.3.1 Specific inspections are performed on activities without a predetermined date. Competent supervisors usually perform inspections for ensuring an activity whether it is executed in accordance to a general set of rules; method statement submitted or developed procedures. The following are examples that will be commonly performed as required on the construction site:

i. Inspection performed before a heavy lifting operation.
ii. Inspection performed before and after the entry of person into a confined space.
iii. Inspection performed before and after a welding and gas cutting operation.
iv. Inspection of formwork before concreting by formwork erector.

10.3.3.2 The list mentioned above is not exhaustive. The contractor shall ensure that a competent supervisor inspects all high-risk processes and activities.

10.3.4 Other Inspection

Other inspections include the following:

i. Mandatory Inspections by Labour Department of Government.
ii. Maha-Metro Health & Safety management team

10.4 Environmental Inspection

10.4.1 The contractor shall evolve and administer a system of conducting Environment inspections on a periodic basis. The purpose of Environment inspection is to identify any variation in construction activities and operations, machineries, plant and equipment and processes against the Site Environment Plan and its supplementary procedures and programs. Following Environment inspections program shall be adopted.

i. Planned General Inspection
ii. Other Inspection

10.4.2 Planned General Inspection Planned general inspections are performed at predetermined intervals and it usually involves the representatives from both Contractor and the Employer. Inspections that will be classified under this inspection program are:

i. Monthly contractor and sub-contractors site SHE committee inspection
ii. Weekly/ daily siteinspection by Contractor's Environment team

10.4.3 Other Inspections: Other inspections include the following:

I. Maha-Metro Environment Management team
II. Inspections by Central Pollution Control Board, /Maharashtra Pollution Control Board, Ministry of Environment and Forest and Climate Change, National Green Tribunal etc.

10.4.4 The contractor shall prepare all required Environmental inspection checklists for all activities, operations and equipment. Checklists will be prepared based on the Indian standards, rules and regulations and Employer's requirements. The formats provided in the General Instruction Maha-Metro/SHE/GI/14 shall be referred.

10.4.5 All inspection records and reports will be properly kept and filed for audit purpose.

10.4.6 Whenever employer's representative conducts an inspection, contractor shall depute its representative to accompany him/her.

10.4.7 Conformity report shall be submitted by the contractor within 1 week of submission of inspection report to the employer.

10.4.8 In case of non-conformity of items, the Employer shall take necessary steps including stoppage of work and or imposing penalty for getting the item implemented.

10.4.9 Whenever employer's representative conducts an inspection, contractor shall depute its representative to accompany him/her.

11.0 SHE AUDITS

11.1General

11.1.1 The purpose and scope of SHE audit is to assess potential risk, liabilities, and the degree of compliance of construction Safety, Health & Environmental plan and its supplementary procedures and programs against applicable and current SHE legalisation regulations and requirements of the Employer.

11.1.2 Project Manager holds the ultimate responsibility in ensuring implementation of SHE audit program during the construction work.

11.2Monthly Audit Rating Score (MARS)

11.2.1 Monthly Audit Rating Score (MARS) will be performed once in a month. A team consisting of Project Manager and Employer representative based on the pre-designed score-rating format will conduct it. The details of the pre-designed monthly audit score rating formats are given in the Project SHE Manual.

11.2.2 This Monthly SHE Audit Rating Score (MARS) report will enable the Employer to evaluate the general compliance by the Contractor with the Conditions of Contract, the Employer's Project SHE Manual and the Contractor's site specific SHE Plan.

11.2.3 Monthly Audits will be conducted in accordance with Maha-Metro Guidelines. The Project Manager accompanied by the Employer's Representatives shall carry out the Audit. The Contractor's senior manager and SHE in-charge should also be invited to attend.

11.2.4 Timing

The Monthly Audit Rating Score (MARS) should be conducted at least 7 days prior to the scheduled date of Monthly SHE Committee meeting.

11.2.5 Evaluation

11.2.5.1 The numerical scoring has been weighed on a 1-10 scale. The audit team will use their observations noted in evaluating the points to be awarded against each of the elements of the audited section. Wherever some topics and sub-topics are not applicable the score rating need not be given. The overall audit ratings shall be achieved by:

$$Overall\ Audit\ Rating = \frac{Actual\ Score\ Achieved}{Max\ Possible\ Score} * 100$$

11.2.5.2 The criticality of the required actions for the respective sections of the Audit will be classified as:

SN	Score	Description	Action
1	< 60%	Immediate	Require Contractor to rectify within 24 hours
2	< 75%	Improvement Necessary	Contractor rectification within 7 days and confirmed in writing to Employer
3	< 90%	Improvement Desirable	Contractor rectification within one month and confirmed in writing to Employer

11.2.6 Report

A copy of each Audit Report will be sent to Employer and to all subcontractors, with whom it will then be discussed in detail at the Monthly health and safety Committee Meeting in order to ensure that any corrective actions are agreed upon.

11.3 Monthly Electrical Safety Audit

11.3.1 A team comprising of Contractor's senior SHE (Electrical) engineer and Employer's Representative shall conduct monthly electrical safety audit covering the following and submit the report to Employer:

I. Electrical accidents investigation findings and remedy
II. Adequacy of power generation and power requirements
III. Power distribution and transmission system in place
IV. Updated electrical single line diagram showing the current condition of power source and distribution including the IP44 DBs arrangement.
V. Electrical protection devices – selection, installation and maintenance.
VI. Earth or ground connection and earth pit maintenance details
VII. Education and training of electrical personnel undertaken
VIII. Routine electrical inspection details
IX. Electrical maintenance system and register.
X. Name plate details of major electrical equipment
XI. Classified zones in the site, if any.

11.4 External Health and Safety Audit

11.4.1 External Health & Safety audits are to be conducted by external agencies having excellent competency in Health and Safety with the prior approval of the Employer.

11.4.2 Areas of competence of Audit team:

11.4.2.1 Practical understanding of BOCW Act and Rules, statutory requirements on health/medical and welfare of workmen, construction hazards and its prevention and control, traffic management, electrical safety, rigging, safety of construction equipment and construction environment management.

11.4.2.2 Audit shall be conducted as per the guidelines of ISO, ILO, and national standards. Audit report shall also be presented as per the above formats.

11.4.3 External Health and Safety audits shall be conducted on a quarterly basis throughout the currency of the Contract.

11.4.4 **Targets of Health & Safety Audit:** The contents and coverage of the external audit shall include the following items

11.4.4.1 Safety and Health management

I. Safety & Health Organization
II. Safety & Health policy and plan
III. SHE Committee
IV. Safety & Health orientation
V. Safety & Health training
VI. Safety & Health inspection
VII. Safety & Health communication and motivation
VIII. Safety & Health submittals to the employer
IX. Safety & Health promotional and awareness program
X. Incident reporting and investigation
XI. Onsite/Offsite Emergency preparedness plan
XII. Hazard identification and Risk Assessment

11.4.4.2 Technical

I. Work Method Statements
II. Operational Control Procedures / Safe operating procedures
III. Working at Height
IV. Hand tools and Power tools
V. Electrical Safety
VI. Fire prevention and control
VII. Housekeeping
VIII. Overhead protection
IX. Slipping, Tripping, Cutting, Drowning and Falling hazard
X. Lifting appliances and Gear, Tools and Tackles
XI. Lifting and Launching operation
XII. Construction plant and machinery
XIII. Machine and area guarding
XIV. Material handling

XV. Hot Work
XVI. Demolition
XVII. Excavation and Tunneling
XVIII. Work Permit System
XIX. Traffic Management
XX. Chemical Handling
XXI. Dangerous and Harmful Environments
XXII. Maintenance matrix of Mechanical and Electrical Machines / Equipment's
XXIII. Working on or under water
XXIV. Working near or under High Tension line
XXV. Personal Protective Equipment's
XXVI. Visitors at Site
XXVII. Occupational Health and Welfare measures
XXVIII. All statutory Forms, returns under various statutes

11.4.5 Audit Documents

11.4.5.1 Contractor shall make the below listed documents available for the review by the Audit team.

i. Safety & Health policy
ii. Safety Inspections
iii. Safety & Health organization chart
iv. Annual Safety & Health objectives / programs
v. Accident / near miss statistics and analysis
vi. Safety & Health Training program / records for all personnel
vii. Operation and Maintenance manual of all equipments including Safe operating procedures for various activities, checklists etc.
viii. Records of test and examination of all lifting appliances and gears, plant and machines
ix. Medical records for all personnel
x. Risk identification, assessment and control details
xi. On-site emergency plans and records of Mock Drills
xii. Records of work permits
xiii. Record of monitoring of flammable and explosive substances at work place
xiv. Maintenance and testing of firefighting equipment's
xv. All statutory Registers, Forms, Returns under various statutes
xvi. First Aid, Medical facilities and other welfare measures
xvii. Material Safety Data Sheets
xviii. Housekeeping inspection records
xix. Minutes of SHE committee meetings
xx. Maintenance procedure of Plant & machines
xxi. Calibration & Testing records
xxii. Records of previous Audits

xxiii. Safety inspection records

11.4.6 Audit Preparation

i. Audit team members are required to gather information by observations through interviews and by checks of hardware and documentation.

ii. Audit team shall prepare checklist to cover all parts based on SHE legislations rules and regulations and Maha-Metro requirements.

iii. Audit team members shall verify the facts and findings leading to the identified gaps and weakness.

iv. Audit leader has overall responsibility for reaching a conclusion.

11.4.7 Reporting

11.4.7.1 Audit report shall be prepared and directly sent to the Employer within 7 days of conducting the audit with a copy to the contractor.

11.4.8 Report contents

i. **Executing summary:** Based on the finalized checklists as written the findings to the Employer by the audit team members, the audit leader will compile a concise and accurate summary of observations and findings.

ii. **Introduction:** This will contain basic information regarding the facilities or organization audited, the specific audit dates (inclusion of those for preparation and post-audit activities).

iii. **Principal positive findings:** This will contain the summary of positive aspects as observed by the auditors. It will also contain highlights of those issue, which may warrant dissemination as best practice regarding methodology used or achievement.

iv. **Audit Findings:** All audit findings as detailed in the audit checklists shall be grouped together as priority 1 and 2 as detailed below in a separate listing.

A. **Priority 1**: Actions to rectify gaps or weakness should generally be implemented within 2 – weeks, if risk potential is high or unacceptable.

B. **Priority 2:** Actions should be generally implemented or rectified with a maximum of 3 – 4 weeks, if not rectified would create a likelihood of minor injury or business loss.

11.4.9 Conformity Report & Action by Employer

11.4.9.1 The auditor shall inspect the site after 14 days of conducting initial audit for checking the adequacy of implementation of items maintained under priority 1 by the Contractor and shall submit a conformity / non-conformity report to the Employer with a copy to the contractor.

11.4.9.2 The auditor shall again inspect after 28 days of conducting initial audit for checking the adequacy of implementation of items mentioned under priority 2 by the Contractor and shall submit a conformity / non-conformity report to the Employer with a copy to the Contractor.

11.4.9.3 In case of non-conformity of items mentioned by auditor, the Employer shall take necessary steps including stoppage of work and or imposing any penalty for getting the item implemented.

11.4.9.4 Failure of Contractor to conduct External SHE Audit

11.4.9.5 If the Contractor fails to conduct the external, SHE audit in time, the Employer at the cost of Contractor shall get it done.

11.5 Environmental Audit

11.5.1 Contractor's Environmental Audit

11.5.1.1 The purpose and scope of environmental audit is to assess the degree of compliance of environmental plan and its supplementary procedures and programs against applicable and current environment legislations and requirements of the employer.

11.5.1.2 The employer may undertake regular audits at monthly/quarterly intervals of the contractor's onsite practices and procedures as a means of assessing the ongoing performance of the contractor.

11.5.1.3 Monthly/quarterly audits will be conducted in accordance with Maha-Metro SHE guidelines. The contractor's Project Manager, Chief SHE/Senior Environment Manager accompanied by Maha-Metro Environment department shall carry out the audit.

11.5.1.4 A checklist of environmental requirements will be prepared amended as necessary, throughout the construction phase to focus on areas of frequent non-compliance and to reflect the potential impacts associated with specific activities within the construction programme.

11.5.1.5 The criteria against which the review will be undertaken will be derived from (but not limited to):

a) The appropriate approaches, procedures and commitments given by the contractor in the 'Site Environmental Management Plan'
b) The clauses contained within the Employer's Requirement on Environment.
c) The allocation of responsibility for fulfilling environmental requirement and the effective lines of communication with regard to environmental issues;
d) Compliance with procedure established to enable and effective response to environmental incident, exceedance or non- compliance;
e) The extent and accuracy of record-keeping related to environmental performance indicators;
f) The effectiveness of ensuring high levels of awareness with regard to environmental requirements; and
g) The effectiveness of environmental management activities including the speed and effectiveness of responses to complaints.

11.5.1.6 The criteria against which the audits will be undertaken shall be derived from the clauses within the Employer's Requirements contract-specific Site Environmental Plan and previous site inspection results.

11.5.1.7 A copy of each Audit Report will be sent to Maha-Metro Environment Department and to all subcontractors, with whom it will then be discussed in detail at the Monthly SHE Committee Meeting in order to ensure that any corrective actions are agreed upon.

11.5.2 External Environmental Audit

11.5.2.1 External Environmental audits are to be conducted by external agencies that are competent in formulating of Environmental Management measures for construction sector shall be engaged with prior approval from the Environment Department of Maha-Metro.

11.5.2.2 The audit team shall undertake regular audits at quarterly intervals, of the contractor's onsite practices and procedures as a means of assessing the on going performance of the contractor.

11.5.2.3 A checklist of Environmental requirements will be prepared and amended as necessary, throughout the construction phase to focus on areas of frequent non-compliance and to reflect the potential impacts associated with specific activities within the construction programme.

11.5.2.4 Areas of competence of Audit team/Auditors

a) Environmental auditiors shall have a regular and qualified degree in Environment and have excellent understanding of environmental issues, knowledge of environmental requirements at construction sites, and shall have demonstrable experience of at least five years in environment management issues.

11.5.2.5 Audit shall be conducted as per the requirements laid out in the conditions of contract on environment, as the case may be.

11.5.2.6 External Environmental audits shall be conducted on a quarterly basis throughout the currency of the contract.

11.5.2.7 Audit Documents:

11.5.2.7.1 Contractor shall make the below listed documents available for the review by the Audit team

a) Environmental policy
b) Site Environment Plan
c) Environmental Rules and Regulation
d) Environmental organization chart
e) Annual Environmental objectives / programs
f) Environment Training program / records for all personnel
g) Environment monitoring and management reports
h) Environmental submittals to the employer
i) Environmental monitoring reports
j) Environmental sanitation records
k) Minutes of SHE committee meetings

11.5.2.8 Reporting:

11.5.2.8.1 Audit report shall be prepared and directly sent to the Employer within 7 days of conducting the audit with a copy to the contractor.

11.5.2.9 Report contents:

i) **Executing summary -** the audit leader will compile a concise and accurate summary of observations and findings.
ii) **Introduction -** this will contain basic information regarding the facilities or organization audited, the specific audit dates (inclusion of those for preparation and post-audit activities).
iii) **Principal positive findings -** This will contain the summary of positive aspects as Observed by the auditors. It will also contain highlights of those issue, which may warrant dissemination as best practice regarding methodology used or Achievement.
iv) **Audit Findings -** All audit findings as detailed in the audit checklists shall be grouped together as priority 1 and 2 as detailed below in a separate listing.

a. **Priority 1:** Actions to rectify gaps or weakness should generally be implemented within two-weeks time, if risk potential is high or unacceptable.

b. **Priority 2:** Actions should be generally implemented or rectified with a maximum of 3 – 4 weeks, if not rectified would create a likelihood of minor injury or business loss.

11.5.2.10 Conformity Report & Action by Employer

11.5.2.10.1 The auditor shall inspect the site after 14 days of conducting initial audit for checking the adequacy of implementation of items maintained under priority 1 by the contractor and shall submit a conformity/non-conformity report to the Employer with a copy to the contractor.

11.5.2.10.2 The auditor shall again inspect after 28 days of conducting initial audit for checking the adequacy of implementation of items mentioned under priority 2 by the contractor and shall submit a conformity/non-conformity report to the Employer with a copy to the contractor.

11.5.2.10.3 In case of non-conformity of items mentioned by auditor, the Employer shall take necessary steps including stoppage of work and or imposing any penalty for getting the item implemented.

11.5.2.10.4 Failure of contractor to conduct External Environmental Audit:- If the contractor fails to conduct the external Environment audit in time, the Employer at the cost of contractor shall get it done.

12.0 SHE COMMUNICATIONS

12.1 The Contractor shall take every effort to communicate the Safety, Occupational health and Environment management measures through posters campaigns / billboards / banners / glow signs being displayed around the work site as part of the effort to rise safety awareness amongst to the work force. Posters should be in Hindi, English and other suitable language deemed appropriate. Posters / billboards / banners/ glow signs should be changed at least once in a month to maintain the impact.

12.2 The Contractor shall also observe important days as listed in General Instruction Maha-Metro/SHE/GI/008 and printing and displaying safety signage and posters as listed in General Instruction Maha-Metro/SHE/GI/009

12.3 The list indicated are the minimum requirements of the Employer and the Contractor is encouraged to further the SHE communication activities by formulating suitable reward schemes for safety performers and any other activities, which deem fit for the purpose.

13.0 SHE SUBMITTALS TO THE EMPLOYER

13.1 The Contractor's SHE management should send the following reports to the Employer periodically:

i) Daily Reporting of total number of workmen (as given in Clause 13.2)
ii) Monthly Environment, Health and Safety Report (as given in Clause 13.3)
iii) SHE Committee Meeting Minutes (as given in relevant clause)
iv) SHE Inspection Reports
v) External Environment Audit report
vi) External Health & Safety Audit Report
vii) Monthly Audit Rating Score (MARS) and Electrical Safety Audit Report etc.

13.2 Daily Reporting of total number of workmen

13.2.1 The Contractor shall report to the Employer the total number of workmen engaged by all including any subcontractor within 2 hours of starting of any shift in any day. This reporting shall be the primary duty of the Chief SHE Manager of the Contractor and reporting shall be through tele-fax / email. The onus of checking the receipt of the same by the Employer lies with the Contractor. If the information is not received or received more than 2 hrs after starting of the shift, penalty shall be levied as per relevant clause.

13.3 Monthly SHE Report

13.3.1 The Contractor shall prepare a monthly SHE reports consisting of the following and submit 3 copies within 7thof next month to the Employer as specified in the Project SHE Manual.

Monthly Health & Safety Report consisting of the followings:	
I.	Monthly Accident Statistics
II.	Monthly accident / incident details category wise.
III.	SHE committee details
IV.	Details of Safety & Health training conducted in the month
V.	Safety & Health Inspection and Compliance status
VI.	Brief details of Safety & Health internal audit like Electrical audit, MARS etc.
VII.	Safety & Health Communication activities undertaken in the month including the number of posters displayed and balance availability in stock.
VIII.	Toolbox talks details
IX.	PPE details: Quantity purchased, issued to the workmen and stock available.
X.	Details on lighting poles, welding and cutting equipment's and inspection of Ladders, Hoists, Lifting appliances, tools & tackles etc.
XI.	Monthly site illumination monitoring results including emergency power back up
XII.	Housekeeping
XIII.	Barricade lighting and maintenance details
XIV.	No of critical excavations
XV.	Health & Welfare activities, Statutory Registers and returns
XVI.	Safety walk conducted by Contractors' Project Manager in the month
XVII.	Safety & Health Activities Planned for next month
XVIII.	Maintenance schedule of plant and machines
Monthly Environmental Report shall include (but not limited to) the followings:	
I.	Executive summary
II.	Brief mention of construction activities
III.	Monitoring report of Air, noise, water, soil and DG set stack quality
IV.	Waste Management Record i.e. quantity generated and disposed of all types of wastes for the month and cumulative quantities
V.	Details of C&D waste produce procured and consumed
VI.	Details of Water Consumption for the month and cumulative consumption
VII.	Details of fly ash consumption for the month and cumulative consumption
VIII.	Raw materials consumption for the month and cumulative consumption
IX.	Weekly Environment Inspection checklist
X.	Details of environmental training imparted
XI.	Point wise compliance of Maha-Metro comments made on previous Monthly Environmental Report

14.0 ACCIDENT REPORTING AND INVESTIGATION

14.1 Reporting to Employer

14.1.1 All accidents, "near miss" and dangerous occurrences shall immediately be informed verbally to the Employer. This will enable the Employer to reach to the scene of accident / dangerous occurrences

to monitor/assist any rescue work and/or start conducting the investigation process so that the evidences are not lost.

14.1.2 Reports of all accidents (fatal / injury) and dangerous occurrences shall also be sent within 24 hours as per approved format.

14.1.3 No accident / dangerous occurrences are exempted from reporting to the Employer.

14.1.4 Any wilful delay in verbal and written reporting to the Employer shall be penalised as per relevant clause.

14.1.5 Near Miss

An incident or a situation with clear potential for an undesirable outcome to occur, even though no actual negative consequences happened. In other words, it is an event with potential to cause injury, property damage, environmental release, or an adverse community reaction. Generally, the following events are some examples of near miss when:

i) A person trips over an object and falls to the ground but did not get injured
ii) A person has to dive or jump out of the way to avoid a collision with a motorized vehicle, a moving object like a suspended part on a conveyor or from an uncontrolled suspended load;
iii) A person has to jump from a falling ladder;
iv) An object with significant mass falls from a distance of sufficient height that would cause injury to a person if they were struck;
v) A machine part becomes a projectile;
vi) A person works on a piece of equipment that he/EHS believes is de-energized and that equipment starts up putting that person in jeopardy;
vii) A low-speed collision occurs and an occupant of that vehicle is not wearing a seat belt and is not injured.
viii) Stored energy unexpectedly releases which could cause injury if a person were struck or contacted, e.g., a high-tension spring (like your garage door spring) breaks or a pocket of steam releases;
ix) Any steps of the vessel entry procedure are omitted in a vessel entry;
x) Any emergency equipment (fire extinguisher, Scott Air Pack, Oxygen sensor, eye wash, etc) fails to operate properly when called on in an emergency.

If Protective Equipment is called for and worn and it prevents an injury, then in this case it would not be a near miss. As an example, a mechanic is wearing a hard hat in a barricaded area where hard hats must be worn and a 100gram bolt falls from a height of 2 meters and strikes his hard hat and no injury occurs. That would not be a near miss. But if he were not wearing a hardhat and the bolt falls a meter away, then it would be a near miss.

14.1.6 Each non-conformity will be documented by a digital photograph with captions to provide a visual illustration, explicitly indicating the location, date of inspection and the non-conformity in question.

14.2 Reporting to Government organisations

14.2.1 In addition to the above verbal and written reporting to the Employer, as per Rule 210 of BOCWR, notice of any accident to a worker at the building or construction site that:

i) causes loss of life; or

ii) disables a worker from working for a period of 48 hours or more immediately following the accident;

iii) shall forthwith be sent by telegram, telephone, fax, or similar other means including special messenger within four hours in case of fatal accidents and 72 hours in case of other accidents, to:

a. the Regional Labour Commissioner, wherein the Contractor has registered the firm/work
b. the board with which the worker involved was registered as a beneficiary;
c. Director General and
d. the next of kin or other relative of the worker involved in the accident;

14.2.2 Further, notice of accident shall be sent in respect of an accident which:

i) causes loss of life; or

ii) disables the injured worker from work for more than 10 days to

a. the officer-in-charge of the nearest police station;
b. the District Magistrate or, if the District Magistrate by order so desires, to
c. the Sub-Divisional Magistrate

14.2.3 In case of an accident-causing minor injury, first-aid shall be administered and the injured worker shall be immediately transferred to a hospital or other place for medical treatment.

14.2.4 Where any accident-causing disablement that subsequently results in death, notice in writing of such death, shall be sent to the authorities mentioned in Clause 14.2.1 and 14.2.2 above within 72 hours of such death.

14.2.5 Reporting of dangerous occurrences

14.2.5.1 The following classes of dangerous occurrences shall be reported to the Inspector having jurisdiction, whether or not any disablement or death caused to the worker, namely:

a. collapse or failure of lifting appliances, or hoist, or conveyors, or similar equipment for handling of building or construction material or breakage or failure of rope, chain, or loose gears; or overturning of cranes used in construction work;

b. falling of objects from height;

c. collapse or subsidence of soil, tunnel, pipe lines, any wall, floor, gallery, roof or any other part of any structure, launching girder, platform, staging, scaffolding or means of access including formwork;

d. explosion of receiver or vessel used for storage of pressure greater than atmospheric pressure, of any gas or gases or any liquid or solid used as building material;

e. fire and explosion causing damage to any place on construction site where building workers are employed;

f. spillage or leakage of any hazardous substance and damage to their container;

g. collapse, capsizing, toppling or collision of transport equipment;

h. leakage or release of harmful toxic gases at the construction site;

14.2.6 In case of failure of launching girder, lifting appliance, loose gear, hoist or building and other construction work, machinery and transport equipment at a construction site, such appliances,

gear, hoist, machinery or equipment and the site of such occurrence shall, as far as practicable, be kept undisturbed until inspected by the Authorities;

14.2.7 Every notice given for fatal accidents or dangerous occurrences shall be followed by a written report to the concerned Authorities under Section 39 of BOCWA and the Director General in the specified Form XIV of BOCWR.

14.3 Accident investigation

14.3.1 General

14.3.1.1 Investigations should be conducted in an open and positive atmosphere that encourages the witnesses to talk freely. The primary objective is to ascertain the facts with a view to prevent future and possibly more serious occurrences.

14.3.1.2 Accidents and Dangerous Occurrences which result in death, serious injury or serious damage must be investigated by the Contractor immediately to find out the cause of the accident/occurrence so that measures can be formulated to prevent any recurrence.

14.3.1.3 Near misses and minor accidents should also be investigated by the Contractor as soon as possible as they are signals that there are inadequacies in the safety management system.

14.3.1.4 Procedure of incident investigation

14.3.1.4.1 It is important after any accident or dangerous occurrence that information relating to the incident is gathered in an organised way. The following steps shall be followed:

a. take photographs and make sketches
b. examine involved equipment, workplace or material and the environmental conditions
c. interview the injured, eye-witnesses and other involved parties
d. consult expert opinion where necessary
e. identify the specific Contractor or sub-contractor involved.
f.

14.3.1.5 Having gathered information, it is then necessary to make an analysis of incident

a. establish the chain of events leading to the accident or incident
b. find out at what stage the accident took place
c. consider all possible causes and the interaction of different factors that led up to the accident, and identify the most probable cause. The cause of an accident should never be classified as carelessness. The specific act or omission that caused the accident must be identified.

14.3.1.6 The next stage is to proceed with the follow-up action

a. report on the findings and conclusions
b. formulate preventive measures to avoid recurrence
c. publicise the findings and the remedial actions taken

14.4 Employers' independent incident investigation

14.4.1 In case of fatal / dangerous occurrence the Employer shall also conduct independent investigation. Contractor and his staff shall extend necessary co-operation and testify about the accident.

14.4.2 The Contractor shall take every effort to preserve the scene of accident till the Employer completes the investigation.

14.4.3 All persons summoned by the Employer in connection to witness recording shall obey the instructions without delay. Any wilful suppression of information by any person shall be removed from the site immediately and / or punishable as per relevant penalty clause.

15.0 EMERGENCY PREPAREDNESS PLAN

15.1 The Contractor shall prepare as required under Rule 36 of BOCWR, an Emergency Response Plan for all work sites as a part of the Contractor SHE Plan. The plan shall integrate the emergency response plans of the Contractor and all other subcontractors. The Emergency Response Plan shall detail the Contractor's procedures, including detailed communications arrangements, for dealing with all emergencies that could affect the Site. This include where applicable, injury, sickness, evacuation, fire, chemical spillage, severe weather and rescue.

15.2 The Contractor shall ensure that an Emergency Response Plan is prepared to deal with emergencies arising out of:

i) Fire and explosion
ii) Collapse of lifting appliances and transport equipment
iii) Collapse of building, sheds, or structure etc.
iv) Gas leakage or spillage of dangerous goods or chemicals
v) Bomb threatening, Criminal or Terrorist attack
vi) Drowning of workers
vii) Landslides getting workers buried floods, Earthquake, storms, and other natural calamities.

15.3 Arrangements shall be made for emergency medical treatment and evacuation of the victim in the event of an accident or dangerous incident occurring, the chain of command and the responsible persons of the Contractor with their telephone numbers and addresses for quick communication shall be adequately publicized and conspicuously displayed in the workplace.

15.4 Contractors shall require to tie-up with the hospitals and fire stations located in the neighbourhood for attending to the casualties promptly and emergency vehicle kept on standby duty during the working hours for the purpose.

15.5 Contractor shall conduct an onsite emergency mock drill once in every month for all his workers and his subcontractor's workers.

15.6 It shall be the responsibility of the Contractor to keep the Local Law & Order Authorities informed and seek urgent help, as the case may be, so as to mitigate the consequences of an emergency. Prompt communication to Maha-Metro, telephonically initially and followed by a written report, shall be made by the Contractor.

15.7 Necessary interfacing and coordination with other working contractors shall be insured by the contractors through the Nodal Officer in charge of the site.

16.0 EXPERTS / AGENCIES FOR SHE SERVICES

I. Contractors may utilise the services of experts/agencies empanelled under Rule 250 of BOCWR for the purpose of training, internal audit and any other SHE services with prior approval of the Employer.

II. As an aide to contractors, a list of experts/agencies and the offered service are given in General Instruction Maha-Metro/SHE/GI/010 for ready reference. In addition to it if the Contractor would like to use any expert/agencies' services for any SHE activities the same can also be allowed provided that they are competent and meet to the general requirements of Employer. In every case prior approval of the Employer is mandatory.

PART II: SAFETY

17.0 HOUSEKEEPING

17.1 Housekeeping is the act of keeping the working environment cleared of all unnecessary waste, thereby providing a first-line of defence against accidents and injuries.

17.2 Contractor shall understand and accept that improper housekeeping is the primary hazard in any construction site and ensure that a high degree of housekeeping is always maintained. Indeed "Cleanliness is indeed next to Godliness"

17.3 Housekeeping is the responsibility of all site personnel, and line management commitment shall be demonstrated by the continued efforts of supervising staff towards this activity.

17.4 General Housekeeping shall be carried out by the Contractor and ensured at all times at Work Site, Construction Depot, Batching Plant, Labour Camp, Stores, Offices, and toilets / urinals. Towards this the Contractor shall constitute a special group of housekeeping personnel as per General Instruction Maha-Metro/SHE/GI/001. This group shall ensure daily cleaning at work sites and surrounding areas and maintain a register as per the approved format by the Employer.

17.5 Adequate time shall be assigned to ensure that good housekeeping is maintained. Team of housekeeping squad shall carry out this.

17.6 The Contractor shall be responsible to provide segregated containers for disposal of debris at required places and regular cleaning of the same.

17.7 Full height fence, barriers, barricades etc. shall be erected around the site in order to prevent the surrounding area from excavated soil, rubbish etc, which may cause inconvenience to and endanger the public. The barricade especially those exposed to public shall be aesthetically maintained by regular cleaning and painting as directed by the Employer. These shall be maintained in one line and level.

17.8 The structure dimension of the barricade, material and composition, its colour scheme, Maha-Metro logo and other details shall be in accordance with specifications laid down in tender document.

17.9 All stairways, passageways and gangways shall be maintained without any blockages or obstructions. All emergency exits passageways, exits fire doors, break-glass alarm points, fire fighting equipment, first aid stations, and other emergency stations shall be kept clean, unobstructed and in good working order.

17.10 Lumber with protruding nails shall be bent or removed and properly stacked.

17.11 All surplus earth and debris are removed/disposed off from the working areas to officially designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. in order to avoid dust or odour impact shall be covered while moving. The tyres of the trucks leaving the site shall be cleaned with water, wherever the possibility of spillage on carriageways meant for regular road traffic exists.

17.12 No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement. All truck drivers should generally be accompanied by a Cleaner.

17.13 Roads shall be kept clear and materials like: pipes, steel, sand boulders, concrete, chips, and brick etc. shall not be allowed on the roads to obstruct free movement of road traffic.

17.14 Water logging or bentonite spillage on roads shall not be allowed. If bentonite spillage is observed on road endangering the safety of road users, the Contractor shall be penalised as per relevant clause.

17.15 Proper and safe stacking of material are of paramount importance at yards, stores, and such locations where material would be unloaded for future use. The storage area shall be well laid out with easy access and material stored / stacked in an orderly and safe manner.

17.16 Flammable chemicals / compressed gas cylinders shall be safely stored.

17.17 Unused/surplus cables, steel items and steel scrap lying scattered at different places within the working areas shall be removed to identified locations(s).

17.18 All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to identified location(s).

17.19 Empty cement bags and other packaging material shall be properly stacked and removed.

17.20 The Contractor shall ensure that all his sub-contractors maintain the site reasonably clean through provisions related to house keeping.

17.21 Cover many general issues around safety management, but not establishing rules of procedure.

17.21.1 Rules of procedure are established by the Contractor for Worksites, addressing the following: safety rules, zero tolerance for substance abuse (refer relevant clause), environmental sensitivity of areas around the Worksites, the dangers of STDs and HIV/AIDS and respect for the beliefs and customs of the populations and community relations generally.

17.21.2 The rules are clearly displayed at the different Worksites and posted in the Contractor'svehicles and machinery driving cabs.

17.21.3 The rules confirm the Contractor's commitment to implementing the ESHS provisions provided for in the Contract.

17.21.4 New employees and existing members of personnel are made aware and acknowledge their understanding of the rules of procedure and the associated provisions. Rules of procedure document are initialed by all employees prior to the start of works.

17.21.5 Pursuant to Clauses 6.9 and 6.11 of the GCC, the rules of procedure include a list of acts considered as serious misconduct and which result in dismissal by the Contractor should an employee repeatedly commit the offence despite awareness of the rules of procedure, and this is without prejudice to any legal action by the public authority for non-compliance with applicable regulations:

I. Drunkenness during working hours, leading to risks for the safety of local inhabitants,
II. customers, users and personnel,
III. Punishable statements or attitudes, and sexual harassment in particular,
IV. Violent behavior,
V. Intentional damage to the assets and interests of others, or the environment,

VI. Repeated negligence or imprudence leading to damage or prejudice to the environment the population or properties, particularly breaching provisions intended to prevent the spreading of STD and AIDS,
VII. Drug use,
VIII. Possession and/or consumption of meat or any other part of an endangered animal or
IX. plant as defined in the Washington convention (CITES) and national regulations

17.21.6 Serious misconduct, such as organization of sex trade (pimping), committing pedophilia, physical aggression, drug trafficking, deliberate and severe pollution, trading and/or trafficking in all or part of protected species, will lead to immediate dismissal as of the first report of misconduct is detected, in application of the rules of procedure and labour laws.

17.21.7 The employer establishes a record for each case of serious misconduct, and a copy will be provided to the employee in question, indicating all action taken to terminate the misconduct by the employee in question and to bring the attention of other members of personnel to the type of incident detected. This record will be provided to the Engineer as an attachment to the monthly report

17.22 Joint Interphase safety walks

17.22.1 It is the responsibility of the civil contractor CSM to arrange weekly or as and when required joint interphase safety walks with all the concerned civil and system contractors CSM and site team to highlight various SHE related issues.

17.23 OHE Charging & Train movements during construction phase

17.23.1 One of the high risk activity during the construction stage is overhead OHE charging and train movement for signal and trains testing. All the concerned contractors Project manager and CSM have to give necessary safety clearance for the same in writing. There shall be no obstruction and/or infringements for the same.

18.0 WORKING AT HEIGHT

18.1 Definitions

18.1.1 "**access**" and "**egress**" include ascent and descent.

18.1.2 "**Fragile surface"** means a surface, which would fail if any reasonably foreseeable loading were to be applied to it.

18.1.3 "**line**" includes rope, chain, or webbing

18.1.4 "**Personal fall protection**" means:

I. a fall prevention, work restraint, work positioning, fall arrest or rescue system, other than a system in which the only safeguards are collective safeguards; or

II. rope access and positioning techniques;

18.1.5 "**Work at height"** means:

I. work in any place, including a place at or below ground level;

II. obtaining access to or egress from such place while at work, except by a staircase in a permanent workplace, where, if protective measures were not taken, a person could fall a distance liable to cause personal injury;

18.1.6 "**Work equipment**" means any machinery, appliance, apparatus, tool or installation for use at work (whether exclusively or not) and includes:

I. a guard-rail, toe-board, barrier, or similar collective means of protection
II. a working platform
III. a net, airbag, or other collective safe guard for arresting falls
IV. personal fall protection system
V. ladders

18.1.7 "**Working platform**" means:

I. any platform used as a place of work or as a means of access to or egress from a place of work;

II. includes any scaffold, suspended scaffold, cradle, mobile platforms, trestle, gangway, gantry and stairway which is so used.

18.2 **Organisation and planning**

The Contractor shall ensure that work at height is:

I. properly planned for any emergencies and rescue
II. appropriately supervised; and
III. carried out in a manner, which is reasonably practicable safe.

18.3 The Contractor shall ensure that work at height is carried out only when the weather conditions do not jeopardise the health or safety of persons involved in the work.

18.4 Competence

The Contractor shall ensure that no person engages in any activity, including organization, planning and supervision, in relation to work at height or work equipment for use in such work unless he is competent to do so or, if being trained, is being supervised by a competent person.

18.5 Avoidance of risks from work at height

The Contractor shall ensure that work is not carried out at height where it is reasonably practicable to carry out the work safely otherwise than at height.

18.6 Where work is carried out at height, the Contractor shall take suitable and sufficient measures as given below to prevent, so far as is reasonably practicable, any person falling a distance liable to cause personal injury.

i) his ensuring that the work is carried out:

A. from an existing place of work; or
B. (In the case of obtaining access or egress) using an existing means, complying to the requirements as given in relevant clause.

Where it is reasonably practicable to carry it out safely and under appropriate ergonomic conditions; and

ii) Where it is not reasonably practicable for the work to be carried out in accordance with sub-paragraph (a), his providing sufficient work equipment for preventing, so far as is reasonably practicable, a fall occurring.

18.7 Where the measures taken under Clause 18.6 do not eliminate the risk of a fall occurring, every Contractor shall:

i) So far as is reasonably practicable, provide sufficient work equipment to minimise:

a. The distance and consequences; or
b. Where it is not reasonably practicable to minimise the distance, the consequences, of a fall; and

ii) Without prejudice to the generality of Clause 18.4, provide such additional training and instruction or take other additional suitable and sufficient measures to prevent, so far as is reasonably practicable, any person falling a distance liable to cause personal injury.

18.8 **Selection of 'work equipment' for work at height**

i) The Contractor, in selecting work equipment for use in work at height, shall:

a. Give collective protection measures priority over personal protection measures; and

b. Take account of:

1. The working conditions and the risks to the safety of persons at the place where the work equipment is to be used;
2. In the case of work equipment for access and egress, the distance to be negotiated;
3. The distance and consequences of a potential fall;
4. The duration and frequency of use;
5. The need for easy and timely evacuation and rescue in an emergency; and
6. Any additional risk posed by the use, installation, or removal of that work equipment or by evacuation and rescue from it;

ii) The Contractor shall select work equipment for work at height which:

(a) has characteristics including dimensions which:

1) Are appropriate to the nature of the work to be performed and the foreseeable loadings; and
2) Allow passage without risk; and

(b) Is in other respects the most suitable work equipment, having regard in particular to the purposes specified in Clause18.5 and 18.6.

18.9 **Fragile surfaces**

18.9.1 The Contractor shall ensure that no person at work passes across or near, or working on, from or near, a fragile surface where it is reasonably practicable to carry out work safely and under appropriate ergonomic conditions without his doing so.

18.9.2 Where it is not reasonably practicable to carry out work safely and under appropriate ergonomic conditions without passing across or near, or working on, from or near, a fragile surface, every Contractor shall:

I. ensure, so far as is reasonably practicable, that suitable and sufficient platforms, coverings, guard rails or similar means of support or protection are provided and used so that any foreseeable loading is supported by such supports or borne by such protection;

II. where a risk of a person at work falling remains despite the measures taken under the preceding provisions of this regulation, take suitable and sufficient measures to minimise the distances and consequences of his fall.

18.9.3 Where any person at work may pass across or near, or work on, from or near, a fragile surface, every Contractor shall ensure that:

(i) prominent warning notices are so far as is reasonably practicable affixed at the approach to the place where the fragile surface is situated; or

(ii) where that is not reasonably practicable, such persons are made aware of it by other means.

18.10 Falling objects

18.10.1 The Contractor shall, wherever necessary to prevent injury to any person and damage to the property of third party, take suitable and sufficient steps to prevent, so far as is reasonably practicable, the fall of any material or object.

18.10.2 where it is not reasonably practicable to comply with the requirements of Clause18.9, every Contractor shall take suitable and sufficient steps to prevent any person being struck by any falling material or object which is liable to cause personal injury & damage to the property of third party.

18.10.3 The Contractor shall ensure that no material or object is thrown or tipped from height in circumstances where it is liable to cause injury to any person and the property of third party.

18.10.4 Every Contractor shall ensure that materials and objects are stored in such a way as to prevent risk to any person arising from the collapse, overturning or unintended movement of such materials or objects.

18.11 Danger areas

18.11.1 Without prejudice to the preceding requirements of these Regulations, every Contractor shall ensure that,

(i) Where a workplace contains an area in which, owing to the nature of the work, there is a risk of any person at work;

a. falling a distance; or
b. being struck by a falling object,

which is liable to cause personal injury, the workplace is so far as is reasonably practicable equipped with devices preventing unauthorised persons from entering such area; and

(ii) such area is clearly indicated.

18.12 Inspection of work equipment

18.12.1 The Contractor shall ensure that, where the safety of work equipment depends on how it is installed or assembled, it is not used after installation or assembly in any position unless it has been inspected in that position.

18.12.2 The Contractor shall ensure that work equipment exposed to conditions causing deterioration which is liable to result in dangerous situations is inspected

(i) at suitable intervals; and
(ii) each time that exceptional circumstances which are liable to jeopardise the safety of the work equipment have occurred,

to ensure that health and safety conditions are maintained and that any deterioration can be detected and remedied in good time.

18.12.3 Without prejudice to Clause 18.12.1, the Contractor shall ensure that a working platform

(i) used for construction work; and
(ii) from which a person could fall 2 metres or more,

is not used in any position unless it has been inspected in that position or, in the case of a mobile working platform, inspected on the site, within the previous 7 days.

18.12.4 The Contractor shall ensure that the reports of all inspections are properly maintained and shown to the Employer as and when required.

18.12.5 **In this clause "inspection",**

(i) means such visual or more rigorous inspection by a competent person as is appropriate for safety purposes; and
(ii) includes any testing appropriate for those purposes,

18.13 Inspection of places of work at height

The Contractor shall so far as be reasonably practicable ensure that the surface and every parapet, permanent rail or other such fall protection measure of every place of work at height are checked on each occasion before the place is used.

18.14 Duties of persons at work

18.14.1 Any workmen employed by the Contractor shall report to the supervisor about any defect relating to work at height which he knows is likely to endanger the safety of himself or another person.

18.14.2 Every workman shall use any work equipment or safety device provided to him for work at height by the Contractor, in accordance with:

(i) any training in the use of the work equipment or device concerned which have been received by him; and

(ii) the instructions respecting that use which have been provided to him by the Contractor as per the requirements of the Employer

18.15 Requirements for existing places of work and means of access or egress at height

Every existing place of work or means of access or egress at height shall:

(i) be stable and of sufficient strength and rigidity for the purpose for which it is intended to be or is being used;

(ii) where applicable, rest on a stable, sufficiently strong surface;

(iii) be of sufficient dimensions to permit the safe passage of persons and the safe use of any plant or materials required to be used and to provide a safe working area having regard to the work to be carried out there;

(iv) possess suitable and sufficient means for preventing a fall;

(v) possess a surface which has no gap

a. through which a person could fall;
b. through which any material or object could fall and injure a person; or
c. giving rise to other risk of injury to any person, unless measures have been taken to protect persons against such risk;

(vi) be so constructed and used, and maintained in such condition, as to prevent, so far as is reasonably practicable:

a. the risk of slipping or tripping; or
b. any person being caught between it and any adjacent structure;

(vii) where it has moving parts, be prevented by appropriate devices from moving inadvertently during work at height.

18.16 Requirements for guardrails, toe-boards, barriers and similar collective means of protection

(i) Unless the context otherwise requires, any reference in this section to means of protection is to a guardrail, toe-board, barrier or similar collective means of protection.

(ii) Means of protection shall

a. be of sufficient dimensions, of sufficient strength and rigidity for the purposes for which they are being used, and otherwise suitable;
b. be so placed, secured and used as to ensure, so far as is reasonably practicable, that they do not become accidentally displaced; and
c. be so placed as to prevent, so far as is practicable, the fall of any person, or of any material or object, from any place of work.

(iii) In relation to work at height involved in construction work

a. the top guard-rail or other similar means of protection shall be at least 950 millimetres above the edge from which any person is liable to fall;
b. toe-boards shall be suitable and sufficient to prevent the fall of any person, or any material or object, from any place of work; and
c. any intermediate guardrail or similar means of protection shall be positioned so that any gap between it and other means of protection does not exceed 470 millimetres.

(iv) Any structure or part of a structure which supports means of protection or to which means of protection are attached shall be of sufficient strength and suitable for the purpose of such support or attachment.

18.17 Requirements for all Working Platforms

(i) Every working platform requires a supporting structure for holding it

(ii) Any surface upon which any supporting structure rests shall be stable, of sufficient strength and of suitable composition safely to support the supporting structure, the working platform and any loading intended to be placed on the working platform.

(iii) Stability of supporting structure

Any supporting structure shall

a. be suitable and of sufficient strength and rigidity for the purpose for which it is being used;
b. in the case of a wheeled structure, be prevented by appropriate devices from moving inadvertently during work at height;
c. in other cases, be prevented from slipping by secure attachment to the bearing surface or to another structure, provision of an effective anti-slip device or by other means of equivalent effectiveness;
d. be stable while being erected, used, and dismantled; and
e. when altered or modified, be so altered, or modified as to ensure that it remains stable.
f. Have suitable base plates and properly footed thereby.

(iv) Stability of working platforms

A working platform shall

a. be suitable and of sufficient strength and rigidity for the purpose or purposes for which it is intended to be used or is being used;
b. be so erected and used as to ensure that its components do not become accidentally displaced so as to endanger any person;
c. when altered or modified, be so altered, or modified as to ensure that it remains stable; and
d. be dismantled in such a way as to prevent accidental displacement.

(v) Safety on working platforms

A working platform shall

a. be of sufficient dimensions to permit the safe passage of persons and the safe use of any plant or materials required to be used and to provide a safe working area having regard to the work being carried out there;

b. possess a suitable surface and, in particular, be so constructed that the surface of the working platform has no gap

1. through which a person could fall;
2. through which any material or object could fall and injure a person; or
3. giving rise to other risk of injury to any person, unless measures have been taken to protect persons against such risk; and

c. be so erected and used, and maintained in such condition, as to prevent, so far as is reasonably practicable

1. the risk of slipping or tripping; or
2. any person being caught between the working platform and any adjacent structure.

(vi) Loading

A working platform and any supporting structure shall not be loaded so as to give rise to a risk of collapse or to any deformation, which could affect its safe use.

(vii) Additional requirements for scaffolding

Strength and stability calculations for scaffolding shall be carried out unless

a. a note of the calculations, covering the structural arrangements contemplated, is available; or
b. it is assembled in conformity with a generally recognised standard configuration.

(viii) Depending on the complexity of the scaffolding selected, a competent person shall draw up an assembly, use and dismantling plan. This may be in the form of a standard plan, supplemented by items relating to specific details of the scaffolding in question.

(ix) A copy of the plan, including any instructions it may contain, shall be kept available for the use of persons concerned in the assembly, use, dismantling or alteration of scaffolding until it has been dismantled.

(x) The dimensions, form and layout of scaffolding decks shall be appropriate to the nature of the work to be performed and suitable for the loads to be carried and permit work and passage in safety.

(xi) While a scaffold is not available for use, including during its assembly, dismantling or alteration, it shall be marked with general warning signs in accordance with and be suitably delineated by physical means preventing access to the danger zone.

(xii) Scaffolding may be assembled, dismantled, or significantly altered only under the supervision of a competent person and by persons who have received appropriate and specific training in the operations envisaged which addresses specific risks which the operations may entail and precautions to be taken, and more particularly in:

a. understanding of the plan for the assembly, dismantling or alteration of the scaffolding concerned;
b. safety during the assembly, dismantling or alteration of the scaffolding concerned;
c. measures to prevent the risk of persons, materials or objects falling;
d. safety measures in the event of changing weather conditions which could adversely affect the safety of the scaffolding concerned;
e. permissible loadings;
f. any other risks which the assembly, dismantling or alteration of the scaffolding may entail.

18.18 Requirements for collective safeguards for arresting falls

(i) Collective safeguard is a safety net, airbag or other collective safeguard for arresting falls

(ii) A safeguard shall be used only if

a. a risk assessment has demonstrated that the work activity can so far as is reasonably practicable be performed safely while using it and without affecting its effectiveness;
b. the use of other, safer work equipment is not reasonably practicable; and
c. a sufficient number of available persons have received adequate training specific to the safeguard, including rescue procedures.

(iii) A safeguard shall be suitable and of sufficient strength to arrest safely the fall of any person who is liable to fall.

(iv) A safeguard shall:

a. in the case of a safeguard which is designed to be attached, be securely attached to all the required anchors, and the anchors and the means of attachment thereto shall be suitable and of sufficient strength and stability for the purpose of safely supporting the foreseeable loading in arresting any fall and during any subsequent rescue;
b. in the case of an airbag, landing mat or similar safeguard, be stable; and
c. in the case of a safeguard, which distorts in arresting a fall, afford sufficient clearance.

(v) Suitable and sufficient steps shall be taken to ensure, so far as practicable, that in the event of a fall by any person the safeguard does not itself cause injury to that person.

18.19 Requirements for personal fall protection systems

(i) A personal fall protection system shall be used only if

a. a risk assessment has demonstrated that

1. the work can so far as be reasonably practicable be performed safely while using that system; and
2. the use of other safer work equipment is not reasonably practicable; and

b. the user and a sufficient number of available persons have received adequate training specific to the operations envisaged, including rescue procedures.

(ii) A personal fall protection system shall

a. be suitable and of sufficient strength for the purposes for which it is being used having regard to the work being carried out and any foreseeable loading;
b. where necessary, fit the user;
c. be correctly fitted;
d. be designed to minimise injury to the user and, where necessary, be adjusted to prevent the user falling or slipping from it, should a fall occur; and
e. be so designed, installed, and used as to prevent unplanned or uncontrolled movement of the user.

(iii) A personal fall protection system designed for use with an anchor shall be securely attached to at least one anchor, and each anchor and the means of attachment thereto shall be suitable and of sufficient strength and stability for the purpose of supporting any foreseeable loading.

(iv) Suitable and sufficient steps shall be taken to prevent any person falling or slipping from a personal fall protection system.

(v) All fall protection system should be inspected weekly as a minimum.

18.20 Requirements for Ladders

(i) Every Contractor shall ensure that a ladder is used for work at height only if a risk assessment has demonstrated that the use of more suitable work equipment is not justified because of the low risk and

a. The short duration of use; or
b. Existing features on site, which he cannot alter.

(ii) Only metal ladders shall be allowed. Bamboo ladders are prohibited.

(iii) Any surface upon which a ladder rests shall be stable, firm, of sufficient strength and of suitable composition safely to support the ladder so that its rungs or steps remain horizontal, and any loading intended to be placed on it.

(iv) A ladder shall be so positioned as to ensure its stability during use

(v) A suspended ladder shall be attached in a secure manner and so that, with the exception of a flexible ladder, it cannot be displaced and swinging is prevented.

(vi) A portable ladder shall be prevented from slipping during use by:

a. securing the stiles at or near their upper or lower ends;
b. an effective anti-slip or other effective stability device; or
c. any other arrangement of equivalent effectiveness.

(vii) A ladder used for access shall be long enough to protrude sufficiently above the place of landing to which it provides access, unless other measures have been taken to ensure a firm handhold.

(viii) No interlocking or extension ladder shall be used unless its sections are prevented from moving relative to each other while in use.

(ix) A mobile ladder shall be prevented from moving before it is stepped on.

(x) Where a ladder or run of ladders raises a vertical distance of 9 metres or more above its base, there shall, where reasonably practicable, be provided at suitable intervals sufficient safe landing areas or rest platforms.

(xi) Every ladder shall be used in such a way that

a. a secure handhold and secure support are always available to the user; and

b. the user can maintain a safe handhold when carrying a load unless, in the case of a step ladder, the maintenance of a handhold is not practicable when a load is carried, and a risk assessment has demonstrated that the use of a stepladder is justified because of

1. the low risk; and
2. the short duration of use.

(xii) Ladders should be inspected weekly for any damage or corrosion.

18.21 Detailed requirements for Scaffolding

18.21.1 Scaffold General

This procedure provides general information about the competent person, erection, inspection, and use of both welded-frame and tube-and-coupler scaffolds.

(i) Scaffolds are intended to provide safe working positions at elevations. To eliminate fall exposures, scaffolds must have complete handrails, mid-rails, and decking. Do not use fall arrest equipment as a substitute for handrails, mid-rails, or a complete deck.
(ii) Before erecting scaffolds, consider all nearby or overhead hazardous energy sources such as electrical, mechanical, pneumatic, thermal, and chemical.
(iii) Welded-frame scaffolds are made of basic prefabricated end frames, cross-bracing, and frame-connecting devices to hold the parts firmly in place. Tube and-coupler and system scaffolds are made of various lengths of tubing clamped together by special patented couplers to support working platforms of various shapes.
(iv) All complete scaffolds will have a top handrail approx. 1.1 meter above the platform, mid rail approx. 0.6 meter above the platform and a toe plate 10 cm tall from the platform.
(v) Do not inter mix scaffold components manufactured by different manufacturers unless the component parts fit together without force or modification.
(vi) Bamboo components are not permitted on Maha-Metro Sites.

Competent person: one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt, corrective measures to eliminate those.

Qualified person: one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his or her ability to solve or resolve problems related to the subject matter, the work, or the project.

18.21.2 Erecting Scaffolds

(i) Only employees who have been trained by and are under the supervision of a competent person will erect scaffolds. The Maha-Metro Project Safety Manager must approve scaffolds higher than 50 feet (15 meters) above the base plates.

(ii) Where fall hazards cannot be eliminated, use fall-arrest systems while erecting, modifying, and dismantling scaffolds. It is the responsibility of the competent person to determine the feasibility and type of fall-arrest system to be used.

(iii) Set scaffold legs on base plates placed on foundations or mudsills that are adequate for supporting the maximum intended loads. Scaffold boards and

(iv) masonry blocks are not appropriate scaffold foundations. The total load on a scaffold consists of the sum of the weight of the workers and materials on a scaffold plus the weight of the scaffold.

(v) Install adjusting screws only between the base plate and the vertical frame section. Never use adjusting screws together with casters. Do not extend adjusting screws beyond 12 inches (30 centimetres).

(vi) The position and number of braces used on a scaffold not only restricts the amount of side movement, but also determines the strength of the scaffold. Never use cross-braces as substitutes for handrails or mid rails.

(vii) When the height of a scaffold exceeds three times the smallest width of the base, secure it to the building or structure at every other lift and every 9 meters horizontally. The scaffold should be secured by both ties and braces to prevent movement Equip scaffold working platforms with handrails approximately one-meter high, mid rails, and toe boards, all secured rigidly. Working platforms should be completely decked with safety planks, manufactured scaffold decking, or laminated wooden planks.

(viii) To allow access to the working platform of a tubular welded frame scaffold, the ladder built into the end frames can be used if it has been specifically designed and constructed by the manufacturer for the purpose of access.

(ix) Employees engaged in erecting or dismantling tubular-welded frame scaffolds may use the end-frame horizontal members for access provided they are parallel, level, and are not more than 22 inches apart vertically. Hook-on attachable ladders shall be installed as soon as scaffold erection has progressed to a point that permits safe installation and use. Consideration should be given to breaking the ladder at approximately 6-meter intervals. Retractable or vertical lifelines should be used for fall protection while climbing more than 20-feet.

(x) When portable straight or extension ladders are used for access to tube-and coupler scaffolds, the 4-to-1 slope should be maintained to avoid a horizontal tube interfering with the use of the ladder.

(xi) Scaffold users should be able to step off the scaffold access ladder directly onto the working platform. Provide entry gates for scaffolds to eliminate the need for users to climb over handrails.

(xii) Tag or otherwise identify scaffolds that should not be occupied or that require particular safety precautions. The tag should indicate special requirements, the date of erection, and the signature of the competent person.

(xiii) Scaffolds and their components must be capable of supporting, without failure, at least four times the maximum intended load. Materials should be evenly distributed on platforms and not concentrated in one small area.

(xiv) During erection of scaffolds, the electrical clearances shall be maintained as per the tabulation mentioned herein in this document

18.21.3 Scaffold Inspection

(i) A competent person shall visually inspect all components of the scaffold for defects prior to each shift's use and following any occurrence that could affect the scaffold's structural integrity. Defective components will be immediately discarded.

(ii) Before erecting and while dismantling scaffolds, inspect all components. Scaffold components should be straight and free from bends, kinks, dents, and severe rusting. Immediately discard defective components. Inspections should include an evaluation of the following components:

a. Handrails, mid-rails, toe boards, cross-bracing and steel tubing for nicks and other damage, especially near the centre span, and for signs that welding arcs may have struck the equipment
b. weld zones on the scaffold frame for cracks
c. the end of tubing for splits or cracks
d. manufactured decks for loose bolts or rivet connections and bent, kinked, or dented frames
e. safety planks for rot, cracks, cuts, and other external damage
f. tie rods or bolts and angle iron cleats
g. cams, springs, threaded connection, toggle pins, or other quick-connecting devices
h. Casters for rough rolling surfaces, "sticky" swivels, and defective locking mechanisms.

(iii) Scaffold Inspection Tag, Boards, identifying that the scaffold is “Safe for Use” or “Scaffolds Under Construction” must be attached to all scaffolds.

18.21.4 Scaffold Training

(i) Employees involved in the erection, dismantling, moving, repairing, etc., of scaffolding shall receive training from a competent person. The purpose of the training is to recognize any hazards associated with the work in question. Training shall consist of:

a. The nature of scaffold hazards
b. The correct procedures for erecting, disassembling, moving, operating, repairing, inspecting, and maintaining the type of scaffold.
c. The design criteria, maximum intended load-carrying capacity, and intended use of the scaffold.

(ii) Employees who perform work while on a scaffold shall be trained by a qualified person so they will recognize hazards associated with the type of scaffold being used and understand the procedures to control those hazards. Training will cover the following topics as necessary:

a. The nature of any electrical hazards, fall hazards, and falling object hazards in the work area.
b. The correct procedures for dealing with electrical hazards and for erecting, maintaining, and disassembling the fall protection systems and falling object protection systems used.
c. The proper use of the scaffold and the proper handling of materials on the scaffold.
d. The maximum intended load and the load-carrying capacities of the scaffolds used.

18.21.5 Suspended Scaffolding

Swinging stages, toothpicks, boatswain chairs, float, and needle beams require special approval prior to use.

Attach and secure safety harness before stepping on these scaffolds and do not remove until clear of the scaffold. Tie off to independent lifeline or building structure. One lifeline per person.

18.22 Provision of safety nets

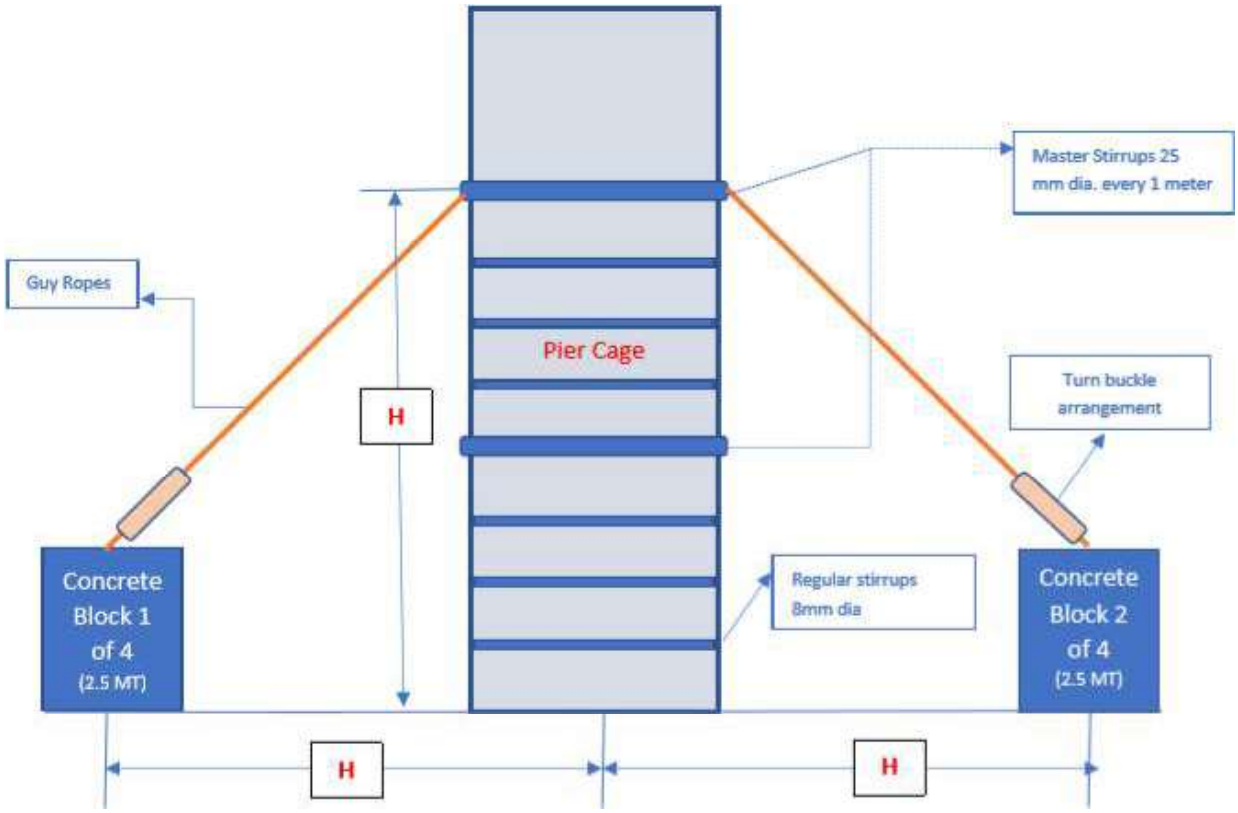
Garware make/Equivalent to safety nets have to be provided at all the locations where there is free fall of men/materials from the site to the live road or ground floor. Double/Triple layer safety nets has to be provided without fail

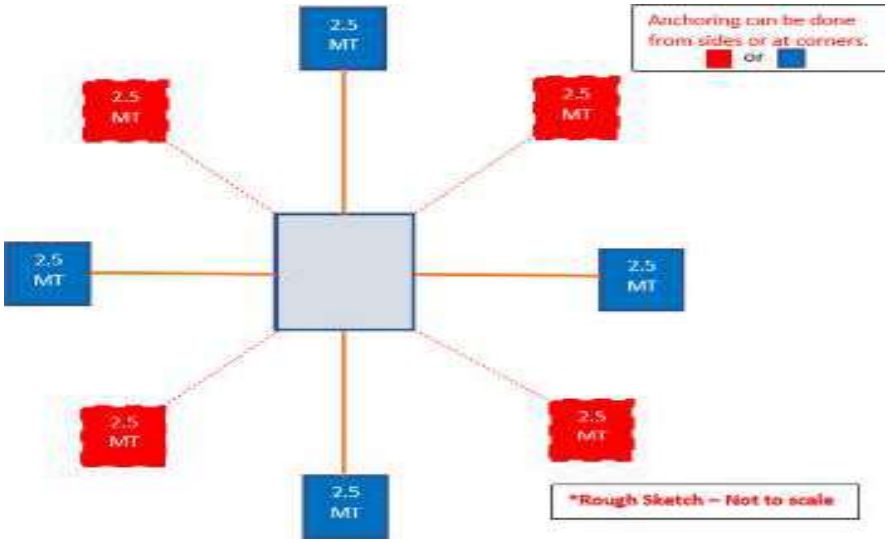
18.23 Pier Reinforcement Cage Protection

Tying of Pier reinforcement should be done as per sketch A. wherever due to space constraint, it isdesirable that two cranes should be used; one to hold the pier reinforcement and the other one toerect the shuttering.

1. 25mm dia. master stirrup to be installed every 1 m height, in addition to regular stirrups.
2. Master stirrup need to be used to anchor the pier cage with guy ropes at four sides. Concrete blocks (2.5 MT) shall be placed in such a way that the guy ropes make an angle of 45^0 with the ground. (referattached sketch A)
3. For all pier reinforcement / shuttering works more than 6m height, advance RFI along with safetyinspection checklist must be raised for permission of GC personnel for de-staging of support and placement of shuttering

Typical Sketch A - Pier cage - Concrete blocks placement & anchorage method





19.0 OVERHEAD PROTECTION

19.1 All contractors shall provide overhead protections as per Rule 41 of BOCWR.

19.2 Overhead protection should be erected along the periphery of every building which is under construction and the building height shall be 15m or above after construction.

19.3 Overhead protection shall be minimum 2m wide and the outer edge shall be 150mm higher than the inner edge and an angle not more than 20º to its horizontal sloping into the building.

19.4 Overhead protection shall not be erected more than a height of 5m from the base of the building.

19.5 Areas of inadvertent hazard of falling of material shall be guarded or barricaded or roped-off thereby by the Contractor.

20.0 SLIPPING, TRIPPING, CUTTING, DROWNING AND FALLING HAZARDS

As per Rule 42 of BOCWR:

20.1 All places should be free from dust, debris or similar materials.

20.2 Sharp projections or any protruding nails or similar objects shall be suitably guarded or shall even be avoided to make the place safe to work.

20.3 Contractor shall not allow workmen to work or use platforms, scaffolds/passageways or any walkways, which has water, or oil or similar substances spilt and has a slipping hazard, unless it is cleaned off or covered or sanded or saw dusted or make it safe with any suitable material.

20.4 When workers are exposed to areas where fall into water is possible, the Contractor shall provide suitable and adequate equipment for saving the workers from drowning and rescuing from such hazard. If the Employer considers, the Contractor shall provide well-equipped boat or launch, manned with trained personnel at the work place.

20.5 Open side or opening where worker, equipment, vehicle or lifting appliance may fall at a building or outside shall be guarded suitably except in places of free access by reasons of nature of work.

20.6 Suitable safety net shall be provided at places of material / man falling is possible in accordance with national standards.

20.7 The collapse of formwork in the construction industry has the potential for severe injury and death. The four stages of the use of formwork (erection, adjustment, concrete placement and dismantling) all need to be managed in a risk assessment framework. Implementing suitable control measures can eliminate or reduce the potential for events such as the collapse of formwork. Suitable control measures include:

I. keeping the documentation for the formwork at the workplace;
II. following the formwork documentation;
III. planning to ensure that all elements of the process are conducted in a safe manner – e.g., ensuring operators such as crane operators, concrete placers are suitably licensed and trained, appropriate personal protective equipment is used etc;
IV. erecting the formwork on foundations which will support the loads to be imposed on the formwork;
V. not erecting formwork near excavation;
VI. ensuring materials used in the erection of formwork are not defective;
VII. securing loose material which may be dislodged as a result of inclement weather;
VIII. inspecting the formwork assembly before and during the placement of concrete;
IX. not attaching equipment to the formwork assembly unless specifically designed for this purpose; and not using a stripping process which may cause damage to the permanent structure.

21.0 LIFTING APPLIANCES AND GEAR

21.1 Lifting appliances means a crane, hoist machinery, derrick, winch, gin pole, sheer legs, jack, hoist drum, slewing machinery, slewing bearing fasteners, lifting machinery sheaves, pulley blocks, hooks or other equipment used for lifting materials, objects or building workers and lifting gears means ropes, chain slings, shackles, hooks, lifting lugs, wire ropes, lifting eyebolts and eyenuts and other accessories of a lifting appliance.

21.2 No machine shall be selected to do any lifting on a specific job until its size and characteristics are considered against:

I. the weights, dimensions, and lift radius of the heaviest and largest loads

II. the maximum lift height, the maximum lift radius and the weight of the loads that must be handled at each lifting operation.

III. Proper mockup without load trials shall be carried out for heavy duty lifting operations by crane before resorting to the actual lifting of the load.

IV. the number and frequency of lifts to be made and maintained in Lifting Register.

V. how long the crane will be required on site to be ensured by lifting team.

VI. the type of lifting to be done (for example, is precision placement of loads important?)

VII. the type of carrier required (this depends on ground conditions and machine capacity in its operating quadrants) capacity is normally greatest over the rear, less over the side, and non-existent over the front

VIII. whether loads will have to be walked or carried

IX. whether loads will have to be suspended for lengthy periods

X. the site conditions, including the ground where the machine will be set up, access roads and ramps it must travel, space for erection and any obstacles that might impede access or operation.

XI. Method Statement with attached Risk Assessment, Lifting Plan, lifting method drawing/sketch and the list of Competent Lifting Team/Responsible Person shall be submitted to employer well in advance as mentioned herein before at Clause 3.5.2.

XII. Pre-lifting Toolbox-Talk must be conducted before lifting operation with listed Lifting team ensuring their roles and responsibilities in lifting operation.

21.3 The Contractor shall ensure that a valid certificate of fitness issued as per Clause 21.5 is available for all lifting appliances including synchronised mobile jacks, pre-stressing hydraulic jacks, jacks fitted with launching girders etc. and Employer's approval before inducting to the site. Only after obtaining the approval from the Employer any lifting appliances and gear shall be used.

21.4 The laminated photocopies of fitness certificate issued by competent person, the Employers' approval letter, the operators' photo, manufacturer's load chart and competency certificate shall always be either kept in the operator cabin or pasted on the visible surface of the lifting appliances.

21.5 All lifting appliances and loose gears shall be clearly marked for its safe working load and identification by stamping or other suitable means.

21.6 The Contractor shall also maintain a register containing a system of identification of all tools and tackles, its date of purchase, safe working load, competent person date of examination etc.

21.7 Test and periodical examination of lifting appliances and gears

21.7.1 All lifting appliances including all parts and gears thereof, whether fixed or movable shall be thoroughly tested and examined by a competent person once at least in every six months or after it has undergone any alterations or repairs liable to affect its strength or stability. Within the validity, if the lifting appliances are shifted to a new site, re-examination by the same competent person for ensuring its safety shall also be done.

21.7.2 Contractors can utilise the services of any competent person as defined in Factories Act, 1948 and approved by Chief Inspector of Factories with the permission of the Employer.

21.7.3 All alarms and signals like Automatic Safe Load Indicators (ASLI), boom angle indicators, boom extension indicators, over lift boom alarm, swing alarm, hydraulic safety valves, mechanical radius indicators, load moment indicators etc. shall be periodically examined and maintained always in working condition.

21.8 Automatic Safe Load Indicators

21.8.1 As stipulated in relevant Rule of GBOCWR 2003, no lifting appliances gear or any other material handling appliance is used, if:

(i) the Inspector having jurisdiction is not satisfied with reference to a certification of test or examination or to an authenticated record maintain as provided under these rules; and

(ii) in the view of such Inspector, the lifting appliance, lifting gear or any other material handling appliance is not safe for use in building or other construction work; and

(iii) no pulley block is used in building or other construction work unless the safe working load and its identification are clearly marked on such block.

21.8.2 All lifting appliances and gears, like cranes, hydras etc, if so constructed that the safe working load may be varied by raising or lowering of the jib or otherwise shall be attached with an automatic indicator of safe working loads approved by Bureau of Indian standards/ International

certifying bodies which gives a warning to the operator and arrests further movements of the lifting parts.

21.9 Qualification of operator of lifting appliances and of signaller etc.

21.9.1 The Contractor shall not employ any person to drive or operate a lifting machine like crane, hydra etc whether driven by mechanical power or otherwise or to give signals to work as a operator of a rigger or derricks unless he:

(i) is above twenty-one years of age and possesses a valid heavy transport vehicle driving licence as per Motor Vehicle Act and Rules.

(ii) is absolutely competent and reliable

(iii) possesses the knowledge of the inherent risks involved in the operation of lifting appliances by undergoing a formal training at any institution of national importance acceptable to Employer

(iv) is medically examined periodically as specified in Schedule VII of BOCW Rules.

21.10 General requirements of appliances

21.10.1 Out-of level

One of the most severe effects of being out-of fit level is that side loads develop in the boom. Because of side loads all mobile cranes lose capacity rapidly as the degree of out-of-level increases and therefore control of out-of-level is of utmost importance.

21.10.2 Boom

(i) The boom is one of the more critical elements of the crane and must be in perfect condition at all time. No boom section with a bent lattice member shall be allowed

(ii) All welds shall be crack and corrosion free

(iii) No member of the boom shall be bent

(iv) All telescopic boom shall be free from cracks, rust, flaking or cracked paint, bulges, greases or varnishes

21.10.3 The sweep area (work area) of the construction machinery shall be always free from obstructions.

21.10.4 All hydraulic piping and fittings shall be maintained leak proof.

21.10.5 The operator cab shall posses good and safe:

(i) structure, windows, and windshield wipers
(ii) Drivers chair and foot rest
(iii) Control handles
(iv) Cab instrumentation
(v) Telecommunication
(vi) Cab out fitting
(vii) wind indicator with an adjustable set point shall be in a position representative for the wind on the crane. The indicator shall give continuous information regarding constant speeds and gusts.

21.11 Mandatory rigging requirements

21.11.1 Rigging shall be done under experienced and qualified rigger only.

21.11.2 The primary requirement in rigging shall be to assess the weight of load before attempting any lift.

21.11.3 All hooks shall be fitted with Master Rings having certificate of fitness from the competent person, so that the hooks are subjected to balanced vertical loading only.

21.11.4 Only four legged slings shall be allowed which includes master link (ring), intermediate master link (ring) if necessary, chain / wire rope sling, sling hook or other terminal fitting.

21.11.5 Hand spliced slings up to 32mm diameter shall not be used at site for any lifting purpose.

21.11.6 No load shall be slewed over public areas without stopping the pedestrians and road traffic first.

21.11.7 Requirements of outriggers

(i) All outriggers shall be fully extended and at all tyres are clear of the ground

(ii) Heavy duty blocking having large bearing area shall be necessary to prevent sinking of floats

21.11.8 All loads shall have tag-lines attached in order to ensure that the load can be controlled at all times.

21.11.9 No close working to any live overhead power line is permitted without the operation of a strict Permit to Work.

21.11.10 Minimum lighting is to be ensured at all lifting operations.

21.11.11 Usage of First-Generation Hydra is STRICTLY PROHIBITED in Pune Metro project, if found violated, penalty shall be imposed without any warning letter.

21.11.12 Crane used for lifting operations shall not be older than 10 years, in case of tyre mounted and 15 years in case of crawler mounted.

21.12 Failure to do any of the above shall attract penalty from the Employer as per relevant clause

22.0 LAUNCHING OPERATION

22.1 As launching operation is one of the riskiest jobs, the Contractor shall take utmost precaution at all stages like; planning, establishing casing yard, casting segments, transporting segments, fabrication and erection of launching girders, launching of segments, pre-stressing, auto launching of girders and dismantling of launching girders.

22.2 The Contractor shall prepare a comprehensive Method Statement for the launching operation, adhering to the SHE conditions laid down in conditions of contract on SHE and Project SHE Manual. Particular reference shall be made to the provisions on working at height. As the entire process of launching has to be undertaken at an elevated level, the safety of workers and the girder is paramount important. The following general guidelines shall be adhered throughout the launching operation.

(i) Necessary 'working platforms' and fall protection anchorage arrangement shall be provided in the launching girder itself.

(ii) Provisions for mounting light fittings shall also be made available in the launching girder.

(iii) The casting yard shall be established ensuring the provision given in Clause 38.0

(iv) The workmen engaged in fabrication of reinforcement, concreting the segment shall be provided with necessary PPEs including compulsory hand protection gloves.

(v) Casting and curing of segment shall be undertaken under the direct supervision of the responsible engineer of the Contractor.

(vi) Trucks with valid registration, licence, safe worthiness certificate, Employer's approval certificate, and pollution under check certificate shall only be used for transport of segments.

(vii) All vehicle drivers including heavy vehicle operators shall be trained on defensive driving at training institute recognized by Maharashtra State Road Transport Corporation / Government of Maharashtra, or any other driving institute registered under Motor Vehicles Act.

(viii) Drivers shall also have undergone proper medical examination as per relevant clause mentioned under 'Medical Facilities.'

(ix) The segments shall be rigidly secured to the truck with necessary wooden wedges and necessary red indicators/safety tapes provided so that the vehicle is clearly seen by other road users both in day / night time. Further, necessary arrangements / modification should be made in the trailer and Engineer / Employer approval shall be obtained before the transportation starts.

(x) Every launching girder shall have a responsible engineer on duty all the time.

(xi) All the time from erection to dismantling the area between the two piers wherein launching is in progress shall always be barricaded.

(xii) Unloading of segments from trucks, lifting of segments, shifting of segments, gluing shall be done under the direct supervision of the approved engineer of the Contractor.

(xiii) Auto launching shall be done only after approval from the Employer. After every auto launching the stability of launching girder shall be ensured.

(xiv) The vertical deflection of launching girder shall be monitored at all critical stages like with/without loads and after every auto launching.

(xv) A register containing all important operational details from erection to dismantling of launching girders shall be maintained and made available to Employer whenever called for.

(xvi) Test certificate for all lifting gears including Macalloy bars shall be maintained at a location closer to the launching girder itself so that it can be referred during all inspections.

(xvii) Adequate lighting at all time shall be ensured in the entire area of operation.

(xviii) Access to drinking water & toilet shall be ensured to all workmen engaged for launching process.

(xix) Proper access ladders/stairways shall be maintained for safe ascending / descending of workmen / engineers.

22.3 Non-adherence to any of the clauses mentioned above shall be viewed seriously by the Employer and penalty levied as per relevant clause.

23.0 CONSTRUCTION MACHINERY

23.1 Construction machineries may include dumpers and dump trucks, lift trucks and telescopic handlers piling rigs, vibro hammers, rail welding equipments, mobile elevating work platforms, cranes, tipper lorries, lorry loaders, skip wagons, 360° excavators, 180° backhoe loaders, crawler

tractors, scrapers, graders, loading shovels, trenchers, side booms, pavers, planers, chippers, road rollers, locomotives, tankers and browsers, trailers, hydraulic and mechanical breakers etc.

23.2 Safe worthiness certificate

23.2.1 Every construction equipment shall be in sound mechanical working condition and certified by either competent person under Factories Act or manufacturers' warranty in case of brand new equipments or authorized persons / firms approved by Employer before induction to any site.

23.2.2 Every such certificate shall have the date of purchase, main overhauling undertaken in the past, any accident to the equipment, visual examination details, critical components safety check, list of safety devises and its working condition, manufacturer's maintenance checklist, past projects wherein the equipments were used etc as its minimum content.

23.3 Reverse Horns and reverse cameras

All Vehicles shall be fitted with audible reverse alarms and reverse cameras, maintained in good working condition. Reversing shall be done only when there is adequate rear-view visibility or under the directions of a banks man

23.4 General operating procedures

(i) Drivers entering site shall be instructed to follow the safe system of work adopted on site. These shall be verbal instructions or, preferably, written instructions showing the relevant site rules, the site layout, delivery areas, speed limits, etc.

(ii) No passengers shall be carried, unless specific seating has been provided in accordance with the manufacturers' recommendations.

(iii) Working on gradients beyond any equipments capability shall not be allowed.

(iv) Prevention of dumper and dump truck accidents should be managed by providing wheel stops at a sufficient distance from the edges of excavations, spoil heaps, pits, etc.

(v) The manufacturer's recommended bucket size must not be exceeded in excavators.

(vi) If excavators operating on a gradient which cannot be avoided, it must be ensured that the working cycle is slowed down, that the bucket is not extended too far in the downhill direction, and that travel is undertaken with extreme caution. A large excavator must never be permitted to travel in a confined area, or around people, without a banks man to guide the driver, who should have the excavator attachment close in to the machine, with the bucket just clear of the ground. On wheeled excavators, it is essential that the tyres are in good condition and correctly inflated. If stabilizing devices are fitted, they should be employed when the machine is excavating.

(vii) When the front shovel of the 180° backhoe loaders is being employed, the backhoe attachment shall be in its "travel" position, with the safety locking device in place.

(viii) When operating the backhoe in poor ground conditions, the stabilisers tend to sink into the surface of the ground, reducing stability. Therefore, frequent checks shall be made for the stability of the machine. The loading shovel should always be lowered to the ground to stabilise the machine when the backhoe is employed.

(ix) The netting operation of the skip wagons should be carried out prior to lifting the skip to reduce the risks of working on the rear platform.

(x) If a tractor dozer is employed on clearing scrub or felling trees, it shall be provided with adequate driver protection.

(xi) When two or more scrapers are working on the same job, a minimum distance of at least 25m shall be kept between them.

(xii) In case of hydraulic breakers, hydraulic rams and hoses shall be in good working condition

23.5 All wood working machines shall be fitted with suitable guards and devices such as top guard, riving knife, push stick, guards for drive belts and chains, and emergency stop switch easily accessible by the operator.

23.6 Requirements related to use of Bulldozers

23.6.1 General

(i) Be careful when working near the edge of banks, ditches, cuts, or fills, or near overhanging material. The vibration and weight of the machine may cause the edge to give way or overhanging material to fall.

(ii) Before starting work, ensure that an observer is present when plant is required to work in water where the depth may endanger the operator.

(iii) Avoid obstacles such as rocks or logs. If forced to cross them, use extreme caution, and change to the lowest gear.

(iv) Ease up to the balance point and ease down to minimise the jolt on contact with the other side.

(v) When receiving a wire rope on a drum or through Sheaves, operators should disengage the master clutch, idle the engine, and lock the brakes.

NOTE: All operators should stop engines before working with ropes wound on front-mounted drums.

23.6.2 Clearing Operations

(i) When clearing trees, watch out for dead branches in treetops.

(ii) Dozer operators should make sure that all persons are standing clear before pushing over trees, dozing rocks or rolling logs.

(iii) A long rope should be used to pull over large dead trees. (Make sure in advance that a falling tree will clear the machine and operator).

(iv) In excavation work, operators should be alert to dangers from overhanging dirt and rocks. In such cases, dozers should be equipped with the relevant overhead protection.

23.7 Requirements related to use of Excavators

(i) When excavating trenches, place the excavated material at a distance of one and a half times the depth of the trench from the edge of that trench. Where this is not practicable, place excavated materials at least one (1) metre from the edge of the trench.

(ii) Ensure the ground beneath the machine is not undercut.

(iii) Watch boom clearance when travelling. Uneven ground may cause the boom to weave and collide with obstructions.

(iv) Avoid jerky slewing or sudden braking. These can make the machine unstable and overload machine components.

(v) Ensure the operator has the appropriate restricted operator's licence if the excavator is to be used in the crane mode.

(vi) When an excavator is used in the crane mode, check that the lifting weight is well within the approved lifting capacity for the machine. This lifting capacity shall be clearly and permanently marked on each machine.

(vii) Only operate attachments while stationary, as operation during travelling may starve one of the track drive motors and result in an unintended turn.

(viii) Consider implementing a 'Permit to Work' system, particularly when working near power lines or underground power for example: - that the height of power lines is known; - that the underground location is known; and - visible measure, such as tiger tails, are put in place.

23.8 Requirements related to use of Trucks

23.8.1 General

(i) Drive defensively
(ii) Obey road signs
(iii) Never race with other vehicles
(iv) When following another vehicle, always allow enough distance to stop safely.
(v) One truck length for every 10 km per hour of truck speed should be the minimum distance between vehicles.
(vi) Reversing is the most hazardous truck operation. Reversing alarms, which are fitted on some trucks, are effective in warning persons of the danger. Reverse trucks only when they are under the direction of a signalman or when satisfied that the way is clear and will remain clear.
(vii) Be cautious of spillage from loaded units and any hazards the spillage might present to people on the ground and to the tyres of other plant.
(viii) Trucks sometimes fall over a tip head because the driver backs over the edge or the edge collapses under the weight of the truck.
(ix) Use a protective beam or timber baulk or back under the control of a signalman in order to avoid this happening.
(x) Principal Contractors should provide an earth mound to at least half the wheel diameter. This is a known control that is also used in the mining industry.
(xi) Where ground conditions are soft, or the tip head is likely to subside, dump loads back from the edge and have a dozer move the material over the edge.

23.8.2 Loading

(i) Never enter or leave the cab during loading.
(ii) Watch for and avoid other vehicles, personnel, and rock outcrops on entering or leaving the loading area.
(iii) Stay a safe distance from trucks ahead at the loading point, and follow the directions of the signalman or loader operator before moving into the loading position.
(iv) Move off when signalled that loading is complete.
(v) Load material, e.g., timber, so that it does not project beyond the truck body and present a hazard to other plant, people, or structures.
(vi) Where material is to be transported on a public road, maintain a distance of 1.2 metre or more beyond the front or rear of the vehicle, or 150 mm on either side, shall have a visible red flag or object fastened to the projecting end.
(vii) Unusually wide or long loads require a permit from the Police Department.
(viii) Secure loads at the lowest possible level on the tray with ropes or chains, and take special care when the truck is to travel over rough terrain.
(ix) Truck operators are responsible for giving load placement requirements to crane operators before loading operations begin.
(x) The load should be placed so that it will remain stable during loading, unloading and travelling.

23.8.3 Unloading

(i) Lower truck bodies before leaving the dump area.
(ii) Only raise truck bodies to unload materials on surfaces where the vehicle will remain stable and upright.
(iii) Never raise truck bodies to within a specified distance of overhead power line.
(iv) Take special care when tipping a load or spreading screenings on a road.
(v) With the tray up, trucks are less stable and are more likely to roll over, particularly on hilly sections or roads with surface irregularities or steep shoulders.
(vi) Check that the raised tray will not foul overhead power lines or telephone wires.
(vii) Never place part of your body under a raised truck body unless the truck body is securely propped.

23.8.4 Transporting personnel

(i) Trucks shall not be used to transport personnel unless they are specifically designed to do so.
(ii) Where a bus is employed for the transportation of personnel, the bus shall: -be enclosed; have seats which are attached to the vehicle; have a safe means of access and exit; and, have two means of exit in case of emergency.
(iii) Drivers transporting personnel should be alert, dependable and careful.
(iv) Relevant safety rules include: never allow passengers to ride with their arms outside the vehicle; only start the vehicle after everyone is seated; persons should only get on or off the vehicle when it is stationary; tools, plant or gear should be stored in a compartment separate from passengers, i.e., compartments that are designed for storage and transportation and are separate from where personnel are seated.
(v) All items stored in this compartment should be secured against movement; and ensure that exhaust fumes do not enter the passengers' compartment.

23.8.5 Towing

(i) When towing another vehicle, take the following precautions: ensure the towing cable is undamaged and has a safe working load adequate for the job.
(ii) Slings, straps, or chains which are used for towing should not be used for lifting any gear or materials and should be identified as such, e.g., slings and chains, etc. should be tagged "not for use in hoisting operations";
(iii) Before reversing, ensure everyone is clear. Get help from a signalman if the rear view is obstructed;
(iv) Attach the towing cable securely to the machines at the points recommended by the manufacturer.
(v) If these are not known, ensure fixing points are selected that will not damage the tow cable or the machine;
(vi) check what brakes are operational on the towed vehicle. There is unlikely to be any power assistance available for the brake system. Do not rely on parking brakes as a means of control;
(vii) When moving off, take up the slack carefully. Do not jerk the cable, and keep it taut to avoid damage;
(viii) keep towing speed down and as constant as possible;
(ix) Keep clear of the area between the towing vehicle and the towed vehicle; and attach a warning sign on the rear of the towed vehicle or machine which reads "Vehicle Under Tow".
(x) Working of heavy mobile equipments in marshy soil, must ensure to keep two nos. of 25 mm thick MS Plates at the base (track chain) of the respective machine to avoid collapse of the same with sand bags at the ground.

23.9 Penalty

If any of the above clauses are not adhered, penalty shall be imposed as per relevant clause depending upon the gravity of the unsafe act and or condition.

24.0 MACHINE AND GENERAL AREA GUARDING

24.1 The Contractor shall ensure at the construction site all motors, cogwheels, chains and friction gearing, flywheels, shafting, dangerous and moving parts of machinery are securely fenced or legged. The fencing of dangerous part of machinery is not removed while such machinery is in motion or in use.

25.0 MANUAL LIFTING AND CARRYING OF EXCESSIVE WEIGHT

25.1 The Contractor shall ensure at his construction site of a building or other construction work that no building worker lifts by hand or carries overhead or over his back or shoulders any material, article, tool, or appliances exceeding in weight as said below as per Rule 38 of BOCWR, unless aided by another building worker or device.

Person	Maximum weight in kg
Adult man	55
Adult woman	30

25.2 No building worker aided by other building worker shall lift or carry weight higher than or exceeding the sum of total of maximum limits set out for each building worker separately as mentioned in the table above.

26.0 SITE ELECTRICITY

26.1 Competency of Electrical personnel

26.1.1 The Contractor shall employ qualified and competent electrical personnel as specified in General Instruction Maha-Metro/SHE/GI/001.

26.2 Assessment of power

26.2.1 The Contractor shall assess the size and location of the electrical loads and the manner in which they vary with time during the currency of the Contract.

26.2.2 The Contractor shall elaborate as to how the total supply is to be obtained / generated. The details of the source of electricity, earthing requirement, substation / panel boards, distribution system shall be prepared and necessary approval from Employer obtained before proceeding of the execution of the job.

26.2.3 The main Contractor shall take consideration, the requirements of the sub / petty contractors' electric power supply and arrive at the capacity of main source of power supply from diesel generators.

26.2.4 As the sub / petty contractors' small capacity generators create more noise and safety hazard, no small capacity diesel generators shall be allowed for whatsoever the type of job to be executed under this contract.

26.2.5 If any unsafe noise making small capacity diesel generators are found used by sub / petty contractors the main contractor shall only be penalised.

26.3 Work on site

The Contractor shall also submit electrical single line diagram, schematic diagram and the details of the equipment for all temporary electrical installation and these diagrams together with the temporary electrical equipment shall be submitted to the Employer's for necessary approval. Failure to do so shall invite penalty as per relevant clause.

26.4 Strength and capability of electrical equipment

No electrical equipment shall be put into use where its strength and capability may be exceeded in such a way as may give rise to danger.

26.5 Adverse or hazardous environments

Electrical equipment, which may reasonably foreseeably be exposed to:

a) Mechanical damage;
b) the effects of the weather, natural hazards, temperature, or pressure;
c) the effects of wet, dirty, dusty, or corrosive conditions; or
d) any flammable or explosive substance, including dusts, vapours, or gases,

shall be of such construction or as necessary protected as to prevent, so far as is reasonably practicable, danger arising from such exposure.

26.6 Distribution system

26.6.1 The Contractor shall provide distribution system for control and distribution of electricity from a main AC supply of 50Hz for typical appliances:

a) Fixed plant – 400V 3 phase
b) Movable plant fed via trailing cable over 3.75 kW – 400V, 3 phase
c) Installation in site buildings – 230V single phase
d) Fixed flood lighting – 230V single phase
e) Portable and hand tools – 115V single phase
f) Site lighting - 115V single phase
g) Portable hand lamps – 115V single phase

26.7 Electrical protection circuits

26.7.1 Precautions shall be taken, either by earthing or by other suitable means, to prevent danger arising when any conductor (other than a circuit conductor) which may reasonably foreseeable become charged as a result of either the use of a system, or a fault in a system, becomes so charged. A conductor shall be regarded as earthed when conductors of sufficient strength and current-carrying capability to discharge electrical energy to earth connect it to the general mass of earth.

If a circuit conductor is connected to earth or to any other reference point, nothing which might reasonably be expected to give rise to danger by breaking the electrical continuity or introducing high impedance shall be placed in that conductor unless suitable precautions are taken to prevent that danger.

26.7.2 Appropriate electrical protection shall be provided for all circuits, against over load, short circuit, and earth fault current.

26.7.3 The Contractor shall provide sufficient ELCBs (maintain sensitivity 30 mA) / RCCBs for all the equipments (including Potable equipments), electrical switchboards, distribution panels etc. to prevent electrical shocks to the workers.

26.7.4 All protection devices shall be capable of interrupting the circuit without damage to any equipments and circuits in case of any fault may occur.

26.7.5 Rating of fuses and circuit breakers used for the protection of circuits should be coordinate with equipment power ratings.

26.7.6 Protection against lightning shall be ensured to all equipment kept in open at sites.

26.8 Cables

26.8.1 Cables shall be selected after full consideration of the condition to which they shall be exposed and the duties for which they are required. Supply cable up to 3.3 kV shall be in accordance with BS 6346.

26.8.2 For supplies to mobile or transportable equipment where operating of the equipment subjects the cable to flexing, the cable shall conform to any of these codes BS 6007 / BS 6500 / BS 7375.

26.8.3 Flexible cords with a conductor cross sectional area smaller than 1.5 mm2 shall not be used and insulated flexible cable shall conform to BS 6500 and BS 7375.

26.8.4 Where low voltage cables are to be used, reference shall be made to BS 7375. The following standards shall also be referred to particularly for underground cables BS 6346 and BS 6708

26.8.5 Cables buried directly in the ground shall be of a type incorporating armour or metal sheath or both. Such cables shall be marked by cable covers or a suitable marking tape and be buried at a sufficient depth to avoid their being damaged by any disturbance of the ground. Cable routes shall be marked on the plans kept in the site electrical register.

26.8.6 Cabling passing under the walk way and across way for transport and mobile equipment shall be laid in ducts at a minimum depth of 0.6 meters.

26.8.7 Cables that need to cross open areas, or where span of 3m or more are involved, a catenary wire on poles or other supports shall be provided for convenient means of suspension. Minimum height shall be 6m above ground.

26.8.8 Cables carrying a voltage to earth in excess of 65V other than supply for welding process shall have metal armour or sheath, which has been effectively earthed and monitored by the contractor. In case of flexible and trailing cables such earthed metal sheath and/or armour should be in addition to the earth core in the cable and shall not be used as the protective conductor.

26.8.9 Armoured cables having an over-sheath of polyvinyl chloride (PVC) or an oil resisting and flame retardant compound shall be used whenever there is a risk of mechanical damage occurring

26.9 Plugs, socket-outlets, and couplers

26.9.1 The Contractor shall ensure plugs, socket-outlets, and couplers available in the construction site as “splash proof” type. The minimum degree of Ingress Protection should be of IP44 in accordance with BS EN 60529.

26.9.2 Only plugs and fittings of the weatherproof type shall be used and they should be colour coded in accordance with the Internationally recognised standards for example as detailed as follows:

i) 110 volts: Yellow
ii) 240 volts: Blue
iii) 415 volts: Red

26.10 Connections

26.10.1 Every joint and connection in a system shall be mechanically and electrically suitable for use to prevent danger. Proper cable connectors as per national/international standards shall only be used to connect cables.

26.10.2 No loose connections or tapped joints shall be allowed anywhere in the work site, office area, stores, and other areas. Penalty as per relevant clause shall be put in case of observation of any tapped joints.

26.11 Portable and hand-held equipments

The Contractor shall ensure the use of double insulated or all-insulated portable electrical hand equipment may be used without earthing (i.e., two core cables), but they shall still be used only on 110V because of the risk of damage to trailing leads.

26.12 Other equipments:

26.12.1 All equipment shall have the provision for major switch/cut-off switch in the equipment itself.

26.12.2 All non-current carrying metal parts of electrical equipment shall be earthed through insulated cable

26.12.3 Isolate exposed high-voltage (over 415 Volts) equipment, such as transformer banks, open switches, and similar equipment with exposed energized parts and prevent unauthorised access.

26.12.4 Approved perimeter markings shall be used to isolate restricted areas from designated work areas and entryways and shall be erected before work begins and maintained for entire duration of work. Approved perimeter marking shall be installed with either red barrier tape printed with the words "DANGER—HIGH VOLTAGE" or a barrier of yellow or orange synthetic rope, approximately 1 to 1.5 meter above the floor or work surface.

26.13 Work on or near live conductors

No person shall be engaged in any work activity on or so near any live conductor (other than one suitably covered with insulating material so as to prevent danger) that danger may arise unless:

a) it is unreasonable in all the circumstances for it to be dead; and
b) it is reasonable in all the circumstances for him to be at work on or near it while it is live; and
c) suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury.

26.14 Inspection and Maintenance

26.14.1 All electrical equipment should be permanently numbered and a record kept of the date of issue, date of last inspection and recommended inspection period.

26.14.2 Fixed installations shall be inspected at least at three monthly intervals; routine maintenance being carried out in accordance with equipment manufactures recommendations.

27.0 LIGHTING

27.1 The Contractor shall provide sufficient site lighting, of the right type and at the right place for it to be properly effective. Lighting ought not to introduce the risk of electric shock. Therefore, 230V supplies should be used for those fittings, which are robustly installed, and well out of reach e.g., flood lighting or high-pressure discharge lamps.

27.2 Selection of Luminaries

The Contractor shall select the luminaries as per the area requirement indicated below:

SN	Type of Lighting	Area of Requirement	Luminaries
1	Area Lighting	Workmen and vehicles to move about in safely.	Shovel type: non-symmetrical Symmetrical or non-symmetrical tungsten halogen
2	Beam flood lighting	Concentrated light over an area from a relatively great distance.	Portable flood light (Conical beam) Wide angle flood (fan shaped beam) Medium or narrow angle flood (Conical beam)

3	Dispersive lighting	Lighting for indoor	Dispersive (Mercury florescent) Cargo cluster Florescent trough
4	Walkway lighting	Lighting for stairways, ladder ways, corridors, scaffold access routes, etc.	Well glass unit Bulkhead unit (tungsten filament) Bulk head unit (Florescent)
5	Local lighting	Lighting on sites and fittings are generally accessible to operatives	PAR (Parabolic Aluminised Reflector) lamp cluster Festoons (with or without shades) Adjustable florescent work lamp Portable flood lamp (mounted on own cable drum)

27.3 The Contractor shall ensure that luminaries should always be placed so that no person is required to work in their own shadow and so that the local light for one person is not a source of glare for the others. Strongly made clamps should be available for attaching luminaries to poles and other convenient supports.

27.4 Luminaries should be robust, resistant to corrosion and rain proof especially at the point of the cable entry.

27.5 The correct type of lamp for each luminary should always be used and when lamps need to be replaced if shall be in accordance with the supply voltage.

27.6 Lamp holders not fitted with a lamp should be capped off.

27.7 The Contractor shall take every effort to illuminate the work site as per the Employer's requirement illustrated in General Instruction Maha-Metro/SHE/GI/011.

28.0 HAND TOOLS AND POWER TOOLS

28.1 General

28.1.1 The Contractor is wholly responsible for the safe condition of tools and equipment used by his employees and that of his sub-contractors.

28.1.2 Use of short / damaged hand tools shall be avoided and the Contractor shall ensure all his hand tools used at his worksite are safe to work with or stored and shall also train his employees (including his sub-contractors) for proper use thereby.

28.1.3 All hand tools and power tools shall be duly inspected before use for safe operation.

28.1.4 All hand tools and power tools shall have sufficient grip and the design specification on par with national/international standards on anthropometrics.

28.2 Hand tools

28.2.1 Hand tools shall include saws, chisels, axes and hatches, hammers, hand planes, screw drivers, crow bars, nail pullers.

28.2.2 The Contractor shall ensure that,

a) For crosscutting of hardwood, saws with larger teeth points (no. of points per inch) shall be preferred to avoid the saw jumping out of the job.
b) Mushroom headed chisels shall not be used in the worksite where the fragments of the head may cause injury.
c) Unless hatchet has a striking face, it shall be used as a hammer.
d) Only knives of retractable blades shall be used in the worksite.
e) No screwdrivers shall be used for scraping, chiselling, or punching holes.

f) A pilot hole shall always be driven before driving a screw.
g) Wherever necessary, usage of proper PPEs shall be used by his employees.

28.3 Power tools

28.3.1 Power tools include drills, planes, routers, saws, jackhammers, grinders, sprayers, chipping hammers, air nozzles and drills.

28.3.2 The Contractor shall ensure that:

(i) Electric tools are properly grounded or / and double insulated.

(ii) GFCIs/ RCCBs shall be used with all portable electric tool operated especially outdoors or in wet condition.

(iii) Before making any adjustments or changing attachments, his workers shall disconnect the tool from the power source.

(iv) When operating in confined spaces or for prolonged periods, hearing protection shall be required. The same shall also apply to working with equipments, which gives out more noise as mentioned in Clause 43.0 of this document.

(v) Tool is held firmly and the material is properly secured before turning on the tool.

(vi) All drills shall have suitable attachments respective of the operations and powerful for ease of operation.

(vii) When any work / operation needs to be performed repeatedly or continuously, tools specifically designed for that work shall be used. The same is applicable to detachable tool bit also.

(viii) Size of the drill shall be determined by the maximum opening of the chuck in case of drill bit.

(ix) Attachments such as speed reducing screwdrivers and buffers shall be provided to prevent fatigue and undue muscle strain to his workers.

(x) Stock should be clamped or otherwise secured firmly to prevent it from moving.

(xi) Workers shall never stand on the top of the ladder to drill holes in walls / ceilings, which can be hazardous, instead standing on the fourth or fifth rung shall be recommended.

(xii) Electric plane shall not be operated with loose clothing or long scarf or open jacket.

(xiii) Safety guards used on right angle head or vertical portable grinders must cover a minimum of 180° of the wheels and the spindle / wheel specifications shall be checked.

(xiv) All power tools / hand tools shall have guards at their nip points.

(xv) Low profile safety chain shall be used in case of wood working machines and the saw shall run at high rpm when cutting and also correct chain tension shall be ensured to avoid “kickback”.

(xvi) Leather aprons and gloves shall be used as an additional personal protection auxiliary to withstand kickback.

(xvii) Push sticks shall be provided and properly used to hold the job down on the table while the heels move the stock forward and thus preventing kickbacks.

(xviii) Air pressure is set at a suitable level for air actuated tool or equipment being used. Before changing or adjusting pneumatic tools, air pressure shall be turned off.

(xix) Only trained employees shall use explosive actuated tools and the tool shall also be unloaded when not in use.

(xx) Usage of such explosive actuated tools shall be avoided in case of places where explosive/flammable vapours or gases may be present.

(xxi) Explosive actuated tools and their explosives shall be stored separately and be taken out and loaded only before the time of immediate use.

(xxii) Misfired cartridges of explosive actuated tools must be placed in a container of water and be removed safely from the project.

(xxiii) No worker shall point any power operated / hand tool to any other person especially during loading / unloading.

29.0 WELDING, GOUGING AND CUTTING

29.1 Gas cylinders in use shall be kept upright on a custom-built stand or trolley fitted with a bracket to accommodate the hoses and equipment or otherwise secured. The metal cap shall be kept in place to protect the valve when the cylinder is not connected for use.

29.2 Hose clamp or clip shall be used to connect hoses firmly in both sides of cylinders and torches.

29.3 All gas cylinders shall be fixed with pressure regulator and dial gauges

29.4 Non-return valve and Flashback arrester shall be fixed at both end of cylinder and torch.

29.5 Domestic LPG cylinders shall not be used for Gas welding and Cutting purpose.

29.6 DCP or CO2 type Fire Extinguisher not less than 5 kg shall be fixed at or near to welding process zone in an easily accessible location. Fire Extinguisher should confirm to IS 2190: 1992.

29.7 Use firewatchers if there is a possibility of ignition unobserved by the operator (e.g., on the other side of bulkheads).

29.8 Oxygen cylinders and flammable gas cylinders shall be stored separately, at least 6.6 meters (20 feet) apart or separated by a fire proof, 1.5 meters (5 feet) high partition. Flammable substances shall not be stored within 15 meters of cylinder storage areas.

29.9 Transformer used for electrical arc welding shall be fixed with Ammeter and Voltmeter and also fixed with separate main power switch.

29.10 Welding grounds and returns should be securely attached to the work by cable lugs, by clamps in the case of stranded conductors, or by bolts for strip conductors. The ground cable will not be attached to equipment or existing installations or apparatus.

29.11 Use a low voltage open circuit relay device if welding with alternating current in constricted or damp places.

29.12 Take precautions against the risk of increased fume hazards when welding with chrome containing fluxed consumables or high current metal inert gas (MIG) or tungsten inert gas (TIG) processes.

29.13 Avoid being in contact with water or wet floors when welding. Use duckboards or rubber protection.

29.14 All electrical installations shall meet the IS: 5571: 1997 and NFPA 70 for gas cylinder storage area and other hazardous areas.

29.15 The current for Electric arc welding shall not exceed 300 A on a hand welding operation.

29.16 Fire blankets are to be used at all the times while hot works are in progress in order to arrest the free fall of welding spatters

30.0 DANGEROUS AND HARMFUL ENVIRONMENT

30.1 A confined space is any space that:

i) Is large enough and so configured that a worker can bodily enter (any portion of the body) and perform assigned work,
ii) Has limited or restricted mean for entry and/or exit,
iii) Is not designed for continuous occupancy
iv) Contains or has the potential to contain a hazardous atmosphere,
v) Contains a material that has the potential for engulfing an entrant,
vi) Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross section, or
vii) Contains other recognized serious safety or health hazard.

30.2 Contractors must ensure all confined spaces are identified and managed using documented site confined space management methods.

30.3 As per BOCWR Rule 40:

(i) When internal combustion engines are to be used into a confined space or excavation or tunnel or any other workplace where neither natural or artificial ventilation system is inadequate to keep carbon monoxide below 50ppm, exposure of building workers shall be avoided unless suitable measures are taken and provided by the Contractor.

(ii) No worker shall be allowed into any confined space or tank or trench or excavation wherein there is given off any dust, fumes / vapours or other impurities which is likely to be injurious or offensive, explosive, or poisonous or noxious or gaseous material or other harmful articles unless steps are carried out by the Contractor and certified by the responsible person to be safe.

30.4 Dangerous Substances: -

30.4.1 A substance is considered dangerous if one or several of its properties render it dangerous. The Contractor identifies and manages dangerous substances planned for use on the Worksite in the manner described in the present Clause.

30.4.2 The transport to the Worksite and use of dangerous substances requires prior authorisation from the Engineer.

30.4.3 Details of risks and related prevention and protection measures are included in the health and safety plan.

30.4.4 The Contractor obtains all necessary authorisations and/or licenses for the storage and use of dangerous substances from local authorities. A copy of the authorisations is provided to the Engineer.

30.4.5 For each dangerous substance used, the Contractor will implement the recommendations described (i) in the Material Safety Data Sheets (MSDS), and (ii) by the Globally Harmonized System of Classification and Labelling of Chemicals established by the United Nations for hazardous chemicals.

30.4.6 Copies of MSDSs are kept on the Worksite and made available to personnel. The Contractor provides the Engineer with copies of all MSDSs.

30.4.7 Storage of dangerous substances

Storage areas are designed and equipped by the Contractor based, not only on the chemical and physical properties of the products, but also on the types of containers stored, the number of people requiring access, and the quantities of the substance used.

Pursuant to SHE Clause 53.11, the Contractor anticipates and plans for the storage and management of hazardous waste.

Storage areas for dangerous substances are subject to strict rules, which are regularly checked by the SHE manager appointed. The rules include the following as a minimum:

a) Access to the storage area is limited to trained and authorised individuals.

b) An inventory is maintained up-to-date.

c) MSDSs must be available for all stored dangerous substances, and the substances must be clearly labelled.

d) A strict and methodical storage system is implemented (storage plan posted, large or heavy packaging may not be stored at heights, equipment and tools may not be stored in the dangerous substance storage room).

e) Compliance with product expiry dates and implementation of a disposal procedure for substances which are not needed, or which have expired.

f) Entrances, exits and access to emergency equipment are always kept clear.

Storage areas are clearly identified with warning signs at the entrance. The Contractor displays the storage plan (location of the different products, maximum inventory), a summary of labelling system and information on chemical incompatibilities.

Chemicals which could react together (leading to explosions, fire, projections, or the emission of dangerous gases) are physically separated.

Products that react violently with water are stored so as to prevent contact with water, even in the event of flooding.

Inflammable products are always stored separately in a dedicated area with adequate ventilation.

Buildings used to store large quantities of dangerous substances are isolated from other buildings to avoid the spreading of fire. Such buildings are constructed using solid and non-combustible building materials and are equipped with evacuation systems and the appropriate firefighting equipment. Access to the buildings is clear, allowing for rapid evacuation in the event of an accident. The electrical systems are reduced to the essential minimum, and access points are equipped with adequate lighting (300 lux).

All storage areas are equipped with secondary retentions. Each storage area acts as a general secondary retention. Suitable absorbents (neutralising and non-combustible) are available in the storage area to clean up any spills and leaks.
The Contractor maintains the storage area at a suitable temperature for dangerous substances to prevent overpressure and bursting of containers.

31.0 FIRE PREVENTION, PROTECTION AND FIGHTING SYSTEM

31.1 The Contractor shall ensure that construction site is provided with fire extinguishing equipment sufficient to extinguish any probable fire at construction site. An adequate water supply is provided at ample pressure as per national standard.

31.2 Recharging of fire extinguishers and their proper maintenance should be ensured and as a minimum should meet Indian National Standards.

31.3 All drivers of vehicles, foreman, supervisors, and managers shall be trained on operating the fire extinguishers and fire fighting equipment.

31.4 The Contractor shall also consider the provision of adequate fire fighting arrangements within the underground and tunnelling operations including the provision of Fire Service compatible hose connections and emergency lighting.

31.5 As per the GBOCW Rules 2003, all lifting appliances' driver cabin should be provided with a suitable portable fire extinguisher.

31.6 Combustible scrap and other construction debris should be disposed off site on a regular basis. If scrap is to be burnt on site, the burning site should be specified and located at a distance no less than 12 metres from any construction work or any other combustible material.

31.7 Every fire, including those extinguished by Contractor personnel, shall be reported to the Employer representatives.

31.8 Emergency plans and Fire Evacuation plans shall be prepared and issued. Mock drills should be held on a regular basis to ensure the effectiveness of the arrangements and as a part of the programme, the Telephone Number of the local fire brigade should be prominently displayed near each telephone on site.

32.0 CORROSIVE SUBSTANCES

As per BOCWR Rule 44, corrosive substances including alkalis and acids shall be stored and used by a person dealing with such substances at a building / construction site in a manner that it does not endanger the building worker and suitable PPE shall be provided by the Contractor to the worker during such handling and work. In case of spillage of such substances on building worker, the Contractor shall take immediate remedial measures.

33.0 DEMOLITION

33.1 The Contractor shall ensure that:

(i) all demolition works be carried out in a controlled manner under the management of experienced and competent supervision.

(ii) the concerned department of the Government or local authority be informed, and permission obtained wherever required. Media shall also be informed regarding this concern.

(iii) all glass or similar materials or articles in exterior openings are removed before commencing any demolition work and all water, steam, electric, gas and other similar supply lines are put-off and such lines so located or capped with substantial coverings so as to protect it from damage and to afford safety to the building workers and public.

(iv) examine the walls of all structures adjacent to the structure to be demolished to determine thickness, method of support to such adjacent structures

(v) no demolishing work be performed if the adjacent structure seems to be unsafe unless and until remedial measures life sheet piling, shoring, bracing, or similar means be ensured for safety and stability for adjacent structure from collapsing.

(vi) debris / bricks and other materials or articles shall be removed by means of:

(a) chutes
(b) buckets or hoists
(c) through openings through floors or
(d) any other safe means

(vii) no person other than building workers or other persons essential to the operation of demolition work shall be permitted to enter a zone of demolition and the area be provided with substantial barricades.

33.2 Damages to people and property.

33.2.1 Pursuant to Clauses 4.14 and 17.1 of the GCC, the Contractor is responsible for damages to people and property caused by the execution of the works or the procedures used for execution.

33.2.2 The Engineer is informed of any damage caused to people, or the property of individuals, other than the Contractor's personnel, within 6 hours of the event, regardless of the value of the prejudice.

33.2.3 Housing existing before the start of the works, located within a minimum radius of 800 m around the perimeter of the quarries and within a minimum radius of 500 m around the other Worksites that will be subject to blasting, will be examined by a bailiff unless agreed upon otherwise with the Engineer.

33.2.4 The bailiff's sworn statement is prepared and provided to the Engineer with the SEPP.

33.2.5 Should any problems be detected due to the intensity of blasting, the Engineer is entitled to request that the Contractor carry out seismic measurements of the intensity of the vibrations induced by the blasting, at variable distances from the blasting points, under the supervision of the Engineer, and at the cost of the Contractor.

34.0 EXCAVATION

34.1 Excavation: The Contractor shall ensure:

(i) where any construction building worker engaged in excavation is exposed to hazard of falling or sliding material or article from any bank or side of such excavation which is more than one 1.5 m above his footing, such worker is protected by adequate piling and bracing against such bank or side.

(ii) where banks of an excavation are undercut, adequate shoring is provided to support the material or article overhanging such bank.

(iii) excavated material is not stored at least 0.65 m from the edge of an open excavation or trench and banks of such excavation or trench are stripped of loose rocks and the banks of such excavation or trench are stripped of loose rocks and other materials which may slide, roll or fall upon a construction building worker working below such bank.

(iv) metal ladders and staircases or ramps are provided, as the case may be, for safe access to and egress from excavation where, the depth of such excavation exceeds 1.5 m and such ladders, staircases or ramps comply with the IS 3696 Part 1&2 and other relevant national standards.

(v) trench and excavation are protected against falling of a person by suitable measures if the depth of such trench or excavation exceeds 1.5 m and such protection is an improved protection in accordance with the design and drawing of a professional engineer, where such depth exceeds 4m.

34.2 Tunnelling

34.2.1 The Contractor shall inform in writing to the Director General within 30 days, prior to the commencement of any tunnelling work.

34.2.2 The Contractor shall appoint a responsible person for safe operation for tunnelling work as per Rule 121 & 125 of BOCWR.

34.2.3 The contractor shall ensure:

(i) every compressed air system in a tunnel is provided with emergency power supply for maintaining continued supply of compressed air as per Rule 155 of BOCWR

(ii) watertight bulkhead doors are installed at the entrance of a tunnel to prevent flooding.

(iii) reliable and effective means of communication such as telephone or walkie-talkie are provided and maintained for arranging better effective communication at an excavation or tunnelling work as per Rule 136 of BOCWR.

(iv) all portable electrical hand tools and inspection lamp used in underground and confined space at an excavation or tunnelling work is operated at a voltage not exceeding 24V.

(v) only flame proof equipment of appropriate type as per IS: 5571:2000 and or other relevant national standard is used inside the tunnel

(vi) petrol or LPG of any other flammable substances are not used, stored inside the tunnel except with prior approval from Employer, and also no oxy-acetylene gas is used in a compressed air environment in excavation or tunnelling.

(vii) adequate number of water outlets provided for fire fighting purpose, an audible fire alarm and adequate number and types of fire extinguishers are provided and maintained.

(viii) temperature in any working chamber in an excavation or tunnelling work where workers employed does not exceed 29ºC as per Rule 165 of BOCWR.

(ix) all working areas in a free air tunnel are provided with ventilation system as approved by the Director General and the fresh air supplied in such tunnel is not less than 6 m^3/ min for each worker employed in tunnel as per Rule 153 of BOCWR.

34.3 Piling

34.3.1 General Precautions

There are certain hazards which are common to all types of piling, and the following precautions are necessary:

i) prior to piling, all underground services should be located and made safe. A check should be made to ensure there are no cellars, underground water courses or ground conditions which might cause hazards; there should be a firm level base for the crane, or crane mats provided;
ii) when working on piling operations one must wear a safety helmet, and ear and eye protection where necessary;
iii) All cranes, lifting appliances and lifting gear must have appropriate certificates of testing and thorough examination, and should be large enough for the job;
iv) particular attention should be paid to the risk of damage to lifting gear from sharp edges;
v) Cranes used for raising or lowering workers must be fitted with a dead man's handle and lowering should be done under power; you must be carried in properly constructed cages which cannot spin or tip;
vi) piling contractors should be asked to provide a written method statement setting out the precautions relevant to the type of piling they are to employ;
vii) Induction training and information for you as supervisor or operative should be specifically related to the method statement.

34.3.2 Bored Piles

Workers may need to enter a borehole for inspection or for clearing out in undercuts, and there are certain precautions which must be taken prior to entry:

(i) the borehole should be at least 75 cm in diameter;

(ii) the borehole should be treated as a confined space and the precautions which are advised elsewhere to ensure a satisfactory atmosphere must be closely followed;
(iii) waste material from the borehole should be kept clear of the borehole;
(iv) Descent into a borehole should be in properly designed skips, chains or cages fitted with an anti-spin device. The power source of the lifting appliance should be kept running throughout the time someone is underground;
(v) while a worker is working down a borehole, he/she must wear a safety harness;
(vi) all workers concerned must be trained and competent in rescue from deep boreholes, and emergency rescue drills should be carried out at regular intervals;
(vii) A banksman who can see workers in the borehole should be present at all times;
(viii) There must be adequate lighting at safe reduced voltage and a means of communication from the borehole.
(ix) Wherever possible, the need for workers to enter pile boreholes should be avoided by the use of television cameras and other techniques for remote inspection.

34.4 Warning signs and notices

The Contractor shall ensure that:

(i) suitable warning signs or notices, required for the safety of building workers carrying out the work of an excavation or tunnelling, shall be displayed or erected at conspicuous places in Hindi and in a language understood by majority of such building workers at such building such excavation or tunnelling work

(ii) such warning signs and notices with regard to compressed air working shall include

(a) the danger involved in such compressed air work
(b) fire and explosion hazard
(c) the emergency procedures for rescue from such danger or hazards.

35.0 WORK PERMIT SYSTEM

35.1 The Contractor shall develop a Work Permit system, which is a formal written system used to control certain types of work that are potentially hazardous. A work permit is a document, which specifies the work to be done, and the precautions to be taken. Work Permits form an essential part of safe systems of work for many construction activities. They allow work to start only after safe procedures have been defined and they provide a clear record that all foreseeable hazards have been considered. Permits to Work are usually required in high-risk areas as identified by the Risk Assessments.

35.2 A permit is needed when construction work can only be carried out if normal safeguards are dropped or when new hazards are introduced by the work. Examples of high-risk activities include but are not limited to:

(i) Entry into confined spaces
(ii) Work in close proximity to overhead power lines and telecommunication cables.
(iii) Hot work
(iv) To dig where underground services may be located
(v) Work with heavy moving machinery
(vi) Working on electrical equipment
(vii) Work with radioactive isotopes
(viii) Heavy lifting operations and lifting operations closer to live power line

35.3 The permit-to-work system should be fully documented, laying down:

(i) How the system works;
(ii) The jobs it is to be used for;
(iii) The responsibilities and training of those involved; and
(iv) How to check its operation;

35.4 A Work Permit authorisation form shall be completed with the maximum duration period not exceeding 12 hours.

35.5 A copy of each Permit-to-Work shall be displayed, during its validity, in a conspicuous location in close proximity to the actual works location to which it applies.

36.0 TRAFFIC MANAGEMENT

36.1 The basic objective of the following guidelines is to lay down procedures to be adopted by Contractor to ensure the safe and efficient movement of traffic and also to ensure the safety of workmen at construction sites.

36.2 All construction workers should be provided with high visibility jackets with reflective tapes as most of viaduct /tunnelling and station works or either above or under right-of-way. The conspicuity of workmen at all times shall be increased so as to protect from speeding vehicular traffic.

36.3 The guiding principles to be adopted for safety in construction zone are to:

(i) Warn the road user clearly and sufficiently in advance.
(ii) Provide safe and clearly marked lanes for guiding road users.
(iii) Provide safe and clearly marked buffer and work zones
(iv) Provide adequate measures that control driver behaviour through construction zones.

36.4 Legal permission

36.4.1 In all cases, the Contractor shall employ proper precautions. Wherever operations undertaken are likely to interfere with public traffic, specific traffic management plans shall be drawn up and implemented by the Contractor in consultation with the approval of local police authorities and/or the concerned metropolitan/civil authorities as the case may be.

36.4.2 Such traffic management plans shall include provision for traffic diversion and selection of alternative routes for transport of equipment. If necessary, the Contractor shall carry out road widening before commencement of works to accommodate the extra load.

36.5 The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.

36.6 The road construction and maintenance signs which fall into the same three major categories as do other traffic signs, that are Regulatory Signs, Warning Signs and Direction (or guidelines) Signs shall only be used. The IRC: 67 (Code of Practice for Road Signs) provide a list of traffic signs. The size, colours and placement of sign shall confirm to IRC: 67.

36.7 Regulatory signs

Regulatory signs impose legal restriction on all traffic. It is essential, therefore, that they are used only after consulting the local police and traffic authorities.

36.8 Warning signs

36.8.1 Warning signs in the traffic control zone shall be utilised to warn the drivers of specific hazards that may be encountered.

36.8.2 The Contractor shall place detour signage at strategic locations and install appropriate warning signs. In order to minimize disruption of access to residences and business, the Contractor shall maintain at least one entrance to a property where multiple entrances exist.

36.8.3 A warning sign as given in General Instruction Maha-Metro/SHE/GI/012 shall be installed at all secondary road which merges with the primary road where the construction work is in progress

at sufficient distance before it merges with the primary road so as to alert the road users regarding the 'Metro Work in Progress'.

36.8.4 Materials hanging over / protruded from the chassis / body of any vehicle especially during material handling shall be indicated by red indicator (red light/flag) to indicate the caution to the road users.

36.9 Delineators

The delineators are the elements of a total system of traffic control and have two distinct purposes:

(i) To delineate and guide the driver to and along a safe path
(ii) As a taper to move traffic from one lane to another.

36.9.1 These channelizing devices such as cones, traffic cylinders, tapes and drums shall be placed in or adjacent to the roadway to control the flow of traffic. These should normally be retro-reflectors complying with IRC: 79 - Recommended Practice for Road Delineators.

36.9.2 Traffic cones and cylinders

Traffic cones of 500mm, 750mm and 1000mm high and 300mm to 500mm in diameter or in square shape at base and are often made of plastic or rubber and normally have retro-reflectorised red and white band shall be used wherever required.

36.9.3 Drums

Drums about 800mm to 1000mm high and 300mm in diameter can be used either as channelizing or warning devices. These are highly visible, give the appearance of being formidable objects and therefore command the respect of drivers.

36.9.4 Barricades

(i) Full height fence, barriers, barricades etc. shall be erected around the site in order to prevent the working area from the risk of accidents due to speedy vehicular movement. Same the way barricades protect the road users from the danger due to construction equipment and other temporary structures.

(ii) The structure dimension of the barricade, material and composition, its colour scheme, Maha-Metro logo and other details shall be in accordance with specifications laid down in tender document.

(iii) All barricades shall be erected as per the design requirements of the Employer, numbered, painted and maintained in good condition and also Barricade in-charge maintains a barricade register in site.

(iv) All barricades shall be conspicuously seen in the dark/night time by the road users so that no vehicle hits the barricade. Conspicuity shall be ensured by affixing retro reflective stripes of required size and shape at appropriate angle at the bottom and middle portion of the barricade at a minimum gap of 1000mm. In addition, minimum one red light or red light blinker should be placed at the top of each barricade.

36.9.5 The Contractor shall ensure that all his construction vehicles plying on public roads (like dump trucks, trailers, etc.) have proper license to ply on public roads from the State Transport Authority. Drivers holding proper valid license as per the requirements of Motor Vehicles Act shall drive these vehicles.

36.9.6 The Contractor shall not undertake loading and unloading at carriageways obstructing the free flow of vehicular traffic and encroachment of existing roads by the contractor applying the excuse of work execution.

36.9.7 Tow away vehicle

The Contractor shall make arrangements by keeping tow away van / manpower to tow away any breakdown vehicle in the traffic flow without losing any time at his cost.

36.9.8 Cleaning of roads

The Contractor shall ensure the cleanliness of roads and footpaths by deploying proper manpower for the same. The Contractor shall have to ensure proper brooming, cleaning washing of roads and footpaths on all the time throughout the entire stretch till the currency of the contract including disposal of sweepage.

36.9.9 The Contractor defines the characteristics of its fleet of vehicles and site machinery in the WESMP.

36.9.9.1 The Contractor defines the itineraries used on a map for each route between the different Worksites and obtains the validation of the Engineer. The Contractor requests that the Employer obtain the authorisations of the competent administrative authorities if public roads are used.

36.9.9.2 Within one month of the start of works, the Contractor informs the administrative authorities of areas crossed by the Contractor's vehicles, of the itinerary and characteristics (frequency of passing, size and weight of trucks, materials carried) of the Contractor's fleet of vehicles.

36.9.9.3 If public roads are used, and unless approved otherwise by the Engineer, the Contractor mandates a bailiff to make a sworn report regarding the state of the road prior to use by the Contractor's vehicles. The report is annexed to the W-ESMP.

36.9.9.4 The Contractor describes in the W-ESMP expected traffic created by its fleet of vehicles (frequency of trips between Worksites, working hours, convoys).

36.9.9.5 Unless specified otherwise in the Contract or instructed otherwise by the Engineer, heavy vehicles (i.e. with a GVWR of more than 3.5 tons) may not be used at night between 22:00 and 06:00.

36.9.9.6 Speed limits

36.9.9.6.1 The Contractor takes action to limit and check the speed of all vehicles and machinery used to execute the works.

36.9.9.6.2 The maximum speed of all machinery and vehicles of the Contractor comply with the lowest of the following: the speed limit defined according to the Employer's country regulations or the following limits.

a) 10 km/h within the Worksites.
b) 30 km/h in villages or hamlets, from 100m before the first house.
c) 50 km/h in towns.
d) 80 km/h on unpaved roads outside of towns, villages, hamlets and camps.

36.9.9.6.3 Pursuant to Clause 4.15 of the GCC, and in coordination with the competent Employer's country authorities, the Contractor provides and installs signs for the fleet of vehicles along public roads, when public signs are inadequate.

36.9.9.6.4 The Contractor provides each of its drivers with a map at the appropriate scale of the roads authorised for the execution of the works, clearly indicating the maximum speeds authorised, and ensures their understanding.

36.9.9.6.5 The Contractor implements a real-time GPS location solution for each of its vehicles and permanently remote monitor of the position and speed of each vehicle.

37.0 WORK ADJACENT TO LIVE RAILWAYS

37.1 Whenever work is to be conducted in close proximity to the live railways then the following measures shall need to be addressed:

(i) The rules provided for in the Railway's manual should be followed.
(ii) No persons are allowed to encroach onto the railway unless the owner has given specific authority.
(iii) Adequate protection in accordance with the railway owner's requirements shall be followed. (Provision of Block Inspectors, Flagmen and Lookouts)
(iv) All persons shall wear high visibility clothing at all times.
(v) Any induction training requirements of the railways shall be strictly observed

38.0 BATCHING PLANT AND CASTING YARD LAYOUT

38.1 The batching plant / casting yard shall be effectively planned for smooth flow of unloading and stacking the aggregates reinforcements and cement, batching plant, transport of concrete, casting the segment, stacking the segment and loading the segments to the trucks. As far as possible the conflicts should be avoided.

38.2 Required permission (CTE and CTO) from Maharashtra Pollution Control Board shall be obtained prior to establishing and commissioning of the batching plant and conditions of the CTE and CTO shall be complied.

38.3 The batching plant area shall be barricaded for wind breaking and shall be made as a compulsory PPE zone

38.4 If in case of material unloading area is not maintainable as PPE zone, the same shall be segregated properly and made as a non-PPE zone with appropriate barrications.

38.5 Electrical system shall also be suitably planned so that location of diesel generator, if any, location of DBs, routing of cables and positioning of area lighting poles/masts does not infringe on any other utility and pose danger.

38.6 Drainage shall be effectively provided and waste water shall be disposed after proper treatment

38.7 Time office, canteen, drinking water, toilet and rest place shall be suitably located for the easy access to workers. All the facilities shall be properly cleaned and maintained during the entire period of operation.

38.8 Manual handling of cement shall be avoided to a larger extent. Whenever it is absolutely necessary the workmen shall be given full body protection, hand protection and respiratory protection as a basic measure of ensuring better health.

38.9 The PPEs provided to cement handling workmen shall conform to international standards.

38.10 Access roads and internal circulation roads shall be well laid and maintained properly at all time.

38.11 Non-adherence to any of the above provision shall be penalised as per relevant penalty clause.

38.12 Approval of the batching plant to be taken from CPCB/MPCB/Local Municipal Corporation.

39.0 PERSONAL PROTECTIVE EQUIPMENTS (PPEs)

39.1 The Contractor shall provide required PPEs to workmen to protect against safety and / or health hazards. Primarily PPEs are required for the following protection

(i) Head Protection (Safety helmets)
(ii) Foot Protection (Safety footwear, Gumboot, etc)
(iii) Body Protection (High visibility clothing (waistcoat/jacket), Apron, etc)
(iv) Personal fall protection (Full body harness, Rope-grap fall arrester, etc)
(v) Eye Protection (Goggles, Welders glasses, etc)
(vi) Hand Protection (Gloves, Finger coats, etc)
(vii) Respiratory Protection. (Nose mask, SCBAs, etc.)
(viii) Hearing Protection (Ear plugs, Ear muffs, etc)

39.2 The PPEs and safety appliances provided by the Contractor shall be of the standard as prescribed by Bureau of Indian Standards (BIS). If materials conforming to BIS standards are not available, the Contractor as approved by the Employer shall procure PPE and safety appliances.

39.3 All construction workers should be provided with high visibility jackets with reflective tapes confirming to the requirement specified under BS EN 471: 1994 as most of viaduct /tunnelling and station works are executed either above or under right-of-way. The conspicuity of workmen at all times shall be increased so as to protect them from speeding vehicular traffic.

39.4 The Contractor shall provide safety helmet, safety shoe and high visibility clothing for all employees including workmen, traffic marshal and other employees who are engaged for any work under this contract as per the following requirement.

All employees of the Contractor including workmen	Traffic marshals
Hard hat with company Logo	Hard hat with reflective tape
Safety boots	Safety boots
Hi-visibility waistcoat covering upper body and meeting the following requirements as per BS EN 471:1994: Background in fluorescent orange-red in colour Two vertical green strips of 5cm wide on front side, covering the torso at least 500 cm2 Two diagonal strips of 5 cm wide on back in an 'X' pattern covering at least 570cm2 Horizontal strips not less than 5cm wide running around the bottom of the vertical strip in front and 'X' pattern at back. The bottom strip shall be at a distance of 5cm from the bottom of the vest. Strips must be retro reflective and fluorescent Waistcoat shall have a side adjustable fit and a side and front tear-away feature on vests made of nylon.	Hi-visibility jacket covering upper body and meeting the following requirements as per BS EN 471:1994: Background in fluorescent orange-red in colour Jackets with full-length sleeves with two bands of retro reflective material, which shall be placed at the same height on the garment as those of the torso. The upper band shall encircle the upper part of the sleeves between the elbow and the shoulder; the bottom of the lower band shall not be less than 5cm from the bottom of the sleeve. Two vertical green strips of 5cm wide on front side, covering the torso at least 500 cm2 Two diagonal strips of 5 cm wide on back in an 'X' pattern covering at least 570cm2 Horizontal strips not less than 5cm wide running around the bottom of the vertical strip in front and 'X' pattern at back. The bottom strip shall be at a distance of 5cm from the bottom of the vest. Strips must be retro reflective and fluorescent.

39.4.1 Colour coding for helmets

Safety Helmet Colour Code (Every Helmet should have the LOGO* affixed /painted)	Person to use
White	Maha-Metro staffs
Grey	All Designers, Architect, Consultants, etc.
Violet	Main Contractors (Engineers / Supervisors)

Blue	All Sub-contractors (Engineers / Supervisors)
Red	Electricians (Both Contractor and Sub-contractor)
Green	Safety Professionals (Both Contractor and Sub-contractor)
Orange	Security Guards / Traffic marshals
Yellow	All workmen/Drivers/Operators
White (with "VISITOR" sticker)	Visitors

Note: LOGO*

(i) Logo shall have its outer dimension 2" *2" and shall be conspicuous
(ii) Logo shall be either painted or affixed
(iii) No words shall come either on Top / Bottom of Logo

Logo of the corresponding main contracting company for their employees and sub-contracting company for their employees shall only be used.

39.5 In addition to the above any other PPE required for any specific jobs like, welding and cutting, working at height, tunnelling etc shall also be provided to all workmen and also ensure that all workmen use the PPEs properly while on the job.

39.6 The Contractor shall not pay any cash amount in lieu of PPE to the workers/sub-contractors and expect them to buy and use during work.

39.7 The Contractor shall at all time maintain a minimum of 10% spare PPEs and safety appliances and properly record and show to the Employer during the inspections. Failing to do so shall invite appropriate penalty as per the provisions of the contract.

39.8 It is always the duty of the Contractor to provide required PPEs for all visitors. Towards this required quantity of PPEs shall be kept always at the security post.

39.9 Warning to Safety offenders

i) A warnings cards shall be issued by nominated person of Maha-Metro to Contractor staff or worker in case of serious violation.

ii) Yellow card shall be issued on first safety offence/violation. A sticker to be pasted on his helmet and his identity card shall be stamped for two weeks during which he will be under observation. The warning cards shall be withdrawn by the same nominated person after satisfactory completion of two weeks of period.

iii) Red card shall be issued in case of repeat safety violation carried out in two weeks by the same person or if he repeats safety violation more than three times in a year. Such Red card holders shall be withdrawn from site and attend a repeat Safety Training for min. three days before re-induction. The person shall be demobilised in case of second Red Card issue.

40.0 VISITORS TO SITE

40.1 No visitor is allowed to enter the site without the permission of the Employer. All authorised visitors should report at the site office. Contractor shall provide visitor's helmet (White helmet with visitor sticker) and other PPEs like Safety Shoe, reflective jacket, respiratory protection etc. as per requirement of the site.

40.2 All Visitors shall be accompanied at all times by a responsible member of the site personnel.

40.3 The Contractor shall be fully responsible for all visitors' safety and health within the site.

40.4 Complaint Response Process

40.4.1 Inquiries, complaints, and requests for information can be expected from a wide range of individuals and organizations both private and government. The majority of complaints are likely to be received by Maha-Metro, although the site offices are also likely to be contacted.

40.4.2 The objective of complaint process is to ensure that public and agency complaints are addressed and resolved consistently and expeditiously.

40.4.3 The Contractor's Site Manager will be notified immediately on receipt of complaint that may relate to environmental impacts. The Site Manager will immediately inform the Engineer and through him the Maha-Metro.

40.4.4 Field investigation should determine whether the complaint has merit, and if so, action should be taken to address the impact.

40.4.5 The outcome of the investigation and the action taken shall be documented on a complaint performa prepared by the Contractor and approved by the Engineer in advance of the works.

40.4.6 Where possible, a formal response to each complaint received shall be prepared by the Contractor within seven days in order to notify the concerned person(s) that action has been taken.

40.5 Completion of the EQM Programme

40.5.1 The construction of Project will be undertaken as a series of individual construction contracts with necessarily different construction program and completion dates.

40.5.2 The Engineer shall maintain an overview of the 'impact causing potential' of each site or contract and monitoring parameter with a view to maintaining the most cost-effective use of the environmental resources dedicated to the Project.

40.5.3 Termination of EQM should focus on the percentage contract completion status and on the basis of a history of environmental impact arising from the site over a representative period of monitoring.

40.5.4 Justifiable application for termination of EQM shall be put forward by the Contractor to the Engineer, as necessary throughout the construction period.

PART III: OCCUPATIONAL HEALTH AND WELFARE

41.0 PHYSICAL FITNESS OF WORKMEN

41.1 The Contractor shall ensure that his employees / workmen subject themselves to such medical examination as required under the law or under the contract provision and keep a record of the same.

41.2 The Contractor shall not permit any employee / workmen to enter the work area under the influence of alcohol or any drugs.

42.0 MEDICAL FACILITIES

42.1 Medical Examination

42.1.1 The Contractor shall arrange a medical examination of all his employees including his sub-contractor employees employed as drivers, operators of lifting appliances and transport equipment before employing, after illness or injury, if it appears that the illness or injury might have affected his fitness and, thereafter, once in every two years up to the age of 40 and once in a year, thereafter.

(i) The Contractor shall maintain the confidential records of medical examination or the physician authorized by the Employer.
(ii) No building or other construction worker is charged for the medical examination and the cost of such examination is borne by Contractor employing such building worker.
(iii) The medical examination shall include:

a. Full medical and occupational history

b. Clinical examination with particular reference to:

(i) General Physique;

(ii) Vision: Total visual performance using standard orthorator like Titmus Vision Tester should be estimated and suitability for placement ascertained in accordance with the prescribed job standards.
(iii) Hearing: Persons with normal must be able to hear a forced whisper at twenty-four feet. Persons using hearing aids must be able to hear a warning shout under noisy working conditions.
(iv) Breathing: Peak flow rate using standard peak flow meter and the average peak flow rate determined out of these readings of the test performed. The results recorded at pre-placement medical examination could be used as a standard for the same individual at the same altitude for reference during subsequent examination.
(v) Upper Limbs: Adequate arm function and grip
(vi) Spine: Adequately flexible for the job concerned.
(vii) Lower Limbs: Adequate leg and foot concerned.
(viii) General: Mental alertness and stability with good eye, hand and foot coordination.

c. Any other tests which the examining doctor considers necessary

42.1.2 If the Contractor fails to get the medical examination conducted as mentioned above, the Employer will have the right to get the same conducted by through an agency with intimation to the Contractor and deduct the cost and overhead charges.

42.2 Occupational Health Centre

The Contractor shall ensure at a construction site an occupational health centre, mobile or static is provided and maintained in good order. Services and facilities as per the scale lay down in Schedule X of BOCWR. A construction medical officer appointed in an occupational health centre, possess the qualification as laid down in Schedule XI of BOCWR.

42.3 Ambulance van and room

The Contractor shall ensure at a construction site of a building or other construction work that an ambulance van and room are provided at such construction site or an arrangement is made with a nearby hospital for providing such ambulance van for transportation of serious cases of accident or sickness of workers to hospital promptly and such ambulance van and room are maintained in good repair and is equipped with standard facilities specified in Schedule IV and Schedule V of BOCWR.

42.4 First-aid boxes

The Contractor shall ensure at a construction site one First-aid box for 100 workers provided and maintained for providing First-aid to the building workers. Every First-aid box is distinctly marked "First-aid" and is equipped with the articles specified in Schedule III of BOCWR.

42.5 HIV/ AIDS prevention and control

42.5.1 The Contractor shall adopt the Employer's Policy on "HIV / AIDS Prevention and Control for Workmen Engaged by Contractors" and the copy of the policy is given in Appendix No. 4.

42.5.2 The Employer will engage a professional agency for implementing the guidelines laid down in the policy and communicate to the Contractor.

42.5.3 The Contractor shall extend necessary support to the appointed agency by deputing the workmen to attend the awareness creation programmes.

42.5.4 The Contractor shall also extend necessary organizational support to the appointed agency for the effective implementation of the Employers' workplace policy on HIV/AIDS for workmen of the Contractors.

42.5.5 As laid down in the policy the Contractor shall identify peer educators (1 for every 100 workers) and refer them for professional training to the Employers' appointed agency for the purpose.

42.5.6 The peer educators on completion of the training shall serve as the focal point for any information, education, and awareness campaign among the workmen throughout the contract period.

42.5.7 The peer educators will be paid a monthly honorarium as fixed by the Employer for rendering his services in addition to his regular duty.

42.5.8 The total number of peer educators (1 for 100 workers) shall always be maintained by the Contractor.

42.5.9 In case if these peer educators leave the Contractor by creating vacancy, then the Contractor at his own expense train the new replacement peer educator from the Employers' appointed agency for the purpose.

42.5.10 It is suggested to the Contractor that due care should be taken to select the peer educators from among the group of workmen so that they remain with the Contractor throughout the contract period.

42.6 Prevention of mosquito breeding

42.6.1 Measures shall be taken to prevent mosquito breeding at site. The measures to be taken shall include:

(i) Empty cans, oil drums, packing and other receptacles, which may retain water shall be deposited at a central collection point and shall be removed from the site regularly.

(ii) There should not be accumulation of still water at any site, in case of still water, it should be covered by earth and levelled.

(iii) Contractor's equipment and other items on the site, which may retain water, shall be stored, covered, or treated in such a manner that water could not be retained.

(iv) Water storage tanks shall be provided.

42.6.2 Posters inHindi and English, which draw attention to the dangers of permitting mosquito breeding, shall be displayed prominently on the site.

42.6.3 The Contractor at periodic interval shall arrange to prevent mosquito breeding by fumigation / spraying of insecticides. Most effective insecticides shall include SOLFAC WP 10 or Baytex, The Ideal Larvicide etc.

42.7 Alcohol and drugs

42.7.1 The Contractor shall ensure at all times that no employee is working under the influence of alcohol / drugs which are punishable under Government regulations.

42.7.2 Smoking at public worksites by any employee is also prohibited as per Government regulations.

42.7.3 Any person suspected by the Engineer to be under the influence of alcohol or controlled substances is immediately suspended from his position by the Contractor, pending the results of medical tests.

42.8 Access to health care

42.8.1 The Contractor guarantees access to health care as defined in Clause 29 for all personnel in case of accident or illness occurring during the execution of the works, i.e.:

a) Medical check ups: initial (recruitment), annual and upon returning to work after sick leave;
b) Screening, vaccinations and preventive healthcare;
c) General healthcare during the execution of the works;
d) Medical assistance in the event of an accident and assistance for emergency evacuations

.

42.8.2 Subcontractor personnel, other contractors, the Employer or the Engineer, present at the Worksite, must never be refused medical assistance, under the pretext that they are not directly employed by the Contractor. The Contractor may however define a unit rate cost per medical act for personnel, other than its own personnel, display this rate in the healthcare centre and forward the information to the Engineer.

42.8.3 In the event of accident or serious illness, medical personnel must be trained, available and equipped with the necessary material, medicines and consumables to provide first aid for the patient, stabilise their condition, until the patient is:

a) a) either treated or discharged, or
b) b) hospitalized at the camp or in a larger hospital, or
c) c) evacuated to a medical centre which is well equipped for intensive care, if necessary.

43.0 NOISE & VIBRATIONS

43.1 The Contractor shall consider noise as an environmental constraint in his design, planning and execution of the Works and provide demonstrable evidence of the same on Employer's request. The Contractor shall, at his own expense, take all appropriate measures to ensure that work carried out by the Contractor and by his sub-Contractors, whether on or off the Site, will not cause any unnecessary or excessive noise which may disturb the occupants of any nearby dwellings, schools, hospitals, or premises with similar sensitivity to noise.

43.1.1 Without prejudice to the generality of the foregoing, noise level reduction measures shall include the following:

a) The Contractor shall ensure that all powered mechanical equipment used in the Works shall be effectively sound reduced using the most modern techniques available including but not limited to silencers and mufflers.

b) The Contractor shall construct acoustic screens or enclosures around any parts of the Works from which excessive noise may be generated.

43.1.2 The Contractor shall ensure that noise generated by work carried out by the Contractor and his sub-Contractors during daytime and night time shall not exceed the maximum permissible noise limits, whether continuously or intermittently. The same may be varied from time to time by and at the sole discretion of the Employer, In the event of a breach of this requirement, the Contractor shall immediately re-deploy or adjust the relevant equipment or take other appropriate measures to reduce the noise levels and thereafter maintain them at levels which do not exceed the said limits. Such measures may include without limitation the temporary or permanent cessation of use of certain items of equipment.

43.2 Control Requirements

43.2.1 Construction material should be operated and transported in such a manner as not to create unnecessary noise as outlined below;

I. Perform Work within the procedures outlined herein and comply with applicable codes, regulations, and standards established by the Central and State Government and their agencies.

II. Keep noise to the lowest reasonably practicable level. Appropriate measures will be taken to ensure that construction works will not cause any unnecessary or excessive noise, which may disturb the occupants of any nearby dwellings, schools, hospitals, or premises with similar sensitivity to noise. Use equipment with effective noise-suppression devices and employ other noise control measures as to protect the public.

III. Schedule and conduct operations in a manner that will minimize, to the greatest extent feasible, the disturbance to the public in areas adjacent to the construction activities and to occupants of buildings in the vicinity of the construction activities.

IV. The Contractor shall submit to the Employer a Noise Monitoring and Control Plan (NMCP) under contract specific Site Environmental Plan. It shall include full and comprehensive details of all powered mechanical equipment, which he proposes to use during daytime and night time, and of his proposed working methods and noise level reduction measures. The NMCP shall include detailed noise calculations and vibration levels to demonstrate the anticipated noise generation and vibrations by the Contractor.

V. The NMCP prepared by the Contractor shall guide the implementation of construction activity. The NMCP will be reviewed on a regular basis and updated as necessary to assure that current construction activities are addressed. It may appear as a regular agenda item in project coordination meetings, if noise is an issue at any location in the contract.

43.3 Occupational Noise

I. Protection against the effects of occupational noise exposure should be provided when the sound levels exceeds the threshold values.

II. When employees are subjected to sound levels exceeding, feasible administrative or engineering controls should be utilized.

III. If such controls fail to reduce sound levels within the levels of the table, personal protective equipment shall be provided and used to reduce sound levels within the levels of the table.

IV. When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. Exposure to different levels for various periods of time shall be computed according to the formula and sample computation.

43.4 Vibration Level

43.4.1 In locations where the alignment is close to historical / heritage structures, the contractor shall prepare a monitoring scheme prior to construction at such locations. This scheme for monitoring vibration level at such historical / heritage sites shall be submitted to Employer for his approval. This scheme shall include:

I. Monitoring requirements for vibrations at regular intervals throughout the construction period.

II. Pre-construction structural integrity inspections of historic and sensitive structures in project activity.

III. Information dissemination about the construction method, probable effects, quality control measures and precautions to be used.

IV. The vibration level limits at work sites adjacent to the alignment shall conform to the permitted values of peak p velocity

44.0 VENTILATION AND ILLUMINATION

44.1 Ventilation

44.1.1 The Contractor shall ensure at a construction site of a building or other construction work that all working areas in a free tunnel are provided with ventilation system as approved by the DG/CIIBC and the fresh air supply in such tunnel is not less than 6m3/min for each building worker employed underground in such tunnel and the free air flow movement inside such tunnel is not less than 9m/min.

44.1.2 The oxygen level shall not be less than 19.5% in the working environment.

44.2 Illumination

44.2.1 The Contractor shall take every effort to illuminate the work site as per the Employer's requirement illustrated in General Instruction Maha-Metro/SHE/GI/011.

44.2.2 The Contractor shall conduct a monthly illumination monitoring by lux meter for all the locations and the report shall be sent to the Employer within 7th of the next month and the same shall be reviewed during the monthly SHE committee meeting.

45.0 RADIATION

45.1 The use of radioactive substances and radiating apparatus shall comply with the Government regulatory requirements and all subsidiary legislation

45.2 Operations involving ionising radiation shall only be carried out after having been reviewed without objection by the Employers representative and shall be carried out in accordance with a method statement.

45.3 Each area containing irradiated apparatus shall have warning notices and barriers, as required by the Regulations, conspicuously posted at or near the area.

45.4 Radioactive substances will be stored, used, or disposed shall be strictly in accordance with the Government Enactments.

45.5 The Contractor shall ensure that all site personnel and members of the public are not exposed to radiation.

46.6 Asbestos

Asbestos fibres are naturally occurring and extremely aerodynamic. Because of this, almost everyone is exposed to asbestos. Asbestos fibres can become a health risk if inhaled at high concentrations over extended periods of time. Asbestos is only dangerous if it becomes airborne. As long as asbestos-containing materials are not damaged, the asbestos fibres do not become airborne, and do not pose a health hazard to building occupants.

As a preventive action, no asbestos containing material will be used during any of the site activity mitigate the hazard

46.7 Lead-Based Paint

Lead-based paint is a source of lead poisoning. Ingestion and inhalation of lead dust that is created as lead-based paint chips and peels, or from improper sanding or scraping of lead-based painted surfaces can lead to exposure.

Paints and other chemicals used for painting should be stored in a proper contained area. Empty Paint containers, waste paint brushes, clothes stained with paint shall be disposed as per prevailing regulations.

46.0 WELFARE MEASURES FOR WORKERS

46.1 Latrine and Urinal Accommodation

46.1.1 The Contractor shall provide one latrine seat for every 20 workers up to 100 workers and thereafter one for every additional 50 workers. In addition, one urinal accommodation shall be provided for every 100 workers.

46.1.2 When women are employed, separate latrine and urinals accommodation shall be provided on the same scale as mentioned above.

46.1.3 Latrine and urinals shall be provided as per Section 33 of BOCWA and maintained as per Rule 243 of BOCWR and shall also comply with the requirements of public health authorities

46.1.4 Moving sites

In case of works like track laying, the zone of work is constantly moving at elevated level or at underground level. In such cases mobile toilets with proper facility to drain the sullage shall be provided at reasonably accessible distance.

46.1.5 In case if the Contractor fail to provide required number of urinals and latrines or fail to maintain it as per the requirements of Public Health laws, the Employer shall have the right to provide/maintain through renowned external agencies at the cost of the Contractor.

46.2 Canteen

In every workplace wherein not less than 250 workers are ordinarily employed, the Contractor shall provide an adequate canteen conforming to Section 37 of BOCWA, Rule 244 of BOCWR

and as stipulated in Rule 247 of BOCWR the changes for food stuff shall be based on 'no profit no loss' basis. The price list of all items shall be conspicuously displayed in such canteen.

46.3 Serving of tea and snacks at the workplace

As per Rule 246 of BOCWR, at a building or other construction work where a workplace is situated at a distance of more than 200 m from the canteen provided under Rule 244(1) of BOCWR, the Contractor employing building works shall make suitable arrangement for serving tea and light refreshment to such building works at such place. Proper Housekeeping should be maintained at such locations where tea and snacks are served.

46.4 Drinking water

46.4.1 As per Section 32 of BOCWA the Contractor shall make in every worksite, effective arrangements to provide sufficient supply of wholesome drinking water with minimum quantity of 5 litres per workman per day. Quality of the drinking water shall conform to the requirements of national standards (**IS 10500**) on Public Health.

46.4.2 While locating these drinking water facilities due care shall be taken so that these are easily accessible within a distance of 200m from the place of work for all workers at all location of work sites.

46.4.3 All such points shall be legible marked "Drinking Water" in a language understood by a majority of the workmen employed in such place and such point shall be situated within six metres of any washing places, urinals, or latrines.

46.5 Labour Accommodation

The Contractor shall provide free of charges as near as possible, temporary living accommodation to all workers conforming to provisions of Section 34 of BOCWA. These accommodations shall have cooking place, bathing, washing and lavatory facilities

46.6 Creches

In every workplace where in more than 50 female workers are ordinarily employed, there shall be provided and maintained a suitable room for use of children under age of 6 yrs, conforming to the provisions of Section 35 of BOCWA.

46.7 Heat Stress

Contractors/Subcontractors shall establish the necessary programs to ensure that project employees work safely in heat stress conditions. The reduction of adverse health effects can be accomplished by engineering controls, work practices, training, acclimatization, monitoring, water and electrolyte balance and the recognition and treatment of heat stress emergencies.

46.8 First aid

The Contractor ensures that at least one first aid officer is present at all times during working hours, per shift for 10 to 50 workers present, and one extra first aid officer for each additional 100 workers allocated to the shift.
The Contractor equips the Worksite with a communication system exclusively for the purposes of communication with the first aid services. Information on how to communicate with the first aid services is clearly indicated near the communications equipment.

46.9 **Pandemic (National Disaster as Covid-19/Omicron etc.)**

1. All the workmen shall be sensitized on the hygiene and other work requirements like social distancing before being engaged for the work.
2. Body temperature need to be monitored by infrared thermometer before being engaged for the work

3. Work area need to be displayed with COVID-19 symptoms, Do's & Don'ts issued by local authorities.

46.9.1 Safety Motivational & Awareness Campaign:

1. Posters about COVID-19 for workplace must be displayed to help staffs and workers to stay informed, have accurate information, and know how to perform in working area to protect themselves and other.
2. Initiatives / Campaigns must be organised to protect the employees and labours against the risk of coronavirus infection. This is applied to both indoor (Labour Camps, Accommodation's) and outdoor accommodation.
3. All areas in the premises including Office, stores Labour camps shall be disinfected completely with the use of approved disinfectant mediums.
4. The workmen welfare facilities including Labour accommodations, Rest areas, Toilet facilities, drinking water facilities shall be inspected for adequate precautions especially from Hygiene and social distancing point of view, by the Contractor to ensure their adequacy.

46.9.2 Reporting of Covid-19

1. A Daily report regarding COVID-19 status must be sent to Maha-Metro for updating of Positive cases, suspected cases, and their control measures to face the challenge and threat posed by the growing pandemic of COVID-19.
2. On daily basis, COVID-19-Follow-up & reporting system must be carried out to the latest numbers on Covid tests, Covid cases status (Negative or Positive), hospitalizations, and patient outcomes from contractors ends.

46.9.3 The following reports must be submitted by the contractors on daily basis who will further scrutinize, compile and forward to Maha metro and to local authorities (as directed by Maha metro).

1. Details of workmen who is get affected by Covid-19 Virus.
2. Status of health of affected workemen and submit the health report by medical expert.
3. Details of Workmen engaged who are from outside Maharashtra
4. Emergency Preparedness & Response report

46.9.4 General Precautionary measures

1. Ensure Social Distancing by Restriction in gathering of 5 or more in workplaces and public places. Large meeting to be prohibited and large gathering of more than 10 people in workplaces is discouraged. Seating arrangement shall be at least 6 feet from each other.
2. Wearing face-cover/musk at public places & workplaces
3. Spitting in workplaces / public places shall be punishable with fine.
4. Ban on liquor, Gutka, and tobacco in workplaces
5. Temperature screening during entry and exit to be done.
6. Sanitizers and hand wash facility shall be made available at convenient places at worksites
7. Staggered lunch breaks to ensure social distancing
8. Persons above 65 years, persons with co-morbidities, parents of children below the age of 5 should be encouraged to work from home.
9. Daily Sanitize/disinfect the workplace
10. Vehicles with 30-40% passenger capacity
11. 2/4 (depending on the size) will be allowed to travel in lifts/hoists
12. Restrict / Ban non -essential visitors
13. List of authorized hospitals/clinics nearby areas to treat COVID 19 to be executed.

46.9.5 Isolation Room/Quarantine Centre

The Contractor shall provide an Isolation Room/ Quarantine Centre if some one found symptoms of virus or get affected positive.

PART- IV ENVIRONMENTAL MANAGEMENT

47.0 ENVIRONMENTAL MANAGEMENT

Environmental Management is an essential part of the overall Environmental protection system employed by Maha Metro for the construction of Pune Metro Rail project and shall apply to all contract packages i.e. Civil, Track, E&M and System contracts subject to activities involved in respective pacakges.

48.0 TOPSOIL CONSERVATION

48.1 The contractor shall ensure that adequate measures are taken for the prevention of erosion of the topsoil during the construction phase.

48.2 The contractor should maintain the record of topsoil quantity excavated from construction from all locations where vegetation existed prior to construction. The record shall include photographic evidence of the topsoil quantity excavated.

48.3 Top soil should be stripped to a depth of 20 cm from the areas to be disturbed, it should be stockpiled to a maximum height of 40 cm in designated areas, covered or stabilized with temporary seeding for erosion prevention and should be reapplied to site during plantation of the proposed vegetation. Topsoil should be separated from subsoil, debris and stones larger than 50mm diameter. The stored topsoil may be used as finished grade for planting areas.

49.0 FELLING OF TREES & TREE PRESERVATION

49.1 The contractor shall identify the number and type of trees that are required to be felled as a result of construction of works and facilities related to Pune Metro Project and inform the Employer.

49.2 All trees and shrubbery, which are not specifically required to be cleared or removed for construction purposes, shall be preserved and shall be protected from any damage that may be caused by Contractor's construction operations and equipment. The contractor shall not fell, remove or dispose of any tree or forest produce in any land handed over to him for the construction of works and facilities related to Pune Metro except with the previous permission obtained from the Forest Department or other Competent Authority.

49.3 The contractor shall ensure that no tree, existing or otherwise, shall be harmed and damage to roots during trenching, placing backfill, driving or parking heavy equipment, dumping of trash, oil, paint, and other materials detrimental to plant health.

49.4 The contractor shall avoid cut and fill in the root zones.

49.5 Special care shall be exercised where trees or shrubs are exposed to injuries by construction equipment, blasting, excavating, dumping, chemical damage or other operation and the Contractor shall adequately protect such trees by use of protective barriers or other methods approved by the Employer. Trees shall not be used for anchorage.

49.6 Trees should be protected around 1m periphery by providing tree guard and no construction or storage of materials shall be carried out within its premise.

50.0 FLY ASH

50.1 The contractor shall use fly ash as a percentage substitution of cement, in concrete for certain structures and works as prescribed in the latest MoEF&CC fly ash notification dated September 1999 and its subsequent amendments.

50.2 As per the notification, only fly ash based products shall be used for construction such as cement or concrete, fly ash bricks or blocks or tiles or clay fly ash bricks, block or tiles or cement fly ash

bricks or bricks or blocks or similar products or a combination or aggregate of them. The contractor shall provide details of usage of such products to employer.

50.3 In all such uses of Fly Ash, the contractor shall maintain a detailed record of usage of Fly Ash. The contractor shall also collect related details and provide to the Employer.

51.0 CONTAMINANT OF AIR POLLUTION

51.1 At Construction Site

51.1.1 The Contractor shall erect barricades securely around all construction work sites during the entire phase of construction activity, to contain dust within the site area and also to reduce air turbulence caused by passing traffic.

51.1.2 Barricades are to be installed on either side of the road or at the centre of the road median.

51.1.3 Barricades are also required at work sites around the periphery of which are located residential or commercial property.

51.1.4 The barricades shall be safely secured to the ground to prevent from toppling. There shall be no gap between bottom of barrier and ground/road. The barrier shall be placed at all times till there is likelihood of dust escaping from the site or material being stored at the site.

51.1.5 In case of construction work located near residential or commercial properties, the contractor shall erect barricade of suitable approved material around the entire construction site of height not more than 10m or 1/3rd of building height whichever is less, having acoustic properties, apart from providing relief from dust. There should be no gap in the enclosure erected by the barrier except at entry and exit to or from site.

51.1.6 The barricading material if used as noise barrier shall conform to have following acoustic properties:

Table 1.1 Properties of Noise Barrier

Barrier type	Absorptive
Life span	At least 3-4 years
NRC	More than 0.75
Insertion Loss	10 dBA

51.1.7 The barrier material shall be light weight, weatherproof, fire resistant and easy to maintain. The supporting frames and mountings should also be light weight and easy to install.

51.1.8 Before the start of work, the Contractor shall provide wet automated wheel washing facility with two stage sedimentation tank at the exit of Batching Plant, Casting Yard, and Underground stations. It shall also be provided at off the road elevated stations. At other locations i.e. viaduct, on the road elevated stations etc. where there are space restrictions, the contractor shall adopt dry wheel cleaning mechanism with prior approval from employer. If work site contains multiple exits, then wheel washing facility shall be provided for all these exits where vehicle carrying construction materials or trucks or vehicles or plant/machinery transit from construction site on to live public roads. The wheel wash shall be located as close to the exit gate, as possible. However, care to be taken to ensure that the surface from wheel wash to exit gate is either bitumen or concrete paved. The contractor shall ensure the wheel washing facility remains functional till the end of contract.

51.1.9 At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. Water shall be pumped through an electrically operated pump set, to hydrants attached with rubber hoses, by activation of push button located at the hydrant, allowing for up to 10 minutes of wash time.

51.1.10 Wheel washing facility shall be provided with efficient drainage, incorporating silt traps to prevent any excessive build-up of water. These facilities should include water re-circulation mechanism to minimise water consumption.

51.1.11 At the wheel wash facility, water, dirt, gravel etc. shall be drained into precast trench drains with removable grated cover. This dirty water shall flow, through a piping, into solids separator and from there to oil separator before final discharge.

51.1.12 At each construction site including batching plant and casting yard, the Contractor shall provide storage facilities for dust generating materials which shall be closed containers/bins or wind protected shelters or mat covering or walled or any combination of the above to the satisfaction of the Employer. Suitable sprinkling system shall be installed and operationalized in this area. The quality of water for sprinkling shall be the same as used for concrete batching.

51.1.13 The contractor shall not store any construction material/debris/soil outside barricaded area.

51.1.14 Soil, sand, aggregate, debris of any kind and all dust prone material that is stored at site will be fully covered with tarpaulin or hessian cloth in all respects with proper anchorage so that it does not disperse in the air in any form.

51.1.15 The dust emissions from the construction site should be completely controlled and all precautions taken in that behalf.

51.1.16 The Contractor shall use nozzle based mist system at construction sites such as elevated station, underground station, launching shaft, depot, retrieval shaft, batching plant & casting yard as required to suppress dust.

51.1.17 Nozzle based mist system shall also be used during the delivery and handling of sand and aggregate and other similar materials, when dust is likely to be generated.

51.1.18 At sites where the sprinkling is to be carried out manually, sprinkling will be carried out at a frequency of at least thrice a day or as directed by engineer in charge. For dust suppression contractor shall use, STP treated water or RO reject or treated water from sedimentation tank. Use of fresh water to be refrained.

51.1.19 Stockpiles of sand and aggregate greater than 20m3, used for concrete manufacturing, shall be enclosed on three sides, with walls extending above the height of stockpile and two (2) meters beyond the front of the stockpile. The contractor shall provide sprinkler system in sand and aggregate storage area and the water for sprinkling shall be of the same quality as used for concrete batching.

51.1.20 Areas within the site such as casting yard and batching plant, where there is a regular movement of vehicles shall have an approved hard surface (PCC) that is kept clear of loose surface material.

51.1.21 Unless the Employer has given consent otherwise, the Contractor shall restrict all motorised vehicles on the site to a maximum speed of 10 kilo-meter per hour and vehicles shall move on designated path.

51.1.22 The contractor shall use wet-jet in grinding and stone cutting works with two stage sedimentation tank facility to recycle/re-use the water. The water from the final chamber of sedimentation tank shall be reused.

51.1.23 In the event recorded PM10 level is greater than the base line/Limit levels, the Employer may direct the Contractor to take effective remedial measures including, but not limited to, reviewing dust sources and modifying working procedures.

51.1.24 Where the recorded baseline levels exceed the ambient air quality standards, then at such locations the baseline level shall be considered as limit level. Contractor shall take all effective remedial measures to contain the levels to their limit level as a result of his activities.

51.1.25 If the measures to control air pollution are found to be ineffective, the employer may issue stop work order till the time remedial measures are found to be effective to the satisfaction of employer.

51.1.26 At the Batching plant the following additional conditions shall be complied with:

a) The contractor shall not install Star Batcher Concrete Batching Plant for manufacturing/producing concrete.

b) Inside the batching plant, ground surface must be paved with Cement Concrete. The plant shall have proper drainage system with outlet connected to two stage sedimentation tank. No dust shall be allowed to deposit on road inside Batching plant.

c) The contractor shall procure cement through bulker instead of conventional cement bags.

d) Continuous dust/wind breaking barricades of height at least 6 meters around the batching plant shall be constructed of suitable material which will act as boundary wall.

e) If the batching plant is located near the residential area, then the boundary wall shall be acoustically treated to act as noise barrier also. In such event the property of boundary wall cum noise barrier will conform to specification given in para 51.1.6 above.

f) The contractor shall provide sufficient number of openings in the cement godown/cement feeding area with industrial grade exhaust fans with ducting system. The ducts shall be connected to a container filled with water.

g) The contractor shall cover the conveyor belt used for carrying aggregate.

h) Nozzle based mist system shall be used during the delivery and handling of sand and aggregate and other similar materials, when dust is likely to be generated and to dampen all stored materials.

i) The contractor shall provide and ensure dust masks (proper PPEs) to all workers/labour/staff working at batching plant.

j) The Contractor shall undertake at all times the prevention of dust nuisance as a result of his activities.

k) The Contractor shall frequently clean and water the concrete batching plant and crushing plant sites and ancillary areas to minimise any dust emission.

51.1.27 Minimum stack height of DG set shall be as given in Central Pollution Control Board (CPCB) Emission Regulations Part IV: COINDS/26/1986- 87 and Emission Standards for Diesel Engines (Engine Rating more than 0.8 MW (800 KW) which were notified by the Environment (Protection) Third Amendment Rules 2002, vide G.S.R. 489 (E), dated 9thJuly, 2002 at serial no. 96, under the Environment (Protection) Act, 1986 and its amendments.

51.1.28 Consent for height of stacks of Diesel Engines with rating more than 800 KW shall be obtained by the Contractor from statutory Government agency. Where the calculated height of stack is obtrusive and does not blend with the neighbourhood, the contractor could provide either alternative source of power or provide a solution that is acceptable to the employer. This may include but not limited to providing appropriate cladding for the stack.

51.1.29 Contractor's transport vehicles and other equipments shall conform to emission standards fixed by Statutory Agencies of Government of India or the State Government from time to time. The contractor shall carry out periodical checks and undertake remedial measure including replacement, if required so as to ply within permissible norms.

51.1.30 Contractor shall provide green net for dust control at construction sites i.e stations, viaduct, depot, batching plant, casting yard, at the top of barricade boards near residential/commercial and sensitive areas. These should be of sufficient height and firmly secured so as to prevent escape of dust to residential/ commercial and industrial areas.

51.1.31 To avoid dust generation during drilling and grinding, it is preferred to use drilling machine, angle grinder and floor grinder connected to a vacuum cleaner. The dust collected in the vacuum cleaner should be disposed off without causing air pollution.

51.1.32 All Air Conditioner's shall confirm the ozone depleting substances (Regulation and Control) Rules, 2000.

51.1.32 The Contractor shall protect structures, utilities, pavements roads and other facilities from disfiguration and damage as a result of his activities. Where this is not possible, the contractor shall restore the structures, utilities, pavements, roads and other facilities to their original or better, failing which the rectification/restoration work shall be carried out at the risk and cost of the contractor.

51.2 During Handling of excavated earth

51.2.1 Storage of Excavated earth should be such that it's maximum height shall be 0.5 m below the barricading height.

51.2.2 Excavated earth shall be covered with tarpaulin sheets which are firmly secured to the ground, as long as it is stored at site.

51.2.3 If the excavated material is to be stored for long duration, dust containment measures like growing grass should be adopted.

51.3 During Transport of Material/muck/soil/C&D Waste (Debris)

51.3.1 The Contractor shall take precautions to minimise visible particulate matter from being deposited upon public roadways as a direct result of his operations. Toe dust along the barricade shall be cleaned regularly at least once a day.

51.3.2 The vehicle carrying construction materials and construction debris of any kind should be cleaned in all respect before it is permitted to ply on the road.

51.3.3 The contractor shall take precaution against spillage of concrete on road from transit mixer by providing collection bag at end point discharge chute

51.3.4 Any deposition of material/muck/soil on public streets due to construction should be promptly removed by manual sweeping, or by deploying electro – mechanical devices.

51.3.5 Trucks carrying construction material, excavated earth and debris shall be fully covered and protected so as to ensure that these materials do not get dispersed into the air or atmosphere, in any form whatsoever or fall off the vehicle. Such trucks carrying construction material shall not be permitted to leave the site until this requirement is met.

51.4 At Dumping Sites

51.4.1 The dumping sites should be temporarily barricaded by the contractor or as per provisions in the Employer's Requirements on Construction. The contractor shall provide wheel cleaning mechanism at the exit gate of dumping site.

51.4.2 The Contractor shall place excavated materials in the dumping / disposal areas approved by Employer.

51.4.3 The Contractor shall place material in a manner that will minimise dust generation. Material shall be stabilised each day by watering or other acceptable dust suppression techniques.

51.4.5 The heights from which materials are dropped shall be the minimum practical height to limit fugitive dust generation.

51.4.6 The Contractor shall stockpile material in the Employer designated locations with suitable slopes. Access to the site shall be regulated for entry of men, material and machine.

51.4.7 The contractor should cover the surface with grass to prevent dust generation during summer months and erosion in rainy period.

51.4.8 The Contractor shall provide water sprinkling at any time that it is required for dust control use.

51.4.9 Sufficient equipment, water, and personnel shall be available at dumping sites at all time to minimise dust formation and to prevent nuisance.

51.4.10 Dust control activities shall continue even during work stoppages.

52.0 CONTAINMENT OF WATER POLLUTION AND CONSERVATION OF WATER

52.1 The Contractor shall provide digital water meters at all the bore wells, inlets and outlets of RO plants, dewatering outlets, municipal water delivery points and other suitable locations to record the accurate figures of water extraction and consumption for various purposes and submit the details. The contractor shall obtain necessary permission for extracting ground water from relevant government agency.

52.2 At underground construction site and dumping sites, temporary drainage works shall be maintained, removed and reinstated as necessary and all other necessary precautions should be taken for avoidance of damage by flooding and silt.

52.3 Temporary open storage of excavated materials from cut and cover and tunnelling work used for backfill at site should be covered with tarpaulin which is firmly secured to ground.

52.4 Polymer slurry or other grouts used in diaphragm wall construction piling and other concrete works shall be collected in a separate slurry collection system. If reuse is not practicable then it shall only be disposed off at nearest landfill site after obtaining permission from agency owning the landfill and under the conditions imposed by the agency concerned, or to a different disposal location as advised by the Employer. Record of disposal of Polymer slurry at landfills or elsewhere shall be maintained by the contractor and reported in the contractor's Monthly Environment Report to be shown to employer when requested.

52.5 Beneath the hopper of Batching Plant, the slope of the surface shall be maintained in a such a way that the slurry from Batching Plant shall enter into sedimentation tank. The area should be cleaned regularly to avoid slush generation.

52.6 Any mud slurry from drilling, tunnelling, diaphragm wall construction or grouting etc. shall not be discharged into the drainage system unless treatment is carried out that will remove silt, mud particles etc. The Contractor shall provide treatment facilities as necessary to prevent the discharge of contaminated ground water.

52.7 The Contractor is not allowed to discharge water from the site without the approval of the Employer. The Contractor must comply with the requirements of the Central Ground Water Board for discharge of water arising from dewatering. Any water obtained from dewatering systems installed in the works must be either re-used for construction purposes or recharged to the ground or pumped into the nearest water body/park or supplied to concerned authority with prior permission of the Employer. In case, the dewatered water is required to be used for reuse in construction or recharge, the Contractor must submit his proposals for prior approval of Employer along with, his proposed locations of dewatering.

52.8 Roof top run-off from casting yard and batching plants as well as water from curing (if, any) should be conserved through properly designed rainwater harvesting structures via adequately designed sand/silt removal facilities such as sand traps, silt traps or sediment basins. Excess discharge should be discharged into storm drains.

52.9 Perimeter channels/drains shall be constructed in casting yard and batching plant. Silt removal facilities, channels and manholes should be maintained and the deposited silt and grit should be removed regularly, to ensure that these facilities are functioning properly at all times.

52.10 Oil separator/interceptors shall be provided to prevent the release of oil and grease into the drainage system. These shall be cleaned on a regular basis. Area which is storing admixtures/oils should be connected to a drainage system with a oil & grease trap. Spillage of material during transfer should be avoided by using appropriate /design mechanism for such transfer.

52.11 Measures should be taken to minimize the ingress of rainwater into trenches. If excavation of trenches in wet seasons is necessary, they should be dug and backfilled in short sections. Rainwater pumped out from trenches or foundation excavation should be discharged into storm drains via silt removal facilities.

52.12 Manholes (including newly constructed ones) should always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris from getting into the drainage system. Discharge of surface run-off into sewers must always be prevented in order not to unduly overload the sewerage system.

52.13 The drainage system should cover the entire area of Casting Yard/ Batching Plant. The drainage system shall be designed in such a way that it should have sufficient capacity to hold the runoff of the catchment area.

52.14 Waste water from Reverse Osmosis (RO) plant shall be used only for dust suppression, wheel washing and road washing. It shall not be drained into public sewers or storm water drainage system.

52.15 The Contractor may discharge wastewater arising from site offices, canteens or toilet facilities constructed by him into sewers after obtaining prior approval of agency controlling the system.

52.16 The Contractor shall provide adequate precautions to ensure that no spoil, wastewater, spills or debris of any kind is pushed, washed, falls or deposited on land adjacent to the site perimeter including public roads or existing stream courses water bodies (Natural /artificial), ground water and drains within or adjacent to the site. In the event of any spoil, wastewater, spills and debris from construction works being deposited or any silt washed down to any area, then all such spoil, wastewater, spills debris or material and silt shall be immediately removed and the affected land and areas restored to their natural state by the Contractor to the satisfaction of the Employer.

53.0 CONTAINMENT OF NOISE AND VIBRATION

53.1 Construction often generates community noise/vibration complaints despite the limited time frame over which it takes place. Complaints typically arise from interface with people's activity, especially when community has no clear understanding of the extent or duration of construction.

53.2 This situation underscores the need for early identification and assessment of potential problem areas. An assessment of the potential for complaints can and should be made.

53.3 If done timely, such assessment can aid contractor in allowing changes in construction approach and reduce noise mitigation cost before the construction plans are finalised.

53.4 The contractor shall conform to ambient air quality standards/Baseline results with respect to noise.

53.5 The Employer will monitor noise level at site before the start of work and share the values with contractor. Thereafter, the contractor will employ necessary engineering control to ensure that noise lelves do not exceed preconstruction noise.

53.6 Where there are no ambient noise measurements, the noise levels from construction activities shall be limited to levels measured near the construction site as given in table below:

Table 1.2.: Allowable Construction Noise

S. No	Land Use	Maximum Noise Levels (Leq- 5min)
1	Industrial	75
2	Residential and Other areas	65

53.7 To the extent required to meet the noise limits, the Contractor shall use reasonable efforts to include noise reduction measures listed below to minimize construction noise emission levels. Noise reduction measures – include, but not limited to the following:

i. Acoustic barriers should be placed near construction sites. The properties of acoustic barrier are given in Table 1.1.

ii. Minimize the use of impact devices, such as jackhammers, and pavement breakers. Equip noise producing equipment such as jackhammers and pavement breakers with acoustically attenuating shields or shrouds recommended by the manufacturers thereof, to meet relevant noise limitations.

iii. Pneumatic impact tools and equipment used at the construction site shall have intake and exhaust mufflers recommended by the manufacturers thereof, to meet relevant noise limitations.

iv. Provide mufflers or shield panelling for other equipment, including internal combustion engines, recommended by manufacturers thereof.

v. Use construction equipment manufactured or modified to dampen noise and vibration emissions, such as:

1. Use hydraulic tools instead of pneumatic impact tools.
2. Maximize physical separation, as far as practicable, between noise generators and noise receptors such as locating stationary equipment so as to minimize noise and vibration impact on community.
3. Use of electric powered equipment instead of diesel-powered equipment.

vi. Schedule work to avoid simultaneous activities that generate high noise levels.

53.8 The contractor shall provide enclosures for stationary equipment and noise barriers around particularly noisy areas on site depending upon the land use.

53.9 To the extent feasible, configure the construction site in a manner that keeps noisier equipment and activities as far as possible from noise sensitive locations and nearby buildings. Plant and equipment known to emit noise in one direction should where possible, be oriented in a direction away from noise sensitive receptor and reduce the number of plant and equipment operating in critical areas close to noise sensitive receptors.

53.10 Schedule truck loading, unloading, and hauling operations so as to minimize noise impact near noise sensitive locations and surrounding communities.

53.11 Other measures that the contractor may adopt to mitigate noise include:

a) Minimize noise intrusive impacts during most noise sensitive hours.
b) Plan noisier operations during times of highest ambient noise levels
c) Keep noise levels relatively uniform; avoid excessive and impulse noises.
d) Equipment and plant should not to be kept idling when not in use.
e) Use only well-maintained plant & equipment at site, which should be serviced regularly.
f) Shall maintain equipment such that parts of vehicles and loads are secured against vibrations and rattling
g) Conduct truck loading, unloading and hauling operations in a manner such that noise and vibration are kept to a minimum.
h) Route construction equipment and vehicles carrying soil, concrete or other materials over streets that will cause least disturbance to residents in vicinity of work.
i) Avoid operating truck on streets that pass by schools during school hours
j) Select truck routes for muck disposal in such a way that noise from heavy-duty trucks will have minimal impact on sensitive land uses (e.g., residential) and submit the proposed routes to the Employer for approval.

53.12 If back-up alarms are used on construction equipment, their noise level near noise sensitive receptors such as residences, schools, hospitals and similar areas where silence is essential, should be regulated, especially at night time. Visual alarms shall preferably be used during night time operation.

53.13 The contractor shall make efforts to bring down the noise levels due to the DG set, outside his premises, within the ambient noise requirements by proper setting and control measures.

53.14 Installation of a DG set must be strictly in compliance with the recommendations of the DG set manufacturer. The contractor shall ensure that all necessary permissions/ approvals/consent is obtained from relevant authorities before installation and operation of Generator set.

53.15 A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

53.16 The maximum permissible sound pressure level for new diesel generator (DG) sets (upto 1000 KVA) manufactured on or after the 1st July,2003 shall be 75 dB(A) at 1 metre from the enclosure surface. The diesel generator sets should be provided with integral acoustic enclosure at the manufacturing stage itself.

53.17 Noise limit for DG sets not covered by above paragraph shall be as follows:

a) Noise from DG set shall be controlled by providing an acoustic enclosure or by treating the room acoustically, at the user's end.

b) The acoustic enclosure or acoustic treatment of the room shall be designed for minimum 25 dB (A) insertion loss or for meeting the ambient noise standards, whichever is on the higher side (if the actual ambient noise is on the higher side, it may not be possible to check the performance of the acoustic enclosure/acoustic treatment. Under such circumstances the performance may be checked for noise reduction up to actual ambient noise level, preferably, in the night time). The measurement for Insertion Loss may be done at different points at 0.5 m from the acoustic enclosure/room, and then averaged.

c) The DG set shall be provided with proper exhaust muffler with insertion loss of minimum 25 dB(A)

53.18 If the measures to control noise pollution are found to be ineffective, the employer may issue stop work order till the time remedial measures are found to be effective to the satisfaction of employer.

53.19 Vibration consists of rapidly fluctuating motions with an average motion of zero. During vibration the oscillatory waves propagate from the source through the ground to adjacent buildings. Vibration from construction projects is caused by general equipment operations is usually highest during pile driving, soil compacting, jack hammering and construction related demolition activities.

53.20 The following steps may be taken by the contractor to reduce construction vibration:

A. Design considerations and project layout:

1. Route heavily loaded trucks away from residential streets.
2. If possible, select street with fewest homes, if no alternatives are available.
3. Operate earthmoving equipment on the construction lot as far away from vibration sensitive sites as possible.

B. Sequence of operations:

1. Phase demolition, earthmoving and ground-impacting operations so as not to occur the same time period. Unlike noise, the total vibration level produced could be significantly less when each vibration source operates separately.
2. Avoid night time activities. People are more aware of vibration in their homes during the night time hours.

C. Alternative construction methods:

1. Avoid impact pile driving where possible in vibration-sensitive areas.
2. Drilled piles or the use of a sonic or vibratory pile driver causes lower vibration levels where the geological conditions permit their use.
3. Select demolition methods not involving impact, where possible. For example, sawing bridge decks into sections that can be loaded onto trucks results in lower vibration levels than impact demolition by pavement breakers, and milling generates lower vibration levels than excavation using clam shell or chisel drops.
4. Avoid vibratory rollers and packers near sensitive areas.

54.0 WASTE MANAGEMENT

54.1 General: The following types of waste are most likely to be encountered during execution of contract:

1. General refuse
2. C&D waste
3. Hazardous waste
4. E-waste
5. Bio medical waste
6. Plastic waste
7. Batteries Waste

54.1.1 Disposal of waste as per legal requirement is found in the table below:

Table 1.3: Construction Wastes – Type and Disposal

S.No	Waste Type	Legal requirement for handling, storage & disposal
1.	General refuse	Solid Waste Management Rules, 2016 and its amendments
2.	Vegetation / Timber etc.	The Maharashtra (Urban Areas) Preservation of Trees Act, 1975 and its amendments
3.	Construction and Demolition (C&D) waste	Construction and Demolition Waste Management Rules, 2016 and its amendments and/or any suitable means acceptable to Maha-Metro/Engineers
4.	Hazardous waste	Hazardous and Other Wastes (Management & Trans-boundary Movement) Rules, 2016 and its amendments
5	Electronic waste	E-waste (Management) Rules, 2016 and its amendments
7.	Bio-medical waste	Bio-medical waste Management Rules, 2016 and its amendments
8.	Chemical waste	Manufacture, Storage and handling of hazardous chemical rules 1989 and its amendments
9.	Plastic Waste	Plastic Waste management Rules, 2016 and its amendments

54.1.2 In addition to above, excavated earth and metal scrap is likely to be generated in large quantity. The excavated material comprises mainly soil and rock. Soil may be used for backfill at locations as directed by employer.

54.1.3 The contractor is required to develop, institute and maintain a Waste Management Programme (WMP) during the construction of the project for his works. This WMP shall be a part of Contractor's site Environmental Management Plan. Data sheet to be provided under WMP. However, the WMP should be prepared and submitted to the Engineer for approval. A Waste

Management Plan specific for handling and disposal of C&D waste shall be prepared separately by the contractor as per the provisions of C&D Waste Management Rules, 2016 or any other means acceptable to the engineers.

54.1.4 A mechanism is required to ensure that designated areas for the segregation and temporary storage of reusable, recyclable and waste materials are incorporated into the WMP.

54.1.5 The Contractor shall handle waste in a manner that ensures they are held securely without loss or leakage thus minimizing potential for pollution following all legal requirements for handling and storage. The Contractor shall maintain and clean waste storage areas regularly.

54.1.6 The contractor shall strictly manage transportation and disposal of all waste complying all legal/statuary requirements.

54.1.7 The contractor shall make available Material Supply Data Sheet (MSDS) for material/chemicals/substances used, for which these are available to the Employer when requested.

54.2 General Refuse

54.2.1 This category of waste is generated from living camps, offices, workshops, kitchen, and other work areas. Such type of waste includes food scraps (solids + liquids), Paper, Cardboard, Plastics (recyclable bottles, other), Glass (different colours), Aluminium and other cans, Wooden boxes, crates etc.

54.2.2 The Contractor shall provide at site, metal or heavy-duty plastic 'Refuse Containers' with tight fitting lids for disposal of all garbage or trash associated with food. The containers shall not have openings that allow access by rodents.

54.2.3 To keep the area free of litter and garbage, specific locations shall be designated for consuming food and snacks to prevent random disposal of waste. All waste shall be deposited in the refuse containers. Suitable all-weather signage shall be prominently displayed for compliance of these requirements.

54.2.4 The refuse containers shall be kept upright with their lids shut. These containers shall be emptied at least once daily by the Contractor to maintain site sanitation. There shall be different containers for each category of waste.

54.2.5 General refuse should be stored in enclosed bins or units separate from construction and chemical wastes. A waste collector should be employed by the contractor to remove general refuse from the site on a daily basis to minimise odour, pest and litter impacts.

54.2.6 Handling and disposal of general refuse should cope with the peak construction workforce during the construction period. The refuse should be stored and transported in accordance with good environment practice and disposed at licensed landfills.

54.2.7 Respective Waste with residual value is to be disposed off by selling to recyclers. The remaining can be disposed off through collection and disposal by local municipal agency.

54.2.8 Office waste can be reduced through recycling of paper if volumes are large enough to warrant collection.

54.2.9 Burning of refuse at construction site is not permitted. Dumping of any type of waste is strictly prohibited along any of the river bed.

54.2.10 Colour Coded Dustbin in suitable numbers at each working area shall be used for segregation of waste during collection. The waste management plan should clearly quantify and identify the number and locations of different types of dustbins that will be provided at each working site. Colour coding of dustbins shall be as per given Table:

Table 1.4 - Colour Coding of Dust Bins

Type of Waste	Colour
Wet/Organic/ Bio-Degradable Waste	Green Bins with lids
Dry/Recyclable waste (excluding Bio-medical waste/ hazardous waste)	Blue
Bio-Medical waste	As per Bio-medical waste Management Rules, 2016
E-Waste	Black
Hazardous Waste	Fluorescent yellow colour background wrien in RED words as 'HAZARDOUS WASTES' and 'HANDLE WITH CARE' in Hindi, English and vernacular language
COVID Waste	Yellow

54.3 Construction and Demolition Waste

54.3.1 Construction and Demolition waste" means the waste comprising of building materials, debris and rubble resulting from construction, re- modelling, repair and demolition of any civil structure.

54.3.2 Construction & Demolition (C&D) waste shall be stored at a designated area.

54.3.3 The C&D waste shall be disposed off in a manner in compliance with the procedure given in the Construction & Demolition Waste Management Rules, 2016. or any other means with prior approval of Maha-Metro/Engineer.

54.3.4 The contractor shall be responsible for collection, segregation and storage of construction and demolition waste, as directed or notified by the concerned local authority in consonance with the Construction& Demolition Waste Management Rules, 2016.

54.3.5 The contractor shall ensure that other waste does not get mixed with this waste and is stored and disposed separately.

54.3.6 The contractor shall dispose C&D waste only at authorized processing facilities/pre approved dumping locations and ensure that there is no littering or deposition of construction and demolition waste so as to prevent obstruction to the traffic or the public or drains.

54.3.7 Disposal of C&D waste along the river bed, natural drainage and wet land is strictly prohibited and the contractor shall be fined for non compliance of this requirement.

54.3.8 The requirement of concrete/RCC/PCC waste disposal, generated from the entire contract shall be either when 15 Tonnes of C&D waste has been generated or such C&D waste has been stored for 15 days (irrespective of quantity), of the two whichever is earlier.

54.3.8 Proper record keeping has to be maintained for all disposed C&D waste. The contractor shall submit the C&D waste record through Monthly Environment Report.

54.4 Hazardous Waste Management

54.4.1 Generally, the hazardous waste from construction site includes used oil, grease, oil filters etc. A comprehensive list of hazardous waste is found in Hazardous waste management and handling rules 2016. If encountered or generated as a result of Contractor's activity, then waste classified as hazardous under the "Hazardous and Other Wastes (Management & Transboundary

Movement) Rules, 2016 shall be disposed off in a manner in compliance with the procedure given in the rules under the aforesaid act.

54.4.2 Chemicals classified as hazardous chemicals under "Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 and amendments of Environment (Protection) Act, 1986 shall be disposed off in a manner in compliance with the procedure given in the rules under the aforesaid act.

54.4.3 The contractor shall identify the nature and quantity of hazardous waste generated as a result of his activities. The contractor shall obtain authorization for handling, storage of hazardous waste from the concerned pollution control board/committee. The contractor shall file annual return in prescribed format with the concerned pollution control board/ committee and forward a copy of receipt to employer.

54.4.4 The contractor shall provide and maintain a separate hazardous waste storage area for a) flammable, ignitable, reactive and b) Non- compatible wastes with suitable opening, Flame proof Electrical fittings should be at 15 m distance between the storage sheds. The storage yards should be provided with proper peripheral drainage system connected with the sump so as to collect any accidental spills.

54.4.5 The storage area for Hazardous waste shall:

a) Be clearly labelled and used solely for the storage of chemical waste;
b) Be enclosed on at least three sides;
c) Have an impermeable floor and bunding of capacity to accommodate 110% of the volume of the largest container or 20% by volume of the hazardous waste stored in that area, whichever is greater;
d) Have adequate ventilation;
e) Be covered to prevent rainfall entering and
f) Be arranged so that incompatible materials are adequately separated

54.4.6 Outside the storage area, the contractor shall place a 'display board', which will display quantity and nature of hazardous waste, on date. Hazardous Waste needs to be stored in a secure place.

54.4.7 It shall be the responsibility of the contractor to ensure that hazardous wastes are stored, based on the composition, in a manner suitable for handling, storage and transport. The labelling and packaging is required to be easily visible and be able to withstand physical conditions and climatic factors

54.4.8 Lubricants including oil and grease generated from operation of the TBM/other Machaneries/vehicles should be disposed off as a hazardous waste.

54.4.9 Drip pans of suitable size and numbers shall be used to collect oil leakages and spills. The area shall be cleaned after completion of maintenance /repair and generated waste disposed off in approved manner.

54.4.10 The contractor shall follow the manifest and approach only Authorised Recyclers of Hazardous Waste for disposal of Hazardous Waste, under intimation to the Employer.

54.5 Chemical Waste

54.5.1 The contractor should ascertain if some paints and solvents are classified as chemical waste and, if used on site, shall be subject to the stringent requirements of the Waste Disposal of Chemical Waste. Empty paint cans shall be recycled or collected as waste.

54.5.2 Any dry paint waste should be swept up (broomed / vacuumed) and collected in containers for disposal.

54.5.3 Containers used for the storage of chemical waste shall:

a) Be suitable for the substances they are holding, resistant to corrosion, maintained in good condition, and securely closed.

b) Be of adequate capacity and
c) Display a label in English and Hindi/Marathi as to the contents, quantity and safe method of disposal in accordance with instructions contained in Material Safety Data Sheet (MSDS).

54.5.4 The storage area for chemical waste shall:

a) Be clearly labelled and used solely for the storage of chemical waste;
b) Be enclosed on at least three sides;
c) Have an impermeable floor and bunding of capacity to accommodate 110% of the volume of the largest container or 20% by volume of the chemical waste stored in that area, whichever is greater;
d) Have adequate ventilation;
e) Be covered to prevent rainfall entering and
f) Be arranged so that incompatible materials are adequately separated.

54.5.5 Disposal of chemical waste shall be through a licensed waste collector duly authorized by the MoEF & CC or State Pollution Control Board as the case may be under intimation to the Employer.

54.5.6 No lubricants, oils, solvents or paint products shall be allowed to discharge into water courses, either by direct discharge, or as contaminants carried in surface water runoff from the construction site.

54.5.7 In sum, even though the exact quantities of chemical waste that will be generated per contract are expected to be small, still, because of the potential environmental and health & safety hazard that these chemicals pose, they must be handled, stored and disposed of appropriately, in accordance with the law.

54.6 Metal Scrap

54.6.1 Steel and other metals should be recovered from the construction waste and recycled as far as practical.

54.6.2 The contractor shall have a separate scrap yard with hard surface

54.6.3 Disposal of scrap shall be through a licensed waste collector/recycler under intimation to the Employer.

54.7 Polymer Slurry

54.7.1 Polymer slurries or other grouts used in diaphragm wall construction, piling and other concrete works should be collected in a separate slurry collection system.

54.7.2 If reuse is not practicable then it should be disposed off at nearest landfill site after obtaining permission from agency owning the landfill and under the conditions imposed by the agency concerned, or to a different disposal location as advised by the Employer.

54.7.3 Some Polymer slurry shall be used in diaphragm wall, bore-pile or to support the cutting face during maintenance of the TBM. This should be reconditioned and reused wherever practicable.

54.8.3 However, it may not be possible for re-use when it is extracted along with rock waste when tunnelling resumes following each intervention period. In this case the polymer will be mixed with rock and drained as usual before sending to the final disposal site.

55.0 ENVIRONMENTAL MONITORING

55.1 GENERAL

55.1.1 The Contractor shall carry out the monitoring of Air, DG stack, Noise, Vibration and ground water to assess the impact on environment during construction.

55.1.2 In addition, soil monitoring shall be carried out at underground station till no excavation is required. Representative sensitive receivers in the vicinity of the works shall be monitored for

noise and air quality impacts. Vibration monitoring shall be carried out as and when directed by the employer.

55.1.3 The Environmental monitoring shall be carried out by a MoEF recognised agency/lab with the prior approval of Maha Metro Environment Department. This approval can be withdrawn at any time if the quality of output of the laboratory/agency is found not satisfactory by Maha Metro Environment Department.

55.1.4 The contractor shall release the payment due to the monitoring agency within 2 months of the submission of bills failing which the Employer may deduct the payment from RA bills and directly pay to the engaged monitoring agency.

55.1.5 The contractor shall submit the method statement for the environmental monitoring with the prior approval of Maha Metro Environment Department.

55.2 Air Monitoring

55.2.1 For carrying out air monitoring the contractor shall appoint agency duly approved by Maha Metro Environment department with intimation to the employer. The contractor shall provide 220V AC power point, safety and security of monitoring equipment and suitable access at each monitoring point. Monitoring stations should be free from local obstructions or sheltering.

55.2.2 The monitoring shall be carried out till handing over of the site to the employer or as approved by Maha Metro Environment Department.

55.2.3 Ambient Air Quality Standards have been notified by the CPCB vide Gazette Notification dated 16th November 2009 and its amedments. These standards have to be referred by the Contractor for Limit Levels of PM10 and PM2.5 and other Parameters in ambient air which may be followed in estimating the pollution level caused by Contractor's activities.

55.2.4 Contractor will undertake baseline monitoring to establish background levels. Action Level of the Contractor shall be based on the results of baseline monitoring programme.

55.2.5 Where the Employer determines that the recorded PM10 & PM2.5 levels are significantly greater than the Limit levels, the Employer may direct the Contractor to take effective remedial measures including, but not limited to, reviewing dust sources and modifying working procedures.

55.2.6 Where the recorded baseline levels exceed the ambient air quality standards, then at such locations the limit level is the recorded baseline. Contractor shall take all effective remedial measures to contain the levels to their baseline value as a result of his activities. The action level may be varied by and at the sole discretion of the Maha Metro.

55.2.7 The Contractor should inform the Maha Metro of all steps taken to investigate cause of exceedance and immediate action taken to avoid further exceedance through written reports and proposals for action.

55.2.8 The contractor shall ensure calibration of monitoring instruments and their respective calibrators shall be carried out in accordance with the manufacturer's requirement to ensure they perform to the same level of accuracy as stated in the manufacturer's specifications.

55.2.9 The Contractor shall keep records of air quality monitoring (including location, date, time) and shall be available for review by the Employer. The Contractor shall submit a copy of monitoring results through the Monthly Environment Report (MER) to the Employer.

55.2.10 PM10 monitoring shall be done using Respirable Dust Sampler (RDS) and for PM2.5 either cyclone or impactor shall be used. Monitoring shall be done as per CPCB methodology

55.2.11 All the parameters as mentioned in Table 1.5 shall be monitored at following locations:

a) Depot, Batching Plant and Casting Yard

b) Elevated Stretch (Station and Viaduct)
c) Underground Station (at ground level)
d) Tunnel (only PM 2.5) Additionally, the contractor shall also carry out monitoring of PM2.5 at those locations where PM10 monitoring is carried out.

55.2.12 Followimng guidelines to be followed while monitoring, the RDS sampler to be placed such that:

a) The entry point of air should be at 2.5± 0.5 m above the ground.
b) The sampler to be placed near to the receptor at least 2.5-3.0 m away from barricades/obstruction.
c) Ensure flow rate of 1.15m^3/m.
d) The location will be finalized by environmental engineer at site in consultation with Maha Metro Environment deptt.
e) Elevated stretch: PM10 & 2.5 and other parameters monitoring to be carried out at every elevated station at a height of 2.5 ± 0.5 m. In the viaduct, monitoring to be performed at one location per 1 km in consultation with Maha Metro Environment department.
f) Underground Station: PM10& 2.5 and other parameters monitoring to be conducted at 2.5± 0.5 m above the ground. The specifications to be as per elevated stations

55.3 Noise Monitoring

55.3.1 Noise monitoring shall be carried out at ambient air monitoring locations in 15 days till site is handed over to the employer or The monitoring location shall be near to boundary of construction site and or as directed by the employer. Construction noise measurements shall coincide with daytime and night time periods of maximum noise generating construction activities.

55.3.2 Contractor will undertake baseline monitoring to establish background levels. Action Level of the Contractor shall be based on the results of baseline monitoring programme.

55.3.3 The Contractor shall submit a copy of monitoring results. The results should represent a comparison of data in form of bar charts for evaluation of trends and comparison with noise emission standards.

55.3.4 Where the Employer determines that the recorded Noise level is significantly greater than the acceptable levels, the Employer may direct the Contractor to take effective remedial measures including, but not limited to, reviewing noise sources and modifying working procedures.

55.3.5 Monitoring shall be carried out for day and night separately.

55.3.6 The noise monitoring parameters are Lmax, Lmin, Leq, L90, L50 & L10. All the parameters will be reported separately for day time and night time.

55.3.7 The contractor shall ensure calibration of noise monitoring instrument and its calibration shall be carried out in accordance with the manufacturer's requirement to ensure it perform to the same level of accuracy as stated in the manufacturer's specifications.

55.3.8 Type I/II integrating sound level meter with free -field microphone and tripod stand of 1 to 1.5 m height shall be used for noise monitoring. The microphone of the instrument shall be near the receptor.

55.3.9 The minimum requirements to the specifications of sound level meter are given in BIS: 9779-1981 and its latest amendment. Measurement frequency of 31.5 Hz to 8000 Hz. Noise measurements shall be reported ion dB(A). Sound Level Meter should be Type-I/II with A, C & Z weighing and measured sound values should also be suitably presented for quick comparison and interpretation.

55.4 Vibration

55.4.1 Steady State Vibration on any pre-identified site or building shall be measured on any foundation or intermediate storey of any building, as directed by the employer or his representative.

55.4.2 Vibration measurements shall be made preferably in velocity mode (PPV) or acceleration (dBv / vdB) in X-Y-Z directions with the help of a measurement system calibrated in an NABL accredited laboratory/equivalent. The transducer used for measurements should be firmly fixed on to the measurement surface as per internationally accepted measurement practices. Precautions should be taken to ensure that the mounting methods do not affect the accuracy of measurement results. The accelerometer shall be fixed firmly to the vibrating surface with the help of special wax or through magnetic mounts.

55.4.3 The measured vibration values should be accurate within an overall measurement uncertainty of ±10 % over the frequency range 1Hz – 100 Hz.

55.4.4 The data should be presented in suitable single number quantities like VdB or PPV values as per current international practices so that the final values are comparable directly with the accepted norms for structural integrity, human comfort etc.

55.5 Ground Water

55.5.1 The employer may require the contractor to monitor surface/ ground water/drinking water, for which requirements of IS 10500:2012 or its latest amendments shall be followed for sampling and testing (physical and chemical parameters).

55.5.2 Frequency of such monitoring at Stations, viaduct, batching plants, casting yard, Labour camps shall be once in 3 months.

55.6 Soil

55.6.1 The contractor shall carry out soil testing at all elevated, underground stations and working Sites. The frequency of testing shall be once in 3 months. The parameters of monitoring shall be Lead (Pb), Cadmium (Cd), Chromium (Cr6+), Mercury (Hg), Arsenic (As) and cyanide (CN). The sample collection, testing shall be as per relevant APHA standard.

55.7 Environmental Monitoring Programme

55.7.1 The various parameters, monitoring locations and Frequency of monitoring are presented in Table below:

Table 1.5: Summary of contractor's Environmental Monitoring Programme

Parameters	Locations	Frequency
Air		
PM2.5, PM10, Sox, Nox, Co, Pb, Ni, As, O_3 (μ/m^3)	Station, Viaduct, depot, Batching plant,Casting yard Inside the Tunnel and in underground stations	Once in 15 days for 24hrs
PM10 Sox, Nox, Co, Pb, (μ/m^3)	DG Sets	Once in 1 month
Noise		
Day Time (6 AM – 10PM) Lmax, Lmin, Leq, L10, L90, L50 Night Time (10PM –6AM) Lmax, Lmin, Leq, L10, L90, L50	Station, Viaduct, depot, Batching plant,Casting yard etc.	Once a 15 days for 24hrs (Separately for day time and night time)
Ground Water/Drinking water		

Parameters	Locations	Frequency
Colour, odour, Taste, Turbidity, pH, toatad Hardness, Calcium, Ammonia, Residual Free Chlorine, Fluoride, Total Dissolved Solids, Magnesium (Mg), Copper (Cu), Sulphide (H_2S), Sodium, Potassium, Chloride, Nitrogen, Phosphorus, Organic Matter, Heavy Metals (Mercury, Cadmium, Arsenic, Cyanide, Lead, Chromium), Oil & Grease, Total Coliform, E.Coli, etc.	Station,Viaduct,Depot, Batching Plant and Casting Yard,Labour Camp	Once in 3 months
Soil		
pH, Conductivity, Boron, Nitrogen, Calcium (Ca), Sodium (Na), Potassium (K), Zinc (Zn), Organic carbon, Magnesium (Mg), Phosphorus, iron (Fe), Lead (Pb), Cadmiun (Cd), Chromium (Cr6+), Mercury (Hg), Arsenic (As) and cyanide (CN).	At elevated & underground stations	Once in 3 months
Vibration		
Vibration in mm/s or VdB.	At elevated & underground stations	During complaints or as directed by employer.

56.0 ENVIRONMENTAL SANITATION

56.1 Environmental Sanitation refers to providing for a clean, hygienic, safe and aesthetically pleasing work area, as far as possible. It is also referred to as good housekeeping.

56.2 The Contractor shall constitute a special group of housekeeping personnel in charge of each work section. Contractor's Environment officer shall be responsible for Environmental sanitation/housekeeping at their respective site.

56.3 Housekeeping is the responsibility of all site personnel, and line management commitment shall be demonstrated by the continued efforts of supervising staff towards this activity.

56.4 General Housekeeping shall be the responsibility of site In-Charge and monitored by the housekeeping manager at all worksite, construction Depot, Batching Plant, Labour Camp, Stores, Offices and toilets / urinals. Towards this the contractor shall constitute a special group of housekeeping personnel. This group shall ensure daily cleaning at work sites and surrounding areas and maintain a register. Contractor's Environment officer shall be responsible for Environmental sanitation / housekeeping.

56.5 Each section of work site shall maintain the site reasonably clean, keep free from obstruction and properly store any construction equipment, tools, and materials. Any wreckage, rubbish shall be temporarily stored in wreckage and rubbish bins. These wreckage and rubbish bins shall be cleaned at frequent intervals. Special housekeeping group will ensure daily cleaning work at the site and its surrounding areas.

56.6 The Contractor's designated department will impart the necessary introduction/awareness and education to labours on housekeeping. This will be done through toolbox talks.

56.7 Every individual would be responsible for environmental sanitation in his area i.e.

A. **At Work Site:** All workers should clean their workplace after completion of their job. Supervisor should ensure good environmental sanitation of their respective work area through their workers. Environment Managers shall ensure sanitation in their area through their supervisors. Contractor's designate department will monitor this activity through environment manager as well as site supervisor.

B. **Labour Camp:** All workers should be responsible to maintain good sanitation and hygienic condition in their respective rooms/dormitories. The Contractor should ensure the availability of dustbins at required place and regular cleaning of rooms, kitchens, toilet blocks and dustbins. Safe disposal of all waste materials should also be ensured. Arrangement for regular fumigation should be made by the contractor.

C. **At Store:** Proper access and stacking shall be ensured at the Stores. A list will display daily stock of materials. All work material should be stored in clearly marked containers or at designated storage area.

D. **At Office:** Everyone is responsible to maintain sanitation of their work station. Disposal of waste materials (i.e. stationary, cigarette buds, tea bags etc.) must be in dustbin only.

56.8 Adequate Time shall be assigned to ensure that good housekeeping is maintained. This shall be carried out by team of housekeeping sqad.

56.9 The contractor shall be responsible to provide segregated containers for disposal of debris at required places and regular cleaning of the same.

56.10 Full height fence, barriers, barricade etc. shall be erected around the site in order to prevent the surrounding area from excavated soil, rubbish etc, which may cause inconvenience to and endanger the public. The barricade especially those exposed to public shall be aesthetically maintained by regular cleaning and painting as directed by the employer. These shall be maintained in one line and level. Measures shall be adopted to ensure that seepage from site shall not go on road / public areas.

56.11 The structure dimension of the barricade, material and composition, its colour scheme, Maha Metro Logo and other details shall be in accordance with specification laid down in tender document.

56.12 All surplus earth and debris are removed/disposed off from the working areas to officially designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. in order to avoid dust or odour impact shall be covered while moving. The tyres of the trucks leaving the site shall be cleaned with water, wherever the possibility of spillage on carriageways meant for regular road traffic exists.

56.13 No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.

56.14 Roads shall be kept clear and material like: pipes, steel, sand boulders, concrete, chips and brick etc. shall not be allowed on the roads to obstruct free movement of road traffic.

56.15 Proper and safe stacking of material are of paramount importance at yards, stores and such locations where material would be unloaded for future use. The storage shall be well laid out with easy access and material stored/stacked in an orderly and safe manner.

56.16 Flammable chemicals / compressed gas cylinders shall be safely stored.

56.17 Unused/surplus cables, steel items and steel scrap lying scattered at different places within working areas shall be removed to identified locations.

56.18 All wooden scrap, empty wooden cable drums and other combustible packing material, shall be removed from workplace to identified locations.

56.19 Empty cement bags and other packaging material shall be properly stacked and removed.

56.20 The contractor shall ensure that all his sub-contractors maintain the site reasonably clean through provision related to housekeeping.

56.21 Debris shall be handled and disposed off in such a manner that it does not create any hazards to the site personnel. Debris shall not be accumulated to form a hazard and should be kept sufficiently moist to bring down the dust level within permissible limit.

56.22 Debris or other material shall not be thrown inside or outside the site premises from any height. The debris or waste material shall be disposed off at regular interval and as soon as the work has been completed.

57.0 AVOIDANCE OF NUISANCE

57.1 The Contractor shall take all precautions to avoid any nuisance arising from his operations. This shall be accomplished, wherever possible by suppression of nuisance at source rather than abatement of the nuisance once generated.

57.2 Following site clearing and before construction, the Contractor shall remove all trash, debris and other weeds.

57.3 The Contractor shall ensure that the workplace is free of trash, garbage, debris and weeds.

57.4 Light used for construction can illuminate adjacent areas in undesired ways. Such lighting and glare shall be prevented from striking adjacent areas, where feasible, through directional shielding.

57.5 The other measures include but not limited to:

a) Careful positioning of construction equipment.
b) Eliminating the possibility of stockpiles of material from being visible to public.
c) Strategically placing high visibility site markings at construction sites indicating facilities, offices and stores.
d) Adequate and properly managed parking of vehicles at construction depots and batching plants.

57.6 Measures shall be taken to prevent Mosquito breeding at site. The measures to be taken shall include, but not limited to, the following:

a) Construction run-off shall not be allowed to stagnate at work sites specially at construction depots and batching plant locations, by executing and efficient drainage system and / or levelling of low-lying areas.

b) Empty cans, oil drums, packing and other receptacles which may retain water shall be deposited at a central collection point and shall be removed from site regularly.

c) Still waters shall be treated at least once every week with eco-friendly chemical in order to prevent mosquito breeding; contractor's equipment and other items on the site, which may retain water, shall be stored, covered or treated in such a manner that water could not be retained.

d) All coolers should be scrubbed and cleaned once a week and mopped, dry before refilling and if cannot be emptied, put one tablespoon of temephos / petrol or Authority approved chemicals.

e) Collection of stagnant water should not be allowed inside or around construction sites / office premises/ project sites / parking area/ labour camps and if the same does not take place a little quantity of kerosene/ petrol/ diesel or chemical approved by local authorities may be put in such stagnant wastewater collection.

f) Ensure that over head and other water tanks / containers are kept closed properly with lid and overflow pipe/ air vent are covered with wire mesh.

g) Unused/ broken bottles, plastic cups, pots and tyres etc that can hold water should not be left in open in all contractor's premises.

h) Provision of access to roof tops and over head tanks in all contractor's offices to facilitate checking of mosquito breeding.

58.0 ARCHAEOLOGICAL AND HISTORICAL PRESERVATION

58.1 The contractor shall seek to accommodate archaeological and historical preservation concerns that may arise due to the construction of the project especially in close vicinity of such areas where such monuments may be located.

58.2 The contractor shall consult the Archaeological Survey of India (ASI) and other parties, on the advice of the Employer, to identify and assess construction effects and seek ways to avoid, minimize or mitigate adverse effects on such monuments.

58.3 Adverse effects may include reasonably foreseeable effects caused by the construction that may occur later in time, be farther removed in distance or those that alter, howsoever temporarily, the significance of the structure.

58.4 Where the alignment, runs within the prohibited/regulated zone of the monuments, Employer will apply for No Objection Certificate (NOC) from Director of Archaeology Archaeological Survey of India as per provision of National Monuments and Archaeological Sites and Remains (Amendment & Validation Act 2010).

59.0 LANDSCAPE AND GREENERY

59.1 As far as is reasonably practicable, the Contractor shall maintain ecological balance by preservation of trees and defacing of natural landscape.

59.2 The Contractor shall, so conduct his construction operations, as to prevent any avoidable destruction, scarring or defacing of natural surroundings in the vicinity of work.

59.3 Where destruction, scarring, damage or defacing may occur as a result of operations relating to Permanent or Temporary works, the same shall be repaired, replanted or otherwise corrected at Contractor's expense. All work areas shall be smoothened and graded in a manner to conform to natural appearance of the landscape as directed by the Employer.

59.4 Contractor shall clear the construction site of all scarp, dust, C&D waste and restore the site as per initial condition at the end of contract.

60.0 ENERGY MANAGEMENT

60.1 The Contractor shall use and maintain equipment so as to conserve energy and shall be able to produce demonstrable evidence of the same upon Employer's request.

60.2 Measures to conserve energy include but not limited to the following:

1. Use of energy efficient motors and pumps
2. Use of energy efficient lighting, which uses energy efficient luminaries
3. Adequate and uniform illumination level at construction sites suitable for the task
4. Proper size and length of cables and wires to match the rating of equipment
5. Use of energy efficient air conditioners

60.3 The Contractor shall design site offices maximum daylight and minimum heat gain. The rooms shall be well insulated to enhance the efficiency of air conditioners and the use of solar films on windows may be used where feasible.

61.0 ENVIRONMENTAL SITE INSPECTION

61.1 Site inspection shall be undertaken by the Contractor's Project Manager along with Environmental team to inspect the construction activities in order to ensure that appropriate environmental protection and pollution control measures are properly followed and implemented. The frequency of site inspection shall be at least once a week.

61.2 The Contractor shall, submit to the Employer a contract specific comprehensive Environment Inspection checklist as requirement of Site Environmental Plan.

61.3 The area of inspection shall not be limited to environmental compliance within the site but areas outside the site which are likely to be affected, directly or indirectly by activities at site.

61.4 Results of inspection shall be discussed with Employer and his recommendations on better environmental protection shall be notified to the Contractor for taking immediate action and rapid resolution of identified non-compliance.

61.5 If any significant environmental problems are identified or if there is an environmental complaint towards any activity performed by contractor, shall be investigated by the Engineer alog with the contractor and report on the same shall be submitted to the employer.

61.6 In addition, the Environment Department of Maha-Metro shall conduct surveillance audit of construction sites, in case of non compliance/violation of environmental conditions, penalties shall be levied in writing.

61.7 The results of monthly environmental inspection shall be discussed in monthly SHE committee meeting.

61.8 Reporting under the Environmental Management plan will contain the adopted mitigation measures for each potential activity and results of monitoring and inspection programmes.

61.9 In Site Environmental Plan, the Contractor shall prepare and submit monthly Environmental Management Reports in accordance with Employer's Requirements.

61.10 The Monthly Environment Management reports shall continue to be submitted till entire duration of contract and its extension.

62.0 IGBC GREEN MRTS RATING REQUIREMENTS

62.1 The Contractor shall, submit all the required documents/certificates/photographs to the Employer required for IGBC Green MRTS Rating which is broadly classified under following categories:

A. Site Selection and Planning
B. Water Efficiency
C. Energy Efficiency
D. Material Conservation
E. Indoor Environment and Comfort

62.2 An indicative list of documents required for IGBC green MRTS certification has been provided in the general instruction Maha-Metro/SHE/GI/13

PART - V: PENALTY AND AWARDS

63.0 PENALTIES TO BE CHARGED/RECOVERED FROM THE CONTRACTOR

63.1 Maha-Metro is committed to provide and maintain Occupational Safety & Health in its all-project work activities, and intends to promote its image as a Safety Conscious Organisation. The unsafe conditions/acts at work place may cause accidents with serious injuries or fatalities to workmen and even to public, which will damage the reputation of Maha-Metro and hamper the project. Most of the accidents are avoidable and caused preliminarily due to Contractors' negligence. Hence Maha-Metro shall recover the cost of damages from the Contractors for every reportable incident (fatality / injury).

63.2 The work of metro construction is mostly executed on the right-of-way (movement of civil traffic) and densely populated business/residential areas. These work sites are more sensitive being in contact with public and may lead to serious accidents/damages. Any unsafe act / unsafe condition when observed by public/critics, attracts media adversely and further tarnishing on Maha-Metro's reputation. If such unsafe practices continue, and if not checked, and not penalised, may lead to serious irreversible damages/losses to the organisation. For the strict promotion of Occupational Safety & Health at the site of work and to avoid any safety violation with increased Safety Consciousness. Maha-Metro is empowered to levy penalties on any Safety violation.

63.4 The following table indicates the Safety, Health violation (unsafe act / unsafe condition) and charges/penalties to be recovered from contractors.

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
1	SHE Policy & Plan	**i) SHE policy**. a) non-compliance of clause 4.1	L1→L2	L1- Rs 5,000 per single violation, compounded to a maximum of Rs 25,000 at any single instance. L2- Rs 10,000 per single violation, compounded to a maximum of Rs 50,000 at any single instance.
		ii) SHE plan	L1→L2	L1- Rs 50,000 per single violation, compounded to a maximum of Rs 1,00,000 at any single instance. L2- Rs 1,00,000 per single violation, compounded to a maximum of Rs 2,00,000 at any single instance.
		a) Not as per Employers' content and coverage (Clause 4.3,4.6)		
		b) Delay in submission (Clause 4.3, 4.5)		
		c) Not updated as per Employer's instruction as per Clause 4.8		
		d) Copies not provided to all required supervisors/engineers		
2	SHE Organisation	Not complying to the minimum manpower requirements as mentioned in General Instruction Maha-Metro/SHE/GI/001(Clause 6.1.1)	L1→L2	L1- Rs 50,000 per month for first month and Rs 1,00,000 for subsequent months. L2- Rs 1,50,000 per month for first month and Rs 3,00,000 for subsequent months.
		Not filling up the vacancies created due to SHE personnel leaving the Contractor within 14 days. (Clause 6.7.2)		L1- Rs 50,000 for first month and Rs 1,00,000 for subsequent months. L2- Rs 1,50,000 for first month and Rs 3,00,000 for subsequent months.

		SHE organisation not provided with required Audiovisual and other equipments as per General Instruction.Maha-Metro /SHE/GI/09		L1- Rs 25000 for first violation and Rs 50000 for subsequent violations. L2- Rs 75000 for first violation and Rs 150000 for subsequent violations.
		Employing through outsourcing agencies and SHE personal are not in the payroll of the main Contractor. (Clause 6.5.1)		
		Disobedience / Improper conduct of any SHE personnel. (Clause 6.2)		
		Chief SHE Manager not reporting directly to CPM of Contractor. (Clause 6.6)		
3	SHE committee	Failed to formulate or conduct SHE Committee meeting for any month (Clause 7.4)	L1→L2	L1- Rs 50000 for the first violation and Rs 200000 for the subsequent violations. L2- Rs 250000 for the first violation and Rs 500000 for the subsequent violations.
		Contractor and Sub-contractor representatives not attending SHE Committee meetings (Clause 7.10)		L1- Rs 5,000 to the contractor of the member who had not attended the meeting for first violation and Rs 25,000 for subsequent violations. L2- Rs 10,000 to the contractor of the member who had not attended the meeting for first violation and Rs 50,000 for subsequent violations.
		Failed to conduct Site inspection before conducting SHE Committee meeting (Clause 7.2.1 (xi))		L1-Rs 25,000 for first violation and Rs 50,000 for subsequent violations. L2-Rs 50,000 for first violation and Rs 1,00,000 for subsequent violations.
		Failed to send SHE Committee Meeting minutes or Agenda to Employer in time (Clause 7.8.1, 7.9.1)		
		Non-adherence of Clause 7.7.1		
		Non-adherence of Clause 7.9		
4	ID card	Non-adherence of Clause 8.1, 8.2 and 8.3	L1→L2	L1- Rs 25,000 for first violation and Rs 50,000 for subsequent violations. L2- Rs 1,00,000 for first violation and Rs 2,00,000 for subsequent violations.
5	SHE Training	Not complying to the requirements as mentioned in conditions of contract on SHE and project SHE manual with regard to:		
		a) Induction training not given (Clause 8.1)	L1→L2	L1- Rs 50,000 for first violation on and Rs 1,00,000 for subsequent violations.
		b) Supervisor / engineer / manager training not conducted as per Clause 9.6		

		c) Refresher training as per Clause 9.7 and 9.11 not conducted		L2- Rs 1,00,000 for first violation on and Rs 2,00,000 for subsequent violations.
		d) Tool-box talk not conducted as per Clause 9.8		
		e) Skill development training not conducted as Clause 9.9		
		f) Daily Safety Oath not conducted as per Clause 9.1		
		g) Top management behaviour based SHE training conducted (Clause 9.4)		
6	SHE Inspection	i) Not complying to the requirements as mentioned in conditions of contract on SHE and project SHE manual as per Clause 10.0	L1→L2	L1- Rs 50000 for first violation on and Rs 100000 for subsequent violations. L2- Rs 1,00,000 for first violation on and Rs 2,00,000 for subsequent violations.
		ii) Non-compliance of clause 10.3 & 10.4		
7	SHE audit	**`Internal Audit: MARS**	L1→L2	
		i) Not conducted as per SHE Plan (Clause 11.2.1) ii) Report not sent to Employer (Clause 11.2.6) iii) Action not taken for any month (Clause 11.2.4)		L1- Rs 50,000 for first violation on and Rs 75,000 for subsequent violations. L2- Rs 1,00,000 for first violation on and Rs 2,00,000 for subsequent violations.
		External Audit		
		i) Not conducted as per SHE Plan (Clause 11.4.3 and 11.5.2.2)		L1-Rs 1,00,000 for first violation and Rs 2,00,000 for subsequent violations. L2-Rs 2,00,000 for first violation and Rs 4,00,000 for subsequent violations.
		ii) Report not sent to Employer (Clause 11.4.7 and 11.5.2.8.1)		
		iii) Action not taken for any quarter (Clause 11.4.9.4 and 11.5.2.10.4)		
8	SHE Communication	Important days to be observed for SHE awareness as furnished by Employer not observed (Clause 12.2)	L1→L2	L1- Rs 10,000 for first violation and Rs 25,000 for subsequent violations. L2- Rs 50,000 for first violation and Rs 1,00,000 for subsequent violations.
		Posters as furnished by Employer not printed and displayed (Clause 12.2)		L1- 50,000 per contract L2- 1,00,000 per contract

9	SHE Submittals	Non compliance of Clause 13.1	L1→L2	L1- Rs 50,000 for first violation on and Rs 1,00,000 for subsequent violations. L2- Rs 1,00,000 for first violation on and Rs 2,00,000 for subsequent violations.
		Non compliance of Clause 13.2		L1-Rs 25,000 for first violation and Rs 50,000 for subsequent violations. L2-Rs 1,00,000 for first violation and Rs 2,00,000 for subsequent violations.
		Non compliance of Clause 13.3		
10	Injury and Incidence reporting	Fatal accidents	L3	L3- Rs 5,00,000 penalty and enforcement of embargo for first fatality, and Rs 10,00,000 penalty and enforcement of embargo for every subsequent fatality.
		Injury accident	L2→L3	L2- Rs 75,000 for first grievously injured person and Rs 1,50,000 for every subsequent grievously injured person (Grievous Injury as defined by Workmen Compensation Act). L3- Rs 2,00,000 for first grievously injured person and Rs 4,00,000 for every subsequent grievously injured person
		Abnormal delay in reporting accidents or wilful suppression of information about any accidents / dangerous occurrence as per Clause 14.1.4	L2→L3	L2-Rs 75,000 for first violation and Rs 1,50,000 for subsequent violations. L3-Rs 2,00,000 for first violation and Rs 4,00,000 for subsequent violations.
		Non-compliance of the Clause 14.4 The contractor shall create a fund to cater, from which in any case of fatal accident or permanent disability, payments will be made to the aggrieved party over and above the statutory requirements.	L2→L3	L2- Rs 50,000 for first violation on and Rs 1,00,000 for subsequent violations. L3- Rs 1,50,000 for first violation on and Rs 3,00,000 for subsequent violations.

		The contractor shall create a fund to cater, from which in any case of fatal accident or permanent disability, payments will be made to the aggrieved party over and above the statutory requirements.		
11	Emergency preparedness Plan	Non-compliance of the Clause 15.1, 15.2, 15.3, 15.4, 15.5 and 15.6	L2→L3	L2- Rs 1,00,000 for non-compliance of any of the clauses. L3- Rs 2,00,000 for non-compliance of any of the clauses.
12	Housekeeping	Housekeeping maintenance register not properly maintained up to date (Clause 17.4)	L1→L2	L1- Rs 10,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance. L2- Rs 20,000 per single violation Compounded to a maximum of Rs 2,00,000 at any single instance.
		Surrounding areas of drinking water tanks / taps not hygienically cleaned / maintained (Clause 17.4)		
		Office, stores, toilet / urinals not properly cleaned and maintained. (Clause 17.4)		
		Required dustbins at appropriate places not provided / not cleaned. (Clause 17.6)		
		Stairways, gangways, passageways blocked. (Clause 17.9)		
		Lumber with protruding nails left as such (Clause 17.10)		
		Openings unprotected (Clause 17.7)		
		Excavated earth not removed within a reasonable time.(Clause 17.15)		
		Truck carrying excavated earth not covered / tyres not cleaned. (Clause 17.11)		
		Vehicles / equipments parked / placed on roads obstructing free flow of traffic (Clause 17.13)		
		Unused surplus cables / steel scraps lying scattered (Clause 17.17)		
		Wooden scraps, empty wooden cable drums lying scattered (Clause 17.18)		
		Water stagnation leading to mosquito breeding (Clause 42.6.1)		
13	Working at Height / Ladders and Scaffolds	Not using or anchoring Safety Belt (Clause 18.9)	L2→L3	L1-Rs 10,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance.
		Not using Safety Net (Clause 18.18)		

		Absence of life line or anchorage point to anchor safety belt (Clause 18.19)		L2-Rs 20,000 per single violation Compounded to a maximum of Rs 2,00,000 at any single instance. L3-Rs 30,000 per single violation Compounded to a maximum of Rs 3,00,000 at any single instance.
		Non-compliance of Clause 18.17		
		Using Bamboo ladders (Clause 18.20)	L1→L2	
		Painting of ladders	L1→L2	
		Improper usage (less than 1m extension above landing point, not maintaining 1:4 ratio) (Clause 18.20)	L2→L3	
		Aluminium ladders without base rubber bush (Clause 18.20)		
		Usage of broken / week ladders (Clause 18.20)		
		Usage of re-bar welded ladders (Clause 18.20)		
		Improper guardrail, toe board, barriers and other means of collective protection (Clause 18.16)		
		Improper working platform (Clause 18.17)		
		Working at unprotected fragile surface (Clause 18.9)		
		Working at unprotected edges (Clause 20.0)		
14	Lifting appliances and gear	Non availability of fitness certificate as per Clause 21.3	L2→L3	L2-Rs 50,000 per single violation Compounded to a maximum of Rs 2,00,000 at any single instance. L3-Rs 1,00,000 per single violation Compounded to a maximum of Rs 5,00,000 at any single instance.
		Documents not displayed on the machine or not available with the operator as per Clause 21.4		
		Maximum Safe Working Load not written on the machine as per Clause 21.5		
		Non-compliance of Clause 21.6		
		Non-compliance of Clause 21.7		
		Automatic safe load indicator not provided or not in working condition as per Clause 21.8		
		Age of the operator less than 21 years or without any licence and non-compliance of other item as per Clause 21.9		
		Non-compliance of Clause 21.10		
		Non-compliance of any of the items mentioned regarding rigging requirements as per Clause 21.11		
		Failure to submit method statement in case of all critical lifting (Clause 21.3)		
		Person riding on crane. (Clause 23.4)		
		Creating more noise and smoke (Clause 43.1.1)		
		Absence of portable fire extinguisher in driver cabin (Clause 31.5)		
		Fail to guard hoist platform (Clause 24.0)		
		No fencing of hoist rope movement area (Clause 24.0)		

		Hoist platform not in the horizontal position (Clause 21.2)		
		Usage of first Generation of Hydra Clause 21.11.11 and 21.11.12		
15	Launching operation	Non-adherence of any of the provisions mentioned in Clause 22.2	L2→L3	L2-Rs 50,000 for first violation and Rs 1,00,000 for subsequent violations. L3-Rs 1,50,000 for first violation and Rs 3,00,000 for subsequent violations.
16	Site Electrical safety	Non-compliance of Clause 26.1.1	L2→L3	L2-Rs 10,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance. L3-Rs 20,000 per single violation Compounded to a maximum of Rs 2,00,000 at any single instance
		Non-compliance of Clause 26.2.3, 26.2.4 & 26.2.5		
		Non-compliance of Clause 26.3.1		
		Non-compliance of Clause 26.7, 26.8 and 26.9.1		
		Non-compliance of Clause 26.10 and 26.13		
		Non-compliance of Clause 28.3.2		
		Exposed electric lines (fermentative damage) and circuits in the workplace. (Clause 26.5.1)		
		Inserting of wires directly into the socket		
		Improper grounding for the electrical appliances Clause 26.7.1)		
		Electrical cables running on the ground (clause 26.8.5 & 26.8.6)		
		Non-compliance Clause 27.0		
17	Hand tools and Power tools	Non-compliance of Clause 28.0	L2→L3	L2-Rs 10,000 per single violation Compounded to a maximum of Rs 50,000 at any single instance. L3-Rs 20,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance.
18	Gas Cutting	Wrong colour coding of cylinder.	L2→L3	L2-Rs 10,000 per single violation Compounded to a maximum of Rs 50,000 at any single instance. L3-Rs 20,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance.
		Cylinders not stored in upright position. (Clause 29.1) Flash back arrester, non-return valve and regulator not present or not in working condition. (Clause 29.3 & 29.4)		
		Fail to put cylinders in a cylinder trolley. (Clause 29.1)		

		Damaged hose and fail to use hose clamps (Clause 29.2)		
		Using domestic LPG cylinders (Clause 29.5)		
		Fail to store cylinder 6.6m away from fire prone materials (Clause 29.8)		
		Fire extinguisher not placed in the vicinity during operation (Clause 29.6)		
19	Welding	Voltmeter and Ammeter not working (Clause 29.9)	L2→L3	L2-Rs 10,000 per first violation and Rs 50,000 for subsequent violations. L3-Rs 75,000 per first violation and Rs 1,50,000 for subsequent violations.
		Non-availability of separate switch in the transformer (Clause 29.9)		
		Improper grounding and return path. (Clause 29.10)		
		Damaged and bare openings in the welding cable. (Clause 29.10)		
		Damaged holder (Clause 29.10)		
		Fire extinguisher not placed in the vicinity during operation (Clause 29.6)		
20	Fire precaution	Smoking and open flames in fire prone area (Clause 31.6)	L2→L3	L2-Rs 5,000 per single violation Compounded to a maximum of Rs 25,000 at any single instance. L3-Rs 10,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance.
		Using more than 24V portable electrical appliances in the fire prone area (Clause 34.2.3)		
		Not proper ventilation in cylinder storage area. (Clause 29.8)		
		Absence of fire extinguishers (Clause 31.1)		
		Fire extinguishers not refilled once in a year. (Clause 31.2)		
		Fire extinguisher placed in a not easily accessible location		
21	Excavation, Tunnelling and confined space	Non-compliance of Clause 34.1.1	L2→L3	L2-Rs 10,000 per single violation Compounded to a maximum of Rs 50,000 at any single instance. L3-Rs 20,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance.
		Non-compliance of Clause 34.2.3		
		Non-compliance of Clause 34.4		L2-Rs 10,000 per first violation and Rs 50,000 for subsequent violations. L3-Rs 75,000 per first violation and Rs 1,50,000 for subsequent violations.
22	Work permit system	Non-compliance of Clause 35.2	L2→L3	L2- Rs 50,000 per first violation and Rs 1,00,000 for subsequent violations. L3- Rs 1,00,000 per first violation and Rs 2,00,000 for subsequent violations.
		Non-compliance of Clause 21.11.9		
23	Traffic Management	Non-compliance of Clause 36.4.1	L2→L3	

		Non-compliance of Clause 36.8.3		L2-Rs 50,000 per first violation and Rs 1,00,000 for subsequent violations. L3-Rs 1,50,000 per first violation and Rs 3,00,000 for subsequent violations.
		Non-compliance of Clause 36.9.2		
		Non-compliance of Clause 36.9.3		
		Non-compliance of Clause 36.9.7		
		Non-compliance of Clause 36.9.8		
		Barricades (Clause 36.9.4)		
		Not Cleaned	L2	Rs 15,000 per single violation Compounded to a maximum of Rs 25,000 at any single instance
		Not in alignment		
		Not numbered		
		Not painted		
		Red ights /reflectros not working		
		Damages not repaired		
		Not secured properly		
		Barricade inspector not employed		
		Protruding parts / portions repaired		
		Barricades maintaining register not properly maintained up to date		
		Contractor Vehicles (Clause 36.9.5 & 36.9.6)		
		i) Over loading of vehicles ii) Unfit drivers or operators iii) Unlicensed vehicles iv) Absence of traffic marshals v) Absence of reversing alarm vi) Absence of fog light (at winter) vii) Power / hand brakes not in working condition.	L2	Rs 15,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance
		Splashing of Bentonite on roads / non-cleaning of tyres of dumpers and transit mixers (Clause 17.11 & 17.14)		
		i) Mishandling of bentonite like splashing of bentonite outside specified width of barricading. ii) Non-cleaning of tyres of dumpers and transit mixers before leaving the site and thereby creating a traffic safety hazard to road users.	L2	a) Rs 50,000 on first observation. b) Rs 1,00,000 on second observation c) Rs 2,00,000 on third and subsequent observations
24	Batching plant / Casting yard	Non-adherence of any of the provisions mentioned in Clause 38.0.	L2	Rs 10000 for single violation compounded to a maximum of Rs 1,00,000 at any single instant.
25	PPE (Personal Protective Equipment)	Not having (Clause 39.1)	L2→L3	L2-Rs 200 per single violation. L3-Rs 400 per single violation.
		Not wearing (or) using and kept it elsewhere (Clause 39.1)	L2→L3	
		Using damaged one (Clause 39.2)	L2→L3	

		Using wrong type (Clause 39.5)	L2→L3	
		Using wrong colour helmet or helmet without logo (Clause 39.4.1)	L1→L2	
		Using for other operation (e.g. Using safety helmet for storing materials or carrying water from one place to other) (Clause 39.5)	L2→L3	
		Not conforming to BIS standard (Clause 39.2)	L2→L3	L2-Rs 10,000 for first violation and Rs 40,000 for subsequent violations. L3-Rs 75,000 for first violation and Rs 1,50,000 for subsequent violations.
		Non-compliance of Clause 39.6, 39.7 and 39.8	L2→L3	L2-Rs 10,000 for first violation and Rs 40,000 for subsequent violations. L3-Rs 75,000 for first violation and Rs 1,50,000 for subsequent violations.
26	Occupational Health	Fail to conduct Medical examination to workers (Clause 42.1)	L1→L2	L1-Rs 5,000 per single violation Compounded to a maximum of Rs 50,000 at any single instance. L2-Rs 10,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance. L3-Rs 15,000 per single violation Compounded to a maximum of Rs 1,50,000 at any single instance.
		Absence of ambulance van & room (Clause 42.3)		
		Workers not having ID card (Clause 8.2)		
		Absence of first-aid person in work site (Clause 42.4)	L2→L3	
		Absence or inadequacy of first-aid box (Clause 42.4)		
		Misuse of first-aid box (Clause 42.4)	L1→L2	
		First-aid box not satisfy the minimum Indian standard. (Clause 42.4)		
		Smoking inside the construction site (Clause 42.7.2)		
		Drink and drive or work (Clause 42.7.1)		
		Fumigation / insecticides not sprayed to prevent Mosquito breeding (Clause 42.6.3)		
		Non-compliance of Clause 44.1 and 44.2		
27	Labour Welfare measures	Inadequate number of toilets (Clause 46.1.1)	L1→L2	L1-Rs 10,000 per single violation Compounded to a maximum of Rs 50,000 at any single instance. L2-Rs 20,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance.
		Toilets not cleaned properly (Clause 46.1.3)		
		Toilet placed more than 500m from the work site (Clause 46.1.3)		
		Absence of water facilities for toilets and washing places (Clause 46.1.3)		
		Accommodation not provided as per BOCWA (Clause 46.5.1))		
		Absence of drinking water (Clause 46.4)		
		Excessive noise and vibration (Clause 43.0)		
		Canteen not provided (Clause 46.2)		
		Food stuff not served on no loss no profit basis (Clause 46.3)		

		Creche not provided (Clause 46.6)		
		Non adherence of Labour welfare provisions of BOCWA (Clause 3.3.1.2)		
		Fail to register establishment and display the registration certificate at workplace (Clause 3.3.1.2)		
		Absence of workers register and records (Clause 3.3.1.2)		
		Absence of muster roll and wages register (Clause 3.3.1.2)		
		Fail to display an abstract of BOCWA and BOCWR (Clause 3.3.1.2)		

63.5 Without limiting to the unsafe acts and or conditions mentioned above in Clause 63.4 the Employer shall have the right to deduct charges for any other unsafe act and or condition depending upon the gravity of the situation on a case-to-case basis. The charges shall be in comparison with that of the similar offence indicated in Clause 63.4.

63.6 Non-conformities detected during inspections carried out by the Engineer are subject to a process adapted to the severity of the situation. Non-conformities are divided into 4 categories as follows:

63.6.1 Notification of observation of minor non-conformities. The non-conformity results in a notification to the on-site Contractor's representative, followed-up by a signed notification of observation prepared by the Engineer. The multiplication of notifications of observation at the Worksite, or absence of corrective actions by the Contractor, can result in the severity of the non-conformity being raised to that of level 1.

63.6.2 **Level 1 non conformity**: non-conformities, that do not represent a serious immediate risk for health and environment. The non-conformity is the subject of a report addressed to the Contractor and which shall be resolved within five (5) days. The Contractor addresses to the Engineer a report explaining how the non-conformity has been corrected. Further to an inspection and a favourable evaluation of effectiveness of the corrective action, the Engineer signs a close-out report for the non-conformity. In all cases where a non-conformity of level 1 is not resolved within one (1) month, the severity of the non-conformity is raised to level 2.

63.6.3 **Level 2 non-conformities**: Applies to all non-conformities that have resulted in damage to health or the environment or which represent a high risk to health and the environment. The same procedure as for level 1 non-conformities is applied. Corrective action shall be taken by the Contractor within three (3) days. The Contractor addresses a report explaining the corrective actions implemented. All level 2 non-conformities which are not resolved within one (1) month, are raised to level 3.

63.6.4 **Level 3 non-conformities**: applies to all non-conformities that represent a risk with major consequences to health and the environment. The highest levels of the Contractor's and Engineer's hierarchies present in the Employer's country are informed immediately and the Contractor has twenty-four (24) hours to bring the situation under control. Clause 14.7 of the Particular Conditions of Contract (PC), a level 3 non-conformity results in the suspension of interim payments until the non-conformity has been resolved. If the situation requires, and in pursuance to Clause 8.8 of the PC, the Engineer can order the suspension of work until the resolution of the non-conformity.

63.7 Environmental Penalties: Following penalties shall be recovered from contractors while dealing the Environmental Protection aspects/Management measures.

SL. No.	Topic	Violation	Deductible Amount
1.	Contractor's Environment Organization	Not engaging Environmental personnel for the entire duration of contract and its extension	Rs. 2,00,000/- for first month and Rs. 4, 00,000/- for subsequent months

2.	ISO Certification	Not obtaining ISO 14001:2015 & ISO 45001:2018 certification within the stipulated time frame with the Maha-Metro approved agency	Rs. 1,00,000/- per single violation and Rs. 2,00,000 for subsequent violations.
3.	External Environmental Audit	Not carrying out External Environmental Audit with the Maha-Metro approved agency	Rs. 1,00,000/-for first violation and Rs. 2,00,000/- subsequent violation
4.	Environmental Training	Not carrying out Environmental Training with the Maha-Metro approved agency	Rs. 50,000/- for first violation and Rs. 1,00,000/- subsequent violation
5.	Legal Requirements	Noncompliance of statutory requirements (CTE,CTO,Factory Act,CGWA Permission etc.)	Rs. 2,00,000/-for first violation and Rs. 4,00,000/- subsequent violation or as per regulatory Authority.
6.	Environmental Sanitation	1. Environment Sanitation maintenance register not properly maintained up to date 2. Surrounding areas of drinking water tanks/ taps not hygienically cleaned / maintained 3. Office, stores, toilet/ urinals not properly cleaned and maintained 4. Required dustbins at appropriate places not provided / not cleaned 5. Water stagnation leading to mosquito breeding 6. Not practicing any other Environmental Sanitation measures mentioned in this document	Rs. 50,000/- for violation of any single item compounded to a maximum of Rs. 1,00,000/- at any single instance
7.	Felling of Trees & Tree Preservation	Felling of trees without obtaining requisite permission from Maha Metro /Statutory Authority	Rs. 1,00,000/- on single violation for item a)
8.	Top Soil Preservation	Top soil preservation not practiced	Rs. 25,000/- on each violation/ per instance
9.	Containment of Air Pollution	1. Wheel washing facility not provided at exit gates of casting yard, batching plant and underground station sites 2. Soil, sand, aggregate, debris of any kind and all dust prone materials stored without proper tarpaulin coverage 3. Sprinkling or mist-based dust suppression methods not practiced at site 4. Casting yard and batching plant not provided with hard surface and access roads and internal circulation roads not maintained properly 5. Not maintaining required DG Stack height as prescribed in the standard 6. Conveyor belt used for carrying aggregate not covered 7. Carrying out construction work without erecting proper barricades 8. Storage facility for dust generating materials/debris not provided 9. Storing material/debris/soil outside barricaded area 10. Storing aggregates and sand in open area	Rs. 50,000/- on single violation compounded to a maximum of Rs. 2,00,000/- at any single instance

		11. Over speeding of construction vehicles 12. Operating vehicles, machineries and other equipments without valid PUC 13. Truck carrying Material/ muck/ soil/ C&D waste (debris) not covered / tyre not cleaned/washed while leaving site 14. Deposition of material/muck/soil on public streets 15. Dumping sites not barricaded 16. Toe dust along the barricade not cleaned regularly 17. Not practicing any other Air Pollution & dust control measures mentioned in this document	
10.	Containment of Water Pollution and Conservation of Water	1. Transit Mixer (TM) washing facility not provided at casting yard/batching plant 2. Drainage system not maintained at casting yard or and batching plant 3. Not providing treatment facility before discharge of muck slurry into drainage system 4. Washout of construction or excavated materials directly diverted to drainage system 5. Spillage or dumping of Bentonite slurry/Poly-mud slurry or other grouts onto public road or any other ecologically sensitive location 6. Discharge water from the site without the approval of the Employer 7. Discharge of de-watered water from underground construction work to drains without prior approval of the Employer 8. Not practicing any other Water Pollution control measures mentioned in this document.	Rs. 5 0 ,000/- for violation of any single item compounded to a maximum of Rs. 2,00,000/- at any single instance
11.	Containment of Noise	1. Not providing noise barrier of required height near noise sensitive receptors such as residences, schools, hospitals and similar areas 2. Not providing acoustic enclosure or acoustic treatment for DG sets for meeting the ambient noise standards 3. Breaching allowable noise limits given in this document 4. Not adhering to noise limits for DG sets 5. Not providing PPE to workers against occupational noise	Rs. 5 0 ,000/- for violation of any single item from a) to b) compounded to a maximum of Rs. 2,00,000/- at any single instance
12.	Containment of Waste	1. Waste Management Plan not submitted along with Environment Plan 2. Leakage of waste during handling, storage and transportation of waste causing pollution	Rs. 5 0 ,000/- for violation of any single item from a) to n) compounded to a maximum of Rs. 2,00,000/- at any single instance

		3. Material Safety Data Sheet for material/ chemicals/ substances used not provided 4. Not following waste disposal mechanism in accordance with this document 5. Discharging of Bentonite slurry/Poly- mud slurry or other grouts drainage directly in to drainage system 6. Delay in disposal of waste items 7. Burning of refuse at construction site 8. Required number of colour coded dust bins not provided 9. Not disposing C&D waste by authorized means 10. Disposal of C&D waste along the river bed, natural drainage and wet land 11. Separate hazardous waste storage area not provided 12. Drip pans of suitable size not provided 13. Not maintaining separate scrap yard with hard surface 14. Not practicing any other waste management measures mentioned in this document.	
13.	Environmental Monitoring	1. Air monitoring not implemented as per requirement given in this document 2. DG set stack monitoring is not implemented as per requirement given in this document 3. Noise monitoring not implemented as per requirement given in this document 4. Soil testing not implemented as per requirement given in this document 5. Groundwater testing not implemented as per requirement given in this document 6. Carrying out monitoring through un- approved laboratories 7. Not keeping records of monitoring 8. Not maintaining check on the quality of monitoring agency while carrying out monitoring work at site 9. Not verifying the correctness of monitoring data submitted by monitoring lab 10. Not ensuring calibration of air monitoring instruments used by monitoring agency 11. Not ensuring calibration of noise monitoring instrument used by monitoring agency	Rs. 5 0 ,000/- for violation of any single item compounded to a maximum of Rs. 2,00,000/- at any single instance
14.	Green Building Requirements	1. Green Building measures not implemented as per requirement given in Green Mass Rapid Transit System (MRTS) Rating (latest revision).	Rs. 1 , 0 0 ,000/- for violation of any single item compounded to a maximum of Rs. 2,00,000/- at any single instance.

		2. Non-Submission of required documents under Green Mass Rapid Transit System (MRTS) Rating. 3. Not practicing any other Green Building requirements mentioned in this document	

63.8 Without limiting to the environmental management measures mentioned above in Clause 63.7 the Employer shall have the right to deduct charges for any other Environmental management noncompliance depending upon the gravity of the situation on a case-to-case basis. The charges shall be in comparison with that of the similar offence indicated in Clause 63.4.

64.0 STOPPAGE OF WORK

64.1 The Employer shall have the right to stop the work at his sole discretion, if in his opinion the work is being carried out in such a way that it may cause accidents and endanger the safety of the persons and / or property, and / or equipments. In such cases, the Contractor shall be informed in writing about the nature of hazards and possible injury / accident.

64.2 The Contractor shall not proceed with the work until he has complied with each direction to the satisfaction of Employer.

64.3 The Contractor shall not be entitled for any damages / compensation for stoppage of work, due to safety reasons and the period of such stoppage of work shall not be taken as an extension of time for Completion of the Facilities and will not be the ground for waiver of levy of liquidated damages.

65.0 OCCUPATIONAL HEALTH AND SAFETY AWARDS

65.1 The following categories will be considered for awards as per the scheme in practice of Employer:

(i) For every safe million-man hour working without any reportable incidents
(ii) Zero fatality contracts
(iii) 100% adherence to voluntary reporting of all accidents throughout the currency of contract
(iv) Safest project team of the year.
(v) Best SHE team of the year.
(vi) Safest Contractor of the year.

66.0 ENVIRONMENTAL AWARDS

66.1 The following categories will be considered for awards as per the scheme in practice of Employer

(i) Best Environmentally managed Underground contract
(ii) Best Environmentally managed Elevated contract
(iii) Best Environmentally managed Batching plant
(iv) Best Environmentally managed Casting yard
(v) Best Condition of Contract compliant contractor

66.2 The above categories may increase or decrease at the sole discretion of the employer.

PART - VI: APPENDIX, FORMS AND GENERAL INSTRUCTION

	MAHARASHTRA METRO RAIL CORPORATION LIMITED
Appendix No.1: MoU between Maha-Metro and the Contractor for safe execution of contract work	

This Memorandum of Understanding is made and executed by and between **Maharashtra Metro Rail Corporation Limited (Maha-Metro).**, a Company registered under the Companies Act 1956 and having its registered office at XXXXor their authorized representative(s), hereinafter referred to as "**EMPLOYER**" (which expression shall wherever the context so requires or admits be deemed to mean and include its successors in business yhs and assigns) of the one party

AND

M/s _____ having its registered office ` _____
hereinafter referred to as the "**CONTRACTOR**" (which expression shall wherever the context so requires or admits be deemed to mean and include its successors in business and assigns) of the other party

WITNESSETH THAT

WHEREAS the EMPLOYER gives highest importance to the occupational safety, health and environment during execution of work, seeks cooperation from the CONTRACTOR in this endeavour.

Thus, this Memorandum of Understanding is for promoting the safety, health and environment aspects required to be followed at workplace/site and will be applicable to any site job to be done by the CONTRACTOR

AND

WHEREAS the CONTRACTOR has read all the terms and conditions of the EMPLOYER and whereas the CONTRACTOR has studied the following documents:

(i) Tender Documents, including Notice Inviting Tender, General Conditions, Special Conditions;
(ii) Conditions of Contract on Safety, Health and Environment and Project Safety, Health, and Environment Manual;
(iii) Building and Other Construction Workers (Regulations of Employment and Conditions of Service) Act 1996, Central Rules 1998 and subsequent MaharashtraBOCW Rules 2003, Building and Other Construction Workers Welfare Cess Act 1996 and Rules 1998 and notification [Central & State] Collection of cesses.
(iv) Indian Electricity Act 2003 and Rules 1956;
(v) Corresponding International / Bureau of Indian Standard Codes.

Including the amendments to any of the above rules and any other rules & regulations or procedures, circulars, notices & advices laid down by the EMPLOYER from time to time.

Now it is hereby AGREED AND DECLARED by and between the EMPLOYER and the CONTRACTOR as follows:

Clause - I The CONTRACTOR shall abide by the terms and conditions stipulated in Condition of Contract on Safety, Health & Environment and Project Safety, Health & Environment Manual.

Clause - II The CONTRACTOR shall undertake full responsibility for safe execution of job at work place/site and safety of his personnel and adjoining road users during work.

Clause - III	Without giving any prior notice, the EMPLOYER shall from time to time be entitled to add/or amend any or all terms and conditions with a view to improving safety and occupational health of personnel and safety of work, with immediate effect and the same shall be binding on the CONTRACTOR. The Contractor agrees to implement all such amendments, which shall be laid down by the EMPLOYER.
Clause - IV	Besides following the guidelines, safety rules and regulations, safety codes given in various safety procedures/documents mentioned above, the CONTRACTOR shall also prepare detailed method statement which includes job safety analysis wherever there are complicated and hazardous/high risk working involved and get it approved from Employer before execution of work.
Clause - V	Any negligence or violation in implementing any of the provision of the conditions of contract on Safety, Health & Environment and Maha-Metro project Safety, Health & Environment Manual shall be viewed seriously and the Contractor is liable to compensate the Employer for the loss of reputation. The cost of damage shall be fixed on case-to-case basis.

In witness thereof the Parties hereto by representatives duly authorised have executed this Memorandum of Understanding on _____ day of _____ 20____.

Signed on	Signed on
For and on behalf of Maha-Metro	For and on behalf of (Contractor)
_____	_____
Signature:	Signature:
Name:	Name:
Title:	Title:

	MAHARASHTRA METRO RAIL CORPORATION LIMITED

Appendix no.: 2: OHS and Welfare requirements as per BOCW Act 1996 and Rules 1998

(This list has been prepared in chronological order with primary importance to Section of Act and secondary importance to Rules)

S - Refers relevant Sections in BOCWA
R - Refers relevant Rules in BOCWR
C - Refers relevant Chapter No. in BOCWR
P - Refers to relevant rules in BOCWWCR 1998
G - Refers to relevant rules in Maharashtra BOCWR 2003

SN	Items	Relevant Sections / Rules in BOCWA and BOCWR and MBOCWR 2003
1.	Registration of establishment	S – 7, R – 23 to 27
2.	Display of registration certification at workplace	R – 26 (5)
3.	Hours of work	S – 28 R – 234 to 237
4.	Register of overtime	S – 28; S – 29 R – 241(1) Form XXII
5.	Weekly rest and payment at rest	R – 235
6.	Night shift	R – 236
7.	Maintenance of workers registers and records	S – 30 R – 238
8.	Notice of commencement and completion	S – 46 R – 239
9.	Register of persons employed as building workers	R – 240
10.	Muster roll and wages register	R – 241(1) (a); Form XVI and XVII
11.	Payment of wages	R – 248
12.	Display of notice of wages regarding	R – 249
13.	Register of damage or loss	R – 241(1)(a); Form XIX, XX, XXI
14.	Issue of wages book	R – 241(2)(a); Form XXIII
15.	Service certificate for each workers	R – 241(2)(b); Form XXIV
16.	Display an abstract of BOCWA and BOCWR	R – 241(5)
17.	Deduction of welfare cess by the government agencies	P – 4(3)
18.	Annual return	R – 242; Form XXV
19.	Drinking water	S – 32
20.	Latrines and Urinals	S – 33 R – 243
21.	Accommodation	S – 34
22.	Creches	S – 35
23.	First-aid boxes	S – 36 R – 231 and Schedule III
24.	Canteens	S – 37 R – 244
25.	Food stuff and other items served in the canteens	R – 245
26.	Supply of tea and snacks in work place	R – 246
27.	Food charges on no loss no profit basis	R – 247
28.	BOCWR 2003 welfare Board Rules	
29.	Safety committee	S – 38 R – 208

SN	Items	Relevant Sections / Rules in BOCWA and BOCWR and MBOCWR 2003
30.	Safety officer	S – 38 R – 209 and Schedule VII
31.	Reporting of accidents and dangerous occurrences	S – 39 R – 210
32.	Procedure for inquiry in to the causes of accidents	R – 211
33.	Responsibility of employer	S - 44 R – 5
34.	Responsibility of Architects, Project engineer and Designers	R – 6
35.	Responsibility of workmen	R – 8
36.	Responsibility for payment of wages and compensation	S – 45
37.	Penalties and Procedures	S – 47; S – 55
38.	Excessive noise, vibration etc	R – 34
39.	Fire Protection	R – 35
40.	Emergency action plan	R – 36
41.	Fencing of motors	R – 37
42.	Lifting of carrying of excessive weight	R – 38
43.	Health, Safety and Environmental Policy	R – 39
44.	Dangerous and Harmful Environment	R – 40
45.	Overhead protection	R – 41
46.	Slipping, Tripping, Cutting, Drowning and Falling Hazards	R – 42
47.	Dust, Gases, Fumes, etc	R – 43
48.	Corrosive substance	R – 49
49.	Eye Protection	R – 45
50.	Head Protection and other protection apparel	R – 46; R – 54
51.	Electrical Hazards	R – 47
52.	Vehicular traffic	R – 48
53.	Stability of structure	R – 49
54.	Illumination	R – 50; R – 124
55.	Stacking of materials	R – 51
56.	Disposal of debris	R – 52
57.	Numbering and marking of floors	R – 53
58.	Lifting appliances and gears	C – VII; R – 55 to 81
59.	Runways and Ramps	C – VIII; R – 82 to 85
60.	Working on or adjacent to water	C – IX; R – 86 & 87
61.	Transport and earthmoving equipments	C – X; R – 88 to 95
62.	Concrete work	C – XI; R – 96 to 107
63.	Demolition	C – XII; R – 108 to 118
64.	Excavation and Tunnelling works	C – XIII; R – 119 to 168
65.	Ventilation	R – 153
66.	Construction, repair and maintenance of step roof	C – XIV; R – 169 to 171
67.	Ladders and Step ladders	C – XV; R – 172 to 174
68.	Catch platform and hoardings, chutes, safety belts and nets	C – XVI; R – 175 to 180
69.	Structural frame and formworks	C – XVII; R – 181 to 185
70.	Stacking and unstacking	C – XVIII; R – 186 & 187
71.	Scaffold	C – XIX; R – 188 to 205
72.	Cofferdams and Caissons	C – XX; R – 206 to 211
73.	Explosives	C – XXI; R – 212 & 213
74.	Piling	C – XXII; R – 214 to 222
75.	Medical Examination for building and other construction worker, Crane operator an Transport vehicle drivers	R – 81; R – 223(a)(iii) and Schedule XII

SN	Items	Relevant Sections / Rules in BOCWA and BOCWR and MBOCWR 2003
76.	Medical examination for occupational health hazards	R – 223(a)(iv)
77.	Charging of workers for Medical Examination	R – 223(b)
78.	Occupational health centres and medical officers	R – 225 and Schedule X &XI
79.	Ambulance van & room	R – 226 & 227 and Schedule IV & V
80.	Stretchers	R – 228
81.	Occupational health service for building workers	R – 229
82.	Medical examination for occupational health hazards	R – 223(a)(iv)
83.	Emergency care services and emergency treatment	R – 232
84.	Panel of experts and agencies	Central Rule 250
85.	Power of inspectors	Central rule 251 MaharashtraState Rules

	MAHARASHTRA METRO RAIL CORPORATION LIMITED
Appendix no. : 3 Site Safety,Health and Environmental Plan	

Contract No	
Contractor Name	
Project Name	

1.	**Project Highlights** i) Title of the content ii) Contractor Number iii) Brief scope of work iv) Location map/ key plan v) Period of the project
2.	**SHE Policy**
3.	**Site Organisation Chart** Chart indicating reporting of SHE personnel
4.	**Roles & Responsibility** Individual responsibility of the: i) Project Manager ii) Construction Manager iii) Construction Supervisors iv) SHE Committee Members v) SHE In charge vi) Environmental Manager vii) Site Engineers viii) First Line Supervisors ix) Sub-contractors
5.	**SHE Committee** i) Details - Chairman, Members, Secretary and Employer's representative ii) Procedures for effective conduct of meeting
6.	**SHE Training**
7.	**Subcontractor Evaluation, Selection and Control**
8.	**SHE Inspection**
9.	**SHE Audit**
10.	**Accident Investigation and Reporting Procedures**
11.	**Occupational Health Measures**
12.	**Labour Welfare Measures**
13.	**Risk assessment and mitigation procedures**

14.	**Safe Work Procedures** i) Work at Height ii) Structural Steel Erection iii) Launching of segments iv) Floor, Wall Openings and Stairways v) Welding, Cutting and Bracing vi) Lifting appliances vii) Work Permit Systems viii) Electrical Equipments ix) Mechanical Equipments x) Excavation xi) Fire Prevention xii) Hazardous Chemicals and Solvents xiii) Ionising Radiation xiv) Lighting xv) Abrasive Blasting
15.	**Work Permit System**
16.	**List of standard job specific PPEs to be used in the site**
17.	**Maintenance of Regime for construction Equipment and Machinery**
18.	**Traffic management**
19.	**Housekeeping**
20.	**Environmental Management**
21.	**Emergency Management**
22.	**Visitors and Security arrangement**

	MAHARASHTRA METRO RAIL CORPORATION LIMITED

Appendix No.4: Workplace Policy on HIV Prevention & Control for Workmen

"Being mobile in and of itself is not a risk factor for HIV infection. It is the situations encountered and the behaviours possibly engaged in during mobility or migration that increase vulnerability and risk regarding HIV / AIDS."

UNAIDS, Technical update on 'Population, Mobility and AIDS', February 2001, p.5

Maha-Metro recognizes HIV / AIDS as a developmental challenge and realizes the need to respond to it by implementing regular HIV / AIDS prevention programmes and creating a non-discriminatory work environment for HIV infected workmen engaged by contractors. For the purpose of making conscientious, sensitive and compassionate decision in addressing the realities of HIV / AIDS, Maha-Metro has established these guidelines based on ILO code of practice on HIV / AIDS.

- Creating awareness through professional agency using IEC (Information, Education and Communication) package specially designed for migrant workers.

- Institutional capacity building by training the project implementation team, Safety, Health & Environment (SHE) Managers, establishing linkages for efficient diagnosis and treatment of the affected workers, effective monitoring of implementation and documentation for further learning.

- Establishing peer educators by selecting them in consultation with Contractors and training them through professional agencies so that they become focal point for any information, education and awareness campaigns among the workmen throughout the contract period.

- Promotion of social marketing of condoms through State Aids Control Society

MAHARASHTRA METRO RAIL CORPORATION LIMITED

General Instruction: Maha-Metro/SHE/GI/001: Minimum Manpower Requirements of SHE Org.

	1	2	3	4	5	6	7	8	9	10	11	12
Awarded Contract value (in Rs Cr.)	**Chief SHE Manager**	**Senior SHE Manager**	**Junior SHE Manager**	**Safety Steward**	**Senior SHE (Electrical Engineer)**	**Junior SHE (Electrical Engineer)**	**Senior SHE (Fire) Manager**	**Occupational Health officer** with Necessary Male Nursing Assistants	**Senior Environmental Manager**	**Senior SHE (Traffic) Engineer**	**House Keeping Cum Barricade Maintenance Manager**	**Labour Welfare Officer**
Up to 2	-	-	1	-	-	1	-	-	-	-	-	-
Up to 10	-	1	-	1	-	1	-	1 (PT)	1	1	**Refer Note 4**	1
Up to 25	1	-	1	-	1	-	1	1 (PT)	1	1		1
Up to 100	1	1	-	1	1	1	1	1 (FT)	1	1		1
Up to 200	1	2	2	2	1	2	1	2 (FT)	1	1		**1 with support staff**
More than 200	1	2	5	5	1	2	1	2 (FT)	**1 with Env. Steward**	1		

Note 1: The above deployment of SHE professionals can be varied as per the progress of work with approval of Engineer In-charge. Nothing extra shall be paid on this account.

Note 2: (PT) means Part-Time and (FT) means Full-time.

Note 3: Senior SHE (Traffic) Engineer Post and Barricade Manager (including the staff) Posts are applicable to contracts where the work has to be executed either below or over the right-of-way like Viaduct, Tunnel Contracts wherein erection and maintenance of barricades are paramount important.

Note 4: One Housekeeping cum Barricade Manager supported by **Minimum 02** (**Two) Supervisors** and **10 (Ten) workmen**

Note 5: Minimum requirement of the SHE organisation given as above (SHE Condition of Tender Documents) with deployment schedule **shall prevail,** in case of any variation/conflict in provisions given in MAHA Metro SHE Manual or elsewhere.

Deployment Schedule of SHE Professionals

SHE Professionals	DEPLOYMENT **
Chief SHE Manager	Within 30 Days from the date of issuance of LOA
Senior SHE Manager	50% Within 30 Days from the date of issuance of LOA and balance 50 % Within 90 Days from the date of issuance of LOA
Junior SHE Manager	50% Within 30 Days from the date of issuance of LOA and balance 50 % Within 90 Days from the date of issuance of LOA
Safety Steward	50% Within 30 Days from the date of issuance of LOA and balance 50 % Within 90 Days from the date of issuance of LOA
Sr SHE (Ele Engineer)	Within 30 Days from the date of issuance of LOA
Jr SHE (Ele Engineer)	50% Within 30 Days from the date of issuance of LOA and balance 50 % Within 90 Days from the date of issuance of LOA
Sr SHE (Fire) Manager	Within 90 Days from the date of issuance of LOA
Occupational Health Officer	Within 60 Days from the date of issuance of LOA
Environmental Manager	Within 60 Days from the date of issuance of LOA
Sr SHE (Traffic) Engineer	Within 30 Days from the date of issuance of LOA.
House Keeping Cum Barricade Maintenance Manager with Team	Within 30 Days from the date of issuance of LOA.
Labour Welfare Officer	Within 60 Days from the date of issuance of LOA.
Note: ** **Deployment to continue till completion of the project work.**	

Note 1: Minimum requirement of the SHE organisation given as above (SHE Condition of Tender Documents) with deployment schedule **shall prevail,** in case of any variation/conflict in provisions given in MAHA Metro SHE Manual or elsewhere.

	MAHARASHTRA METRO RAIL CORPORATION LIMITED

General Instruction: Maha-Metro/SHE/GI/002: Minimum Qualification and exp. for SHE Professionals

SN	Designation	Qualification	Experience (in years)
1.	Chief SHE Manager	The Chief SHE Manager shall have qualified in any of the following degree/diploma: i) Post Graduate Diploma in Industrial Safety & Environmental Management (PGDISEM) from National Institute of Industrial Engineering, Mumbai ii) M.E. in Industrial Safety from NIT, Trichy, Tamil Nadu iii) M.E. in Industrial Safety from MepcoSchlenk Engineering College, Sivakasi, Tamil Nadu iv) B.E. in Fire and Safety Engg. From Cochin University of Science and Engg. Cochin, Kerala v) B.E. with advanced Safety Management Diploma from CLI / RLI Mumbai / Chennai / Kolkata and Kanpur. vi) B.E / B.Arch., with one-year Full Time advanced Safety diploma from NICMAR, Hyderabad. vii) B.E / B.Tech with any other equivalent State and Central Govt. recognized full time Degree / Diploma in Safety. viii) International qualifications like CSP (Certified Safety Professional), NEBOSH, MIOSH, MSISO etc.	12 years for Diploma holders and 10 years for Degree holders 2 {for all category except (iv) and 5yrs for category (iv)
2.	Senior SHE Manager	As stated in SN1 and in addition the following categories: i) B.Sc. (Physics/Chemistry/Maths) with one-year Full Time advanced Safety diploma from NICMAR, Hyderabad ii) B.Sc. / Diploma in Engg with advanced Safety Management Diploma from CLI / RLI / Mumbai / Chennai / Kolkata and Kanpur. iii) B.Sc. (Physics/Chemistry/Maths) with One-year Full Time diploma in Safety Engineering offered by West Bengal State Technical Education Departments and similar courses by other states. iv) Any Graduate or diploma holder with 7 years of work experience in full fledged SHE department of any Public Sector / Leading Private Sector / MNC / with prior approval of employer on a case-to-case basis	05 years for Diploma holders and 03 years for Degree holders 2 {for category (i), (ii) and (iii) only}
3.	Senior Environment Manager	Govt. recognized B. Tech/ M.Sc./M.Tech. in Environmental Science/Engineering with experience in Metro Rail Project/Construction sector	5 Years
4.	Junior SHE Manager	i) Degree in Science / Diploma in Engineering with Govt. recognized safety diplomas from Correspondence course of NICMAR, Annamalai University, National and State Productivity Councils, Other State Technical Education Boards etc. ii) Any Graduate or diploma holder with 5 years of work experience in full fledged SHE department of any Public Sector / Leading Private Sector / MNC / with prior approval of employer on a case-to-case basis	2 (for category (i) only)

SN	Designation	Qualification	Experience (in years)
5.	Safety Steward	Any basic qualification with any SHE related certificate courses.	2
6.	Environment Steward	Any basic qualification with Environment Management certificate courses.	2
7.	Senior SHE (Electrical) Manager	Degree in Electrical Engineering + Govt. recognized Electrical Licence holder	2
9.	Junior SHE (Electrical) Manager	Diploma in Electrical Engineering + Govt. recognized Electrical Licence holder	1
10.	Senior SHE (Fire) Manager	i) B.E. (Fire) from National Fire Service College, Pune ii) B.E (Fire & Safety) from Cochin University iii) Graduate with any Govt. recognized diploma in Fire Safety with 5 years of experience	2 (for category (i) and (ii) only)
11.	Junior SHE (Fire) Manager	Any Diploma holder with any Govt. recognized diploma in Industrial Fire Safety.	1
12.	Occupational Health Officer	MBBS with Govt. recognized degree/diploma in Industrial/ occupational health	1
13.	Senior SHE (Traffic) Engineer	Govt. recognized PG Degree / Degree / Diploma in Traffic/Transportation Engineering or Planning	1
14.	House Keeping Cum Barricade Manager	Any Diploma in Engineering	1
15.	Labour Welfare Officer	Any Degree with Govt. Recognized Degree / Diploma / P G Diploma in Labour Welfare related fields like Law, Personnel / Industrial Relations etc.	2

Note 1: In some extraordinary cases where the candidate had earlier worked in any metro projects in India, they can be considered for the following posts:

- Senior SHE Manager
- Junior SHE Manager
- Safety Steward

depending upon the qualification and number of years of experience on a case-to-case basis even if they do not possess the prescribed qualification as listed above.

Note 2: In all other cases other than listed under Note 1 irrespective their earlier experience with metro projects in India the candidates shall qualify as specified above.

	MAHARASHTRA METRO RAIL CORPORATION LIMITED

General Instruction: Maha-Metro/SHE/GI/003: Min. Requirements of SHE Monitoring and A.V. Equip.

1. For the purpose of minimum requirements of Audio-visual and Other equipment the contracts are categorized into the following groups:

Contract Value (Initial awarded value of contract)	Group
Upto 25 Cr	A
Upto 100 Cr	B
Upto 250 Cr	C
More than 250 Cr	D

2. Every contractor falling into the above groups shall provide the following minimum required audio-visual aids for conducting weekly review, monthly safety committee and other post review meeting of all fatal and major incidences effectively. These audio-visual equipments are a must for conducting periodical in-house safety presentations in the training programmes.

3. In addition to the above portable hand-held digital sound level meter (SLM) and portable hand-held digital lux meter are also to be provided.

SN	SHE monitoring and Audio-Visual Equipment details	SHE monitoring and Audio-Visual equipment required for			
		Group A Contract	Group B Contract	Group C Contract	Group D Contract
1.	Portable hand-held Digital Sound Level Meter (SLM) Noise Monitoring deleted	1	1	1	1
2.	Portable hand-held Digital Lux Meter	1	1	1	1
3.	Laptop Computer with standard configuration including multimedia facilities	1	1	1	1
4.	Colour Printer	1	1	1	1
5.	Computer projector with screen	-	1	1	1
6.	Overhead projector	1			
7.	35mm Camera (For taking accident investigation photos in which case the images cannot be easily altered)	1	1	1	1
8.	Digital camera with flash of minimum 4 mega pixel and video facility	1	1	1	2
9.	Digital still camera with flash of minimum 4 mega pixel	1	2	4	6
10.	Portable loudspeaker (for tool-box talk and emergency purpose)	1	1	2	6
11.	Communication facility like mobile phone, walky-talky etc	For all supervisors and managers/engineers working in Safety, Health & Environment			
12.	Accident investigation Kit containing the following:	1	1	1	2
a)	Chalk piece for marking				
b)	Measuring tape for measuring Flexible tape – 2m length Metal Foot long scale and Metal tape – 30m				

SN	SHE monitoring and Audio-Visual Equipment details	SHE monitoring and Audio-Visual equipment required for			
		Group A Contract	Group B Contract	Group C Contract	Group D Contract
c)	Equipment tags				
d)	Multipurpose Flash light				
e)	Barrier tape of 20m length				
f)	Accident investigation Forms and checklists				
g)	Enough Paper for witness recording and other noting				
h)	Emergency Phone Numbers list				

	MAHARASHTRA METRO RAIL CORPORATION LIMITED
General Instruction: Maha-Metro/SHE/GI/004:SHE Induction Training	

A) Safety and Health induction training Topic

1. Hazard Identification Procedure

Hazards on site:

- Falls
- Earthing work
- Electricity
- Machinery
- Handling materials
- Transport
- Site housekeeping
- Fire

2. Personal Protective Equipment

- What is available?
- How to obtain it?
- Correct use and care

3. Health

- Site welfare facilities
- Potential health hazards
- First Aid/Cardio-Pulmonary Resuscitation (CPR)

4. Duties of the Contractor

- Brief outline of the responsibilities of the Contractor by law
- Details of Contractor's accident prevention policy
- Maha-Metro's SHE manual
- Building and other Constructions Welfare Law

5. Employee's Duties

- Brief outline of responsibilities of employee under law
- Explanation of how new employees fit into the Contractor's plan for accident prevention. (Induction and orientation).

B) Environment induction training Topic

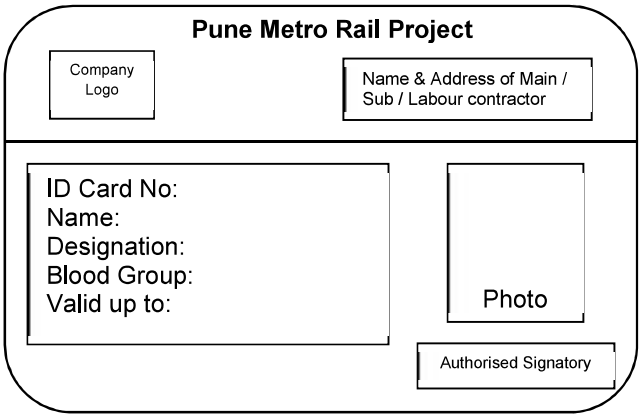
- Contractor's Environment Policy
- Avoidance of Nuisance
- Environmental Sanitation
- Dust Control Measures
- Water Pollution and Control
- Occupational noise mitigation
- Waste Management and Disposal
- Key legal requirements

Note: This is a sample list; other topic can also be included in first day induction training

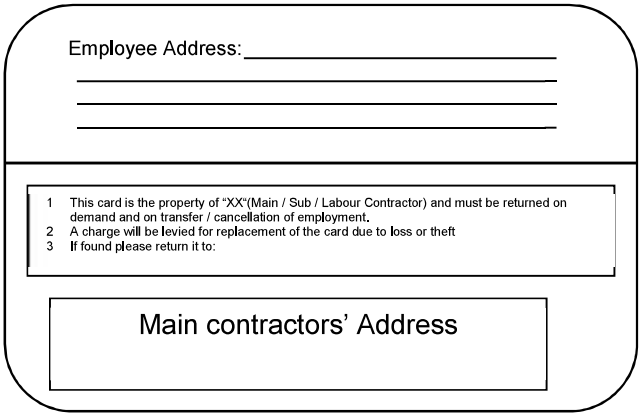
	MAHARASHTRA METRO RAIL CORPORATION LIMITED
General Instruction: Maha-Metro/SHE/GI/005: ID Card Format	

(85 mm x 55mm)

Front side of ID card:



Backside of ID card:



	MAHARASHTRA METRO RAIL CORPORATION LIMITED
General Instruction: Maha-Metro/SHE/GI/006: SHE Training details for Managers and Supervisors	

1. The Law and Safety	**2. Policy and Administration**
Statutory requirement Appropriate regulations Duties of employer and employee	Effect of incentive on accident prevention Human relations Consultation Safety Officer: duties, aims, objectives
3. Safety and the Supervisor	**4. Principles of Accident Prevention**
Safety and efficient production go together Accidents affect morale and public relations	Attitudes of management, supervision, and operations Methods of achieving safe operations Accident and injury causes
5. Site Inspection	**6. Human Behaviour**
The role of management Hazard Identification Procedure Records results Follow-up procedures Feedback	Motivating agencies Individual behaviour Environmental effects Techniques of persuasion
7. Site housekeeping	**8. Health**
Site organization Relationship of site housekeeping to accident occurrence Site access Equipment storage Material stacking Materials handling	Medical examination Hazard to health on site Sanitation and welfare Protective clothing First Aid/CPR
9. Personal Protective Equipment	**10. Electricity**
Eye, face, hands, feet and legs Respiratory protective equipment Protection against ionizing radiation	Appreciation of electrical hazards Power tools Arc welding Low voltage system Lighting and power system on sites ELCB, RRCB, Grounding/Ground fault circuit interrupters (GFCIs)
11. Oxygen and Acetylene Equipment	**12. Equipment**
Cylinder storage and maintenance Condition and maintenance of valves, regulators, and gauges Condition and maintenance of hoses and fittings Pressures	Accidents related to moving parts of machinery Appreciation of principles of guarding Importance of regular maintenance
13. Transportation	**14. Excavations**
Transport to and from site Hazard connected with site transport Competent drivers Dumpers Tipping trucks Movement near excavations	Method of shoring Precautions while shoring Precautions at edge of excavations Removal of shoring Sheet steel piling
15. Working platforms, Ladders, and Scaffolding	**16. Cranes and other Lifting Machines**
Hazards connected with the use of ladders Maintenance and inspection Type of scaffold Overloading Work on roofs Fragile material	Licensing, certification, and training required for operation of cranes Slinging methods Signalling Access to crane(s) Maintenance and examination

Openings in walls and floors Use of safety belts and nets	Ground conditions Hazards and accident prevention methods connected with the use of different types of cranes/heavy equipment Crane Lift Plan for all lifts
17. Lifting Tackle	**18. Fire Prevention and Control**
Slings - single and multi-legged Safe working loads (SWLs) Safety hooks and eyebolts Cause of failure Maintenance and examination	Principle causes determining fire Understanding fire chemistry Fire fighting equipment Fire fighting training
19. Communications	**20. Manual Handling**
Effective methods of communication (particular interest to non-English speaking workers) Method and preparation of reports Safety committees Safety meeting	Body posture and procedure for lifting, pushing, pulling, dragging, sitting and walking Ergonomics Stretching exercises

CONTENTS OF ENVIRONMENTAL TRAINING PROGRAMME

1. Environment Policy
2. Regulatory requirements i.e. Central, State and Environmental requirement of funding agency
3. Overview of Environmental issues at construction sites and funding agency's requirements.
4. Avoidance of nuisance
5. Environmental sanitation
6. Dust control measures
7. Contractual requirements to reduce construction related impacts
8. Monitoring of environmental parameters and their significance
9. Waste Management
10. Occupational Noise and its mitigation
11. Health impacts of construction industry
12. Green Buildings certifications (IGBC)
13. Resource minimization
14. ISO requirement (as applicable)

MAHARASHTRA METRO RAIL CORPORATION LIMITED

General Instruction: Maha-Metro/SHE/GI/007: SHE Training Matrix

Types of training	Management																		Supervisor										Specific													
	Safety & Health Orientation	safety & Health Leadership	Safety & Health Plan	safety & Health Improvement Plan	Management of Change	Safety & Health Audit & Inspection	Safety & Health Emergency Response &	Incident/Accident Investigation &	Sefety & Health Communication	Safety & Health Promotion & Incentives	Traffic Management	Hazard Identification & Risk Analysis	Permit to work system	Confined space entry	scaffolding	Labour welfare measures	Behavioral Based Safety Management	Job/Task Safety Analysis (JSA)	Safety Training Observation Programme (STOP)	Industrial First Aid & CPR	Incident / Accident Investigation &	Fire fighting	Confined Space Testing & Certification	Scaffold Erection & Inspection	Rigging	Wire Rope Inspection	Crane Inspection	Electrical/Mechanical Isolation	Permit to Work System	Confined Space Working	Explosive Handling & Control	Heavy Lifting Operation	Radiography (X-Ray)	HAZMAT Handling & Control	Welding, Cutting & Bracing	Power Actuated Hand Tool	Electrical/Mechanical Isolation	Roofing Work	Steel erection work	Scaffold Erection/Dismantling	False-work Erection / Dismantling	Painting in Confined Area
Project Manager	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•																					
Sr. Construction Managers	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•					•							•									
Quality Manager	•	•	•	•	•		•	•	•		•	•	•	•	•	•	•	•	•	•																					
Planning engineer	•	•	•		•	•	•	•	•			•		•						•																					
Construction Managers	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				•	•	•	•	•												
Construction Supervisors	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Construction Foreman	•		•				•		•			•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Machinery Operators	•						•				•									•		•			•																
Material Handlers	•						•					•	•		•					•	•	•			•																
Station Building Workers	•						•						•		•					•		•							•		•		•		•			•	•	•
Steel workers	•						•						•		•					•		•			•				•		•		•	•		•	•	•		
Mechanical workers	•						•													•		•			•				•	•	•		•			•	•			•
Other Civil workers	•						•													•		•			•				•	•	•	•	•			•	•		•	•
Electrical workers	•						•													•		•			•				•	•		•	•			•	•			•
Radiographers	•						•													•		•							•	•			•						•		
Transportation Drivers	•						•				•									•		•																			
Security Officers	•						•	•			•	•	•		•					•	•	•																			
Clerical Staff	•						•													•		•																			
Medical Doctor	•	•	•				•	•								•				•																					
Sr. Safety & Health Managers		•					•								•					•																					
Jr. Safety & Health Managers	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Safety & Health Supervisors	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

	MAHARASHTRA METRO RAIL CORPORATION LIMITED

General Instruction: Maha-Metro/SHE/GI/008: Days to Be Observed for Creating SHE Awareness

1st Monday to Sunday of January	Road Safety Week (Subjected to confirmation from Ministry of Road Transport, Govt. of India every year.)
16th February	Kyoto Protocol Day
March	Red Cross Month
4th March	National Safety Day
7th April	World Health Day
14th April	Fire Safety Day
April 18 to 22	Earth Week
20th April	Earth Day
20th April	Noise Awareness Day
28th April	ILO World Day for Safety and Health at Work
May 1 to 7	Emergency Preparedness Week
5th June	World Environmental Day
12th June	World Day against Child Labours
9th July	Occupational Health Day
17th October	World Trauma Day
1stDecember	World AIDS Day

MAHARASHTRA METRO RAIL CORPORATION LIMITED

General Instruction: Maha-Metro/SHE/GI/009: Minimum Requirements of SHE Communications

1. For the purpose of Minimum requirements of SHE Communication Posters / Signages / Video the contracts are categorized into the following groups:

Contract Value (Initial awarded value of contract)	Group
Upto 25 Cr	A
Upto 100 Cr	B
Upto 250 Cr	C
More than 250 Cr	D

2. Every contractor falling into the above groups shall prepare a SHE Communication Plan as a part of site specific SHE Plan and shall include the following minimum requirement of Posters / Signages / Video as applicable. In case readymade posters are available in any of the category from National Safety Council, Loss Prevention Association of India or any other safety related organisations they may procure the same and display it. In case the same is not available then the contractors shall make necessary arrangements to get the posters designed and printed on their own.

   All the above are to be detailed in the Site SHE Plan and get an approval from the Employer before displaying the posters.

Table 1: Minimum number of Posters

SN	SHE Poster Title	Min No. of concepts in each title	No. of Posters / Signage / Video			
			Group A Contract	Group B Contract	Group C Contract	Group D Contract
1.	Safety Culture	5	Each 10	Each 50	Each 75	Each 100
2.	Daily Safety Oath	1 English, 1 Hindi	Each 100	Each 200	Each 500	Each 1000
3.	Mandatory PPE Usage					
a)	Signages to display the messages like PPE ZONE, NO PPE ZONE, HARD HAT AREA etc.	2 types of sizes made up of metal sheet to be mounted at different locations	Each 25	Each 50	Each 75	Each 200
b)	Helmet	5	Each 25	Each 50	Each 75	Each 200
c)	Shoe	5	Each 25	Each 50	Each 75	Each 200
d)	Goggles & Ear Protection	5	Each 25	Each 50	Each 75	Each 200
e)	Full Body Harness	5	Each 25	Each 50	Each 75	Each 200
f)	Hi-Vi Jacket	5	Each 25	Each 50	Each 75	Each 200
4.	Emergency Management Plan	5	Each 25	Each 50	Each 75	Each 200
5.	Working at Heights	10	Each 25	Each 50	Each 75	Each 200
a)	Ladder, Stairway, Scaffold - Signages to display the messages like SAFE, UNSAFE, FIT FOR USE, AVOID USE etc.	5 types of sizes made up of metal sheet to be mounted at different locations	Each 25	Each 50	Each 75	Each 200
6.	Site Electricity	5	Each 25	Each 50	Each 75	Each 200
7.	Fire and Explosion	5	Each 25	Each 50	Each 75	Each 200
8.	Crane Safety	5	Each 25	Each 50	Each 75	Each 200
9.	Slings	5	Each 25	Each 50	Each 75	Each 200
10.	Rigging Procedures	5	Each 25	Each 50	Each 75	Each 200
11.	Excavation	5	Each 25	Each 50	Each 75	Each 200

SN	SHE Poster Title	Min No. of concepts in each title	No. of Posters / Signage / Video			
			Group A Contract	Group B Contract	Group C Contract	Group D Contract
12.	Occupational Health (Mosquito Control, HIV/AIDS awareness, Dust Control, Noise Control, No Smoking/Spitting, etc.)	10	Each 25	Each 50	Each 75	Each 200
13.	First – Aid	3	Each 25	Each 50	Each 75	Each 200
14.	Labour Welfare Measures (Payment of Minimum Wages, Avoidance of Child labour, signing in the Muster Roll, In case of accidents-what to do? etc	5	Each 25	Each 50	Each 75	Each 200
15.	Importance of "Safety Handbook"	1	25	50	75	200
16.	Traffic Safety (Speed limi safe crossing and workin within barricaded area etc.)	5	Each 25	Each 50	Each 75	Each 200
17.	Environmental Sanitation, Dust Control, Waste Management, Water Conservation, Tree Protection, General Environmental Awareness Measures against noise pollution etc	5	Each 25	Each 50	Each 75	Each 200
18.	Video in Hindi on PPE usage – 15 minutes duration	1	-	-	-	1

Note 1: Items mentioned under 17 is video. Items under 3 (a) and 5 (a) are metal signage boards and all other items are posters.

Table 2: Size of Posters / Signages

SN	Item	Size
1.	Posters – Standard	17"x22" –135 GSM 4 Colour Printing
2.	Posters – Special (Wherever required)	17"x22" card laminated FA Poster
3.	Posters - Mega size (Wherever required)	32"x40" Flex FA Poster
4.	First-Aid Booklet	6"x4"
5.	SHE Handbook	6"x4"
6.	Signages	Small: 12"x6" Big : 24"x12"
7.	Road Traffic Sign Boards	Strictly as per Indian Road Congress (IRC) specifications

Table 3: Safety Signage Colour (as per IS 9457)

SN	Type of signage	Colour
1	Mandatory	Blue
2	Danger	Yellow
3	Prohibit	Red
4	Safe conditions	Green

MAHARASHTRA METRO RAIL CORPORATION LIMITED

General Instruction: Maha-Metro/SHE/GI/010: Experts / Agencies for SHE Services

SN	Organisation	Services
1.	Bureau Veritas Industrial Services (India) Pvt. Ltd., B-21 & 22, First Floor, Sector-16, NOIDA-201 301 (U.P.) Phone: 0120 - 2515055 Fax: 0120 - 2515248 E-mail: enp.delhi@in.bureauveritas.com	• External SHE Audit • SHE Management / Technical Training
2.	Central Labour Institute Post box no: 17851, NSMonkikarMarg Sion, Mumbai- 400 022 Tel.: 022- 4092203 Fax: 022 – 4071986 E-mail: cli@dgfasli.nic.in	SHE Management / Technical Training
3.	Construction Industry Development Council 801, 8th Floor, Hemkunt Chambers, 89, Nehru Place, New Delhi – 110 019 E-mail: cidc@vsnl.com	SHE Management / Technical Training
4.	Delhi Productivity Council 1E/10, Swami Ramtirath Nagar New Delhi – 110 055 Tel.: 23522835	SHE Management / Technical Training
5.	Det Norske Veritas AS, 203, SavitriSadan 1, 11 PreetVihar Community Centre, New Delhi-110 092 Phone: 011-22531502/2253/1503, 22427688/22531278 Fax: 011-2253 0247 Website: www.dnv.com	• External SHE Audit • SHE Management / Technical Training
6.	Dr AV Baliga Memorial trust Link House, Bagadur Shah ZafarMarg Press Area New Delhi – 110 002 Phone: 011 – 23311119	HIV / AIDS awareness
7.	Dr. Cris Research Centre for Occupational Health & Safety 306, Guru ArjunaDevBhawan, Ranjit Nagar Complex, New Delhi – 110 008 Phone: 9810040406 Fax: 011 – 25702929 E-mail: team@drcris.com Website: www.drcris.com	• Ambulance Room & Van • Communication Materials • First-aid box • First-aid Training • HIV / AIDS awareness • ID Card • Medical Facilities • SHE Orientation Training
8.	DuPont Safety Resources, E.I. DuPont India Private Limited, ArihantNitco Park 6th Floor, 90, Dr. Radhakrishnan Salai, Mylapore, Chennai-600 004 Phone: 044-2847 2800, 2847 3752 Fax: 044-2847 3800 Mobile: 9381201040 Website: in.dupont.com	SHE Management Training

SN	Organisation	Services
9.	Automech Engineering India Pvt. Ltd, L-1, Shivalay, Deenanath Mangeshkar Road, Pune-411004, Phone: 09423732672 E-Mail: info@automechengineering.in	ISO certification services SHE Trainings External SHE audits T&P testing and certifications
10.	Green Cross Consultants 59, 7th Cross, 1st Floor, Jai Bharath Nagar, Banglore-560 033 Phone: 080-2549 6782 E-mail: etgrangan@yahoo.com	SHE Management / Technical Training
11.	HSRTC, PENTASAFE, 201, 2nd Floor, Town Centre, AndheriKurla Road, Marol, Andheri (East), Mumbai-400 059 Phone: 022-2850 2210/20/50 Fax: 022-2850 2260 E-mail: training@penta-safe.com	SHE Practical Field Training for Height Safety
12.	Institute of Driving Training & Research, Wazirabad Road, Adjoining Loni Road flyover. New Delhi – 110 094 Phone: 011 – 22813474, 22815833 Fax: 011 - 22811131	SHE Technical Training for Vehicle Drivers.
13.	Institute for Research, Development & Training of Construction Trades & Management, An Educational Institute, Society and Trust, 1st Floor, UVCE Alumni Association Building, K.R. Circle, Bangalore-560 001 Phone: 080-22294291/22243257 Fax: 080-22243257 E-mail: ubrco@vsnl.com Website: www.instructindia.org	SHE Technical /Field Training
14.	International Engineering Company K – 10, South Extension, Part – 2, New Delhi – 110 049 Phone: 011 – 26254761, 26258130 Mobile: 9312260130 E-mail: ashok@intenco.net	• Crane and Lifting appliances and Gears Certification • SHE Practical Field Training for Crane Safety
15.	L & T Eutectic 32, SivajiMarg, New Delhi – 110 015 Phone: 011 - 51419538, 51419539 Fax: 011 - 51419600 Website: www.lnteutecticwelding.com	SHE Practical Field Training for Welding Safety
16.	Loss Prevention Association of India Ltd. Warden House, Sir P.M. Road, Mumbai – 400 001 Website: www.lpaindia.org	SHE Management / Technical Training
17.	MFA Crucial Moments Healthcare Pvt. Ltd., 42, Okhla Industrial Estate, Phase – II New Delhi – 110 020 Phone: 011 – 55624000 Fax: 011 – 55624010 E-mail: contact@crucialmoments.net	First-aid Training
18.	Modicare Foundation 4 Community Centre, New Friends Colony, New Delhi – 110 065 Phone: 011 – 5167235059 Fax: 011 – 26915469 E-mail: nivedita@modi.com nivedita@gmavil.com Website: www.modicarefoundation.org	HIV / AIDS awareness

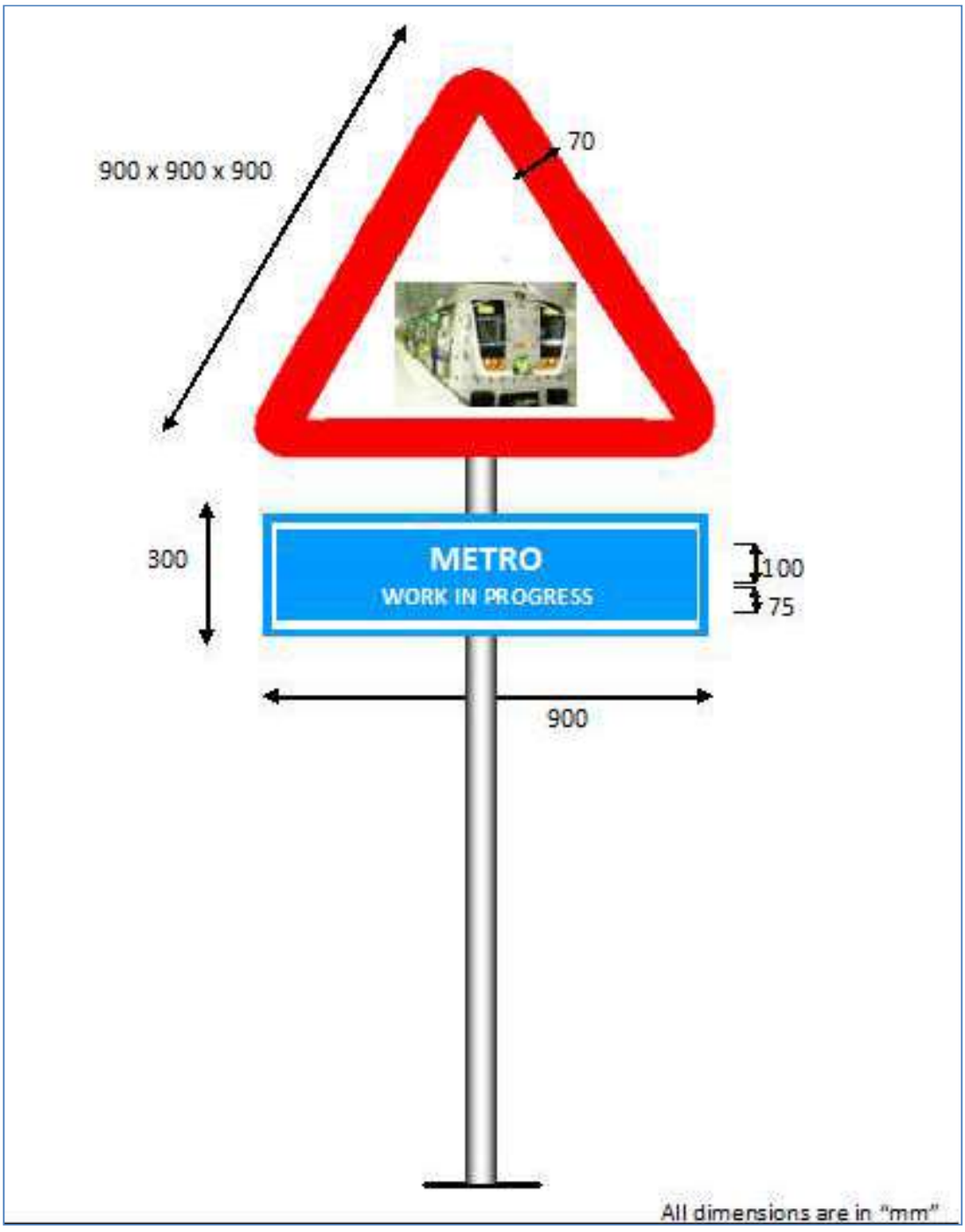
SN	Organisation	Services
19.	National Safety Council HQ and Institute Building 98A, Sector 15, industrial Area C.B.D Belapur, Navi Mumbai – 400614 Phone: 27579924	SHE Management / Technical Training
20.	NICMAR (National Institute of Construction Management and Research) 910,9th Floor, Hemkunt Chambers, 89, Nehru Place, New Delhi – 110 019 Phone: 011 – 51618415, 51618417, 51618418 Fax: 011 – 51618416	SHE Management / Technical Training
21.	Quality Growth Services Pvt. Ltd. H-13, Kirti Nagar, New Delhi – 110 015 Fax: 011 – 25431737 / 25438598 / 25918332 E-mail: qgs@qgspl.com Website: www.qgspl.com	ISO Certification
22.	Safety Engineers Association / Safety Educational Trust – India 2/257, First Floor, Dr.Ambedkar Nagar, Manapakkam, Chennai – 600 116 Phone: 044 – 22523461 E-mail: safetrustindia@rediffmail.com	SHE Management / Technical Training
23.	SHE Management Consultancy & Support Services, 145 A, Pocket-VI, (DDA Flats), KondliGharoli, MayurVihar-II, Delhi-110 096 Fax: 011-2262 5015 Mobile: 9811153873 E-mail: r_k_p@vsnl.net	SHE Management / Technical Training
24.	St. Johns' Ambulance Red Cross Road New Delhi – 110 001	First-aid Training
25.	Vexil Business Process Services Pvt. Ltd. 208, A/4, Savitri Nagar, New Delhi – 110 017 Mobile: 9350232714, 98102832201, 9350232716 E-mail: info@vexilbps.com Website: www.vexilbps.com	• Emergency Preparedness Mock drill • SHE Management / Technical Training
26.	Welding Research Institute Bharat Heavy Electricals Ltd. (BHEL) Trichirappalli, Tamil Nadu – 620 014 Phone: 0431 – 2577029, 2577283 Fax: 0431 – 2520770 E-mail: wri@bheltry.co.in	SHE Practical Field Training for Welding Safety

General Instruction: Maha-Metro/SHE/GI/011: Minimum Lighting Requirements

SN	Facility or Function	Luminance – lx (lm/ft2)
1.	Administrative areas (offices, drafting and meeting rooms, etc.)	540 (50)
2.	**Construction areas** • general indoor • general outdoor • tunnel and general underground work areas (minimum 110 lux required at tunnel and shaft heading during drilling, mucking and scaling)	 55 (5) 33 (3) 55 (5)
3.	**Access ways** • exit ways, walkways, ladders, stairs	 110 (10)
4.	**Maintenance / Operating areas / shops** • vehicle maintenance shop • carpentry shop • outdoors field maintenance area • refueling area, outdoors • shops, fine details work • shops, medium detail work • welding shop	 325 (30) 110 (10) 55 (5) 55 (5) 540 (50) 325 (30) 325 (30)
5.	Mechanical/electrical equipment rooms	110 (10)
6.	Hoists, Elevators, freight and passenger	215 (20)
7.	**Warehouses and storage rooms/area** • indoor stockroom, active/bulk storage • indoor rack storage • outdoor storage	 110 (10) 270 (25) 33 (3)
8.	Health Centers and First aid stations and infirmaries	325 (30)
9.	Toilets, wash and dressing rooms	110 (10)
10.	Work areas – general (not listed above)	325 (30)
11.	Parking areas	33 (3)
12.	Visitor areas	215 (20)
13.	Laboratories	540 (50)

	MAHARASHTRA METRO RAIL CORPORATION LIMITED

General Instruction: Maha-Metro/SHE/GI/012: Warning Traffic Sign



MAHARASHTRA METRO RAIL CORPORATION LIMITED

General Instruction: Maha-Metro/SHE/GI/013 :IGBC Document submission

Credit-wise list of documents applicable to respective contractor of Elevated and Underground Station		
SSP MR1	Site environment Management	1. Emergency excavation plans / Site Management Plan (DWG) with photograph of site barricading and stacking of fresh material yard with signange
		2. Photograph of Wheel Wash Facility/ Grating/Manual cleaning
		3. Photograph of Water sprinkling
		4. Photograph of Covering excavated soil with tarpaulin or green net and tree protection at site
		5. Photograph of Diesel Storage area with drip tray
		6. Air & Noise test Reports at various locations in the station area along with photograph of monitoring measures during construction
		7. Environmental Management Plan
		8. Photograph of Waste Segregation with dust bins at the site
		9. Photograph of Electrical equipment covered at the site during civil construction and finishing
		10. Photograph of Covering of HVAC ducts
		11. Photograph of Scrap Material yard with signage
		12. Photograph of Good Housekeeping activities
		13. Photograph of Keep the Construction pathway free from interruption
		14. Photograph of DG Sets with proper exhaust (10m height from the breathing level)
		15. Photograph of Protect temporary area, and staircase using net or caution tape
		16. Traffic management permission and plan/policy along with photographs
		17. TopSoil test report showing porosity and percolation rate (Applicable only at grade station), also mentions the quantity and the process of preservation and uses and Photographs of Topsoil during excavation and preservation
SSP MR2	Basic Facilities for Construction Workforce	1. Welfare facilities and emergency excavation Plan for construction workforce for all stations (DWG)
		2. Photographs for basic facilities for the construction workforce - PPE Kits - First Aid & Medical Facilities - Sanitation facilities - Drinking-Water facilities
		3. Policy or contract documents and site layout for basic facilities for the construction workforce (Typical) - PPE Kits, First Aid & Medical Facilities, Sanitation facilities, Drinking-Water facilities, Assembly Point, Wheel cleaning area, Dustbin / waste storage area, DG, Fire-point, worker restroom etc.
SSP CR5	Preserve/Restor Tree	1. Tree Survey Report
		2. Details Trees inventory
		3. Permission for tree cutting from the authority
		4. PO of new saplings and name of the saplings
		5. Trees Maintenance Clause
		6. Site plan indicating the location of existing trees, before construction (Kindly Provide the Survey drawing showing the location of trees)

		7. Landscape plan (post-construction) highlighting the location of preserved/restored trees and newly planted saplings. In the landscape plan, please also provide a legend indicating the type of new plant species used (Kindly provide the landscape plan and also mention plant species)
		8. Photographs of Transplanted Trees with location
		9. Landscape plan and calculations demonstrating the percentage of the median area below the viaduct, covered with native/naturalized vegetation
		10. List of native / naturalized species planted in median area below the viaduct
		11. Photographs of landscape areas at various station locations
		12. Photographs of the median area below the viaduct tree plantation area
		13. Photographs during the tree plantation
		1. SRI Certificate for pavers from the manufacturer, also mention the distance from the manufacturer unit to the project location
		2. PO of the pavers block
		3. Photographs of Non Roof Areas, pavers blocks
SSP CR6.2	Heat Island Mitigation, Roof	1. PO and manufacturer specifications for SRI Paint (showing SRI Values) for exposed roof area
		2. Photographs of Exposed Roof Area
SSP CR8	Green Education	1. Any kind of Green Education Strategies, like Green Signage Program Environmental Awareness Program Tree Plantation Various Green Workshop, seminars or training programs for staff
		2. Photographs of the taken Green Education Strategies
WE MR1	Efficient Water Fixtures	1. A list of all plumbing fixtures installed(make and model no.) in the project indicating their flow and flush rates.
		2. Manufacturer letters (addressed to the project) or test certificates indicating the flow rates (at design water pressure of 3 bar) and flush rates of plumbing fixtures installed.
		3. Photographs of Installed Water Fixtures
		4. PO of installed Water Fixtures
WE MR2	Rainwater Harvesting, Station	1. Site storm water layout and storm water drain typical section
		2. Rainwater harvesting system sizing calculations (if applicable)
		3. Rainwater harvesting system plan, section (pits, storage tanks, etc.,) (if applicable) **If the ground Water table is less than 4m, such projects need not comply to the requirement. For these, need to submit the soil test report or Geo-technical Investigation report indicating the water table level
		4.Photos of Rainwater Harvesting System (if applicable) during construction and after construction at all the station Locations
WE CR1	Ultra Efficient Water Fixtures	Efficient Water Fixtures Details, PO, vendor certificate for Flow & Flush rate and photos
WE CR2	Rainwater Harvesting, Station and Viaduct	1. Total Length of Viaduct
		2. No of rainwater pits or tanks are provided throughout the viaduct
		3. Cross-sectional diagram for pits provided at viaduct area
WE CR3	Water Monitoring	1. Single line diagram (SLD) showing the installed water metering system (station wise, at least 2 locations in each station) (DWG)
		2. Photos of provided water meter

		3. PO of water meter
		1. Wall & Roof Construction Details (i.e., cross-section drawings in DWG) for all Air-Conditioned Spaces and fenestration details like a certificate from manufacturer mentioning the VLT, U-Value, SF, Make, and Model
		2. Lighting drawing layout (DWG) for all the proposed areas with fixture wattage and LPD level (station-wise)
		3. HVAC Layout (DWG) for all the stations
		4. List of HVAC Equipments space-wise for every station, Manufacturer Technical Specifications, PO and BOQ
		5. PO & BOQ of Lighting Fixtures
		6. Tender Document or Manufacturer test certificate for Escalator & Elevator, PO and VVVF technology Details
		7. Technical Specification of occupancy sensors in the toilet (if applicable)
		8. Technical Details and agreement/tender of BMS system if installed
		9. All office equipment such as printers, computers fax etc should be energy star-labeled. Please provide any contact agreement or policy regarding this.
		10. Pumps & Motors TDS, PO with VSD (Variable Speed Drive) systems.
		11. Photographs of All types of LED Lighting Fixtures
		12. Photographs of LED Signages inside stations
		13. Photographs of Occupancy Sensor (if applicable)
		14. Photographs of Escalator & Elevator VVVF control System
		15. Photographs of HVAC System
		16. Photographs of Pumps & Motors with VSDs system (Only of Under-Ground)
EE CR2	Eco-Friendly Refrigerants and Halon-free System	1. Technical specifications of installed fire suppression system
		2. A list of all Fire suppression systems used in the project
		3. A list of HVAC System and Technical details of refrigerants used in HVAC equipment & systems
		4. Photographs of installed Fire Suppression Systems
EE CR3	On-Site Renewable Energy	*If any renewable energy system is installed: 1. Commissioning Report
		2. Capacity of the Installed Renewable Energy
		3. Technical Details of Installed Renewable Energy
		**If the installing Renewable Energy is in progress
		1. Tender Documents or LoA with the Agency
		2. Tentative Calculation for each station
EE CR5	Energy Monitoring	1. Schematic drawing showing the location of energy meters in the project
		2. Energy (kwh) meter manufacturer specifications and PO
		3. Photographs of Electrical Panel
MC CR1	Handling of Waste Materials, During Construction	1. Site logistic plan highlighting the construction waste segregation, storage, areas of topsoil storage, barricading, wheel washing area, labour facility (construction site management plan)
		2. A list of construction waste generated and diverted for reuse, recycle & land-fill within the project or outside the project
		3. Photographs taken at various stages of the project showing construction waste management yard and reuse of construction waste within site

		4. Letters from scrap dealers (addressed to the project) / contractors stating the type and quantity of construction waste received/ reused from the project site, for recycling/ reuse
MC CR2	Materials with Recycled Content	1. Master material sheet (in excel format) listing all the civil and interior materials with quantities used in the project (BOQ will be accetable to calculate the quantity of all building civil and construction materials)Note: For quantities, specify the units (Sqm, no., tons, cum, liters etc.,) in line with bills/PO
		2. PO for all civil and interior material listed in master material sheet indicating the cost
		3. Manufacturers letters (addressed to the project) indicating the percentage of post consumer post-industrial recycled content of the major materials used in project
MC CR3	Local Matrials	1. Major civil and interior materials used in the project along with their cost. Clearly highlight the local materials and their corresponding cost along with approximate distance from the project site to the place of manufacturing unit.
		2. Manufacturer letters (addressed to the project) for local materials which are manufactured within a distance of 400km from project site.
IEC CR1	Indoor Air Quality (IAQ) Monitoring	1. For all station types and tunnel submit Indoor Air Quality (IAQ) management plan would be provided by Contractor's representative describing the strategies implemented during construction and pre-occupancy phases for addressing measures such as scheduling, electrical and mechanical equipment & systems protection, housekeeping, isolating clean areas and source control (as applicable).
		2.Contractor's representative have to ensure and provide evidence indicating IAQ measures implemented at various development stages of the project such as construction, installation, commissioning and before occupancy phases of the project.
IEC CR4	Low-Emitting Materials	**1. Paints & Coatings:** a. A list of low or no VOC content paints & coatings (make & model) used in the project interiors, along with the VOC content (in g/L, less water).
		b. Test certificate or manufacturer letters (addressed to the project) indicating the VOC content (in g/L, less water) of the paints & coatings sourced.
		2. Adhesives:
		a. A list of low or no VOC content adhesives (make & model) used in the project interiors, along with the VOC content (in g/L, less water).
		b. Test certificate or manufacturer letters (addressed to the project) indicating the VOC content (in g/L, less water) of the adhesives sourced.
		3. Sealants & Sealant Primers:
		a. A list of low or no VOC content sealants & sealant primers (make & model) used in the project interiors, along with the VOC content (in g/L, less water).
		b. Test certificate or manufacturer letters (addressed to the project) indicating the VOC content (in g/L, less water) of the sealants & sealant primers sourced.
		** Photographs of all the above mentioned materials
IEC CR6	Daylighting	1. Manufacturer cut-sheet / brochure / letter of the proposed glass showing the visual light transmittance (VLT)

	MAHARASHTRA METRO RAIL CORPORATION LIMITED

General Instruction: Maha-Metro/SHE/GI/014: Environmental Inspection Checklist

Report No.:	**Inspection Date:**	**Inspected by :**
Inspection Area:		
Participants:		

Sl. No	**Item**	**Compliance**		**Photograph**	**Observation & Recommendat ion**	**Action**	
		Yes	**No**			**By whom**	**Target date**
1.0	**ENVIRONMENTAL SANITATION**						
1.1	Regular housekeeping done at site						
1.2	Materials are properly stored						
1.3	Construction equipment's and tools are kept properly						
1.4	Designated storage area for all materials as per requirement						
2.0	**CONTAINMENT OF AIR POLLUTION**						
2.1	Site is properly barricaded						
2.2	Dust generating materials are stored properly as per requirement given in the contract document						

2.3	construction equipment/ instruments/ construction material/debris/soil are not kept outside barricaded area						
2.4	Nearby roadways are clean from dust/Muck/debris						
2.5	Wheel washing facility is provided near the exit gate						
2.6	Wheel washing facility is in working condition						
2.7	Soil & debris stored in the site fully covered						
2.8	Regular water sprinkling						
2.9	Batching plant and / or casting yard area kept clean and neat						
2.10	Sufficient number of openings with exhaust fans are provided at cement storage area						
2.11	Proper PPEs are provided to workmen involved in manual cement handling						
2.12	Conveyor belt used for carrying aggregate are fully covered						
2.13	Access roads and internal circulation roads are well laid and maintained						
2.14	Stack height of DG set is as per norms						
2.15	Regular cleaning of toe dust						
2.16	Vehicle carrying construction materials, debris, muck etc are properly cleaned and covered						
3.0	**CONTAINMENT OF WATER POLLUTION**						

3.1	Water meters are provided as per requirements and are functional						
3.2	Waste water from site is not discharged into sewer without approval						
3.3	Waste water from RO reject, curing etc is put to effective use						
3.4	Transit Mixer washing facility /Beton washing provided at casting yard/batching plant						
3.5	Transit Mixer washing facility provided at casting yard/batching plant is functional						
3.7	Drainage system is functional						
3.8	Refuse/ excavate muck are not stored near the drains						
3.9	Site and adjacent areas are free from water logging						
3.10	Water consumption is recorded regularly						
4.0	**CONTAINMENT OF NOISE**						
4.1	Construction plant & equipments are serviced regularly						
4.2	Acoustic enclosures are provided for DG sets and maximum permissible sound pressure level is within 75dB(A) at one meter distance from the enclosure						
5	**WASTE MANAGEMENT**						
5.1	Adequate number of colour coded dust bins are available						
5.2	All waste items are deposited in refuse containers						

5.3	Bins are Emptied regularly						
5.4	No refuse is burnt at site						
5.5	Waste materials are properly stored at designated areas only						
5.6	C&D waste is not disposed along river bed, drainage & wet land						
5.7	Regular disposal of all types of waste as per law						
5.8	Availability of drip pans to prevent leakage and spill.						
5.9	No oil stains on ground						
5.10	Spill absorption material available						

Senior Environment Manager Chief SHE Officer

	MAHARASHTRA METRO RAIL CORPORATION LIMITED

Form No. SF/001: Formation of Site SHE Committee

Contract No.	
Contractor Name	
Contract Title	

CIRCULAR

Committee

The following SHE Committee is constituted with immediate effect:

Chairman:
Members:

1.
2.
3.
4.
5.

Secretary

Periodicity

The committee will meet at least once in a month on the day (specify date)

Agenda

Secretary will circulate agenda of the meeting at least two days in advance of the schedule date of the meeting.

Circulation

Gist of the meeting will be minuted in the standard format and circulated to the following under the signature of the secretary

1. Chairman
2. Members
3. Maha-Metro Representatives
4. Others concerned

Date: Signed By: ----------

CHAIRMAN

	MAHARASHTRA METRO RAIL CORPORATION LIMITED

Form No. SF/002: Minutes of SHE Committee Meeting

Contract No.			
Contractor Name			
Contract Title			
Meeting No.		**Date of Meeting**	
Location of Meeting			

MEMBERS PRESENT	INVITEES	MEMBERS ABSENT

REPORT SENT TO					
No. of Copies	**Name / Dept.**	**No. of Copies**	**Name / Dept.**	**No. of Copies**	**Name / Dept.**

Prepared by: Location: Date:

MINUTES OF SHE MEETING

Item No.	Description of Discussion	Action By	Target	Remarks
1	Complaints received from Clients and corrective and preventive action			
2	Review of MOM of previous meeting			
3	NCR's / Observation from third party			
4	First - Aid cases / Reportable accident cases			
5	Future jobs and specific requirement			
6	Status of implementation of Safety plan			
7	Sub-contractor performance			
8	Analysis of first-aid cases			
9	Need for any specific system / training / PPE's / resources			
10	Observation of SHE committee during last walk down			

Next, SHE Meeting is scheduled on:

Date: **Chief SHE Manager** **(Signature & Name)**
Date: **Project Manager** **(Signature & Name)**

Annexure-11:

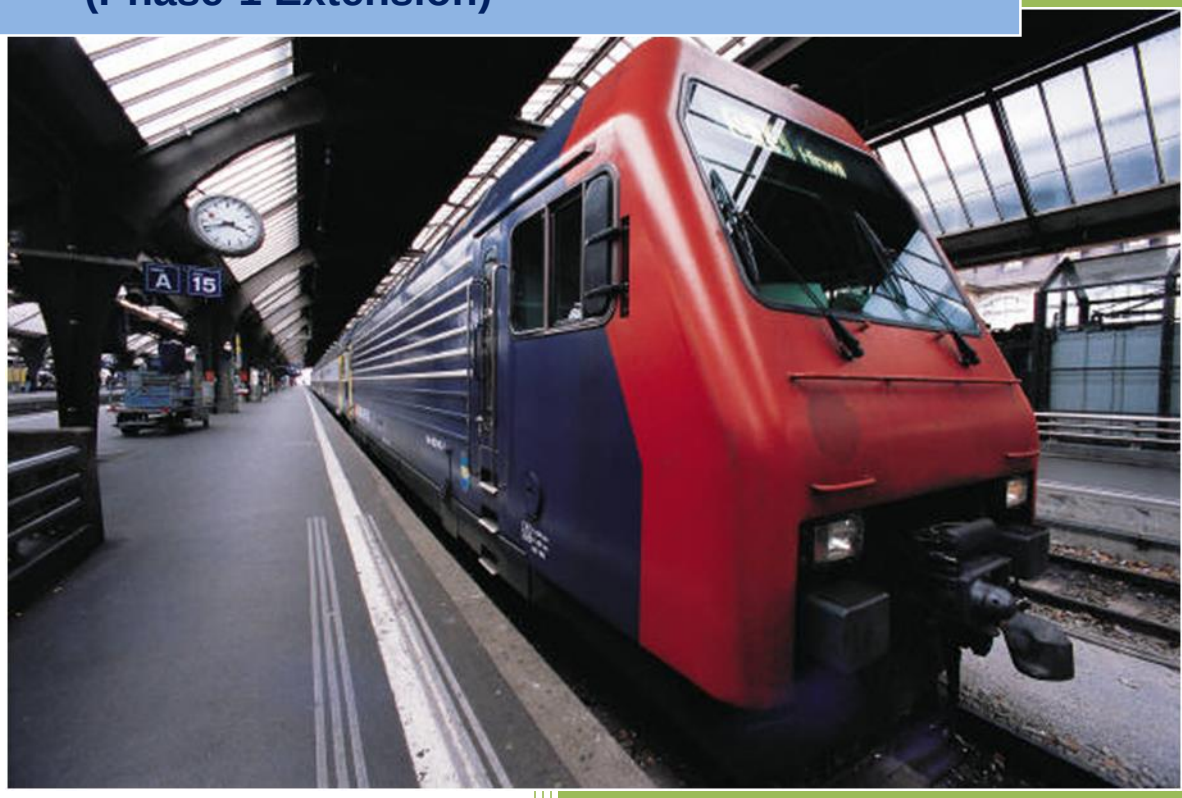
Vibration Modelling Report

-

(Report)

Jan. -2025

Vibration Modelling for Pune Metro Rail Project PCMC to Nigdi (Phase-1 Extension)



Submitted to:

MITCON Consultancy & Engineering Services Ltd, Pune

1. Introduction

Vibration is one of the major environmental threats to our health as well as to our surrounding environment. Nature provides its own vibration sources such as earthquakes, winds and ocean waves. With the advent of the technological era, vibration sources have multiplied and have become a threat to residents of buildings and also to the sensitive receptor and historical buildings.

Vibration effects on sensitive receptor are a more serious matter of concern especially in cities. In many Indian cities, buildings that are located close to the vibration sources are slowly deteriorating because of road traffic and train passing. As a matter of fact, one of the main reasons for this is the increase in traffic within a limited available space and also, the existence of business centers closes to the structures. This implies that restricted space is left to the transport planners for proposing alternative routes and means of conveyance.

One of the plausible means in such situations can be a commuters trains services either by elevated and above ground rail system. The detrimental effects of **vibration** due to elevated and above ground level activities and Train passage needs to be viewed in perspective and has to be investigated with improved methods and prediction models. This study therefore aims to address these very issues for elevated train service.

Vibration modelling was carried out at the 8 locations of proposed metro rail corridors. In the vibration modelling, the peak vibration was calculated considering the maximum load and maximum speed with the futuristic data given in the DPR. The study of vibration modelling was carried out using empirical calculations and mapped using GIS software.

1.1 Scope of work

The following is the scope of work of the project.

1. Study the existing vibration monitoring data of 8 locations.
2. GIS mapping of all 8 locations along the proposed metro rail corridors.
3. Data compiling for vibration modelling
4. Vibration modelling of all 8 locations using GIS software.
5. Vibration modelling analysis and validation.
6. Report preparation and presentation.

1.2 Vibration

The vibration of an object is always caused by an excitation force. This force may be externally applied to the object, or it may originate inside the object. It will be seen later that the rate (frequency) and magnitude of the vibration of a given object is completely determined by the excitation force, direction, and frequency. This is the reason that vibration analysis can determine the excitation forces at work in a machine. Vibration is usually measured in units of inches per second or mm per second.

1.3 Vibration due to Rail Traffic

Vibration due to rail traffic depends on many factors such as height of elevated structure, soil condition, geological condition, type of train, train speed, type of loads etc. In case of elevated train operations, the major vibrations, that is vertical and radial vibrations passes through pier and foundation deep into the ground and it may not cause any serious damage to the nearby structures. Horizontal vibration passing through ground surface may cause some damage to nearby structures depend on frequency of train passing and distance of the structures from tracks. It is in this context; horizontal vibration is predicted with respective to the proposed alignment and location of sensitive receptors.

1.4 Effect of Vibration

After vibration is received by the building foundations, the vibrations are then propagated through other parts of the building and damage the building.

1.4.1 Effect on Humans

Human response to ground-borne vibration is influenced by many factors. Some of these factors are amplitude, duration and frequency content of vibration, while other factors relate to population type, age and gender. People may be more annoyed if they are exposed to both noise and vibration compared to when only vibration is felt.

1.4.2 Vibration Impact on Buildings

Continuous effect of vibration on the buildings can cause damage to buildings. Building subjected to the vibration effect with more than 150 VdB would receive structural damage. Historic buildings are more susceptible to vibration effects due to the type of building material and design. Old structures generally lose structural strength over a period of time. Therefore, it is more important to study the effects of vibration on the historical buildings, especially the structures that come under a heritage category.

2. Study area and Data Description

2.1 Study Area

Pune Metro Rail Project (PMRP) was planned to construct in two phases. PCMC to Nigdi (Phase-1 Extension) of the PMRP includes extension of the North–South corridor

The coordinates of the vibration monitoring points are given in table 2.1 below:

Table 2.1: Details of vibration study locations.

Sampling Code	Sampling Location	Significance	Latitude	Longitude
VB1	Bhakti Shakti Metro Station	Metro Station	18°39'55.09"N	73°46'20.46"E
VB2	Vidyanand Bhavan High School	Sensitive Receptor - Educational	18°39'40.58"N	73°46'30.32"E
VB3	Diwan Hospital Pune	Sensitive Receptor - Healthcare	18°39'35.73"N	73°46'38.20"E
VB4	Star Hospital, Akurdi	Sensitive Receptor - Healthcare	18°39'6.87"N	73°47'0.86"E
VB5	Khandoba Mandir / Akurdi Metro Station	PCR - Temple	18°39'2.70"N	73°47'7.01"E
VB6	Aegis Multispeciality Hospital	Sensitive Receptor - Healthcare	18°38'56.35"N	73°47'12.56"E
VB7	Chinchwad Metro Station / Shri Mahalaxmi Aai temple	Metro Station / PCR - Temple	18°38'20.83"N	73°47'42.50"E
VB8	Hanuman Mandir, Chinchwad (End of Alignment)	PCR - Temple	18°38'5.48"N	73°47'56.08"E

2.2 Soil Condition at Study Area

The Geotechnical investigation work included drilling of 150mm diameter boreholes (BHs) in all kind of soil including gravels and cobbles, & 76 mm dia. drilling in weathered rock, soft rock & hard Rock up to depths ranging from 6m to 30m. Boreholes have been terminated at shallower depths after completing at least 3m drilling in fresh and hard rock. Boreholes have been drilled

at an interval of about 1000m distance along the alignment or at change of strata. In total, 50 BHs were drilled (up to 30 m depth each), along the lengths of all four proposed Metro alignments.

2.3 Section details

The proposed extensions of metro rail corridors are elevated structures over the existing roads. Typical design of elevated section is shown in figure 2.2. Since the stations are planned generally in the middle of the road, minimum vertical clearance of 5.50 m has been provided under the concourse. Concourse floor level is about 7.0 m above the road. Consequently, platforms are at a level of about 13.0 m from the road.

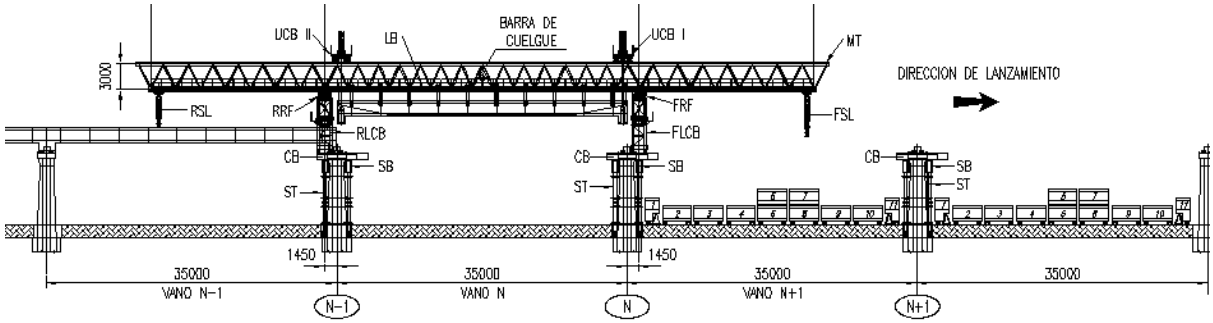


Figure 2.2: showing the cross-section of Box Girder Viaduct Section

The distance between the rail and ground level is 9 meters. During train operation, the vibrations from the rails will transmit through pier into ground. Vibration in ground will move in three directions vertical, radial and horizontal. Since the building are located on ground levels, horizontal vibrations will create more impact than vertical and radial vibrations. Therefore, horizontal vibrations are predicted in the vibration modelling at these 8 locations.

2.4 Use of GIS for Vibration study

The base map for the study of vibration impact assessment is prepared using a Geographical Information System (GIS). GIS provides a powerful set of tools for storing, retrieving, transforming and displaying spatial data from the real world for a particular set of purposes. Therefore, GIS is increasingly important in the study on possible effects of vibration. GIS facilitates the visual presentation of the vibration effects and is an additional tool for analyzing the results. The integration of GIS with vibration prediction models provides fast and accurate assessment of the environmental impact of vibration.

3. Ground Borne Vibration

3.1 Requirement of Ground Borne Vibration prediction

Ground-borne vibration can be a major concern for nearby neighbors of a transit system route or maintenance facility, causing buildings to shake and rumbling sounds to be heard. In contrast to airborne noise, ground-borne vibration is not a common environmental problem. Some common sources of ground-borne vibration are trains, buses on rough Rails, and construction activities such as jack hammer, earth driving equipment, operation of earth moving equipment.

The effects of ground-borne vibration include perceivable movement of the building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. In extreme cases, the vibration can cause damage to buildings, though it is an uncommon phenomenon as a result of regular train operations, with the occasional exception of earth drilling, train passing and pile-driving during construction. Annoyance from vibration often occurs when the vibration exceeds the threshold of perception by only a small margin. A vibration level that causes annoyance will be well below the damage threshold for normal buildings.

A model capable of predicting excessive ground-borne vibration due to train traffic would be a powerful tool for Railway designers in order to avoid the problem at early stages of the project. In this vibration modelling study, empirical calculation was used to predict the vibration due to train operation.

The mathematical form in the equation below:

$$A(f) = F[S(f), P(f), R(f)]$$

where

$S(f)$ is Source related term as a function of frequency
$P(f)$ is Path related term as a function of frequency
$R(f)$ is Receiver related term as a function of frequency

The US Department of Transport has suggested a prediction called DOT-T95-16 which is widely used in US for prediction of ground–borne vibration from the train traffic. The model is based on the Root Mean Square (r.m.s) method. The r.m.s vibration velocity level in 1/3 octave band according to the method is given by the equation below:

$$L_v = L_F + TM_{line} + C_{build}$$

where, L_v is the r.m.s. vibration velocity level in 1/3 octave band, L_F is the force density for line vibration source, TM_{line} is the line source transfer mobility from the track to a point on the ground

close to the building, and C_{build} is the adjustment to account for ground-building foundation interaction and attenuation of vibration amplitudes as vibration propagates through the building. The generalized ground-borne vibration curve is given in figure 3.1

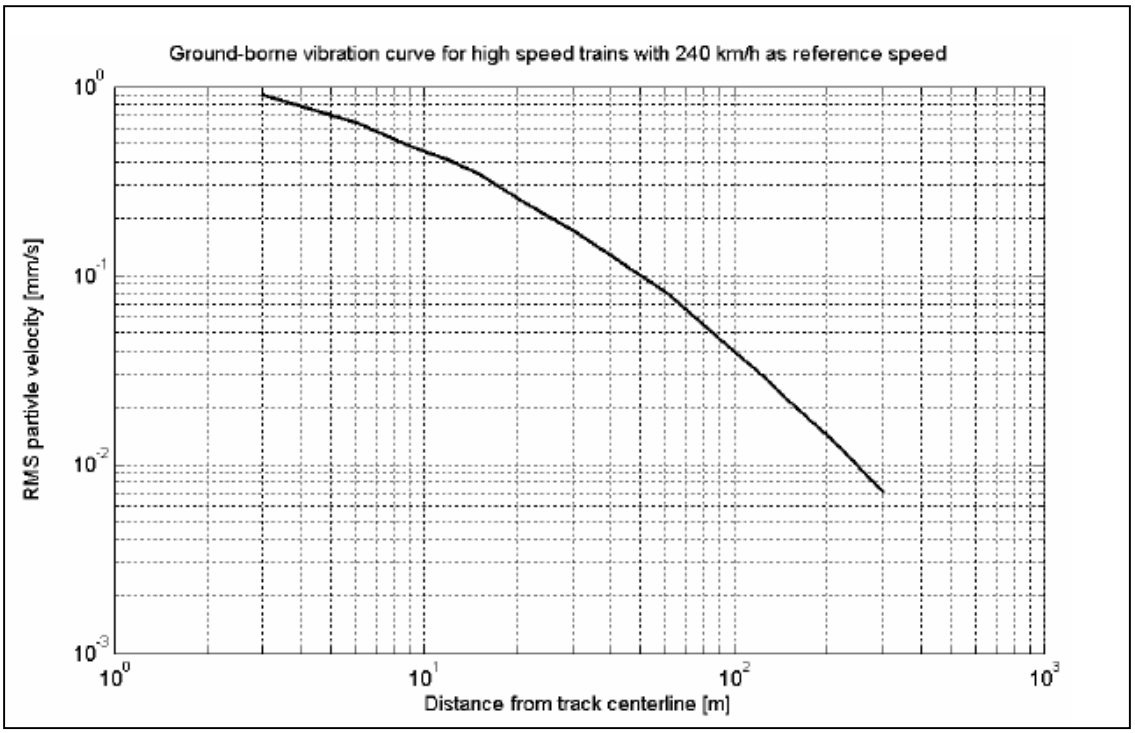


Figure 3.1: Generalized ground-borne vibration curve (DOT-293630-1, 1989).

3.2 Human perception of ground- Borne vibration

The background vibration velocity level in residential areas is usually 50 VdB or lower, well below the threshold of perception for humans which is around 65 VdB. Most perceptible indoor vibration is caused by sources within buildings such as operation of mechanical equipment, movement of people or slamming of doors. Typical outdoor sources of perceptible ground-borne vibration are construction equipment, steel- wheeled trains, and traffic on rough Rails. If the Railway is smooth, the vibration from train traffic is rarely perceptible.

The range of interest is from approximately 50 VdB to 100 VdB. Background vibration is usually well below the threshold of human perception and is of concern only when the vibration affects very sensitive manufacturing or research equipment. the perceptibility threshold is about 65 VdB, human response to vibration is not usually significant unless the vibration exceeds 70 VdB. Rapid transit or light Rail systems typically generate vibration levels of 70VdB or more near their tracks. Because of the heavy locomotives on diesel commuter Rail systems, the vibration levels average about 5 to 10 decibels higher than Rail transit vehicles. If there is unusually rough Rail or track, wheel flats, geologic conditions that promote efficient propagation of vibration, or vehicles with

very stiff suspension systems, the vibration levels from any source can be 10 decibels higher than typical.

The figure 3.2 indicates common vibration source and the human and structural response to ground –borne vibration.

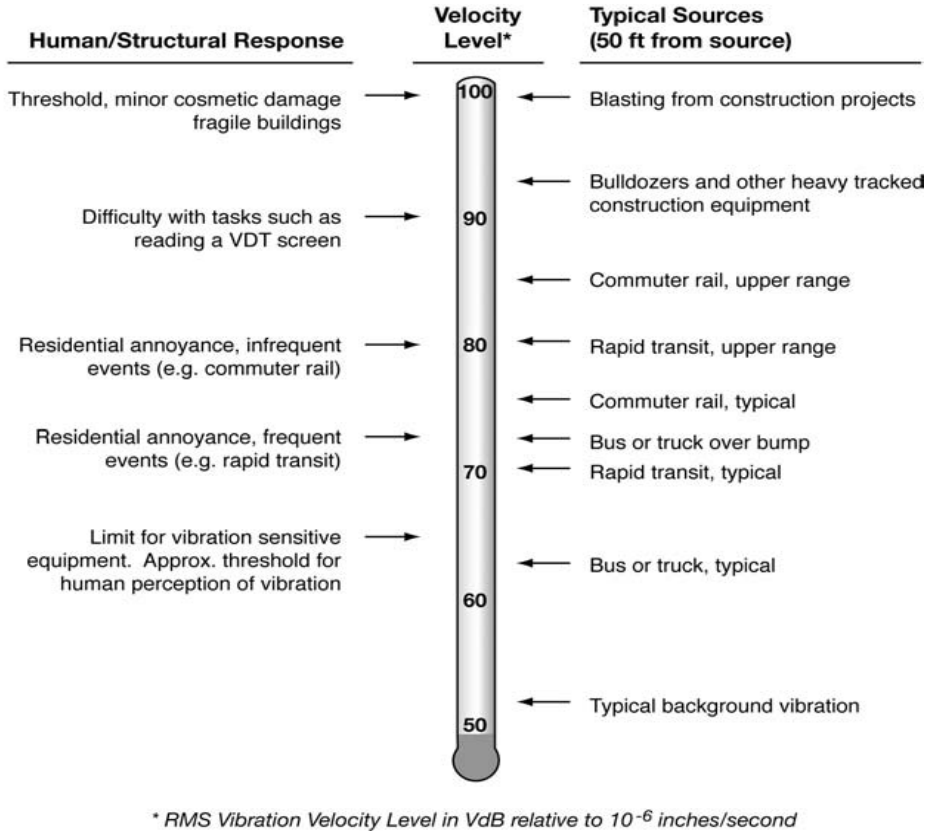


Figure 3.2 Typical levels of Ground-Borne Vibration

The vibration at 15.2 meters (50 feet), the upper range for rapid transit vibration is around 80 VdB and the high range for commuter Rail vibration is 85 VdB. If the vibration level in a residence reaches 85 VdB, most people will be strongly annoyed by the vibration.
Vibration of train operation was calculated at the section near to the sensitive receptors at 8 locations. The vibration was calculated with train movement equations in a homogeneous conduction considering the ground topography, soil condition and the source distance. The prediction of vibration is based on the concept that the train can be considered as a moving multi-punctual excitations source (due to train velocity), where each axes of the train is considered as appoint load that excites the sleepers of the track as the train is running over them. Therefore, each sleeper of the track can be considered as a static punctual source of vibration that transmits the vibration to the ground through piers.

Parameters considered for modeling:

Parameters	Values from DPR
Axle load (Max @8p/m2)	< 16 T
Maximum design speed	80kmph
Average speed	32kmph
Gross tonnage (T) of 3 car rake	184.58
Soil type	Silty clay
Conductivity of soil (1:2% Aq. Extract)	250.6
Elastic modulus of soil	550MN/m^2
Poisson's ration	0.5
Density of soil	1500 kg/m^3
Safe bearing capacity	260 to 300 T/M^2
Number of tracks	2
Height of train passing from ground level	9 m
Average train movement per Hour	17
Basic Unit	3 Car basic unit 2 DMC and 1 TC Every coach should be fully interchangeable with any other coach of same type
Train Composition	3 Car: DMC+TC+DMC
Rail spacing	1435 mm
Distance between the two tracks	4000 mm c/c

4. Vibration Monitoring and Analysis

Vibration modelling was carried out using GIS software and empirical formula mentioned in this report. Vibration modelling was conducted at the sensitive receptors where vibration monitoring was conducted. Vibration modelling was conducted at the center line of metro rail corridor for a stretch of 100 m at each location. The maps of the vibration modelling show the lines with different color representing vibration levels during operation of train. Though vibration is calculated in logarithmic scale, the results is converted into equidistance isopters. The vibration modelling results were validated with the actual measurements carried out at existing metro rail operations. Vibration modelling of all 8 locations is described below:

4.1 Location VB1: Bhakti Shakti Metro Station,

Bhakti Shakti Metro Station is located in PCMC which is at outskirts of Pune city. The Bhakti Shakti Metro Station is at a distance of 40 m from the center line of proposed metro rail alignment. Vibration modelling was conducted at a stretch of 100m at the center of the alignment.

The figure 4.1 is shows the predicted vibration contours that can be generated during operation of metro rail.

Figure 4.1: showing the predicted vibration contours due to train operation at Bhakti Shakti Metro Station location.

The minimum vibration of about 1.225 mm/s is at a distance of 95m from the center line of rail corridor. At the Bhakti Shakti Metro Station location, the predicted vibration (Peak Particle Velocity) would be around 2 mm/s during train operation and the vibration of 2 mm/s will not

cause any impact on the school building and the school building structures will be safe against vibration during metro rail operation.

4.2 Location VB2: Vidyanand Bhavan High School

School is located at Nigdi. It is one of the top School in Nigdi. The School is at a distance of 46 m from the center line of proposed metro rail alignment. Vibration modelling was conducted at a stretch of 100m at the center of the alignment.

The figure 4.2 is shows the predicted vibration contours that can be generated during operation of metro rail at Rachana Hospital.

Figure 4.2: showing the predicted vibration contours due to train operation at Vidyanand Bhavan High School location

The minimum vibration of about 1.225 mm/s is at a distance of 95m from the center line of rail corridor. At the Vidyanand Bhavan High School location the predicted vibration (Peak Particle Velocity) would be around 1.2 mm/s during train operation and the vibration of 1.2 mm/ s will not cause any impact on the School building and will be safe against vibration during metro rail operation.

4.3 Location VB3: Diwan Hospital Pune

Diwan Hospital Pune is located near Tilak Chowk, Nigdi. It is a Diwan Hospital is one of the leading hospital in Pune. The best healthcare professionals provide Comprehensive healthcare; It is located at Nigdi. It provides advanced levels of care in over different specialties including General Surgery, Physiotherapy, Neurology, Orthopedics, Oncology. The Hospital is at a distance of 26 m

from the center line of proposed metro rail alignment. Vibration modelling was conducted at a stretch of 100m at the center of the alignment.

The figure 4.3 is shows the predicted vibration contours that can be generated during operation of metro rail at Diwan Hospital Pune.

Figure 4.3: showing the predicted vibration contours due to train operation at Diwan Hospital Pune

The minimum vibration of about 1.225 mm/s is at a distance of 95m from the center line of rail corridor. At the Asharam collage location the predicted vibration (Peak Particle Velocity) would be around 3.7 mm/s during train operation and the vibration of 3.7 mm/s will not cause any significant impact on the hospital building will be safe against vibration during metro rail operation.

4.4 Location VB4: Star Hospital, Akurdi

Star Hospital, Akurdi is located in Vivek nagar residential area. Star Multispeciality Hospital in Akurdi Pune aims to provide expert healthcare to patients. Their staffs are committed to delivering professional services and outstanding hospitality. All modern facilities and sophisticated medical equipment are available with the objective of providing comprehensive healthcare under one roof. This temple is located at a distance of 72 m from the center line of proposed metro rail alignment. Vibration modelling was conducted at a stretch of 100m at the center of the alignment.

The figure 4.4 is shows the predicted vibration contours that can be generated during operation of metro rail at Star Hospital, Akurdi.

Figure 4.4: showing the predicted vibration contours due to train operation at Star Hospital, Akurdi

The minimum vibration of about 1.225 mm/s is at a distance of 95m from the center line of rail corridor. At the Star Hospital, Akurdi location the predicted vibration (Peak Particle Velocity) would be around 0.25 mm/s during train operation and the vibration of 0.25 mm/s will not cause any significant impact on the hospital structure will be safe against vibration during metro rail operation.

4.5 Location VB5: Khandoba Mandir / Akurdi Metro Station

Khandoba Mandir / Akurdi Metro Station is a distance of 105 m from the center line of proposed metro alignment. It is very famous and lot of devotees come to the temple.

The figure 4.5 is shows the predicted vibration contours that can be generated during operation of metro rail at: Khandoba Mandir / Akurdi Metro Station.

Figure 4.5: showing the predicted vibration contours due to train operation at: Khandoba Mandir / Akurdi Metro Station

The minimum vibration of about 1.225 mm/s is at a distance of 95m from the center line of rail corridor. At the: Khandoba Mandir / Akurdi Metro Station is located at a distance of 105 m from the metro rail corridor, therefore the vibration due to train operation is very minimum (beyond predictable level) and does not have any impact on the Mandir structure.

4.6 Location VB6: Aegis Multispeciality Hospital

Aegis Multispeciality Hospital is located at Pimpri-Chinchwad. It is located at a distance of 42 m from the center line of proposed metro alignment.

The figure 4.6 is shows the predicted vibration contours that can be generated during operation of metro rail at Aegis Multispeciality Hospital.

Figure 4.6: showing the predicted vibration contours due to train operation at Aegis Multispeciality Hospital

The minimum vibration of about 1.225 mm/s is at a distance of 95 m from the center line of rail corridor. At the Aegis Multispeciality Hospital location the predicted vibration (Peak Particle Velocity) would be around 1.8 mm/s during train operation and the vibration of 1.8 mm/s will not cause any impact on the Hospital building and will be safe against vibration during metro rail operation.

4.7 Location VB7: Chinchwad Metro Station / Shri Mahalaxmi Aai temple

Shri Mahalaxmi Aai temple is a sacred space dedicated to worship, reflection, and spiritual connection. It is located at a distance of 92 m from the center line of proposed metro alignment.

The figure 4.7 is shows the predicted vibration contours that can be generated during operation of metro rail at Shri Mahalaxmi Aai temple.

Figure 4.7: showing the predicted vibration contours due to train operation at Chinchwad Metro Station / Shri Mahalaxmi Aai temple

At the Chinchwad Metro Station / Shri Mahalaxmi Aai temple location, the predicted vibration (Peak Particle Velocity) would Be around 0.12 mm/s during train operation and the vibration of 0.12 mm/s is very minimum and will not cause any impact on the i temple building and it will be safe against vibration during metro rail operation.

4.8 Location VB8: Hanuman Mandir, Chinchwad (End of Alignment)

Hanuman Mandir, Chinchwad is a revered spiritual site dedicated to Lord Hanuman, offering a peaceful space for devotion and reflection. It is located at a distance of 22 m from the center line of proposed metro alignment.

The figure 4.8 is shows the predicted vibration contours that can be generated during operation of metro rail at Hanuman Mandir, Chinchwad.

Figure 4.8: showing the predicted vibration contours due to train operation at Hanuman Mandir, Chinchwad

At the Hanuman Mandir, Chinchwad location, the predicted vibration (Peak Particle Velocity) would be around 3 mm/s during train operation and the vibration of 3 mm/s is minimum and will not cause any impact on the Hanuman Mandir, Chinchwad structures and it will be safe against vibration during metro rail operation.

5 Conclusion

5.1 Vibration comparison with criteria mentioned in DGMS standards

Directorate General of Mines and Safety (DGMS), has published the limits for ground vibration for various type of structures. The following table describes the prescribed permissible limits of ground vibration in India, according to the Directorate General of Mines and Safety (DGMS).

Table 5.1: Directorate General of Mines and Safety (DGMS) prescribed permissible limit of ground vibration (INDIA).

Type of Structures	Dominant excitation frequency (Hz)		
	< 8Hz	8-25 Hz	>25hz
(A)Buildings/Structures not belong to the owner			
(i) Domestic houses/structure (Kuchcha, bricks & cement)	5 mm/s	10mm/s	15 mm/s
(ii) Industrial Buildings (RCC & Framed structures)	10 mm/s	20 mm/s	25 mm/s
(iii) Objects of historical importance & sensitive structures	2 mm/s	5 mm/s	10 mm/s
(B)Buildings belonging to owner with limited span of life			
(i) Domestic house/structures (kuchcha, brick & cement)	10 mm/s	15 mm/s	25 mm/s
(ii) Industrial buildings (RCC & framed structures)	15 mm/s	25 mm/s	50 mm/s

The results of the predicted vibration were compared with the DGMS standards as shown in table 5.2:

Table 5.2: Vibration modelling results compared with standards

Location code.	Location	Results from vibration modelling (mm/s)	Results from vibration modelling (VdB)	Vibration standard in (mm/s)	Vibration standard in (VdB)
VB1	Bhakti Shakti Metro Station	2	74	5	134
VB2	Vidyanand Bhavan High School	1.2	72	5	134
VB3	Diwan Hospital Pune	3.7	81	5	134
VB4	Star Hospital, Akurdi	0.25	60	5	134
VB5	Khandoba Mandir / Akurdi Metro Station	Below detectable level	nil	5	134

VB6	Aegis Multispeciality Hospital	1.8	72	5	134
VB7	Chinchwad Metro Station / Shri Mahalaxmi Aai temple	0.12	54	5	134
VB8	Hanuman Mandir, Chinchwad (End of Alignment)	3	81	5	134

The table 5.2 shows that the vibration levels monitored at various locations are within the DGMS limits. Thus, there would be any significant impact on the structures due to the operation of metro rail.

Annexure-12:

List of Trees likely to be Affected

A: Along the Allignment
B: At Entry Exit portals of proposed Stations

A:Trees Likely to be Affected - PCMC to Nigdi Alignment

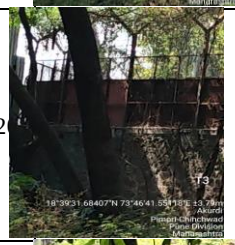
Section	Side	Sr.No.	Botanical Name	Family	Common Name	GBH (cm)	Height (m)	Canopy (m)	Age in years (approx)	GPS Location
		1	*Ficus religiosa* L.	Moraceae	Pimpal	29	5	3	6	18.665954, 73.771715
		2	*Ficus religiosa* L.	Moraceae	Pimpal	27	4	2	6	18.665967, 73.771853
		3	*Azadirachta indica* A.Juss.	Meliaceae	Neem	50	6	4	8	18.666026, 73.771797
		4	*Holoptelea integrifolia* (Roxb.) Planch.	Ulmaceae	Vavla	63	6	4	10	18.665982, 73.771624
		5	*Ficus benjamina* L.	Moraceae	Nandruk	76	7	5	13	18.6636863, 73.7736004
		6	*Ficus benghalensis L.*	Moraceae	Vad	109	4	2	16	18.6635599, 73.7736876
		7	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	87	5	1	14	18.6634179, 73.773797
		8	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	102	3	1	16	18.6633423, 73.7738374
		9	*Ficus religiosa* L.	Moraceae	Pimpal	100	5	2	15	18.663318, 73.773898
		10	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	103	4	2	16	18.6632886, 73.7738931
		11	*Ficus religiosa* L.	Moraceae	Pimpal	69	3	1	11	18.6632400, 73.7739323
		12	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	60	4	1	9	18.663234, 73.773979
		13	*Ficus religiosa* L.	Moraceae	Pimpal	109	5	1	15	18.663204, 73.774020
		14	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	56	4	1	8	18.663127, 73.774109
		15	*Ficus religiosa* L.	Moraceae	Pimpal	89	5	1	13	18.663084, 73.774160
		16	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	26	5	2	6	18.663032, 73.774211
		17	*Ficus religiosa* L.	Moraceae	Pimpal	55	4	2	9	18.6630854, 73.7741147
		18	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	65	4	1	10	18.6630326, 73.7741616
		19	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	54	6	4	10	18.662929, 73.774312
		20	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	89	8	5	16	18.662910, 73.774320
		21	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	108	8	5	19	18.662870, 73.774367
		22	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	115	9	6	21	18.6627715, 73.7744211
		23	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	213	13	10	65	18.662753, 73.774448
		24	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	85	10	6	13	18.6626403, 73.7745009
		25	*Spathodea campanulata* P.Beauv.	Bignoniaceae	Pichkari	57	6	4	10	18.662607, 73.774631
		26	*Saraca asoca* (Roxb.) Willd.	Fabaceae	Sita Ashok	40	5	4	8	18.662517, 73.774589
		27	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	188	11	9	20	18.6624237, 73.77468
		28	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	165	12	7	17	18.6623494, 73.7747105
		29	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	70	6	4	10	18.6624243, 73.7747997
		30	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	67	5	3	10	18.6622582, 73.7749241
		31	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	39	5	2	8	18.661558, 73.775524
		32	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	87	8	5	13	18.6614196, 73.7756298
		33	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	103	7	5	17	18.661410, 73.775669
		34	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	95	7	4	13	18.661368, 73.775696
		35	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	100	8	5	15	18.661221, 73.775842
		36	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	113	7	5	16	18.6558270, 73.7807247
		37	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	238	11	9	60	18.655771, 73.780779
		38	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	329	14	11	73	18.655747, 73.780814
		39	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	183	13	9	34	18.655726, 73.780848
		40	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	200	13	9	43	18.655695, 73.780885
		41	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	109	11	8	18	18.655648, 73.780926
		42	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	256	14	12	64	18.655581, 73.780989
		43	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	138	10	8	27	18.655499, 73.781037
		44	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	114	10	9	18	18.655460, 73.781078
		45	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	191	13	8	26	18.655415, 73.781113
		46	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	100	7	7	15	18.655379, 73.781153
		47	*Caryota urens* L.	Arecaceae	Bherli Mad	56	5	3	8	18.654993, 73.781447
		48	*Ficus benjamina* L.	Moraceae	Nandruk	93	7	6	14	18.654950, 73.781487
		49	*Ficus benjamina* L.	Moraceae	Nandruk	47	5	4	8	18.654919, 73.781513
		50	*Ficus benjamina* L.	Moraceae	Nandruk	85	7	5	13	18.654898, 73.781529
		51	*Ficus benjamina* L.	Moraceae	Nandruk	76	7	4	9	18.654876, 73.781553
		52	*Ficus benjamina* L.	Moraceae	Nandruk	44	5	3	7	18.654864, 73.781577
		53	*Ficus benjamina* L.	Moraceae	Nandruk	53	6	4	8	18.654840, 73.781595
		54	*Ficus benjamina* L.	Moraceae	Nandruk	69	7	4	9	18.654819, 73.781616
		55	*Ficus benjamina* L.	Moraceae	Nandruk	103	8	5	11	18.655090, 73.781395
		56	*Ficus benjamina* L.	Moraceae	Nandruk	42	4	3	7	18.655057, 73.781426
		57	*Ficus benjamina* L.	Moraceae	Nandruk	36	4	3	6	18.655023, 73.781458

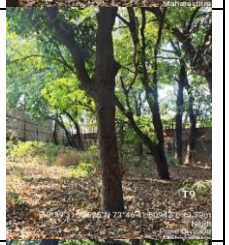
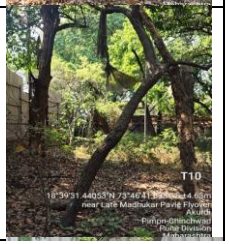
		58	*Ficus benjamina* L.	Moraceae	Nandruk	75	8	5	10	18.654976, 73.781475
		59	*Ficus benjamina* L.	Moraceae	Nandruk	61	6	4	9	18.654940, 73.781495
		60	*Ficus benjamina* L.	Moraceae	Nandruk	29	4	2	5	18.654915, 73.781522
		61	*Ficus benjamina* L.	Moraceae	Nandruk	84	7	4	13	18.654881, 73.781538
		62	*Ficus benjamina* L.	Moraceae	Nandruk	29	3	2	6	18.654853, 73.781570
		63	*Ficus benjamina* L.	Moraceae	Nandruk	56	6	3	9	18.654800, 73.781607
		64	*Ficus benjamina* L.	Moraceae	Nandruk	61	6	4	9	18.654767, 73.781642
		65	*Ficus benjamina* L.	Moraceae	Nandruk	65	7	4	10	18.654741, 73.781661
		66	*Ficus benjamina* L.	Moraceae	Nandruk	89	8	5	14	18.654707, 73.781685
		67	*Ficus benjamina* L.	Moraceae	Nandruk	103	9	5	15	18.654684, 73.781712
		68	*Ficus benjamina* L.	Moraceae	Nandruk	50	4	3	7	18.654645, 73.781742
		69	*Ficus benjamina* L.	Moraceae	Nandruk	49	4	3	7	18.654533, 73.781849
		70	*Ficus benjamina* L.	Moraceae	Nandruk	36	4	2	6	18.654489, 73.781879
		71	*Ficus benjamina* L.	Moraceae	Nandruk	77	8	5	12	18.654456, 73.781904
		72	*Ficus benjamina* L.	Moraceae	Nandruk	81	8	5	14	18.654426, 73.781926
		73	*Ficus benjamina* L.	Moraceae	Nandruk	105	8	6	15	18.654391, 73.781962
		74	*Ficus benjamina* L.	Moraceae	Nandruk	110	8	5	15	18.654358, 73.781981
		75	*Ficus benjamina* L.	Moraceae	Nandruk	61	5	3	8	18.654330, 73.782007
		76	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	215	13	9	43	18.654301, 73.782027
Pimpri to Nigadi Metro Line	**Median**	77	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	192	11	8	40	18.653152, 73.782995
		78	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	140	12	8	35	18.653115, 73.783026
		79	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	92	10	6	28	18.653062, 73.783076
		80	*Ficus benjamina* L.	Moraceae	Nandruk	50	6	4	8	18.653045, 73.783099
		81	*Ficus benjamina* L.	Moraceae	Nandruk	43	5	4	7	18.653022, 73.783122
		82	*Ficus benjamina* L.	Moraceae	Nandruk	61	6	3	8	18.652976, 73.783174
		83	*Holoptelea integrifolia* (Roxb.) Planch.	Ulmaceae	Vavla	34	4	2	6	18.652940, 73.783225
		84	*Holoptelea integrifolia* (Roxb.) Planch.	Ulmaceae	Vavla	41	5	3	6	18.652915, 73.783244
		85	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	119	8	7	25	18.652891, 73.783278
		86	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	105	9	5	23	18.652870, 73.783303
		87	*Melaleuca viminalis* subsp. viminalis	Myrtaceae	Bottlebrush Tree	32	5	3	7	18.652835, 73.783312
		88	*Melaleuca viminalis* subsp. viminalis	Myrtaceae	Bottlebrush Tree	27	4	2	7	18.652777, 73.783348
		89	*Ficus benjamina* L.	Moraceae	Nandruk	69	6	4	9	18.652314, 73.783721
		90	*Ficus benjamina* L.	Moraceae	Nandruk	73	8	5	11	18.652260, 73.783777
		91	*Ficus benjamina* L.	Moraceae	Nandruk	52	6	4	8	18.652209, 73.783816
		92	*Ficus benjamina* L.	Moraceae	Nandruk	51	5	3	8	18.652157, 73.783856
		93	*Ficus benjamina* L.	Moraceae	Nandruk	59	6	3	9	18.652106, 73.783920
		94	*Ficus benjamina* L.	Moraceae	Nandruk	66	5	4	10	18.652062, 73.783960
		95	*Ficus benjamina* L.	Moraceae	Nandruk	93	7	6	15	18.652017, 73.784021
		96	*Ficus religiosa* L.	Moraceae	Pimpal	269	15	13	47	18.6521723, 73.7838045
		97	*Melaleuca viminalis* subsp. viminalis	Myrtaceae	Bottlebrush Tree	43	6	3	7	18.652141, 73.783868
		98	*Melaleuca viminalis* subsp. viminalis	Myrtaceae	Bottlebrush Tree	29	4	3	6	18.652112, 73.783906
		99	*Melaleuca viminalis* subsp. viminalis	Myrtaceae	Bottlebrush Tree	54	6	4	9	18.652081, 73.783946
		100	*Melaleuca viminalis* subsp. viminalis	Myrtaceae	Bottlebrush Tree	36	4	3	6	18.652045, 73.783974
		101	*Melaleuca viminalis* subsp. viminalis	Myrtaceae	Bottlebrush Tree	55	6	4	8	18.651997, 73.784011
		102	*Azadirachta indica* A.Juss.	Meliaceae	Neem	76	6	5	14	18.6470428, 73.7881966
		103	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	83	8	6	16	18.6450408, 73.7899032
		104	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	100	8	6	18	18.644953, 73.789979
		105	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	76	6	4	13	18.644926, 73.789992
		106	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	149	13	8	34	18.644883, 73.790024
		107	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	66	7	5	11	18.644857, 73.790047
		108	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	59	6	4	10	18.644833, 73.790079
		109	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	63	7	5	11	18.644809, 73.790096
		110	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	49	5	3	8	18.644758, 73.790154
		111	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	75	6	4	12	18.644715, 73.790184
		112	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	93	8	5	15	18.644681, 73.790217
		113	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	64	7	4	9	18.644637, 73.790256
		114	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	50	5	3	7	18.644601, 73.790288
		115	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	69	6	4	9	18.644572, 73.790326
		116	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	43	4	2	7	18.644538, 73.790337
		117	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	135	11	8	28	18.644492, 73.790390
		118	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	59	6	4	10	18.644406, 73.790447

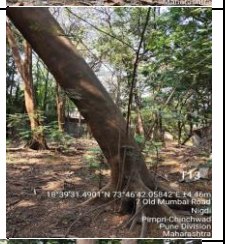
		119	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	54	5	3	10	18.644363, 73.790484
		120	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	63	6	4	10	18.644314, 73.790519
		121	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	66	6	5	11	18.644282, 73.790551
		122	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	75	8	5	12	18.644230, 73.790606
		123	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	55	4	3	10	18.644182, 73.790638
		124	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	40	4	4	8	18.644157, 73.790667
		125	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	58	6	3	9	18.644126, 73.790696
		126	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	67	6	4	8	18.644101, 73.790715
		127	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	75	6	5	11	18.644060, 73.790743
		128	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	181	12	9	43	18.644024, 73.790793
		129	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	76	8	4	12	18.643344, 73.791386
		130	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	52	6	3	9	18.643300, 73.791419
		131	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	39	4	3	7	18.643258, 73.791461
		132	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	53	6	4	8	18.643218, 73.791507
		133	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	48	5	4	8	18.643203, 73.791534
		134	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	63	6	5	10	18.643163, 73.791554
		135	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	60	7	5	10	18.643143, 73.791581
		136	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	79	7	4	14	18.643112, 73.791593
		137	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	82	8	5	15	18.643093, 73.791628
		138	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	54	5	3	10	18.643015, 73.791686
		139	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	43	4	4	9	18.642963, 73.791706
		140	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	51	6	3	9	18.643072, 73.791607
		141	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	28	4	2	7	18.643003, 73.791652
		142	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	61	5	3	10	18.642936, 73.791699
		143	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	53	6	4	8	18.642884, 73.791764
		144	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	48	4	3	8	18.642802, 73.791824
		145	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	58	5	4	10	18.642626, 73.792002
		146	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	69	6	5	11	18.642752, 73.791891
		147	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	52	6	4	8	18.642726, 73.791929
		148	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	96	10	7	20	18.642701, 73.791953
		149	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	127	13	8	31	18.642653, 73.791989
		150	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	159	13	9	45	18.642573, 73.792065
		151	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	108	11	7	24	18.642529, 73.792098
		152	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	73	6	4	12	18.641954, 73.792540
		153	*Tabebuia pentaphylla* Hemsl.	Bignoniaceae	Pink Trumpet Tree	56	6	4	10	18.641965, 73.792536
		154	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	106	9	8	23	18.6418958, 73.7925733

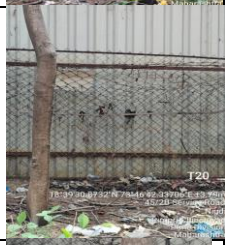
B. Trees Likely to be Affected - At Entry Exit portals of proposed Stations

Section	Side	Tree ID	Sr.No.	Botanical Name	Family	Name of Tree	GBH (M)	Height (m)	Canopy (m)	Age in years (approx)	GPS Location	Tree Photo
hakti Shakti Metro Stati	LHS	T56	1	*Mangifera indica* L.	Anacardiaceae	Amba	0.26	5	2	6	18.6650582, 73.7732292	
	RHS	T57	2	*Ficus religiosa* L.	Moraceae	Pimpal	3.20	12	6	40	18.6653009, 73.7721346	
		T58	3	*Azadirachta indica* A.Juss.	Meliaceae	Neem	1.05	6	3	17	18.6655220, 73.77208661	
		T59	4	*Ficus religiosa* L.	Moraceae	Pimpal	2.10	13	6	29	18.6656364, 73.771807	
		T60	5	*Muntingia calabura* L.	Muntingiaceae	Singapore Cherry	0.30	5	3	7	18.6654242, 73.7721745	
		T61	6	*Spathodea campanulata* P.Beauv.	Bignoniaceae	Pichkari	0.22	5	2	6	18.6654051, 73.7721718	

		T62	**7**	*Ficus religiosa* L.	Moraceae	Pimpal	0.25	4	2	5	18.6653753, 73.7721708	
		T63	**8**	*Ficus religiosa* L.	Moraceae	Pimpal	0.80	10	5	17	18.6650938, 73.7723458	
		T1	**9**	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun	0.83	10	5	14	18.6587917, 73.7781947	
		T2	**10**	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun	0.71	10	5	13	18.6588120, 73.7782275	
		T3	**11**	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun	1.03	11	5	19	18.6588400, 73.7782	
		T4	**12**	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun	1.12	12	5	24	18.6589356, 73.7783177	

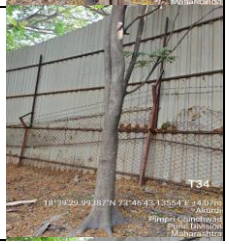
T5	**13**	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun	1.10	9	3	18	18.6589632, 73.7782242	
T6	**14**	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun	1.00	10	5	17	18.6589737, 73.7782822	
T7	**15**	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun	1.52	12	5	27	18.6587586, 73.7781923	
T8	**16**	*Mangifera indica* L.	Anacardiaceae	Amba	1.81	12	6	36	18.6588260, 73.7782339	
T9	**17**	*Mangifera indica* L.	Anacardiaceae	Amba	1.44	12	6	31	18.6587968, 73.7782232	
T10	**18**	*Bauhinia racemosa* Vahl	Fabaceae	Apta	0.65	6	3	9	18.6587443, 73.7782423	

T11	**19**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	0.95	12	6	14	18.6586894, 73.7782587	
T12	**20**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	0.53	9	3	8	18.6586665, 73.7782758	
T13	**21**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	2.41	12	6	51	18.6587088, 73.7783295	
T14	**22**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	1.03	12	6	17	18.6586668, 73.7784431	
T15	**23**	*Azadirachta indica* A.J uss.	Meliaceae	Neem	0.45	6	2	6	18.6586227, 73.7783372	
T16	**24**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	2.10	12	5	43	18.6585779, 73.7783771	

	T17	**25**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	1.20	12	3	15	18.6585455, 73.7784139	
	T18	**26**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	1.50	8	3	19	18.6585344, 73.7784247	
	T19	**27**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	0.51	6	2	8	18.6585214, 73.7784408	
	T20	**28**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	0.35	7	2	6	18.6585099, 73.7784555	
	T21	**29**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	0.50	9	3	8	18.6584994, 73.7784622	
	T22	**30**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	1.34	12	6	18	18.6584867, 73.7785011	

LHS

	LHS	**T23**	**31**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	0.90	9	3	19	18.6584616, 73.7785179	
		T24	**32**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	0.80	8	3	16	18.6584766, 73.7785424	
		T25	**33**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	0.40	8	3	7	18.6584969, 73.7785504	
		T26	**34**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	0.41	9	3	7	18.6585166, 73.7785665	
		T27	**35**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	0.52	10	3	8	18.6585325, 73.7785719	
Nigadi Metro Station		**T28**	**36**	*Delonix regia (Hook.) Raf.*	Leguminosae	Gulmohar	0.72	11	2	14	18.6585493, 73.778648	

T29	**37**	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	0.50	9	3	8	18.6583800, 73.7785645	
T30	**38**	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	0.40	7	2	6	18.6583473, 73.778592	
T31	**39**	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	1.10	12	5	25	18.6582911, 73.7786081	
T32	**40**	*Ficus racemosa* L.	Moraceae	Umbar	0.90	9	5	21	18.6583250, 73.7786141	
T33	**41**	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun	2.10	12	4	45	18.6583282, 73.778649	
T34	**42**	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	0.90	12	5	16	18.6582533, 73.7786745	

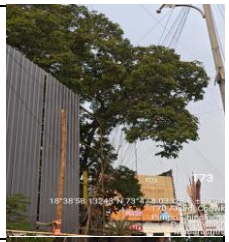
T35	**43**	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	0.35	6	2	6	18.6582155, 73.7787093	
T36	**44**	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	0.28	5	2	5	18.6581815, 73.778764	
T37	**45**	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	0.24	6	2	5	18.6581993, 73.7787817	
T38	**46**	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	0.25	5	2	6	18.6581453, 73.7788226	
T39	**47**	*Mangifera indica* L.	Anacardiaceae	Amba	0.28	6	2	6	18.6580849, 73.7788391	
T40	**48**	*Caryota urens L.*	Arecaceae	Bherali Mad	0.30	6	2	5	18.6581043, 73.7788679	

	T41	**49**	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	5.60	15	8	96	18.6581125, 73.7789497	
	T42	**50**	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	0.75	11	5	14	18.6584591, 73.7785591	
	T43	**51**	*Grevillea robusta* A.Cunn. ex R.Br.	Proteaceae	Silver Oak Tree	0.28	6	2	7	18.6580465, 73.7789641	
	T44	**52**	*Leucaena leucocephala* (Lam.) de Wit	Mimosaceae	Subabul	0.30	6	2	6	18.6579832, 73.7790218	
	T45	**53**	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun	0.80	9	3	12	18.6586011, 73.7777025	
	T46	**54**	*Alstonia scholaris (L.) R. Br.*	Apocynaceae	Satvin	1.20	11	4	16	18.6585248, 73.7777622	

	RHS	**T47**	**55**	*Mangifera indica* L.	Anacardiaceae	Amba	1.12	10	6	24	18.6584629, 73.777847	
		T48	**56**	*Mangifera indica* L.	Anacardiaceae	Amba	0.67	10	5	9	18.6583994, 73.777906	
		T49	**57**	*Alstonia scholaris (L.) R. Br.*	Apocynaceae	Satvin	1.00	11	6	13	18.6584677, 73.777846	
		T50	**58**	*Alstonia scholaris (L.) R. Br.*	Apocynaceae	Satvin	1.20	12	5	16	18.6583987, 73.7778996	
		T51	**59**	*Alstonia scholaris (L.) R. Br.*	Apocynaceae	Satvin	1.40	11	5	19	18.6582888, 73.7780056	
		T52	**60**	*Ficus racemosa* L.	Moraceae	Umbar	1.40	7	6	25	18.6582755, 73.7779332	

		T53	**61**	*Alstonia scholaris (L.) R. Br.*	Apocynaceae	Satvin	0.86	10	4	14	18.6579165, 73.7783764	
		T54	**62**	Cordia dichotoma G.Forst.	Boraginaceae	Bhokar	1.00	11	4	16	18.6580102, 73.7782842	
		T55	**63**	*Alstonia scholaris (L.) R. Br.*	Apocynaceae	Satvin	0.70	10	5	10	18.6581106, 73.7781796	
	LHS	**T64**	**64**	*Samanea saman (Jacq.) Merr.*	Fabaceae	Rain Tree	3.80	11	8	75	18.6508593, 73.7863731	
		T65	**65**	*Ficus racemosa* L.	Moraceae	Umbar	0.30	4	1	6	18.6502497, 73.785731	
		T66	**66**	*Mangifera indica* L.	Anacardiaceae	Amba	0.26	5	2	6	18.6501926, 73.7857458	

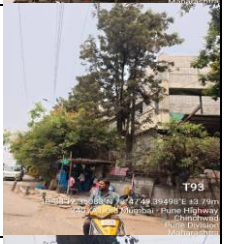
	T67	**67**	*Millingtonia hortensis* L.f.	Bignoniaceae	Akashneem	0.90	10	3	17	18.6492516, 73.7857565	
	T68	**68**	*Millingtonia hortensis* L.f.	Bignoniaceae	Akashneem	0.35	7	3	6	18.6492516, 73.7857565	
	T69	**69**	*Millingtonia hortensis* L.f.	Bignoniaceae	Akashneem	0.90	10	4	12	18.6493577, 73.7856868	
	T70	**70**	*Millingtonia hortensis* L.f.	Bignoniaceae	Akashneem	0.99	10	4	15	18.6494054, 73.7856418	
	T71	**71**	*Millingtonia hortensis* L.f.	Bignoniaceae	Akashneem	0.90	10	3	17	18.6494416, 73.7856049	
	T72	**72**	*Millingtonia hortensis* L.f.	Bignoniaceae	Akashneem	1.20	11	4	20	18.6494686, 73.785575	

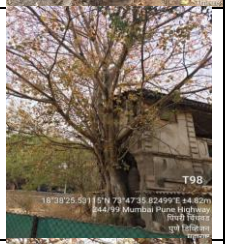
Akurdi Metro Station		**T73**	**73**	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	1.80	11	6	26	18.6495391, 73.7854893	
		T74	**74**	*Ficus benjamina* L.	Moraceae	Nandruk	1.81	11	5	17	18.6510245, 73.784349	
		T75	**75**	*Ficus benjamina* L.	Moraceae	Nandruk	0.98	11	5	15	18.6510013, 73.7843691	
		T76	**76**	*Ficus benjamina* L.	Moraceae	Nandruk	0.85	10	5	14	18.6509616, 73.7844003	
		T77	**77**	*Ficus benjamina* L.	Moraceae	Nandruk	0.90	10	5	16	18.6509334, 73.7844372	
		T78	**78**	*Ficus benjamina* L.	Moraceae	Nandruk	0.90	10	5	17	18.6509159, 73.7844204	

RHS

T79	**79**	*Ficus benjamina* L.	Moraceae	Nandruk	1.40	12	5	16	18.6508918, 73.7844425	
T80	**80**	*Ficus benjamina* L.	Moraceae	Nandruk	1.30	10	5	21	18.6508911, 73.7844627	
T81	**81**	*Ficus benjamina* L.	Moraceae	Nandruk	0.40	9	3	7	18.6508803, 73.7844818	
T82	**82**	*Ficus benjamina* L.	Moraceae	Nandruk	1.40	11	5	22	18.6508609, 73.7844982	
T83	**83**	*Ficus benjamina* L.	Moraceae	Nandruk	1.30	11	5	16	18.6508412, 73.7845079	
T84	**84**	*Ficus benjamina* L.	Moraceae	Nandruk	1.45	10	4	24	18.6508190, 73.7845347	

		T85	**85**	*Ficus benjamina* L.	Moraceae	Nandruk	1.70	10	4	19	18.6507653, 73.784577	
		T86	**86**	*Polyalthia longifolia (Sonn.) Hook.f. & Thomson*	Annonaceae	Ashok	0.50	8	3	8	18.6508403, 73.7844466	
		T87	**87**	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	0.75	10	5	13	18.6508911, 73.7844151	
		T88	**88**	*Ficus benjamina* L.	Moraceae	Nandruk	0.66	10	4	9	18.6509073, 73.7844164	
		T89	**89**	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	0.76	10	3	12	18.6509356, 73.7843842	
		T90	**90**	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Sonmohar	1.10	12	4	16	18.6509724, 73.7843416	

		T91	**91**	*Ficus benjamina* L.	Moraceae	Nandruk	1.40	9	4	26	18.6406676, 73.7931705	
		T92	**92**	*Ficus benjamina* L.	Moraceae	Nandruk	0.78	10	3	16	18.6405580, 73.7932563	
		T93	**93**	*Ficus benjamina* L.	Moraceae	Nandruk	0.65	10	3	9	18.6404646, 73.7933106	
		T94	**94**	*Ficus benjamina* L.	Moraceae	Nandruk	0.35	8	3	7	18.6404090, 73.7933538	
		T95	**95**	*Ficus religiosa* L.	Moraceae	Pimpal	3.20	11	5	59	18.6403705, 73.7932774	
	RHS	**T96**	**96**	*Pithecellobium dulce (Roxb.) Benth.*	Fabaceae	Vilayati Chinch	0.70	6	4	8	18.6403362, 73.7932657	

Chinchwad Metro Station		**T97**	**97**	*Ficus benjamina* L.	Moraceae	Nandruk	0.70	9	4	11	18.6392370, 73.7943466	
		T98	**98**	*Ficus religiosa* L.	Moraceae	Pimpal	0.98	8	4	16	18.6391843, 73.7943318	
		T99	**99**	*Ficus benjamina* L.	Moraceae	Nandruk	0.89	9	4	14	18.6392850, 73.7943382	
		T100	**100**	*Ficus benjamina* L.	Moraceae	Nandruk	0.90	7	3	18	18.6394572, 73.7942024	
		T101	**101**	*Ficus benjamina* L.	Moraceae	Nandruk	0.85	9	3	16	18.6395121, 73.7941578	
		T102	**102**	*Ficus benjamina* L.	Moraceae	Nandruk	1.60	9	4	20	18.6366742, 73.7972082	

	LHS	**T103**	**103**	*Ficus benjamina* L.	Moraceae	Nandruk	1.80	10	5	24	18.6367673, 73.7971612	
		T104	**104**	*Grevillea robusta* A.Cunn. ex R.Br.	Proteaceae	Silver Oak Tree	0.80	12	4	14	18.6368693, 73.7970965	

Annexure-13:
Public Consultation Report

Public Consultation
for
PCMC to Nigdi (Phase-1 Extension) of the Pune Metro Rail Project (PMRP)

- The PCMC to Nigdi (Phase-1 Extension) of the Pune Metro Rail Project (PMRP) is a significant infrastructure initiative aimed at improving urban mobility in the rapidly growing Pimpri-Chinchwad region.
- This extension covers four elevated stations namely Chinchwad, Akurdi, Nigdi and Bhakti Shakti.
- The project, financed by the European Investment Bank (EIB), addresses the increasing demand for an efficient and sustainable public transport system, helping reduce traffic congestion, air pollution, and reliance on private vehicles.
- The Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) have been prepared in accordance with national regulations and the environmental and social standards of the EIB.

As per EIB Environmental & Social Standards (ESS) 2022,

"In order to ensure the effective participation of the identified stakeholders, the promoter shall make available to the public the following information in the most accessible way and as soon as it can reasonably be provided:

a. *The purpose, nature and scale of the project, including the duration of proposed project activities;*
b. *The description of the likely project impacts and risks for local communities, as well as the proposed mitigation and/or compensatory/remedial measures as defined in Standard 1;*
c. *As and where applicable, the description of potential impacts and risks that might disproportionately affect vulnerable, marginalised, and/or discriminated-against groups and an overview of the different measures proposed to avoid and minimise these;*
d. *The proposed stakeholder engagement process and opportunities for public participation, including locations and dates of any envisaged public consultation meetings, and the process by which meetings are notified and reported, as described in the SEP and its revisions/updates where applicable;*
e. *The available project-level grievance or feedback mechanism, the EIB Group's Complaints Mechanism20 and how stakeholders can access them; and*
f. *Any opportunities for benefit-sharing and added value for affected communities, where applicable."*

Accordingly, Maha-Metro (PMRP) with the help of MITCON (the environmental consultant engaged for preparation of the ESIA) organised Public Consultations at following two locations along the PMRP North extension (PCMC to Nigdi) alignment:

- Location 1: .....Tilak Chowk, Nigdi.....
- Location 2: .....Chinchwad Station Chowk.....

Notice for the same was given in the identified areas one week in advance (i.e. on 1st April, 2025) in the form of posters put up at bus stations and other locations along the alignment, frequented by general public. Following persons attended the Public Consultations and were informed about all relevant details of the project as mentioned above:

Attendance Sheet

Date : 08/04/2025
Location 1 : Tilak Chowk, Nigdi
Start Time : 3:00 pm ~~to 3:45 pm~~
End Time : 3:45 pm

Sr. No.	Name of Stakeholder	Contact No.	Signature
1.	Prabhakar Deshpande	Toration	Prabhakar Deshpande
2.	Santosh Shinde	—	Santosh
3/4	Madhukar Suryavanshi / Santosh Girmkar	Tilak chowk Nigdi	
5	ARJUN Gole		
6	Rahul Kanivasare		Rahul
7	Sambhaji Dhumal		
8	Rohidas Parathe.		
9	Shabbir Nabaf		Shabbir
10	~~Bekdhe~~ B. B.	Night 95	~~Bekdhe~~ B. B.
11)	Bandu Pangam		
12)	Santosh Yadav		
13)	Deepak mokashi		
14)	K.G.K.		K.G.K.
15)	R. L. Gorwhe	9822108277	
16)	Vishal Waghmode	9359924844	
17)	Omkar	9307283270	
18)	Narayan Apte	—	
19)	Sudhakar Pulate	—	
20)	Pandurang Bhosale	—	
21)	Sunil Patil	—	
22)	Sopan Mahadik	—	
23)			

Attendance Sheet

Date : 08/04/2025
Location 2 : Chinchwad Station Chowk
Start Time : 4:30 pm
End Time : 5:15 pm

Sr. No.	Name of Stakeholder	Contact No.	Signature
1)	Sagar Asule	7972958981	
2)	Sunil Thorat	9881286928	
3)	Geeta Khilare	9112845573	
4)	Irfana khaja Bagwan		
5)	Manali Mehtre		
6)	Laxmi Nasade		
7)	AKASH		
8)	mussur		
9)	Murti Nair		
10)	Muddsar Shaikh		
11)	Arbaaz Shaikh		
12)	Navneet Naik		
13)	pramod pathare		
14)	Puneet chuvan		
15)	Jay Prakash Singh	—	
16)	Asif Khan	—	
17)	Akil Syed	—	
18)	Suraj Singh	—	

Some Photographs taken during Formal Public Consultations at Tilak Chowk (Nigdi) and Chinchwad Station Chowk (Chinchwad) along the PCMC-Nigdi alignment

PUBLIC CONSULTATION

for

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT (ESIA)

of

PUNE METRO RAIL PROJECT PHASE-1 EXTENSION

(PCMC TO NIGDI ALIGNMENT)

Date: 8th April, 2025

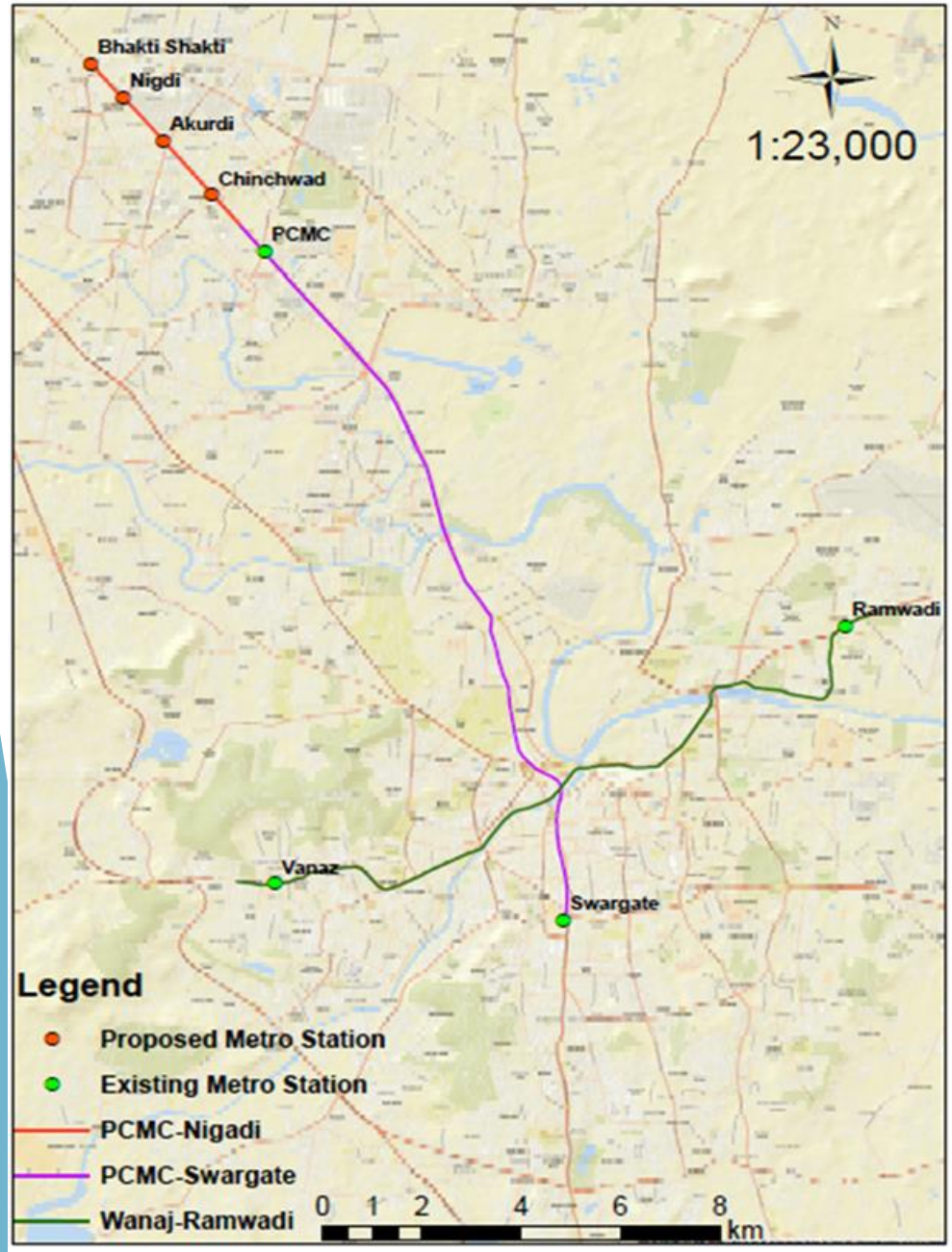
Project Brief

The PCMC to Nigdi (Phase-1 Extension) is a vital part of Pune's urban transit expansion, aimed at providing efficient, safe, and environmentally friendly transport options. This extension will integrate seamlessly with existing metro infrastructure and enhance commuter convenience.

- **Project Name:** PCMC to Nigdi Metro (PMRP Phase-1 Extension).
- **Corridor Type:** Fully elevated.
- **Total Length:** 4.413 km.
- **Funding Agency:** European Investment Bank (EIB).
- **Implementation Agency:** Maharashtra Metro Rail Corporation (Maha Metro).
- **Stations Covered:** Station 1 (Chinchwad), Station 2 (Akurdi), Station 3 (Nigdi), Station 4 (Bhakti Shakti)

Corridor	Stations			Length (in Km)		
	Elevated	At Grade	Total	Elevated	Underground	Total
PCMC to Nigdi (Phase-1 Extension)	4	0	4	4.413	0	4.413
Total	**4**	**0**	**4**	**4.413**	**0**	**4.413**

Alignment Map Showing Station Locations



Legal Framework (Key Applicable Legal Framework for the Project**)**

Environment (Protection) Act (1986) and Rules (1986)	National Conservation Strategy and Policy Statement on Environment and Development of 1992
National Environment Policy of 2006	Environmental Impact Assessment (EIA) under EIB's Environmental and Social Standards (updated in February 2022)
The Noise Pollution (Regulation and Control) Rules, 2000 (Amended 2002)	The Water (Prevention and Control of Pollution) Act 1972 (Amended 1988) and Rules 1974
Metro Rail Transit System, Guidelines for Noise and Vibrations, RDSO, Ministry of Railways, September 2015	The Maharashtra Prevention of Water Pollution Act, 1969 (Amended 1981)
The Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules 1982	Policy Statement for Abatement of Pollution of 1992
Municipal Solid Waste (MSW) Rules, 2000	Solid Waste Management Rules, 2016
Hazardous and Other Wastes (Management and Transboundary Movement) Amendment Rules 2019	Construction and Demolition Waste Management Rules, 2016
Guidelines on Environmental Management of Construction and Demolition (C&D) Waste, March 2017	The Mines and Minerals (Development and Regulation) Act, 1957
Central Motor Vehicle Act (1988) and Rules (1988	Indian Treasure Trove Act, 1878 (as modified up to September 1949); Ancient Monuments and Archaeological Sites and Remains Act (1958)
Interstate Migrant Workmen (Regulation of Employment and conditions of Service) Act 1979	Child and Adolescent Labour (Prohibition and Regulation) Act, 1986
Occupational Safety, Health and Working Conditions Code, 2020 (OHSWC Code)	Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2007
Employees State Insurance Act, 1948 (ESI)	Workmen's Compensation Act, 1923

Baseline / Findings

Methodology:

- **Primary data collection:** Air, water, soil, noise, vibration monitoring, ecology, socio-economics.
- **Secondary data sources:** Meteorology, biodiversity, socio-economics, hydrogeology, traffic study.
- Field surveys and interactions with stakeholders.

Physical Environment & Geology

Physiography:

The region is part of the Western Ghats and Deccan Plateau, characterized by hills, valleys, and plains.

Three distinct topographical belts: western (rugged terrain), central (hills and plateaus), eastern (gradual slopes and plains).

Major drainage systems: Bhima-Ghod, Mula-Mutha, and Nira Rivers, contributing to the hydrogeological framework.

Geology:

Dominated by Deccan Volcanic Basalts of Upper Cretaceous to Eocene age.

Composed of simple and compound lava flows with varied porosity and water retention capacities.

Presence of dykes and fractures, which influence groundwater movement and availability.

Hydrogeology:

Two major aquifer systems: Shallow (9-30m) and Deep (48-175m) basalt formations.

Groundwater occurs in phreatic to semi-confined conditions, with variable yield potential.

Baseline / Findings

Ambient Air Quality (6 Locations Monitored)

Pollutant	NAAQS Limit	Range Found	Observation
PM2.5 (µg/m³)	60	10.54 - 32.85	Air quality is **within GoI's NAAQS limits** for **PM10, PM2.5, NOx, and SO2**.
PM10 (µg/m³)	100	42.14 - 78.65	
SO2 (µg/m³)	80	≤10 - 21.87	
NOx (µg/m³)	80	16.47 - 27.45	
CO (mg/m³)	2	0.02 - 1.54	

Noise Level (6 Locations Monitored)

Location	Zone	Day Time (dB)	Night Time (dB)	CPCB Limit (dB)	Observation
Bhakti Shakti Metro Station	Commercial	64.7	46.7	65/55	Noise levels are **within CPCB limits at all the monitored locations**
Vidyanand Bhavan High School	Silent	41.5	38.5	50/40	
Nigdi Metro Station	Commercial	63.8	53.4	65/55	
Khandoba Chowk	Commercial	62.7	43.5	65/55	
Chinchwad Metro Station	Commercial	64.4	52.8	65/55	
Chinchwad End of Alignment	Commercial	63.4	53.7	65/55	

Baseline / Findings

Water Quality (4 Groundwater & 3 Surface Water Locations)

Parameter	IS 10500 Limit	Groundwater (Range)	Surface Water (Range)	Observation
pH	6.5 - 8.5	7.32 - 7.45	7.18 - 7.27	▪ Groundwater is **safe for drinking** but **hardness is slightly high**. ▪ Surface water is **contaminated with coliform bacteria**, requiring **treatment before use**.
Total Dissolved Solids (mg/l)	≤ 500	195 - 391	143 - 289	
Total Hardness (mg/l)	≤ 200	98.13 - 189.25	71.14 - 137.89	
Chloride (mg/l)	≤ 250	21.57 - 48.25	10.15 - 14.56	
Fluoride (mg/l)	≤ 1.0	<0.1	<0.1	
BOD (mg/l)	≤ 3	-	7 - 10	
DO (mg/l)	≥ 4	-	4.0 - 4.5	
Total Coliform (MPN/100ml)	0	Absent	Present in all surface water samples	

Baseline / Findings

Soil Analysis Results (5 Locations):

Parameter	Range Found	Standard Classification	Observation
Soil Moisture (%)	12.42 - 24.02	Low to moderate	▪ Soil quality is **poor for agriculture** in the project area.
Water Holding Capacity (%)	41.6 - 58.4	Moderate	
Organic Carbon (%)	0.14 - 0.32	Low	
Nitrogen (kg/ha)	87.28 - 110.28	Very Low	
Phosphorus (kg/ha)	5.25 - 15.24	Poor	
Potassium (kg/ha)	91.25 - 120.44	Moderate	

Biological Aspects- Vegetation:

- **154 trees will be affected** due to metro construction, primarily along roads and medians.
- Common species include Neem, Peepal, Banyan, Rain Tree, and Gulmohar.

Flora:

448 plant species recorded:

211 Trees, 110 Herbs, 69 Shrubs, 58 Climbers.

154 trees will be affected by construction, mostly along roadsides.

Threatened Species (IUCN List):

Near Threatened (NT): *Aegle marmelos*, *Dalbergia melanoxylon*

Vulnerable (VU): *Khaya senegalensis*, *Santalum album*, *Saraca asoca*

Endangered (EN): *Tectona grandis*, *Ailanthus altissima*

Fauna:

Wildlife Recorded in 10 km Study Area:

Mammals: Indian Palm Squirrel, Indian Hare.

Birds: 40 species (Egret, Kingfisher, Parakeet).

Reptiles: Indian Cobra, Garden Lizard.

Amphibians: Common Toad, Skittering Frog.

Insects: 25 Butterfly species.

Impact: Loss of tree cover but no significant impact on protected wildlife.

Impact & Mitigation

Significance of the Project:

Impact Category	Significance	Nature of Impact
Public Transport	High – Enhances connectivity and accessibility.	Permanent Positive Impact
Traffic Congestion	High – Reduces dependency on private vehicles.	Permanent Positive Impact
Economic Growth	Medium – Boosts local business opportunities.	Permanent Positive Impact
Environmental Impact	Moderate – Air & noise pollution during construction.	Temporary Negative Impact
Social Impact	Moderate – Disruptions to local businesses & traffic.	Temporary Negative Impact

Environmental & Social Impact:

Impact Area	Potential Impact	Duration	Severity
Air Quality	Increased dust & emissions.	Temporary	Moderate
Noise & Vibration	Higher levels near sensitive areas.	Temporary	Moderate
Water Resources	Risk of groundwater contamination.	Temporary	Low
Biodiversity	Some tree cutting; minimal wildlife impact.	Permanent	Low
Traffic Disruption	Increased congestion during construction.	Temporary	High
Community Impact	Restricted access to businesses & public services.	Temporary	Moderate

Impact & Mitigation

Mitigation Measures:

Impact Category	Mitigation Strategy	Implementation Stage
Air Pollution	Dust suppression, emission control on machinery.	Construction
Noise Control	Noise barriers, low-noise equipment.	Construction
Water Protection	Proper wastewater disposal, groundwater monitoring.	Construction
Waste Management	Safe disposal of hazardous and construction waste.	Construction
Traffic Control	Diversion plans, traffic marshals, road safety measures.	Construction
Social Measures	Compensation, local employment (50%), grievance redressal.	Design & Pre-, Construction

Residual Impact After Mitigation:

Stage	Expected Residual Impact	Impact Level
Construction	Moderate – Some air, noise, and traffic issues will remain.	Medium
Operation	Minimal – Improved transportation reduces long-term pollution.	Low

Institutional Framework for ESMP Monitoring

Particulars	Frequency of reporting	Reporting by / Reporting to	Review by / Monitoring by
Implementation of ESMP: • Start of the construction & during construction. (Monthly Environmental Monitoring Report)	Monthly till completion of construction	Contractor to GC	Maha-Metro
Submission of ESMP & EMoP Progress report to MDBs	Half Yearly	GC to MDBs	Maha-Metro
Submission of External E&S progress report by third party (If required)	• Semi-annually for the three years of construction phase • Yearly during first 2 years of Operation & Maintenance.	GC to MDBs	Maha-Metro

Grievance Redress Mechanism (GRM)

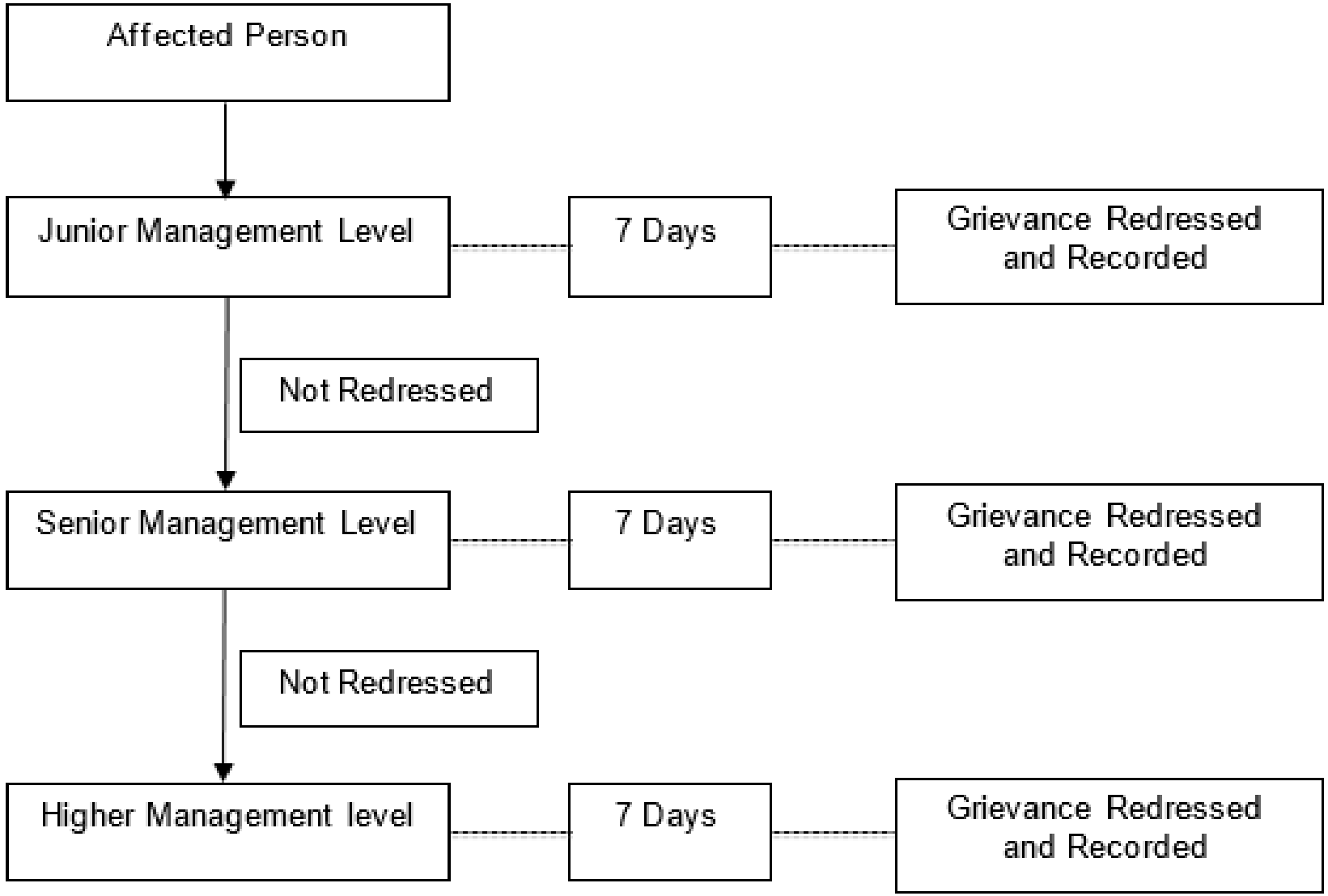
Purpose of GRM:

- Provide a structured, transparent system for addressing grievances from Project-Affected Persons (PAPs), workers, and local communities.
- Minimize disputes and conflicts related to land acquisition, displacement, compensation, and environmental/social concerns.
- Ensure compliance with national and international standards, including EIB's Environmental and Social Standards.
- Promote stakeholder engagement by facilitating dialogue and timely dispute resolution.

Types of Grievances Covered:

- ✔ Land acquisition and compensation disputes.
- ✔ Impact on livelihoods (businesses, employment loss).
- ✔ Environmental concerns (noise, dust, water contamination).
- ✔ Safety concerns related to construction activities.
- ✔ Worker grievances on wages, working conditions, and safety.

Grievance Redress Mechanism (GRM)



ESMP Budget

Sr. No.	Item	Estimated Total Cost (₹)
1.	Compensatory Plantation of 1540 trees in lieu of 154 affected trees (as per the PCMC Tree Authority guidelines in 1:10 ratio)	1,54,00,000
2.	Rainwater Harvesting (@ Rs. 2,00,000 /RWH structure for total of 20 structures)	40,00,000
3.	Environmental Monitoring	1,90,40,000
4.	Training and Capacity building	10,00,000
5.	R&R and RP	21,88,00,000
Total ESMP Cost for PCMC to Nigdi (Phase-1 Extension)		**25,82,40,000**

THANK YOU!!!

Annexure 14: Noise Modelling Report

ABBREVIATIONS

EIB	-	European Investment Bank
CPCB	-	Central Pollution Control Board
EIA	-	environmental impact assessment
FTA	-	Federal Transit Administration
MMRCL	-	Maharashtra Metro Rail Corporation Limited
PMRP	-	Pune Metro Rail Project
RoW	-	right of way
SPL	-	sound pressure level
SPS	-	Safeguards Policy Statement 2009

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A. INTRODUCTION

1. This is the noise assessment report prepared for the Phase-1 of the proposed Pune Metro Rail Project -(PMRP) located in Pune City of Maharashtra State in India. The project will be implemented by the Maharashtra Metro Rail Corporation Ltd. (Maha Metro) and it is proposed for financing from the European Investment Bank (EIB).

2. An environmental & social impact assessment (ESIA) has been carried out for the project in line with EIB's Safeguards Policy Statement (SPS 2009) requirements. Considering the nature and the location of project, additional assessments are required to ensure that the noise impacts from the project are analyzed and mitigated. Accordingly, this noise assessment report has been carried out as a supplementary assessment to comply with EIB's SPS 2009 requirements. This report will be annexed to the ESIA report.

B. PROJECT DESCRIPTION

3. With a view of developing effective and efficient mass transit system in addition to existing public transportation, the Maharashtra Metro Rail Corporation Ltd. intends to develop the proposed Pune Metro Rail Project – Phase 1 having North & South Corridors. Details of the North extension corridor (PCMC to Nigdi alignment) is given in **Table 1**. The proposed metro corridor in Pune city are shown in **Figure 1**.

Table 1 Details of Pune Metro Rail Project – Phase-1 Extension

Corridor	Stations			Length (in Km) As per DPR		
	Elevated	At Grade	Total	Elevated	Underground	Total
PCMC to Nigdi (Phase-1 Extension)	4	**0**	**4**	4.413	0	4.413
Total	**4**	**0**	**4**	**4.413**	**0**	**4.413**

C. BASELINE NOISE LEVELS AT SENSITIVE RECEPTORS

4. 1 sensitive receptor which is Vidyanand Bhawan High School have been found to be located within 100 m on either side of the project alignment. The baseline noise levels at sensitive receptors are presented in **Table 2** below.

Table 2 Baseline Noise Levels at Sensitive Receptors

Sample No.	Location	Significance/Category of Area/ Zone	24 hourly Average Noise Level Values [in Leq dB (A)]	
			Day	Night
NQ1	Bhakti Shakti Metro Station	Proposed Station/ Commercial	64.7	46.7
NQ2	Vidyanand Bhawan High School (Near)	Sensitive Receptors (School)/ Silent	41.5	38.5
NQ3	Nigdi Metro Station	Proposed Station/ Commercial	63.8	53.4
NQ4	Khandoba Chowk	Commercial	62.7	43.5
NQ5	Chinchwad Metro Station	Proposed Station/ Commercial	64.4	52.8
NQ6	Chinchwad (End of Alignment)	Commercial	63.4	53.7

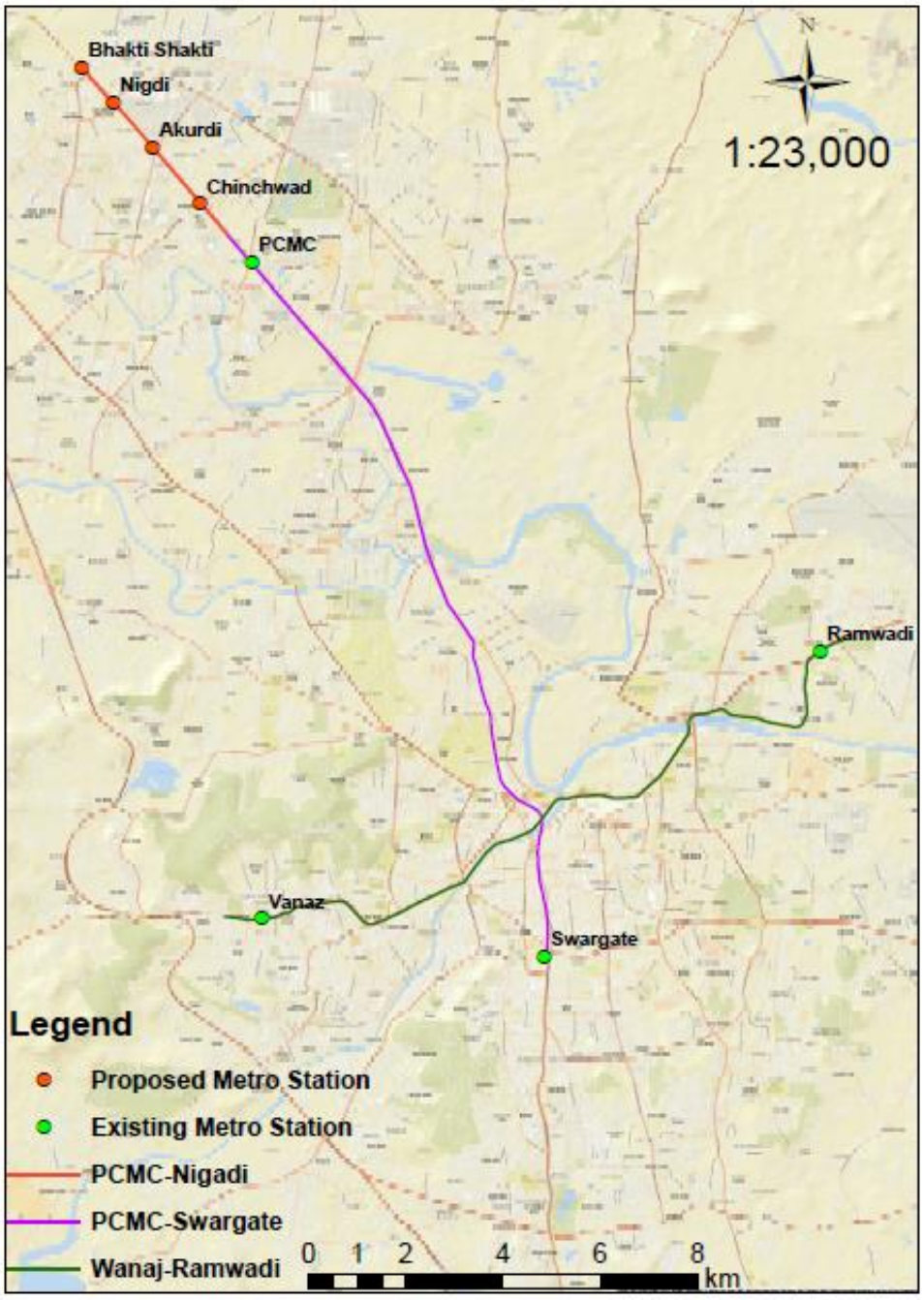

Figure 1: Routes of PMRP Phase-1 with PCMC to Nigdi Extension alignment

D. OPERATION PHASE NOISE LEVEL PREDICTION

5. To estimate the operational noise level, the internationally recognized noise modelling software 'SoundPLAN' version 9.0 has been utilized. The Environmental noise propagation methodology adopted, and the equations used within the SoundPLAN model are based on the ISO 9613 'Acoustics – Attenuation of Sound during Propagation Outdoors' (ISO, 1996) and Railway noise using FTA/FRA- HSGT:2005.

6. SoundPLAN has been developed by Braunstein & Berndt GmbH in Germany, and belongs to the class of sophisticated provisional models, based on the technique of the Ray Tracing Inverted (from the receivers), that allows to simulate the propagation of noise in complex source situations and orography. The model allows calculating the sound levels due to various types of sources and introduces its own algorithms for the calculation of the ground effect, the absorption and the other phenomena involved.

7. The equations used to estimate the propagation of the sound waves, for sources type, are those described in the International Standard ISO 9613. The sound pressure level at the receiver is the sum of all contributing frequencies, and the fundamental equation is the following:

$$SPL = PWL + D_i - (A_d + A_a + A_g + A_b + A_n + A_v)$$

where:

- SPL=Sound Pressure Level at the receiver
- PWL=Sound Power Level of noise source
- Di=directivity of the source
- Ad=attenuation of sound wave due to geometric divergence
- Aa=attenuation of sound wave due to air absorption
- Ag=attenuation of sound wave due to ground absorption and reflection
- Ab=attenuation of sound wave due to diffraction An=attenuation of sound wave due to variations of the vertical gradient of the temperature, of the wind speed and of the atmospheric turbulence
- Av=attenuation of sound wave due to vegetation

- The directivity correction Di describes the extent by which the equivalent continuous Sound Pressure Level deviates from the point source in a specified direction from the level of an Omni directional point source.
- The geometrical divergence Ad accounts for spherical spreading in the free field from a point sound source, making an attenuation in decibels.
- The law of spreading is different for point, line, and area sources.
- The attenuation due to atmospheric absorption Aa, in decibels, during the propagation through a distance “d”, in meters, is equal to Aa = d/1000, where is the atmospheric attenuation coefficient for each octave band. It depends strongly on the frequency of the sound, the ambient temperature, and the relative humidity.
- The attenuation of sound wave due to ground absorption and reflection “Ag” and that one due to the meteorological conditions “An” depend on the average height of the line of sight above the terrain and the distance from source to receiver. The absorption of sound waves by terrain is expressed by the model using a coefficient G (dimensionless), between 0 (hard ground, such as paving, water, ice and other surface having a low porosity) and 1 (porous ground, such as ground covered by grass, trees or other vegetation); for intermediate terrains (0<G<1), G represents the percentage of porous terrain.

1. Methodology

8. As per the Federal Transit Administration (FTA) manual, the transit project category includes projects where the project noise is exclusively due to new transit sources, no changes are made to the highway or to existing noise barriers, and the existing noise levels generated by sources will not change because of the project.

9. As a part of the project a general screening assessment was performed. The General Noise Assessment is used to examine potentially impacted areas identified in the screening step by examining the location and estimated severity of noise impacts. This procedure considers noise source and land use information likely to be available at an early stage in the project development process. Estimates are made of project noise levels and of existing noise conditions to model the location of a noise impact contour that defines the outer limit of an impact corridor or area. This modelling method uses transit-specific noise and adjustment data (in tabular and graphical form) for the noise computations. Major steps in the General Noise Assessment procedure is listed below.

- **Step 1: Identify Noise-Sensitive Receivers –** Identify noise-sensitive receivers and their proximity to the project and major noise sources.

- **Step 2: Determine Project Noise Source Reference Levels –** Determine the project noise sources and reference levels. Then, estimate the project noise exposure at the reference distance of 50 ft considering operational characteristics with preliminary estimations of the effect of mitigation.
- **Step 3: Estimate Project Noise Exposure by Distance –** Estimate project noise exposure at distances beyond 50 ft considering propagation characteristics using a simplified procedure.
- **Step 4: Combine Noise Exposure from All Sources –** Combine all sources associated with the project to predict the total project noise at the receivers.
- **Step 5: Measure Existing Noise Exposure –** Measure the existing noise or estimate the existing noise exposure using a simplified procedure.
- **Step 6: Inventory Impacts**
    a. **Option A:** Tabulate the change in noise (existing vs. estimated project noise) at each noise-sensitive receiver or cluster, identifying all moderate and severe impacts.
    b. **Option B:** Take inventory of noise-sensitive receivers that fall within the moderate and severe noise contours.
- **Step 7: Determine Noise Mitigation Needs** – Evaluate the need for mitigation and repeat the General Noise Assessment with proposed mitigation.

10. At an early project stage, the information available for a General Noise Assessment includes:

- Candidate transit mode
- Guideway options – design conditions
- Operational headways – will be single or double
- Design speed – maximum and average speed
- Alternative alignments

11. **Evaluate Path Treatments** – When noise mitigation treatments cannot be applied at the noise source or additional mitigation is required after treating the source, the next preferred placement of noise mitigation is along the noise propagation path between the source and receiver.

12. **Noise Barriers** – Noise barriers are effective in mitigating noise when they break the line-of-sight between source and receiver. The necessary height of a barrier depends on the source height and the distance from the source to the barrier.

- **Noise barriers close to vehicles** – Barriers located very close to a rapid transit train, for example, may only need to be approximately 2 to 3 m above the top of rail to be effective. Standard barriers close to vehicles can provide noise reductions of 6 to 10 dB.

- **Noise barriers at Right of Way (ROW) line** – Barriers on the ROW line or for trains on the far track, the height must be increased to provide equivalent effectiveness to barriers located close to the vehicles. Otherwise, the effectiveness can drop to 3 dB or less, even if the barrier breaks the line-of-sight.

13. All barrier effectiveness can be increased by as much as 5 dB by applying sound-absorbing material to the inner surface of the barrier. The length of the barrier wall is also important to its effectiveness. The barrier must be long enough to block noise from a moving train along most of its visible path. This is necessary so that train noise from beyond the ends of the barrier will not severely compromise noise-barrier performance at noise-sensitive locations. The barrier length can be refined in the engineering phase, closely examining the predicted sound level exceedances at specific receivers, site geometries, and the contribution of barrier flanking noise, then adjusting the length as appropriate.

14. The noise modelling simulation of the project requires noise input data for all significantly

noisy equipment in the project area with following input.

- Sound Pressure Level (SPL) of noise source at a distance of 1 m from the edge of the source·
- Source type estimation of the wave-front of the source, modelled as either a point, line or area source.
- Other data types which improve source accuracy include operational duty cycles (as a conservative assessment, all equipment's are operating continuously at maximum operating conditions)

15. FTA criteria for noise impact were developed specifically for transit noise sources operating on fixed-guideways in urban areas. These criteria are based on well-documented research on human response to community noise and represent a reasonable balance between community benefit and project costs. These criteria do not reflect specific community attitudinal factors. The levels of impact are described in **Table 3** below. The criteria at which the levels of impact occur are presented in two ways depending on the relationship of project and existing noise sources.

16. If the project noise source is a new source of transit noise in the community, such as a new project in an area currently without transit, use the criteria as presented in analyzing the Project Noise Impact criteria presentation.

Table 3 Levels of Impact

Level of Impact	Description
No Impact	Project-generated noise is not likely to cause community annoyance. Noise projections in this range are considered acceptable by FTA and mitigation is not required.
Moderate Impact	Project-generated noise in this range is considered to cause impact at the threshold of measurable annoyance. Moderate impacts serve as an alert to project planners for potential adverse impacts and complaints from the community. Mitigation should be considered at this level of impact based on project specifics and details concerning the affected properties.
Severe Impact	Project-generated noise in this range is likely to cause a high level of community annoyance. The project sponsor should first evaluate alternative locations/alignments to determine whether it is feasible to avoid severe impacts altogether. In densely populated urban areas, evaluation of alternative locations may reveal a trade-off of affected groups, particularly for surface rail alignments. Projects that are characterized as point sources rather than line sources often present greater opportunity for selecting alternative sites. This guidance manual and FTA's environmental impact regulations both encourage project sites which are compatible with surrounding development when possible. If it is not practical to avoid severe impacts by changing the location of the project, mitigation measures must be considered.

Table 4 Land use Category and Metrics for Transit Noise Impact Criteria

Land Use Category	Land Use Type	Noise Metric, dBA	Description of Land Use Category
1	High Sensitivity	Outdoor Leq(1hr)*	Land where quiet is an essential element of its intended purpose. Example land uses include preserved land for serenity and quiet, outdoor amphitheaters and concert pavilions, and national historic landmarks with considerable outdoor use. Recording studios and concert halls are also included in this category.
2	Residential	Outdoor Ldn	This category is applicable all residential land use and buildings where people normally sleep, such as hotels and hospitals.
3	Institutional	Outdoor Leq(1hr)*	This category is applicable to institutional land uses with primarily daytime and evening use. Example land uses include schools, libraries, theaters, and places of worship where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds, and recreational facilities are also included in this category.

** Leq(1hr) for the loudest hour of project-related activity during hours of noise sensitivity.*

2. Noise Model

17. Using SoundPlan 9.0, the calculation options that were selected for this project provided a balance between accuracy of noise assessment and time to complete the computation. The required inputs for modeling of Noise were collected from Maharashtra Metro Rail Corporation Limited (MMRCL) and presented in below **Table 5**. As mentioned earlier, in addition to the FTA/FRA-HSGT (2005) standards that were applied, the following options were adopted:

- The maximum distance between any two stations is 1km, respectively.
- The metro train service timing for all routes is 5:00 AM till midnight, 19 hours per day.
- The scheduled speed on all the routes is 34 kmph
- The maximum acceleration and deceleration shall be 1.0 m/s2 and 1.1 m/s2
- Assessment: Day, Night, Ldn
- Emission time slices: 6-22, 22-6
- Reflection order: 3

Table 5 Features of rolling stock and track

Parameter	Detail
Unit	3 car basic unit DMC+TMC+DMC
DMC dimension	21.64x2.9x3.9 (LxBxH)
TMC dimension	21.34x2.9x3.9 (LxBxH)
Maximum coach length	22.6m

Axle Load	≤ 16T or 157kN
Number of axles	4
Normal braking system	Regenerative
Braking type	Disc brakes
Wheel diameter	860mm (assumption)
Track Gauge	1435mm
Track base	Ballast-less track with elastic and absorbent fittings
Rail joints	Minimum spacing (assumption)

2.1. Noise Emission Sources

18. Noise radiated from train operations and track structures generally constitute the major noise sources. Airborne noise is radiated from at-grade and elevated structures, while ground- borne noise are of primary concern in underground operations. Basic sources of wayside airborne noise are:

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

19. Predicted noise levels for the project area were modelled in accordance with the FTA guidelines. Predicted future noise levels in the project area were based on existing measured sound levels and future daily transit operations.

2.2. Ground Elevation and Digital Ground Model

20. The ground elevation data was taken from Google Earth to generate Digital Ground Model.

2.3. Superstructure

21. The viaduct has pre-stressed concrete “Box” shaped Girders/Double U-Girder on a Single pier with pile / Open foundations. It is assumed that the viaduct side wall height is 750mm and will act as a noise wall. For elevated viaducts, the rail level is 11.16m AGL.

2.4. Rail Elevation

22. The rail elevations from the engineering vertical profiles were used to establish the absolute and relative height of the railway every 11.16 meters.

2.5. Building Location and Heights

23. Building locations were taken from Open Street Map and Google Maps while the building heights were extrapolated from the number of floors as observed from field survey.

E. ASSESSMENT FINDINGS

24. The baseline noise levels at receptors on the PCMC to Nigdi alignment, along with the modelled noise values from the metro train, are as presented in **Table 6**. The findings are

summarized in following paragraph.

25. The noise from the operation of the metro is within the permissible limits of CPCB and do not exceed +3 dB(A) of the existing ambient noise levels except at one sensitive receptor along the alignment where noise levels are not within permissible limits but exceeding the +3 dB(A) during night time. However, there is no activity at these sensitive receptors during night time and metro will not be operational during whole night. Therefore, no mitigation measures are required at these receptors.

Table 6 Noise levels due to Metro Operation

Name of Receptor	Land use Category as per CPCB	Baseline Noise Levels, dB(A)		Projected Noise Levels, dB(A)		Increase over Baseline Noise Levels, dB(A)		Noise Levels after installation of Noise Barriers dB(A)		Central Pollution Control Board Noise Standards (dBA)
		Day time	Night time	Day time	Night time	Day time	Night time	Day time	Night time	
Bhakti Shakti Metro Station	Proposed Station/ Commercial	64.7	46.7	65.2	47.8	0.5	1.1	64.9	45.3	Day: 65 Night: 55
Vidyanand Bhawan High School (Near)	Sensitive Receptors (School)/ Silent	41.5	38.5	44.3	42.2	2.8	**3.7**	42.1	39.7	Day: 50 Night: 40
Nigdi Metro Station	Proposed Station/ Commercial	63.8	53.4	64.9	54.7	1.1	1.3	62.7	52.2	Day: 65 Night: 55
Khandoba Chowk	Commercial	62.7	43.5	63.8	45.1	1.1	1.6	62.6	42.6	Day: 65 Night: 55
Chinchwad Metro Station	Proposed Station/ Commercial	64.4	52.8	66.5	53.8	2.1	1	63.9	51.3	Day: 65 Night: 55
Chinchwad (End of Alignment)	Commercial	63.4	53.7	64.1	54.9	0.7	1.2	61.9	52.4	Day: 65 Night: 55

F. CONCLUSION AND RECOMMENDATIONS

26. The noise from the operation of the metro is well within the permissible limits of CPCB and do not exceed +3 dB(A) of the existing ambient noise levels except at one sensitive receptor. Since the sensitive receptor i.e. Vidyanand Bhawan High School will be closed during night time and metro will not be running in the night time, no control measures are needed at this stage. It is highly recommended that the metro tracks be maintained throughout the project life following ISO 3095:2013 for the smooth movement of metro trains and low noise generation.

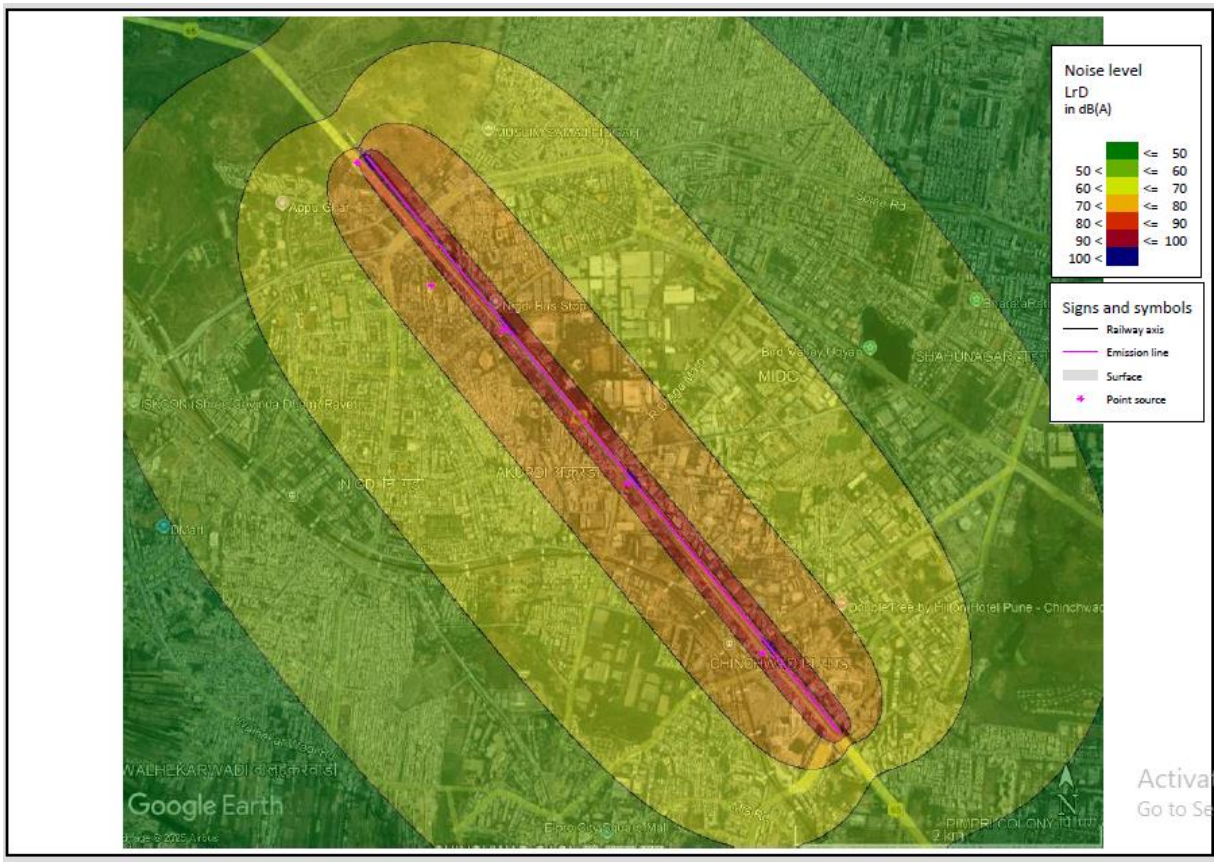

Figure 2 Predicted Noise contours along Metro line Phase-1 Extension – PCMC to Nigdi Alignment

Figure 3 Noise levels along Metro line Phase-1 Extension – PCMC to Nigdi Alignment with Noise Barriers